PROCEEDINGS

38th ANNUAL GROUP MEETING OF AICRP ON SEED (CROPS)

TECHNICAL PROGRAMME (2023-24)

09-10 May, 2023

Held at
Tamil Nadu Agricultural University, Coimbatore

ICAR-Indian Institute of Seed Science
(Indian Council of Agricultural Research)
Mau 275 103 (UP), INDIA
(ISO 9001: 2008 Certified Institute)
www.seedres.icar.gov.in

PROCEEDINGS

38th ANNUAL GROUP MEETING OF AICRP ON SEED (CROPS)

TECHNICAL PROGRAMME (2023-24)

09-10 May, 2023

Held at

Tamil Nadu Agricultural University, Coimbatore

ICAR-Indian Institute of Seed Science
(Indian Council of Agricultural Research)
Mau 275 103 (UP), INDIA
(ISO 9001: 2008 Certified Institute)
www.seedres.icar.gov.in

Citation: Sanjay Kumar, Lal, S.K., Yadav, S.K., Atul Kumar, Amit Bera, Ashwani Kumar, Singh, A.N., Sripathy, K.V., Kalyani Kumari, Vinesh, B., Udaya Bhaskar, K., Bhojaraja Naik, K., Anjitha George, Gopi Kishan and P. Sivamma (2023). Proceedings of 38th Annual Group Meeting of AICRP on Seed (Crops) organized during 09-10 May, 2023 at Tamil Nadu Agricultural University, Coimbatore.

Institutional Publication No.: IISS/2023/36

Published by:

Dr. Sanjay Kumar
Director
ICAR-Indian Institute of Seed Science
Kushmaur, Post – Kaithauli
Maunath Bhanjan - 275 103
Uttar Pradesh, India
Phone: 0547-2970721; Fax: 0547 – 2970721
Email: director.seed@icar.gov.in

Website: http://www.seedres.icar.gov.in/

CONTENTS

AICRP on Seed (Crops)

Session- I

Inaugural session of 38th AGM of AICRP on Seed (Crops)

Date: 09.05.2023 **Time: 09.30AM-11.00 AM**

Chairman	:	**Dr. V. Geethalakshmi** Vice-Chancellor, TNAU, Coimbatore
Chief Guest	:	**Dr. T.R. Sharma** DDG (Crop Science), ICAR, New Delhi
Guest of Honour	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi
Convener	:	**Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	**Dr. Sudipta Basu** Principal Scientist, DSST, ICAR-IARI, New Delhi **Dr. Banoth Vinesh** Scientist, ICAR-IISS, Mau

ICAR-Indian Institute of Seed Science, Mau in collaboration with Tamil Nadu Agricultural University, Coimbatore organized 26th Annual Breeding Seed Review meeting and 38th AGM of AICRP on Seed (Crops) during 9-10 May, 2023 at TNAU, Coimbatore. The inaugural session was chaired by Dr. V. Geethalakshmi, Vice-Chancellor, TNAU, Coimbatore, Dr. T.R. Sharma, DDG (Crop Science), ICAR, New Delhi as Chief Guest and Dr. D.K. Yadava ADG (Seed), ICAR, New Delhi as guest honor. The session was convened by Dr. Sanjay Kumar, Director, ICAR-IISS, Mau.

At the onset, Dr. M. Raveendran, Director of Research TNAU, Coimbatore welcomed the dignitaries to AGM. He briefed about the journey of TNAU's Seed Centre and highlighted its achievements in the area of seed production and research.

Dr. Sanjay Kumar, Director, ICAR-IISS, Mau presented the progress report of 2022-23 and the action taken report (ATR). He appraised about the progress under AICRP on Seed (Crops) in increasing the breeder/ quality seed production, varietal replacement rate and reduction of varietal mismatch. He highlighted the achievements under the seed production and certification, seed physiology, storage & testing, seed pathology, seed entomology and seed processing themes. He also presented the various activities, budget allocation and innovative approaches for QSP. He emphasized upon monitoring of centres for better seed production and feasibility of incorporation of horticultural crops under AICRP on seed (Crops). He mentioned the receipt of an indent of 26 thousand quintals with a production of 30 thousand quintals of bio- fortified crops during 2022-23. The Director highlighted the breeder seed production of 1.02 lakh quintals against indent of 0.9 lakh quintals. He urged cooperating centres to calculate the benefit cost ratio of various technologies developed under STR.

Dr. D. K. Yadava, ADG (Seed), ICAR, New Delhi in his introductory remarks highlighted the objectives and mandate of aforesaid components and contributions of AICRP Seed in Indian seed domain in last four decades. He also briefed about the status of seed research, seed production, supply system and network in the country along with the role of private sector. He appreciated the progress made during last three years and also highlighted the challenges. He addressed breeder seed quality issues and under taking the maintenance breeding programmes on project mode, use of SATHI software for monitoring and distribution of breeder seed production, inviting private seed sector to collaborate under STR component for quality seed production.

Dr. V. Geethalakshmi, Vice-Chancellor, TNAU, Coimbatore acknowledged the role of veteran seed technologist for their contribution in building the Department of Seed Science and Technology and Seed Center of TNAU. On the eve of golden jubilee celebration, she presented the best quality seed production centre awards to SAUs and ICAR Institutes for the year 2022-23 to CSKVV, Palampur and ICAR-IIMR, Ludhiana respectively whereas TNAU, Coimbatore bagged the best STR center award for 2022-23. She also distributed certificates for technology development to concerned PIs of seed production and certification, seed pathology, seed entomology and seed processing. A book entitled 'Seed Science and Technology: Biology, Production, Quality' edited by Dr. M. Dadlani and Dr. D K Yadava was also released. Similarly, one book entitled 'Technological progression on seed in India: Compendium of STR under AICRP on Seed (Crops)' and one bulletin 'Improved seed production techniques for millets' compiled by ICAR-IISS, Mau was released.

Dr. T.R. Sharma, DDG (CS) chief guest in his address congratulated the entire group of ICAR-IISS, Mau for the Choudhury Devi Lal outstanding AICRP award for 2021-22. He praised the efforts of participating centers including ICAR institutes, SAU's as well as ICAR-IISS, Mau for their critical role in facilitating quality seed production. He highlighted the need for systematic maintenance breeding in field crops for ensuring genetic purity and opined need to identify suitable offseason production sites in the scenario of climate change. He also stressed on the need of validation and upgradation of field and seed standards and protocols for sample size, physical purity, ODV etc. for various crops. He also emphasized the need to prioritize seed production of bio-fortified varieties and opined that 25% FLDs should be undertaken with bio-fortified varieties. He also stressed the group to work on following areas.

- Basic studies in seed biology domain
- Nutrient homeostasis-how nutrient move during germination
- Hormonal regulation and ion uptake in seeds
- Activation of antioxidants and defense systems
- Role of ROS during seed development
- Seed longevity-molecular mechanisms involved
- Role of PGPR in bio priming
- Role of endophytes /seed borne microorganisms in enhancement of seed vigour
- Development of gene chips to detect seed borne pathogens, multiplexing of diagnostic tools for viruses and seed borne pathogens.

- Role of epigenetics for quality seed production
- Development of QTLs for seed germination, priming, drought and heat stress during seed germination.
- In the view of international year of millets, development of new varieties and their quality seed production.

The session ended with vote of thanks by Dr. R. Umarani, Director Seed center, TNAU, Coimbatore.

During the detailed deliberations, following action points were emerged:

- In light of the obvious effects of climate change on seed production programmes, the identification of offseason seed production sites is necessary for the assured supply of quality seed in adequate quantities, especially in crops viz. soybean, groundnut and pulses. **[Action: Director, ICAR-IISS, Mau & ADG (Seed), ICAR]**
- In order to meet the SDGs of the United Nations and programmes of the state to eliminate malnutrition and hunger in the country, there is a need to upscale the quality seed production in bio-fortified crop varieties under the AICRP on Seed (Crops). **[Action: Director, ICAR-IISS, Mau & ADG (Seed), ICAR]**
- Supply of disease-free planting material is the mandate of AICRP on Seed (Crops), in this regard, special impetus needs to be given to the development of gene chips to detect seed borne pathogens, multiplexing of diagnostic tools for viruses and seed borne pathogens. **[Action: Director, ICAR-IISS, Mau & PI (Seed Pathology)]**
- Understanding physiological and molecular mechanisms is crucial for technology development. In this regard, the STR group may also initiate basic studies pertinent to nutrient homeostasis, hormonal regulation, ion uptake regulation, the role of ROS in seed biology, etc. **[Action: Director, ICAR-IISS, Mau & PI (Seed Physiology, Storage & Testing)]**

Session II

Presentation of Seed Technology Research Achievements during 2022-23 by Principal Investigators and Identification of Technologies by the Panel of Experts

Date: 09.05.2023 **Time: 2.00 PM to 6.00 PM**

Chairman	:	**Dr. R.R. Hanchinal** Former Chairperson, PPV&FRA, New Delhi
Co-Chairman	:	**Dr. M. Bhaskaran** Former VC, TNOU & Chairman, RAC, ICAR-IISS, Mau
External Experts	:	**Dr. V. Sankaran,** Formerly National Seeds Corporation, New Delhi **Dr. K. Vanangamudi,** Former Head, DSST, TNAU, Coimbatore
Convener		**Dr. Sanjay Kumar,** Director, ICAR-IISS, Mau
Rapporteurs		**Dr. T. Ramanadane** Professor & Nodal Officer (Seed), PAJANCOA&RI, Karaikal **Dr. Deepanshu Jayaswal** Scientist, ICAR-IISS, Mau

Session was Chaired by Dr. R.R. Hanchinal, Former Chairperson, PPV&FRA, New Delhi and Co-Chaired by Dr. M. Bhaskaran, Former VC, TNOU & Chairman, RAC, ICAR-IISS, Mau. Dr. Sanjay Kumar, Director, ICAR-IISS, Mau convened the meeting. The session was graced by external experts' *viz*., Dr. V. Sankaran, Former Managing Director, National Seeds Corporation, New Delhi and Dr. K. Vanangamudi, Former Head, DSST, TNAU, Coimbatore. The discipline wise presentation of progress report for the year 2022-23 was made by the respective Principal Investigators.

Sl. No.	Discipline	Principal Investigator
1	Seed Production & Certification	Dr. Sandeep K. Lal Pr. Scientist, DSST, ICAR-IARI, New Delhi
2	Seed Physiology, Storage and Testing	Dr. Shiv K. Yadav Pr. Scientist, DSST, ICAR-IARI, New Delhi
3	Seed Pathology	Dr. Atul Kumar Pr. Scientist, DSST, ICAR-IARI, New Delhi
4	Seed Entomology	Dr. Amit Bera Sr. Scientist, ICAR-CRIJAF, Barrackpore
5	Seed Processing	Dr. Ashwani Kumar Pr. Scientist, ICAR-IARI, RS, Karnal

6	Centre-wise QSP Achievements and issues w.r.t. AUCs, Monitoring, etc.	Dr. Sripathy K.V. Scientist, ICAR-IISS, RS, Bengaluru

Some of the important issues deliberated in the Session are:

Seed Production & Certification: Dr. Sandeep Kumar Lal, PS, ICAR-IARI, New Delhi and PI presented the significant findings of 2022-23. Based upon three years observation, an isolation distance of 400 m was found to be best for producing genetically pure seeds in pigeon pea hybrids. The PI informed that Standardization of isolation distance in Hybrid Mustard could not be conducted during 2022-23 due to non-availability of seeds of parental lines of mustard hybrids at PAU, Ludhiana. He also mentioned that based on the statistical analyses of data and comparison of OECD standards, suitable decision shall be taken on formulation of standards for Breeder seeds.

Seed Physiology, Storage & Testing: Dr. Shiv Kumar Yadav, PS, ICAR-IARI, New Delhi & PI presented the highlights pertinent to 2022-23. The PI suggested that the experiment on validation of validity periods of certified seeds of field crops need to be conducted for one more year. He also opined that the experiment on use of nano-particles in enhancing seed quality and storability of seed needs to be discontinued due to variations in reporting of significant treatments by different centres posed by use of different varieties by different centres.

Seed Pathology: Dr. Atul Kumar, PS, ICAR-IARI, New Delhi and PI presented the salient achievements for 2022-23. Atlas of seed borne pathogens across the country was depicted highlighting the prevalence of rice bunt, BLB, BPB etc. Seed borne diseases *viz.* false smut of paddy, wheat glume blotch and head blight have been regarded as emerging diseases in few pockets in the country. He also pointed out that loose smut was reported in Palambur and Durgapura only.

Seed Entomology: Dr. Amit Bera, Senior Scientist, ICAR-CRIJAF, Barrackpore and PI presented the achievements for 2022-23. The PI informed that six experiments were conducted during 2022-23 and presented two recommendations:
Seed treatment with neem formulations containing 10000ppm Azadirchtin @7.5ml/Kg seed as seed protectant can provide effective management of storage insects infesting cereal (wheat, paddy, and sorghum) and pulse (pigeon pea, chickpea, cowpea and black gram) seeds. He also recommended that ***seed treatment with Spinetoram @ 3 ppm (11.7%SC @25.6mg / kg seed*** as seed protectant can provide effective management of storage insects infesting cereals (wheat, paddy, sorghum and pearl millet) and pulses (pigeon pea, chickpea, cowpea, green gram, black gram and field pea) seeds. He suggested that Experiment on ***Integrated approach for management of Pulse beetle (Callosobruchus sp.)*** may be discontinued since

the combination of treatments are not performing consistently across the centres. In consistent results are reported by the centres.

Seed Processing: Dr. Ashwani Kumar, PS, ICAR-IARI, RS, Karnal and PI presented the progress report for 2022-23. The PI informed pointed out that grading sieve size standardized for 12 crop varieties under this project has been submitted to CSCB for inclusion in the IMSCS.

Centre-wise QSP Achievements and issues w.r.t. AUCs, Monitoring, etc.: Dr. Sripathy K.V., Scientist, ICAR-IISS, RS, Bengaluru presented the Centre-wise QSP Achievements and issues with respect to AUCs, Monitoring. He pointed out that the share of SAUs and ICAR Institutes in quality seed production across the country is 88.4% and 11.6%, respectively. He also addressed the quality issues in Breeder seed production. The report of monitoring team visits of 10 zones across the country was also discussed.

Some of the suggestions given by the Chairman, Co-chairman and external experts are:

Dr. Hanchinal, suggested that same variety needs to be used by all the centres for getting uniform results in STR Experiments. In light of non-uniformity in reporting of data/ non-interpretation of results in proper way across the centres, suggested that PIs to make periodic review to provide necessary instructions to centres. Further he requested to identify an innovative method for extending seed storability in soybean, ground nut and onion. He also emphasized to discuss the results of concluding experiments in a suitable forum before making recommendation for adoption. He pointed out that there is a need to identify the centres with better performance under STR and accordingly means for strengthening these centres may be brought out. He also mentioned that suitable advisory must be given to the farming community in survey experiments under Seed Pathology and Seed Entomology. He also suggested to identify simple method by using plant products for safe storage of seeds.

Dr. K. Vanangamudi suggested the PIs of SPC and SPST to include the commercially available liquid biofertilizers for seed priming treatments in STR Experiments of Seed Production and Certification and SPST. He also suggested to use the nano particles developed by the Dept. of Nano Technology of TNAU for seed treatment in STR Experiments. He also suggested to include fresh and stored seeds in seed pathology experiments. He also emphasized the importance of vacuum packaging and requested to exploit the possibility of including vacuum packaging in STR experiments. He also opined to include farmers friendly treatment while formulating technical programme for STR Experiments. He also suggested to include few more crops where in the recommended grading sieve size is not found in the book on IMSCS.

Dr V. Sankaran opined that the Expt. on standardization of isolation distance for hybrid mustard may be conducted in seed production areas of mustard. He also mentioned that the validity period must be six months. He suggested to organize large scale demonstration plots as lab to land programme before making any valid recommendation. Dr S. K. Rao briefed

about the safe seed moisture content at different levels of post-harvest handling and management of soybean seeds.

Dr. Sanjay Kumar, informed that the progress of STR Experiments is frequently monitored by the respective PIs and the Monitoring Team constituted exclusively for that purpose physically visited the individual centres and gave suitable advisory in this regard. Further he opined that two were experiments conducted under Seed Pathology exclusively for advising the farmers on the spreading of new diseases in various crops across the country. Dr M. Bhaskaran requested the scientists involved in the STR project to bestow their full involvement and strictly adhere the technical programme for conducting the STR experiments and report the results as per the data sheet.

The session ended with formal vote of thanks by Dr. Udaya Bhaskar K., Senior Scientist, ICAR-IISS, RS, Bengaluru.

During the detailed deliberations, following action points were emerged:

- While evaluating the efficacy of bio-formulations for seed quality enhancements and the management of seed borne infections, it is advised to include commercially available bio-formulations in such experiments. **[Action: PI (SPC), PI (SPST) and PI (Seed Pathology)]**
- The seed processing group may work out the grading sieve sizes for all agricultural crops where there are no recommended sieve sizes in IMSCS. **[Action: PI (Seed Processing)]**
- In light of non-uniformity in reporting of data/ non-interpretation of results in a proper way across the centres, it was suggested that PIs make periodic reviews to provide necessary instructions to centres. **[Action: All PIs and Director, ICAR-IISS, Mau]**

Session III

Panel discussion on Redefining seed research and prioritising seed prospective of Shree Anna (Global millets)

Date: 10.05.2023 **Time: 9.30 AM to 11.30 AM**

Chairman	:	**Dr. S. K. Rao** Ex-vice chancellor, RVSKVV Gwalior **Dr. D.K. Agrawal** Registrar General, PPV & FRA, New Delhi
Co-chairman	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi
Convenor	:	**Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	**Dr. Amrapali Atul Akhare,** Dy. Director of Research (Seed), PDKV, Akola **Dr. Bhojaraja Naik K.,** Sr. Scientist, ICAR-IISS, RS, Bengaluru

Panel discussion on **'Redefining seed research and prioritising seed prospective of Shree. Anna (Global millets)'** was held in session III under the chairmanship of Dr. S.K. Rao, Ex-Vice Chancellor, RVSKVV Gwalior and Dr. D.K. Agrawal, Registrar General, PPV & FRA, New Delhi. **Dr. D.K. Yadava**, ADG (Seed), ICAR, New Delhi Co-chaired the session and **Dr. Sanjay Kumar,** Director, ICAR-IISS, Mau convened the meeting. At the outset, Dr. S.K. Rao Chairman of the session briefly introduced all seven speakers referring to contribution in their respective fields. Seven esteemed speakers took the stage to deliberate and discuss major aspects of Seed research and seed prospectives of millets.

The first deliberation was by **Dr. Vilas Tonapi,** Ex-Director, ICAR-IIMR, Hyderabad. He delivered a compressive presentation on 'Resilient seed production systems of Shree Anna'. Indian and global seed production scenario of millets with emphasis on developing strategies to have network policy to strengthen quality seed production system in millet. The major emphasis of the deliberation was to develop a robust and sustainable millet-based seed system in the country. He proposed models of cooperation in which industry or institute-supported community-led seed system for millet seed production is worth noting.

The Second presentation was by **Dr. V. Sankaran,** Formerly National Seed Corporation, New Delhi on the topic 'Priorities for seed research: meeting regional and global perspective'. The presentation highlighted 21 different research gaps where research and technology interventions are needed. The thought-provoking points were presented to develop a need-based research project in seed entomology (Insect damage assessments, search for alternative fumigant or seed dresser), genetic purity (heterogeneity test), pathology, production (quality of organic seed produced), certification (minimum plant population with

in isolation distance) and seed physiology. Reiterated the significance of seed technological studies on farmers' conserved varieties and rare/endangered species. Redefining of GMS based seed production strategies was also highlighted. He stressed the importance of the declaration of National Seed Day/ Rashtriya Beej Diwas.

Next deliberation was on the topic "Contemporary seed research: perspective of private sector" by **Dr. M. Ramasami,** Founder Rasi Seeds Pvt., Ltd., Coimbatore. Dr. Ramasami elaborated on the significance of minor millets as 'Millets – The First and the Future' and 'Millet as Climate Smart Crops'. He has elaborately presented the millet status of India with present and future production scenarios and discussed the share of millets in present crop production conditions. The presentation highlighted key drivers and 7 future road maps for the success of nutri-cereals in India. The key drivers he emphasized for popularizing millet seed productions were the development of CGMS based hybrids; germplasm collection, conservation, evaluation and effective utilization; capacity building towards millet-based seed production system; formulation of business-friendly seed laws, and public and private hybrids testing and notification.

The fourth deliberation was from **Dr. G.V. Jagadish,** Head (QA), Indo-American Hybrid Seeds India (Pvt) Ltd. Bengaluru on 'Nuances of contemporary seed testing: Emphasis on collaborative research with public sector'. He has pinpointed the areas where seed testing protocols need to be standardized such as Sampling size, purity analysis and other crop seeds identification, germination test (temperature range, medium that should be used and dormancy status of seed), moisture determination methods, radical emergence test, TZ test etc. He has emphasized the upgradation of equipment and use of advanced instruments in seed testing. The advantages of becoming a member laboratory of ISTA was dealt in detail.

Shri. G. Krishna Prasad, Founder and Director, Sahaja Seeds, Mysore delivered a presentation on "Prospective research needs for organic seed production and certification system". He has pinpointed importance and need for community seed management system through seed mapping, seed collection, characterization and evaluation; participatory research; conservation and revival of farmer's variety; community seed bank, millet village and millet corridor. Proposed Guli method of ragi cultivation which can enhance yield by up to 20%. Due credit should be given to the farmers for their conserved varieties.

Dr. T.K. Behera, Director ICAR-IIVR, Varanasi delivered a presentation on "Pristine areas of seed research in vegetable crops" He discussed the production related challenges and highlighted priority areas of vegetable seed research. Seed Biology, pollen storage, molecular markers, genetic manipulations, gene chips, isolation distance, seed germination standards, storage studies, seed pelleting and priming with nano materials/ zeolite beads, seed production under protected conditions were major areas where he focused on need of seed technological interventions.

A representative from Asteria Aerospace Ltd. Bengaluru has given deliberation on "Drones and artificial intelligence for seed quality assurance". Post presentation's opinion of experts was invited and emphasis was again given on promoting seed production in millets as

social responsibility and the millet-based intercropping should be promoted. The session was concluded by chairman Dr. D. K. Agarawal Sir with compliments to all speakers.

During the detailed deliberations, following action points were emerged:

- The embryolessness and variation in seed size is common in *Umbelliferae* species viz. carrot, coriander, cumin and other seed spices. In this regard, experiment may be initiated to enhance the proper seed development and improve the source-sink relationship for better seed yield and quality. **[Action: Director, ICAR-IISS, Mau & PI (Seed Production & Certification]**
- Development of seed testing protocols and seed/ field standards for economically important vegetables viz. *Tinda [Indian squash], Ajwain, Drumstick [Moringa oleifera],* a wide range of Medicinal & Aromatic species viz., *Ashwagandha [Withania somnifera], Giloy [Tinospora cordifolia], Kalmegh [Andrographis paniculata], Muskdhana [Abelmoschus moschatus], Neem, Sarpagandha [Rawolfia serpentina], Sattavari [Asparagus racemosus], Bhringraj [Eclipta alba]*and *Tulsi [Ocimum sp].* **[Action: Director, ICAR-IISS, Mau & PI (Seed Physiology, Storage & Testing]**
- Search for alternative fumigants and seed protectants; and documentation/ validation of ITKs for safe storage of seeds need to be prioritised. **[Action: Director, ICAR-IISS, Mau & Concerned PIs]**

Session IV

Northern & Eastern Zone- Centre-Wise Presentation of Achievements under QSP and STR during 2022-23

Date: 10.05.2023 **Time: 11.30 AM to 02.00 PM**

Chairman	:	**Dr. R.R. Hanchinal** Former Chairperson, PPV&FRA, New Delhi
Co-Chairman	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi
Convener		**Dr. Sanjay Kumar,** Director, ICAR-IISS, Mau
Rapporteurs		**Dr. Anjitha George** Senior Scientist, ICAR-IISS, RS, Bengaluru **Dr. R. Shivramakrishnan** ASRO, JNKVV, Jabalpur

The session was chaired by Dr. R.R. Hanchinal, Former Chairperson, PPV&FRA, New Delhi, Co-Chaired by Dr. D.K. Yadava, ADG (Seed), ICAR, New Delhi and Convener, Dr. Sanjay Kumar, Director, ICAR-IISS, Mau. There were 9 QSP + STR centres and 13 QSP centres of which achievements of two centres viz., NDUAT, Faizabad and BHU, Varanasi were not presented. The panel appreciated the centres for their great efforts and urged to follow strict guidelines with reference to quality seed production programmes in northern and eastern zone. Different constraints faced by each centre were also discussed and mentioned below are the recommendations emanated from the deliberations of the above session:

General comments:

- Target and production under QSP programmes should be increased gradually.
- Variety wise deficit/mismatch should be reduced considerably.
- Capacity building programmes through SCSP, TSP and other extension activities need to be carried out on a larger scale.
- Centre wise research publications should be improved in the forthcoming years.
- Timely submission of AUC and appropriate budget utilization to be streamlined in all the centres.
- It is recommended to take up commercialization of new varieties through licensing and MoUs as a part of revenue generation.

Major recommendations

QSP & STR related activities

- To strengthen the seed processing and storage infrastructure, it is recommended to submit proposals for financial assistance under SMSP to DA & FW. Also, for the development of seed farm infrastructure like fencing, financial assistance may be sought from RKVY funding through proper channel.
- To address the problem of man power shortage in some centres, it is suggested to recruit skilled manpower utilizing the revolving fund of the respective centres.
- The panel has urged to transfer the technologies developed from STR components as a package of practices to region specific farmers in their respective SAU/ICAR institutes for popularisation of the same.
- Centre specific target of Quality Seed production (QSP) should be provided in the technical programme of AICRP on Seed (Crops)
- In order to compensate the varietal mismatch or deficit in the coming years, all the centres are requested to take up off-season seed production as a contingent plan in the coming years.

Administrative

- Immediate action may be taken up to fill all the sanctioned but vacant posts at the respective university levels as early as possible.

During the detailed deliberations, following action points were emerged:

- To strengthen the seed processing and storage infrastructure, it is recommended to submit proposals for financial assistance under SMSP to DA&FW, GoI. Also, for the development of seed farm infrastructure like fencing, financial assistance may be sought from RKVY funding through proper channel. **[Action: Nodal Officers, AICRP on Seed Crops)]**
- For effective transfer of technology from lab to land, for the benefit of region-specific farmers, the technologies developed from STR components need to be included in package of practices of respective SAU/ICAR institutes for popularisation of the same. **[Action: Nodal Officers, AICRP on Seed Crops)]**
- In order to compensate the varietal mismatch or deficit in breeder seed production, all the centres to take up off-season seed production as a contingent plan. **[Action: Nodal Officers, AICRP on Seed Crops)]**

SEED TECHNOLOGY RESEARCH TECHNICAL PROGRAMME, 2022-23

A. Seed Production & Certification

Date: 20.04.2023 & 09.05.2023

Chairman : **Dr. Sanjay Kumar**
Director, ICAR-IISS, Mau

Convener : **Dr. Sandeep Kumar Lal,** Principal Investigator/Principal Scientist, ICAR-IARI, New Delhi

General Instructions:

- The centers should follow the technical programme strictly, without any deviation/s and conduct the experiment accordingly.
- The data should be reported timely and uniformly in the prescribed format. The deviation/s in conduct of experiments, including constraints should be communicated well in advance to the concerned PI, Co-PI and Director, ICAR- IISS, Mau. Further, the progress of experiments shall be reviewed by PI/ Co-PI as and when necessary.
- The deadline for the submission of reports should be strictly adhered to (July 31 and January 31 for rabi and kharif experiments, respectively).
- The centers should furnish meteorological data (monthly mean) and soil analysis reportand interpret the results the data to analyze the environmental variations between the centers, failing which the results will not be considered valid.
- The report should be sent in a prescribed format with brief experimental lay out, detailsabout net and gross plot area, name of variety/ hybrid/ parental lines, date of sowing, relevant figures and tables (properly numbered and formatted, along with MS Excel tables), salient findings, interpretation of the results and conclusion.
- The data should be reported after subjecting to appropriate statistical analysis, along with CV and CD data for the experiments conducted as standard error is not sufficient toanalyze the precision of the experiment.
- The report submitted by the cooperating centers should be supplemented with high quality photographs.
- The benefit cost ratio may be worked out for all the experiments to assess the economic feasibility of the developed technologies.
- The excel sheets of raw data need to be supplied along with the report (as per the technical programme) for pooled analysis.

Recommendations:

Standardization of isolation distance in pigeon pea and mustard hybrids: There was no seed setting observed in the female parent beyond a distance 350 m from the male line. Hence, an isolation distance of 400 m may be considered for the production of genetically pure seed in pigeon pea hybrids.

Technical Programme for 2023-24

Experiment 1: Standardization of isolation distance in Mustard hybrids

Rationale: The development of CGMS based hybrids in Indian mustard has prompted for undertaking experimentation for working out isolation distance standards and recommend for inclusion in IMSCS, 2013

Objective: To recommend isolation distance in certified seed production of mustard hybrids

Year of start: 2018-19

Crop	Centres
Mustard (3)	ICAR-IARI, Jharkhand; RARI, Durgapura and SKUAST, Jammu

Methodology: A plot size of 2.25 m (width) x 27 m (length) with a spacing of 45 x 15 cm (minimum of 5rows) will be maintained for the pollen parent. Four rows of female parent (CMS line) will be planted (3 m row length) at different distances viz., 600, 650, 700, 750, 800, 850, 900, 950 and 1000 m. Precaution will be taken that no other crop variety of mustard should be grown within a periphery of 1000 m.

Seed Source: 125 g seed (25 g seed per center) each of pollen parent (R line) and female parent (CMS line) will be supplied by **Dr. S.K. Chakrabarthy**, Principal Scientist, DSST, ICAR-IARI, New Delhi **(Mob. No.: 9968279444).**

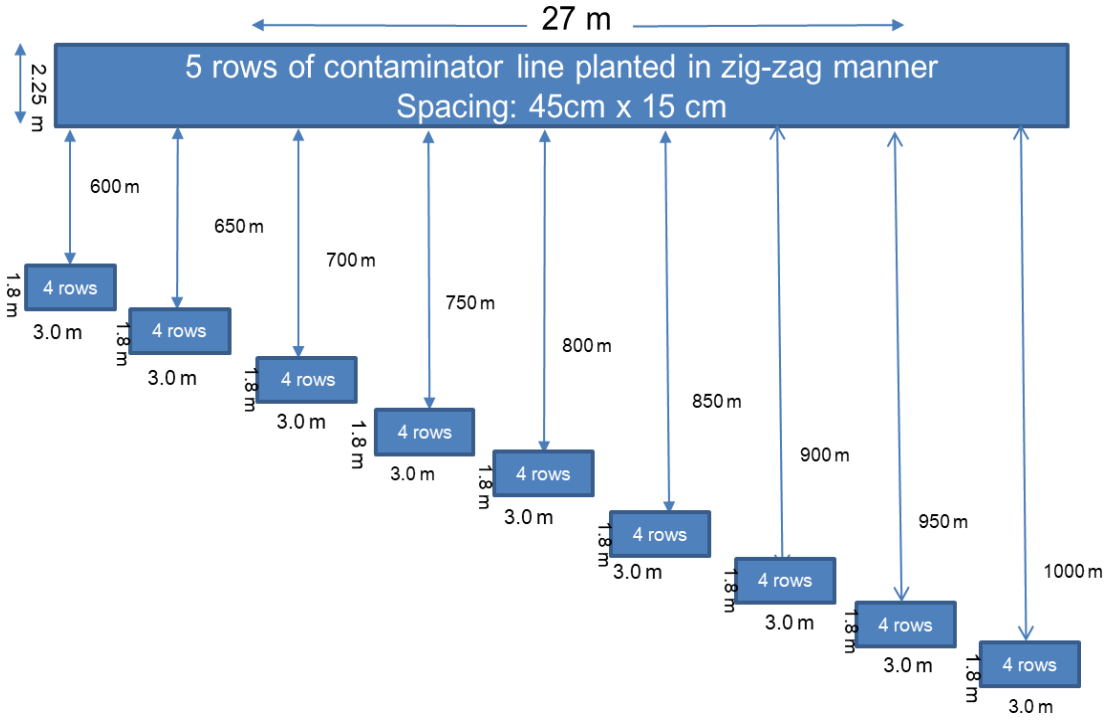


Fig.1.1: Schematic field layout for standardization of isolation distance in hybrid Mustard

Observation to be recorded (Table 1.1 & 1.2)

- Location details of experimental plot (including GPS coordinates) along with

photographs

- Field emergence (%) – **up to 15 DAS**
- Plant stand establishment (per m2) - **15 DAS**
- Plant height at 30 days and at harvest (cm)
- Days to first flowering and 50% flowering in parental lines
- Duration of flowering in parental lines (days)
- Extent of selfing in female line by bagging (percent seed set on bagging)
- Seed setting percentage in the female parent (percent seed set throughout crossing)
- Seed yield/plant(g) - The data may be recorded on 10 plants each in three rows, constitutingthree replications
- Test weight - 1000 seed(g)

Note:

1. The recommended packages of practices will be followed for the raising of crop.
2. The meteorological data should be recorded for the respective centre. Further, the observations on the activity of pollinators visiting the parental lines will be studied as per the given table and correlated with the seed setting (along with relevant and good quality photographs).
3. The most important consideration in spraying of the insecticide is that it should not kill thepollinating insects. Hence, spraying should be done either before 8AM or after 4 PM, as the activity of pollinators are minimum at above timings.
4. The timings for recording pollinator related observations can be adjusted depending upon visit of honeybee/ pollinators. Five random plants (around 10 min. /plant) should be observed for about one hour (8-10AM for FN and 2-4 PM for AN) for the visit of insect pollinators during peak flowering stage (>50% flowering). Honeybees carrying pollen fromcontaminator plots should be recorded as pollen gatherers. The nectar collectors will be devoid of pollen in their pollen basket. The pollen gatherers and nectar collectors should be identified in consultation with the entomologist. The observations should be repeated atsame timings for three days and reported.
5. In order to study the pollinator activity & variability of pollinators in isolation distance experiment, a local entomologist may be involved for identification and taking the observations on insect pollinators and nectar collectors.

Expected output: The isolation distance will be worked out in mustard hybrid seed production for maintaining genetic purity of seed and enhancing seed quality

Table1.1: Flowering and seed setting behavior in parental lines of mustard

Isolation distances/	Field emer	Days to	Duration of floweri	Extent of selfing in	Plant height at (cm)	Seed set (%)	Seed yield/	Test weig

Parental lines	gence (%)	First flowering	50% floweri ng	ng	female lines on bagging	30 DAS	Harvest		plant (g)	ht (g)
Pollen parent (Male parent)										
-										
Female parent (Female parent)										
D1 (600m)										
D2 (650m)										
D3 (700m)										
..										
..										
..										
D8 (1000m)										
Mean										

Table 1.2: Observations on pollinator activity at different isolation distances in mustard

Isolation distances/ Parental lines	Honeybee/other pollinators			
	Pollen gatherers		Nectar collectors	
	FN	AN	FN	AN
	(8-9/9-10AM)	(2-3/3-4 PM)	(8-9/9-10AM)	(2-3/3-4 PM)
Pollinator line (Male parent)				
-				
CMS line (Female parent)				
D1 (600m)				
D2 (650m)				
D3 (700m)				
..				
..				
..				
D8 (1000m)				
Mean				

Experiment 2: Optimization of organic seed production systems in selected crops

Objectives:

1. Evaluation of crop varieties for their suitability under organic seed production systems
2. To study the influence of organic nutrient sources on seed yield and quality attributesunder organic production systems

Year of start: 2018-19

Crop	Centre
Paddy (7)	ICAR RC NEHR Manipur; AAU, Jorhat; IGKV, Raipur; IISS, Mau;PJTSAU, Hyderabad and UAS, Bengaluru
Maize (5)	GBPUAT, Pantnagar; UAS, Dharwad; ICAR RC NEHR Manipur and PJTSAU,

	Hyderabad
Ragi (3)	UAS, Bangalore; PDKV, Akola and ICAR RC NEHR Sikkim

TREATMENT DETAILS		
Treatments: Nutrient Management and cultivars		**Replications:** Four
Factor 1: Nutrient management **N1-**Control (No Fertilizer & Manure) **N2-** State Recommended Dose of NPK Fertilizer (Inorganic) **N3**- Organic practices **Factor 2: Cultivar -** A set of 3 local/ traditional/ Organic varieties (minimum), which are widely cultivated in the region		
Sowing method		**Direct sowing** - 20x10 cm (Paddy and Ragi) and 60 x 20cm (Maize: sown at 3- 4 cm depth)
Design		Factorial Randomized Block Design
Plot size	**Gross plot size**	3m × 5.0 m =15.0 m^2
Spacing between plots (Plot border)		One meter
Seed treatment		Seed treatment with biocontrol agents *viz., Trichoderma harzianum* or *Pseudomonasfluorescens*@10g/kg of seed
Plant protection (As prophylactic measure)		Uniform application of botanicals i.e., Neem oil (@ 5 ml/liter of water) to all the plots. Spray of commercially available *T. harzianum* Emulsifiable concentrate @ 2 ml/liter *P. fluorescens* Emulsifiable concentrate@5ml/ liter or Combination of *P. fluorescens* + *Bacillus subtilis*@ 5 gm/liter water as a prophylactic measure. Application schedule of *P. fluorescens* (Paddy) 1. Boot emergence stage 2. 50% panicle emergence stage 3. Pre-harvest stage (15 days prior to harvest) 4. Application schedule of combination of 5. P. fluorescens + B. subtilis (Maize and Ragi) • 45 DAS • 60 DAS • 90 DAS

Observations to be recorded

Paddy and Ragi

i. **Location details of experimental plot (including GPS coordinates), along withphotographs**
ii. Field emergence (%) – **up to 15 DAS**
iii. Plant stand establishment/m^2 - **15 DAS**
iv. Plant height at 30 days and at harvest(cm)
v. Days to first flowering and 50% flowering
vi. No. of tillers/m^2
vii. Seed yield/plant (g)
viii. Seed yield (q/ha)
ix. 1000 seed weight (g)
x. Seed recovery percent- manual basis
xi. Seed Quality-Seed germination and Vigourindex I
xii. Net monetary returns (Rs.)
xiii. Benefit Cost ratio (BCR) - Annexure II

Maize

i. **Location details of experimental plot (including GPS coordinates), along with photographs**
ii. Field emergence (%) – **up to 15 DAS**
iii. Plant stand establishment/m^2 -**15 DAS**
iv. Plant height at 30 days and at harvest (cm)
v. Days to first flowering and 50 % flowering
vi. No. of cobs/ plant
vii. Seed yield/plant (g)
viii. Seed yield (q/ha)
ix. 1000 seed weight (g)
x. Seed recovery percent- manual basis
xi. Seed Quality - Seed germination and Vigour index I
xii. Net monetary returns (Rs.)
xiii. Benefit Cost ratio (BCR)- Annexure II

Guidelines:

I. This experiment should be conducted only in organically maintained plots. The organic treatment plots have to be laid out in separate block (organically converted field) and in organic treatments (RDF) and control are to be laid out in the adjacent inorganic/regular field having almost similar conditions to avoid the heterogeneity.
II. The soil fertility status of the experimental plot in all the three treatments should be estimated for parameters like texture, bulk density, pH, EC, organic carbon content, available N, P, K and Zn at pre- and post-experiment stages.
III. **The nutrient composition of the organic nutrient sources (in case of N3- for N, P, K, Zn and other nutrients, if any) and the spore concentration (cfu/g) of bio-agents (Rhizobium, PSB, KSB, *T. harzianum, P. fluorescens, B, subtilis* etc.) should be analyzed/ furnished before use/ field application. The nutrient management dose in case of N3 (Organic practices) should be optimized accordingly so as to provide same level of nutrients as being supplied through inorganics fertilizers (N2 - State Recommended Dose of NPK fertilizer).**
IV. The organic sources of NPK *viz.,* Neem cake, FYM/ Vermicompost should be applied to experimental plots as per treatment schedule, at least 20 days prior to sowing and the nitrogen supplied through these sources should be calculated. Alternatively, the bio-fertilizers *viz.,* Azospirillum, PSB and KSB should be mixed with FYM/ Vermicompost at

the time of last ploughing.

V. Adequate care should be taken to avoid the flow of water from inorganic field to organic experimental site/plots.

VI. No other crop should be grown in subsequent season in the experimental site/plots of organic seed production technology.

Note: Package of Practices recommended by Government of Sikkim is given in ***Annexure I***

Expected output: The organic seed production technology will be optimized in different field crops**.**

Annexure I

Paddy (*Oryza sativa* L.)		
S. No.	**Parameters**	**Remarks**
1.	**Sowing time and seed rate**	The main field is prepared with the onset of monsoon because the rainfall occurs during May-June to facilitate ploughing of the field.
2.	**Seed inoculation**	• Seed can be treated with fungal culture, *Trichoderma harzianum*, *Trichoderma viride* and *Trichoderma virens*@10 g per kg of seed. Seed can also be treated with *Pseudomonas* bacterium culture @ 10g per kg of seed to minimize the incidence of blast and bacterial blight. • For efficient use of soil nutrients like Phosphorus, seed is to be treated with Phosphorus solubilizing bacteria (PSB) and for N, the N-fixing cultures i.e., Azolla, Azospirillum, Azotobacter and Cynobacteria are to be used.
3.	**Spacing and Transplanting**	Usually, 2 to 3 young healthy seedlings of 21 to 25 days old should be planted in a hill at a distance of 20 x 15 cm, row to row and plant to plant
4.	**INM**	Application of FYM @ 10-15 t/ha and/or vermicompost @ 3-6 t/ha either alone or in combination is recommended for optimum yield
5.	**Water management**	Keep less water (2-3cm) initially and then gradually increase its level up to 5-6 cm. Under limited water condition apply water only in critical stages like tillering, panicle initiation, heading / flowering and milking.

6.	**Weed management**	• Weeds of the rice fields are grouped into three categories such as grassy, sedge and broadleaved weeds • Manual weeding needs 2-3 weddings (20, 40 and 60 days after transplanting) • Hand tools such as the hoe, narrow spade (Kudali), Swiss hoe, knife, machete, and pointed sticks are primarily used to remove weeds.
7.	**Pests and diseases**	Blast (*Pyricularia grisea*), Brown spot(*Helminthosporiun oryzae*), Sheath rot (*Sarocladium oryzae*), Sheath blight (*Rhizoctonia solani*), Stem rot(*Sclerotium oryzae*), False smut (*Ustilaginoidea virens*), Bacterial leaf blight (BLB) (*Xanthomonas oryzae pv. oryzae*), Leaf streak (*Xanthomonas oryzae pv. oryzicola*), Tungro virus (Rice Tungro Virus)
8.	**Harvesting and PHM**	• Paddy is generally harvested at about 20-25 per cent moisture content. It is dried to about 16 to 20 per cent moisture before threshing. It is generally threshed manually by hand. Harvesting should be done when more than 90 per cent grains turned into greenish tint color and the moisture content reached less than 25 per cent, but for combine harvesting it should be less than 20 per cent. • Under normal transplanted conditions, one can harvest 6- 7 t paddy for yielding or hybrid rice of medium duration (135-140 days) rice and 5-6 t per ha for mid early duration (125-130 days) and 5 t for short duration

Maize (*Zea mays* Linn.)		
S. No.	**Parameters**	**Remarks**
1.	**Sowing time and seed rate**	The season starts with February-March and ends with July-August depending upon the altitude. **Seed rate:** Local and Composite varieties: 20 kg/haHybrid Varieties: 10 kg/ha

2.	**Seed inoculation**	• Seeds should be well coated with bio-fertilizer like *Azotobacter* @ 200gm and *Phosphobacteria* in 400 ml water per 10 to 12 kg seeds. It will considerably increase the yield by fixing atmospheric nitrogen to 10 kg/ha and make unavailable phosphorus availableto plants by solubilization. • Instead of *Azotobacter,* it is better and wherever Ricebean/soybean/urd intercropping is planned, 2 kg of Rhizobium may be added in addition to *Azotobacter* and*Phosphobacteria.* • If seed treatment is not given, apply *Rhizobium*@4 kg + *Phosphotica*@2kg in 100 - 200 kg of compost.
3.	**Spacing and Transplanting**	1. Low fertile soil: 45 × 20 cm 2. Medium fertile soil: 60 × 15 cm.
4.	**INM**	• Application of FYM @ 10-15 t/ha + vermicompost @ 2.5 - 5.0 t/ha either alone or in combination as basaldose will also meet the nutrient needs. • Neem cake can also be added @ 150 kg/ha to the field for effective control of soil-borne insect pests. • FYM @ 15 t/ha applied 20 days before planting along with 150 kg rock phosphate.
5.	**Water management**	• About 2 to 3 liter of water per day during peakgrowing period or on an average its consumptive useof water varies from 2.5 to 4.3 mm per day. • Maize crop requires more than 50% of its total water requirement in about 30 to 35 days after tasselling
6.	**Weed management**	Hoeing or intercultural operations a few days after the first and second irrigation will break the crust and will also remove the weeds. Manual weeding - 4- 6 weeks after sowing
7.	**Pests and diseases**	Turcicum leaf blight (*Helminthosporium turcicum*), Maydis leaf blight (MLB) (*Bipolaris maydis*), Bacterial stalk rot (*Erwinia carotovora*, *Erwinia chrysanthemi*), Pythium stalk rot (*Pythium aphanidermatum*), False head smut (*Ustilaginoidea virens*), Downy mildews, Brown stripedowny mildew (*Sclerophthora rayssiae)*
8.	**Harvesting and PHM**	Crop is harvested in the month of March- April and extended up to May-June when the grains contain about 10 % moisture. The maize seed can be stored safely by drying them to 7 % moisture content and packing in 700 gauge polythene bags which maintain above 80 % germination up to 3 years at room temperature. The prevalent practice of hanging maize cobs on ceiling of the house or godown is a good storage practice.

Ragi (*Eleusine coracana* Gaertn.)		
S. No.	**Parameters**	**Remarks**
1.	**Sowing time and seed rate**	Ragi may be grown as a hot weather crop, from May to September, using long duration varieties and as a cold season crop, from November and December, using early types. Ragi is mono-cropped in India under irrigation or transplantation. Seed requirement varies from 8 to 10 kg/ha in case of line sowing. When crop is raised by transplanting, 5 kg/ha seed is sufficient for raising nursery. If seeds are directly sown without transplanting, 10 kg seed is adequate for one hectare.
2.	**Seed inoculation**	Seed treatment with bio-fertilizers is not possible as the seeds are very small. So, the bio-fertilizers should be applied directly in the field @ 3 to 4 kg/acre. Before applying the bio-fertilizers should be mixed with fine FYM and spread over the field.
3.	**Spacing and Transplanting**	The seeds are raised in a well-prepared nursery bed during the months of May-June and the seedlings become ready for transplanting after 3 to 4 weeks. Before pulling the seedlings, the nursery should be irrigated. Field should be well prepared before transplanting. Two seedlings should be transplanted at a distance of 25 x 8-10 cm or 20 x 10 cm at a depth of 2-3 cm.
4.	**INM**	Apply about 5 tonnes FYM and/or compost or vermicompost@ 2.5 t/ha 15-30 days prior to sowing of the crop. Bio-fertilizers like *Azospirillum brasilense* (N- fixing bacterium) and *Aspergillus awamori* (P- solubilizing fungus) are also useful and may be applied@ 25 g/kg seed. Adhesive gum Arabic, jaggery etc. is also to be used in solution form, since it is necessary for effective seed inoculation. This can be prepared by dissolving 25 g jaggery or sugar in 250 ml water and boiling for 5 minutes.
5.	**Water management**	Crop grown as rainfed does not need any irrigation. But during tillering and flowering stages, if rain stops for a long spell, then irrigation would be required to obtain good yield. Furrows and ridges should be prepared for irrigation which would serve dual purpose of irrigation and drainage. The crop does not do well under water logged conditions; therefore, proper removal of excess water after rains is also essential.
6.	**Pests and diseases**	Blast (*Pyricularia setariae*), Seedling blight or Foot rot (*Cochliobolus nodulosus*)

7.	**Harvesting and PHM**	The crop matures in about 120-135 days, depending on the altitude and variety. The earheads do not have synchronous maturity. Therefore, staggered harvesting at weekly interval is recommended. The earheads are harvested with ordinary sickles and straw is cut close to the ground. Bold and diseases free earheads are collected during the first picking. They are dried and carefully threshed with hand. Either earheads as such or grains are kept for seed purpose. With improved package of practices, it is possible to harvest 20-25 quintals of grains and 60 to 80 quintals of fodder per hectare. **PHM:** The harvested earheads are heaped over gunny bags and again covered on top with one or two layers of gunny bags for 5 to 7 days. This process is known as "curing", which facilitate easy detachment of grains from spikelet. The curved ear heads are beaten with wooden logs or trampled below feet or bullock to separate grains. The grains should be dried in sun to bring the moisture content below 12%. Well dried ragi/finger millet can be stored for more than 3 years without much loss in viability. Ear heads are heaped for 3 to 4 days to cure, which helps the grain to separate easily from the tight grip of the spikelets. The grains are removed from cured ear heads by hand threshing, bullock threshing or by machine threshing. The grains are winnowed and stored properly.

Table 2.1: Effect of organic nutrient management on plant growth and seed yield attributesin paddy / ragi

Treatments / Parameters	Field emergence (%)	Field stand establishment/ m^2	Plant height at(cm)		Daysto		No. of tillers / m^2	Seed yield/ plant(g)	Seed yield(q/ ha)
			30 DAS	Harvest	First flowering	50% flowering			
Varieties (V)									
V1									
V2									
V3									
V4									
Mean									
SEm±									
CD									
CV(%)									
Nutrient Management treatments (N)									
N1									

N2									
N3									
Mean									
SEm±									
CD									
CV (%)									
Interaction effects									
V1N1									
V2N1									
V3N1									
V4N1									
V1N2									
V2N2									
V3N2									
V4N2									
V1N3									
V2N3									
V3N3									
V4N3									
Mean									
SEm±									
CD									
CV (%)									

Table 2.2: Effect of organic nutrient management on seed quality parameters and economic indicators in paddy/ ragi

Treatments/ Parameters	Seed Recovery(%)	1000 seed weight(g)	Seed quality		Net monetary returns (Rs.)	Benefit Cost ratio
			Germination(%)	Vigour index-I		
Varieties(V)						
V1						
V2						
V3						
V4						
Mean						
SEm±						
CD						
CV (%)						
Nutrient Management treatments(N)						
N1						
N2						
N3						
Mean						
SEm±						
CD						
CV (%)						
Interaction effects						

V1N1						
V2N1						
V3N1						
V4N1						
V1N2						
V2N2						
V3N2						
V4N2						
V1N3						
V2N3						
V3N3						
V4N3						
Mean						
SEm±						
CD						
CV (%)						

Table 2.3: Effect of organic nutrient management on plant growth and seed yield attributes in maize

Treatments/ Parameters	Field emergence (%)	Field stand establishment	Pl. height at (cm)		Days to		No. of cobs/ m^2	Seed yield / plant (g)	Seed yield (q/ ha)
			30 DAS	Harvest	First flowering	50% flowering			
Varieties (V)									
V1									
V2									
V3									
V4									
Mean									
SEm±									
CD									
CV (%)									
Nutrient Management treatments (T)									
N1									
N2									
N3									
Mean									
SEm±									
CD									
CV (%)									
Interaction effects									
V1N1									
V2N1									
V3N1									
V4N1									

V1N2									
V2N2									
V3N2									
V4N2									
V1N3									
V2N3									
V3N3									
V4N3									
Mean									
SEm±									
CD									
CV (%)									

Table 2.4: Effect of organic nutrient management on seed quality parameters and economic indicators in maize

Treatments/ Parameters	Seed Recovery(%)	1000seed weight(g)	Seed quality		Net monetary returns (Rs.)	Benefit Cost ratio
			Germination(%)	Vigour index-I		
Varieties(V)						
V1						
V2						
V3						
V4						
Mean						
SEm±						
CD						
CV (%)						
Nutrient Management treatments(T)						
N1						
N2						
N3						
Mean						
SEm±						
CD						
CV (%)						
Interaction effects						
V1N1						
V2N1						
V3N1						
V4N1						
V1N2						
V2N2						
V3N2						
V4N2						
V1N3						
V2N3						
V3N3						

V4N3						
Mean						
SEm±						
CD						
CV (%)						

Experiment 3: Optimization of seed rate for enhancing seed yield and recovery of pure live seed

Year of start: 2022-23

Objective: To determine the optimum seed rate for maximizing seed yield and quality.

Assumptions: Assured irrigation along with recommended dose of fertilizers

Crops	**Centers**
Chickpea (10)	**Small seeded** - UAS, Bengaluru; UAS, Raichur and PJTSAU Hyderabad
	Medium seeded - MPKV, Rahuri; RARI, Durgapura; ICAR-IARI, Jharkhand and VNMKV, Parbhani
	Large seeded - ICAR-IARI, New Delhi; CCSHAU, Hisar and PDKV,Akola
Wheat (10)	ICAR-IARI, New Delhi; PAU, Ludhiana; MPKV, Rahuri; ICAR-IARI, Jharkhand; RARI, Durgapura; JNKVV Jabalpur; IGKV Raipur; ICAR-IISS, Mau; CSKHPKV Palampur and VNMKV, Parbhani

Chickpea

Treatments (Seed rates):

Small seeded (100 seed weight:<20g)	**Medium seeded (100 seed weight:20-30g)**	**Large seeded (100 seed weight:30-40g)**
T1: 60 kg/ha (Recommended Seed rate)- Control	T1: 90 kg/ha (Recommended Seed rate)- Control	T1:120 kg/ha (Recommended Seed rate)- Control
T2: 54 kg/ha (10% less than The recommended seed rate)	T2: 81 kg/ha (10% less than The recommended seed rate)	T2:108 kg/ha (10% less than The recommended seed rate)
T3: 48 kg/ha (20% less than the recommended seed rate)	T3: 72 kg/ha (20% less than the recommended seed rate)	T3: 96 kg/ha (20% less than the recommended seed rate)
T4:42 kg/ha (30% less than The recommended seed rate)	T4: 63 kg/ha (30% less than The recommended seed rate)	T4:84 kg/ha (30% less than The recommended seed rate)
T5: 36 kg/ha (40% less than The recommended seed rate)	T5:54 kg/ha (40%lessthan The recommended seed rate)	T5:72 kg/ha (40% less than The recommended seed rate)
Note: Only Desi type varieties should be considered for all the three categories		

Wheat

Treatments (Seed rates):

- T1: 100 kg/ha (Recommended seed rate)- Control
- T2: 90 kg/ha (10% less than the recommended seed rate)
- T3: 80 kg/ha (20% less than the recommended seed rate)
- T4: 70 kg/ha (30% less than the recommended seed rate)
- T5: 60 kg/ha (40% less than the recommended seed rate)

CHICKPEA	
Cultivar	**Any popular cultivar of the respective zone/centre**
Test weight (100 seed wt.)	**As mentioned above**
No. of treatments	**Five**
Replications	**Four**
Design	**RBD (Randomized Block Design)**
Plot Size (m)	**5.0 x 2.0**
Spacing (cm)	**30 (R-R), plant to plant spacing to be adjusted according to the seed rate**
Total plots	**20 (Area - 200 m^2)**
Sowing: Direct sowing; depth of sowing: 6-8 cm	
Note: I. Apply FYM @ 5 t/ ha, 10 to 15 days prior to sowing supplemented with 20:40:20 kg/ha N: P:K, respectively based on soil test or State Recommended Dose of Fertilizer. II. Apply Zinc Sulphate@25kg/ha. III. Seed treatment with Thiram + Bavistin (2:1) @3g/kg of seed before sowing. IV. Pre-emergence herbicides, such as Fluchloralin @ 1 kg a.i. / ha or Pendimethalin @ 1.0 to 1.5 kg a.i. /ha for controlling early flush of weeds. V. Chickpea is generally grown as a rainfed crop, but two irrigations, one each at branching and Pod filling stages, are recommended for higher yield.	

Observations to be recorded

- Location details of experimental plot (including GPS coordinates), along with photographs
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Days to first flowering and 50% flowering
- Days to pods formation
- No. of pods/plant
- Seed yield per plant (g) and per plot (kg/ area)

- Seed yield (q/ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) and Graded seed yield (q/ha)
- Seed quality parameters: Seed germination, Vigor indices, Pure live seed [(Physical Purity

% X Germination %) /100] and Seed health (% infection in blotter method)

- Net monetary returns (Rs.) and Benefit Cost ratio (Annexure II)

WHEAT	
Cultivar	**Any popular cultivar of the respective zone/centre**
Test weight (1000 seed wt.)	**30-35g**
No. of treatments	**Five**
Replications	**Four**
Design	**RBD (Randomized Block Design)**
Plot Size(m)	**5.0 x 2.0**
Spacing (cm)	**22.5 (R-R), plant to plant spacing to be adjusted according to theseed rate**
Total plots	**20 (Area - 200 m^2)**
Sowing: Direct sowing, depth of sowing: 5-6 cm	

Note:

I. Pre-sowing seed treatment with Thiram or Captan or Carbendazim or Mancozeb @2 g/kg

II. Apply FYM@10 to 12t/ha, 10 to15 days prior to sowing supplemented with 120:60:40kg/ha N: P: K dose, respectively along with 25 kg/ha of Zinc Sulphate or State Recommended Doseof Fertilizer based on soil test report. Full doses of P, K and Zn should be applied as basal. Nitrogen is applied in two split dosages.

III. Weeding to be done 45-60 DAS or weedicides like 2, 4 D, Avadex or Nitrofen (Tok E-25) forcontrolling weeds like *Chenopodium* sp., *Angallis* sp. *Asphodelus* sp. *Phalaris* sp.

IV. The irrigations should be given at critical growth stages viz. Crown root initiation, tillering, jointing, flowering, milk and dough viz. 21-25, 45-60, 60-70, 90-95, 100-105 and 120-125 DAS, respectively.

V. In case white ants or other pests' problems, Aldrin 5% or BHC 10% dust @ 25g/ha should beapplied to the soil after the last ploughing or before planking.

Observations to be recorded (Wheat)

- **Location details of experimental plot (including GPS coordinates), along with photographs**
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)

- Days to first flowering and 50% flowering
- Seed yield per plant (g) and per plot (kg/ area)
- Seed yield (q/ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) and Graded seed yield (q/ha)
- Seed quality parameters: Seed germination, Vigor indices, Pure live seed [(Physical Purity

% X Germination %) /100] and Seed health (% infection in blotter method)

- Net monetary returns (Rs.) and Benefit Cost ratio (Annexure II)

Expected output: The optimized seed rates will facilitate in reduction of seed production costs

Table 3.1: Effect of differential seed rates on plant growth and seed yield attributes in Chickpea

Treatments	Field emergence (%)	Plant stand establishment/ m^2	Days to		Plant height (cm)		Seed yield/ plant(g)	Seed yield (q/ha)	Seed recovery (%)
			First flowering	50% flowering	30 days	Harvest			
T1									
T2									
T3									
T4									
T5									
Mean									
SEm±									
CD									
CV(%)									

Table 3.2: Effect of differential seed rates on seed quality and economic indicators in Chickpea

Treatments	Graded seed yield (q/ha)	Test weight 1000 seeds (g)	Seed quality		Pure live seed	Seed health (% infection in blotter)	Net monetary returns (Rs.)	Benefit Cost ratio
			Germination (%)	Vigor Index I and II				
T1								
T2								
T3								
T4								
T5								
Mean								
SEm±								
CD								
CV(%)								

Table 3.3: Effect of differential seed rates on plant growth and seed yield attributes in Wheat

Treatments	Field emergence (%)	Plant stand establishment/ m^2	Days to		Plant height (cm)		Seed yield/ plant(g)	Seed yield (q/ha)	Seed recovery (%)
			First flowering	50% flowering	30 days	Harvest			
T1									
T2									
T3									
T4									
T5									
Mean									
SEm±									
CD									
CV(%)									

Table 3.4: Effect of differential seed rates on seed quality and economic indicators in Wheat

Treatments	Graded seed yield (q/ha)	Test weight 1000 seeds (g)	Seed quality		Pure live seed	Seed health (% infection in blotter)	Net monetary returns (Rs.)	Benefit Cost ratio
			Germination (%)	Vigor Index I andII				
T1								
T2								
T3								
T4								
T5								
Mean								
SEm±								
CD								
CV (%)								

Experiment 4: PGPR mediated seed coating for quality seed production

Year of start: 2022-23

Objective: To study the effect of seed coating with PGPR formulations on seed yield and quality

Crops	Centers
Maize (5)	ICAR-IARI, New Delhi; PAU, Ludhiana; PJTSAU, Hyderabad; ICARRC NEHR, Manipur Centre and TNAU, Coimbatore
Soybean (6)	ICAR-IARI, New Delhi; GBPUAT, Pantnagar; MPKV, Rahuri; JNKVV, Jabalpur; UAS, Bengaluru and VNMKV, Parbhani
Chickpea (5)	ICAR-IARI, New Delhi; MPKV, Rahuri; PDKV, Akola; JNKVV,Jabalpur and RARI, Durgapura

MAIZE	
No. of treatments	8
No. of replications	3
Design	RBD (Randomized Block Design)
Plot Size (m)	5.0 x 3.0 (15 m^2)
Spacing (cm)	75 x 25
Total plots	24 (Area - 360m^2)
Sowing: Direct seed sowing@20kg seed/ha; Spacing of 75x 25cm; prepare ridges at 75cm spacing	

Seed requirement

100 seed wt.- 33g (approx.)

1 plot - 4 rows, 5m each i.e. 25 plants per row and 4x 25 plants/plot i.e.100 plants/plot. We need to sow at least 30 seeds/ row (assuming 80% field emergence)

Hence, seed requirement/ plot (one replication/ treatment) = 4 x 30 = 120 seeds

(40g)Total seed requirement for each treatment (three replications) = 40g x 3 =120g seed

Note:

1. Apply FYM 10 t/ha, 10-15 days prior to sowing, supplemented with 165:75:75 kg/ ha N: P: K dose, respectively based on soil test or State Recommended Dose of Fertilizer
2. Apply Zinc Sulphate@25kg/ha
3. Full doses of P, K and Zn should be applied as basal. Nitrogen is split applied at four dosages as:

S. No.	Crop Stage	Nitrogen (%)
1.	**Basal (before sowing)**	**20**
2.	**V4 (four leaf stage)**	**25**
3.	**V8 (eight leaf stage)**	**30**
4.	**VT (tasseling stage)**	**25**

4. Weeding, inter culture, irrigation, plant protection etc. be followed for raising healthy crop.

Seed Treatments:

- T1: Recommended practice (Thiram@3g/kg seed + Gaucho@10ml/kg seed and 100% RDF)
- T2: Thiram@3g/kg seed + Gaucho@10ml/kg seed (75%N+Full dose of P, K)
- T3: BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K)
- T4: Thiram @3g/kg seed + Gaucho @10ml/kg in combination with BF1-4 Cyanobacteriumconsortium (75% N + Full dose of P, K)
- T5: *Anabaena* sp. + *Providencia* sp (75% N + Full dose of P, K)
- T6: *Anabaena* sp. + *Providencia* sp in combination with Thiram @3g/kg seed + Gaucho@10ml/ kg seed (75% N + Full dose of P, K)
- T7: *Anabaena laxa* (75% N + Full dose of P, K)
- T8: *Anabaena tr* biofilm (75% N+ Full dose of P, K

Fertilizer requirements:

Fertilizer nutrient	Dose (kg/ha)	Fertilizer requirement (per ha)	Dose for one plot of 10m^2	Fertilizer requirement with 100% RDF for one plot of 15 m^2(g)	Fertilizer requirement with 75% N for one plot of 15m^2(g)
N	165	358.70 kg Urea (165 kg N)	358.70 g Urea (165g N)	538 g Urea	403.5 g Urea
P	75	468.75 kg SSP (75 kg P)	468.75 g SSP (75 g P)	703 g SSP	-NA-
K	75	125 kg MOP (75 kg K)	125 g MOP (75 g K)	187.5 g MOP	-NA-
ZnSO4	25	25 kg ZnSO4 (21 kg Zinc)	25 g ZnSO4 (21 g Zinc)	37.5 g ZnSO4	-NA-

Treatments	Treatmentdetails	Fertilizer through soil application for one plot of 15 m^2
T1	Recommended practice (Thiram@ 3 g/kg seed + Gaucho @ 10 ml/kg seed and 100% RDF) - **Control**	538g Urea + 703g SSP + 187.5g MOP + 28.125 g$ZnSO_4$ (100% RDF)
T2	Thiram@3g/kg seed + Gaucho @ 10 ml/kg seed (75%N + Full dose of P, K)	403.5g Urea + 703 g SSP+ 187.5g MOP + 28.125 g$ZnSO_4$ (75% N)
T3	BF1-4 Cyanobacterium consortium (75%N + Full doseof P, K)	403.5g Urea + 703 g SSP + 187.5g MOP +28.125 g$ZnSO_4$ (75% N)
T4	Thiram @ 3g/kg seed + Gaucho @ 10 ml/kg in combination with BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K)	403.5g Urea + 703 g SSP+ 187.5g MOP + 28.125 g$ZnSO_4$ (75% N)
T5	*Anabaena* sp. + *Providencia* sp (75% N + Full dose ofP, K)	403.5g Urea + 703g SSP + 187.5g MOP + 28.125 g$ZnSO_4$ (75% N)
T6	*Anabaena* sp. + *Providencia* sp in combination with Thiram@3g/kg seed + Gaucho@10ml/kg seed (75% N + Full dose of P, K)	403.5g Urea +703g SSP + 187.5g MOP+28.125 g$ZnSO_4$ (75% N)
T7	*Anabaena laxa* (75% N + Full dose of P, K)	403.5g Urea + 703g SSP + 187.5g MOP + 28.125 g $ZnSO_4$ (75% N)
T8	*Anabaena tr* biofilm (75% N + Full dose of P, K)	403.5g Urea + 703g SSP + 187.5g MOP + 28.125 g $ZnSO_4$ (75% N)

Note: 100% RDF means application of 100% NPK and Zn. Urea: 46%N; SSP: 16% P and 11% S; MOP: 60% K; $ZnSO_4$: 21%Zn

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates), along with photographs
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis: Soil chlorophyll, SOC, seedproteins, pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 area - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll - **30 DAS at V10-VT stage (SPAD value)**
- Days to first flowering & 50% flowering
- No. of cobs/plant
- Seed yield per plant (g) and per plot (kg/ area)
- Seed yield (q/ha) - whole plot basis
- 1000 seed weight(g)
- Seed recovery (%) - manual basis
- Seed quality parameters: Seed germination, Vigour indices and Seed health
- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)Vigour Index - II = Germination percent x Average dry weight of 10 seedlings (mg)
- Net monetary returns (Rs.) and Benefit Cost ratio (Annexure II)

Soybean	
Variety	**JS 20-116**
No. of treatments	**8**
Replications	**4**
Design	**RBD (Randomized Block Design)**
Plot Size(m)	**5.0 x 2.70**
Spacing(cm)	**45 x 5**
Total plots	**24(Area - 324 m^2)**
Sowing: Direct sowing @70kg seed/ha, Direct sowing; depth of sowing: 4-5cm	

Seed requirement
100 seed wt.-10g (approx.)
1 plot – 6 rows, 5m each i.e.,100 plants/row and 6x100 plants/plot i.e., 600 plants/plot We need to sow at least 200 seeds/ row
Hence, seed requirement for one replication = 6 x 200 = 1200 seeds (120g)
Total seed requirement for four replications = 1200 x 4 seeds (480g seed for each treatment)

Note:

I. Apply FYM @5 t/ ha, 10 to 15 days prior to sowing supplemented with 25:40:60 kg/ha N: P: K:S dose, respectively based on soil test or State Recommended Dose of Fertilizer
II. Apply Zinc Sulphate@25 kg/ ha
III. Pre-emergence herbicides, such as *Fluchloralin* @ 1 kg a.i. / ha or Pendimethalin @ 1.0 to 1.5kg a.i. /ha for controlling early flush of weeds.

Seed Treatments:

- T1: Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with Rhizobium and100% RDF) - Control
- T2: Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with Rhizobium and 75%N + Full dose of P, K)
- T3: *Anabaena Rh* (75% N + Full dose of P, K)
- T4: *Anabaena Rh* in combination with Thiram + Bavistin (2:1) @3g/kg (75% N + Full dose of P, K)
- T5: BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K) in combination with Rhizobium
- T6: BF1-4 Cyanobacterium consortium (Thiram + Bavistin (2:1) @3g/kg (75% N + Full dose of P, K)in combination with Rhizobium
- T7: *Anabaena laxa* (75% N + Full dose of P, K) in combination with Rhizobium
- T8: *Anabaena tr* (75% N + Full dose of P, K) in combination with Rhizobium

Note: The seeds will be coated with PGPR strains by Dr. Radha Prasanna, Principal Scientist, Divisionof Microbiology, ICAR-IARI, New Delhi.

Fertilizer requirements:

Fertilizer nutrient	Dose (kg/ha)	Fertilizer requirement (per ha)	Dose forone plotof 10m^2 (g)	Fertilizer requirement with 100% RDF for one plot of 13.5m^2 (g)	Fertilizer requirement with 75% N for one plot of 13.5 m^2 (g)
N	20-25	100 kg DAP (18 kg N)	130	176 g DAP	132 g DAP

P	60	100 kg DAP (46 kg P)	130	176 g DAP	132 g DAP + 125 g SSP
K	35-40	62.5 kg MOP (37.5 kg K)	62.5	84.5 g MOP	-NA-
ZnSO4	25	25 kg ZnSO4 (21% Zinc)	25	33.75 g ZnSO4	-NA-

Treatments	**Treatment details**	**Fertilizer through soil application for one plot of 10 m^2**
T1	Recommended practice (Thiram + Bavistin (2:1) @3g/kg incombination with *Rhizobium* and RDF) - Control	176 g DAP+ 84.5 g MOP + 33.75g $ZnSO_4$ (100% RDF)
T2	T2: Recommended practice (Thiram + Bavistin (2:1) @3g/kg incombination with *Rhizobium* and75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T3	*Anabaena Rh* (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T4	*Anabaena R*h in combination with Thiram + Bavistin (2:1)@3g/kg (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T5	BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T6	BF1-4 Cyanobacterium consortium in combination with Thiram + Bavistin (2:1) @3g/kg (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T7	*Anabaena laxa* (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)
T8	*Anabaena tr* (75% N + Full dose of P, K)	132 g DAP+ 125 g SSP + 84.5 g MOP + 33.75 g $ZnSO_4$ (75% N)

Note: 100 % RDF means application of 100% NPK and Zn. Urea: 46% N; SSP: 16% P and 11% S; MOP: 60% P; $ZnSO_4$: 21% Zn

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates) **along with photographs**
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis: Soil chlorophyll, SOC, seedproteins, pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 area -**15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll - **30 DAS at first bloom stage/budding stage (SPAD value)**

- Number of nodules/ effective nodules per plant (DAS) – **30 DAS after sowing**
- Days to first flowering and 50% flowering
- Days to pod formation
- Acetylene reduction assay (ARA) - Determination of biological nitrogen fixation in the nodules
- No. of pods/plant
- Seed yield per plant (g) and per plot (kg/area)
- Seed yield (q /ha) - whole plot basis
- 1000 seed weight(g)
- Seed recovery (%) - manual basis
- Seed quality parameters: Seed germination, Vigour indices and Seed health
- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)
- Vigour Index - II = Germination percent x Average dry weight of 10 seedlings (mg)
- Net monetary returns (Rs.) and Benefit Cost ratio (Annexure II)

CHICKPEA	
No. of treatments	**8**
Replications	**4**
Design	**RBD (Randomized Block Design)**
Plot Size (m)	**5.0 x 1.8**
Spacing (cm)	**30 x10**
Total plots	**32(Area- 288 m^2)**
Sowing: Direct sowing @ 60-80 kg seed / ha, Direct sowing; depth of sowing: 6-8 cm	
Seed requirement 100 seed wt.- 25 g (approx.) 1 plot - 6 rows, 5 m each i.e., 50 plants/ row and 6x50 plants/ plot i.e., 300 plants/ plot. We need to sow at least 100 seeds/ row Hence, seed requirement for one replication = 6 x 200 = 600 seeds (150g) Total seed requirement for four replications = 150 x 4 seeds (600g seed for each treatment)	
Note: I. Apply FYM @5 t/ ha, 10 to 15 days prior to sowing supplemented with 20:40:20kg/ha N: P: K, respectively based on soil test or State Recommended Dose of Fertilizer. II. Apply Zinc Sulphate@25 kg/ ha III. Pre-emergence herbicides, such as Fluchloralin @ 1 kg a.i. / ha or Pendimethalin @ 1.0 to 1.5 kg a.i. /ha for controlling early flush of weeds. IV. Chickpea is generally grown as a rainfed crop, but two irrigations, one each at branching and pod filling stages, are recommended for higher yield.	

Seed Treatments:

- T1: Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with *Rhizobium* and100% RDF) -**Control**
- T2: Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with *Rhizobium and*

75% N + Full dose of P, K)

- T3: *Anabaena Rh* (75% N + Full dose of P, K)
- T4: Anabaena Rh in combination with Thiram + Bavistin (2:1) @3g/kg (75% N + Full dose of P,K)
- T5: BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K)
- T6: BF1-4 Cyanobacterium consortium in combination with Thiram + Bavistin (2:1) @3g/kg (75%N + Full dose of P, K)
- T7: *Anabaena laxa* (75% N + Full dose of P, K)
- T8: *Anabaena tr* (75% N + Full dose of P, K)

Note: The seeds will be coated with PGPR strains by Dr. Radha Prasanna, Principal Scientist, Division of Microbiology, ICAR-IARI, New Delhi

Fertilizer requirements:

Fertilizer nutrient	**Dose (kg/ha)**	**Fertilizer requirement (per ha)**	**Dose for one plot of 10m^2(g)**	**Fertilizer requirement with 100% N for one plot of 9.0m^2(g)**	**Fertilizer requirement with 75% N for one plot of 9.0 m^2(g)**
N	18-20	100 kg DAP (18 kg N)	100	90 g DAP	72 g DAP
P	40-45	100 kg DAP (46 kg P)	100	90 g DAP	72 g DAP + 80 g SSP
K	20	33.5 kg MOP (20 kg K)	33.5	30.25 g MOP	--
ZnSO4	25	25 kg ZnSO4 (21% Zinc)	25	25g ZnSO4	--

Treatments	**Treatment details**	**Fertilizer through soil application for one plotof 10 m^2**
T1	Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with *Rhizobium* and RDF) - Control	90 g DAP + 30.25 g MOP + 25gZnSO4 (100% RDF)
T2	T2: Recommended practice (Thiram + Bavistin (2:1) @3g/kg in combination with *Rhizobium* and75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g ZnSO4 (75% N)

T3	*Anabaena Rh* (75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)
T4	*Anabaena Rh* in combination with Thiram + Bavistin(2:1) @3g/kg (75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)
T5	BF1-4 Cyanobacterium consortium (75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)
T6	BF1-4 Cyanobacterium consortium in combination with Thiram + Bavistin (2:1) @3g/kg (75% N + Fulldose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)
T7	*Anabaena laxa* (75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)
T8	*Anabaena tr* (75% N + Full dose of P, K)	72 g DAP + 80 g SSP + 30.25 g MOP + 25g $ZnSO_4$ (75% N)

Note: 100% RDF means application of 100% NPK along with 100% Zn DAP: 18% N + 46 % P; SSP: 16% P; MOP: 60% P; $ZnSO_4$: 21% Zn

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates) **along with photographs**
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis. Soil chlorophyll, SOC, seed proteins,pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 area - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll **- 30 DAS at first bloom stage/budding stage (SPAD value)**
- Number of nodules/ effective nodules per plant - **30 DAS after sowing**
- Days to first flowering and 50% flowering
- Days to pod formation
- Acetylene reduction assay (ARA) - Determination of biological nitrogen fixation in the nodules
- No. of pods/plant
- Seed yield per plant (g) and per plot (kg)
- Seed yield (q /ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) - manual basis
- Seed qualityparameters: Seed germination, Vigour indices and Seed

health (% infection in blottermethod)

- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)Vigour Index - II = Germination percent x Average dryweight of 10 seedlings (mg)
- Net monetary returns (Rs.)
- Benefit Cost ratio (Annexure II)

Expected output: Identification of suitable PGPR strains for seed quality enhancement, which canfacilitate adoption of organic seed production practices.

Table 4.1: Effect of PGPR seed coating on plant growth and seed yield attributes in Maize

Treatments	Field emergence (%)	Plant stand establishment/m^2	Days to			Numberof nodules/ effective nodules per plant	Acetylene reduction assay (ARA)	Leaf Chlorophyll content (SPAD value) (40-45 DAS) at first bloom stage/budding stage	Plant Height at(cm)		No. of cobs / plant
			first flowering	50% flowering	pod formation				30 DAS	Harvest	
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											
SEm±											
CD(p=0.05)											
CV (%)											

Table 4.2: Effect of PGPR seed coating on seed quality parameters and economic indicators in maize

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germinationn (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T5											

T6										
T7										
T8										
Mean										
SEm±										
CD(p=0.05)										
CV (%)										

Table 4.3: Effect of PGPR seed coating on plant growth and seed yield attributes in soybean

Treatments	Field emergence (%)	Plant stand establishment/ m^2	Days to			Numberof nodules/ effective nodules per plant	Acetylene reduction assay (ARA)	Leaf Chlorophyll content (SPAD value) (40-45 DAS) at first bloom stage/budding stage	Plant Height at(cm)		No. of pods / plant
			first flowering	50% flowering	pod formation				30 DAS	Harvest	
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											
SEm±											
CD(p=0.05)											
CV (%)											

Table 4.4: Effect of PGPR seed coating on seed quality parameters and economic indicators in soybean

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germinationn (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T5											
T6											

T7										
T8										
Mean										
SEm±										
CD(p=0.05)										
CV (%)										

Table 4.5: Effect of PGPR seed coating on plant growth and seed yield attributes in chickpea

Treatments	Field emergence (%)	Plant stand establishment/m^2	Days to			Numberof nodules/ effective nodules per plant	Acetylene reduction assay (ARA)	Leaf Chlorophyll content (SPAD value) (40-45 DAS) at first bloom stage/budding stage	Plant Height at(cm)		No. of pods / plant
			first flowering	50% flowering	pod formation				30 DAS	Harvest	
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											
SEm±											
CD(p=0.05)											
CV (%)											

Table 4.6: Effect of PGPR seed coating on seed quality parameters and economic indicators in chickpea

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germinationn (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T5											
T6											
T7											

T8										
Mean										
SEm±										
CD(p=0.05)										
CV (%)										

Experiment 5: Evaluation of liquid bio-fertilizers in enhancing seed yield and quality

Rationale: Liquid biofertilizers consists of living microorganisms that enhance soil properties and increase plant growth and yield. Liquid biofertilizers have been used in different crops and out yield chemical or carrier-based fertilizers in terms of plant growth. However, more research is required to overcome the limitations for better climate adaptation, longer shelf life, better liquid inoculants etc.

Objective: To evaluate the effectiveness of liquid biofertilizers on seed yield and quality

Crops	**Centers**
Soybean (6)	VNMKV, Parbhani; JNKVV, Jabalpur; IISS, Mau; GBPUAT, Pantnagar; MPKV, Rahuri and PAU, Ludhiana
Chickpea (4)	CSAUAT, Kanpur; GBPUAT, Pantnagar; PAU, Ludhiana and MPKV,Rahuri
Wheat (5)	VNMKV, Parbhani; JNKVV, Jabalpur; CSAUAT, Kanpur; NDUAT, Faizabad and OUAT, Bhubaneswar

Expected outcome: Identification of the suitable liquid biofertilizer on the basis of crop, seasonand soil type across the country and promotion of organic seed production

Soybean	
Variety	**JS 20-116**
No. of treatments	**8**
Replications	**3**
Design	**RBD (Randomized Block Design)**
Plot Size(m)	**5.0 x 2.70**
Spacing(cm)	**45 x 5**
Total plots	**24**
Sowing: Direct sowing @70kg seed/ha, Direct sowing; depth of sowing: 4-5cm	
Seed requirement 100 seed wt.-9g (approx.) 1 plot – 6 rows, 5m each i.e.,100 plants/row and 6x100 plants/plot i.e., 600 plants/plotWe need to sow at least 200 seeds/ row Hence, seed requirement for one replication = 6 x 200 = 1200 seeds (108 g) Total seed requirement for four replications = 1200 x 3 seeds (324 g seed for each treatment	

Note:

i. Apply FYM @5 t/ ha, 10 to 15 days prior to sowing supplemented with 25:40:60 kg/ha N: P: K:Sdose, respectively based on soil test or State Recommended Dose of Fertilizer

ii. Apply Zinc Sulphate@25 kg/ ha

Pre-emergence herbicides, such as *Fluchloralin* @ 1 kg a.i. / ha or Pendimethalin @ 1.0 to 1.5kg a.i. /ha for controlling early flush of weeds.

Treatment details (Soybean)

- T1: No seed treatment – Control
- T2: SRDF+ Recommended seed treatment practice (Thiram + Bavistin (2:1) @3g/kg in combination withRhizobium@ 5g/ kg seed
- T3: SRDF+seed treatment with Jawahar EM culture@ 20ml/kg seed
- T4: SRDF+seed treatment with Jawahar PSB @ 20 ml/kg seed
- T5: SRDF+seed treatment with Jawahar KSB @ 20 ml/kg seed
- T6: SRDF+seed treatment with Jawahar *Azospirillum* @ 20 ml/kg seed
- T7: SRDF+seed treatment with Jawahar *Pseudomonas* @ 20 ml/kg seed
- T8: SRDF+seed treatment with Jawahar Rhizobium culture@ 20 ml/kg seed

Note: The seeds will be treated with all liquid inoculum strains @ 20 ml per kg seed i.e., 2.52 mlper 126 gm seed for each replication per treatment.

Chickpea	
No. of treatments	**9**
Replications	**4**
Design	**RBD (Randomized Block Design)**
Plot Size(m)	**5.0 x 1.8**
Spacing(cm)	**30 x10**
Total plots	**32**
Sowing: Direct sowing @ 60-80 kg seed / ha, Direct sowing; depth of sowing: 6-8 cm	
Seed requirement 1 plot - 6 rows, 5 m each i.e., 50 plants/ row and 6x50 plants/ plot i.e., 300 plants/ plot.We need to sow at least 100 seeds/ row Hence, seed requirement for one replication = 6 x 100 = 600 seeds Total seed requirement for four replications = 600 seeds x 4 seeds (2400 seed for each treatment)	
Note: I. Apply FYM @5 t/ ha, 10 to 15 days prior to sowing supplemented with 20:40:20 kg/ha N: P: K:S dose, respectively based on soil test or State Recommended Dose of Fertilizer II. Apply Zinc Sulphate@25 kg/ ha III. Pre-emergence herbicides, such as *Fluchloralin* @ 1 kg a.i. / ha or Pendimethalin @ 1.0 to 1.5kg a.i./ha for controlling early flush of weeds.	

Treatment details (Chickpea)

- T1: No seed treatment - Control
- T2: SRDF+ Recommended seed treatment practice (Thiram + Bavistin (2:1) @3g/kg in combination with Rhizobium@ 5g/ kg seed
- T3: SRDF+seed treatment with Jawahar EM culture@ 20ml/kg seed
- T4: SRDF+seed treatment with Jawahar PSB @ 20 ml/kg seed
- T5: SRDF+seed treatment with Jawahar KSB @ 20 ml/kg seed
- T6: SRDF+seed treatment with Jawahar *Azospirillum* @ 20 ml/kg seed
- T7: SRDF+seed treatment with Jawahar *Pseudomonas* @ 20 ml/kg seed
- T8: SRDF+seed treatment with Jawahar Rhizobium culture@ 20 ml/kg seed
- T9: SRDF+seed treatment with Jawahar Trichoderma culture@ 20 ml per kg seed

Note: The seeds will be treated with all liquid inoculum strains @ 20 ml per kg seed

WHEAT	
Cultivar	Any popular cultivar of the respective zone/centre
Test weight (1000seedwt.)	30-35g
No. of treatments	7
Replications	4
Design	RBD (Randomized Block Design)
Plot Size(m)	5.0 x2.0
Spacing(cm)	22.5 (R-R), plant to plant spacing to be adjusted according to the seed rate
Total plots	28(Area- 280m^2)
Seed requirement 100 seed wt.- 35g (approx.) 1 plot - 6 rows, 5 m each i.e., 100 plants/ row and 6x100 plants/ plot i.e., 600 plants/plot. We need to sow at least 200 seeds/row Hence, seed requirement for one replication=6x200=1200seeds Total seed requirement for four replications=1200 seeds x 4seeds (4800 seed for each treatment)	
Sowing: Direct sowing, depth of sowing: 5-6cm	

Note:

I. Pre-sowing seed treatment with Thiram or Captanor Carbendazim or Mancozeb @2g/kg

II. Apply FYM@10 to 12t/ha, 10 to15 days prior to sowing supplemented with 120:60:40kg/ha N: P: K dose, respectively along with 25 kg/ha of Zinc Sulphate or State Recommended Dose of Fertilizer based on soil test report. Full doses of P, K and Zn should be applied as basal. Nitrogen is applied in two split dosages.

III. Weeding to be done 45-60 DAS or weedicides like 2,4D, Avadexor Nitrofen (TokE-25) for controlling weeds like *Chenopodium* sp., *Angallis* sp. *Asphodelus* sp. *Phalaris* sp.

IV. The irrigations should be given at critical growth stages viz. Crown root initiation, tillering, jointing, flowering, milk and dough viz. 21-25, 45-60, 60-70, 90-95, 100-105 and 120-125DAS, respectively.

V. In case white ants or other pests' problems, Aldrin 5% or BHC 10% dust @ 25g/ha should be applied to the soil after the last ploughing or before planking.

Treatment details (Wheat)

- T1: No seed treatment - Control
- T2: SRDF+ Recommended seed treatment practice (Thiram + Bavistin (2:1) @3g/kg)
- T3: SRDF+seed treatment with Jawahar EM culture@ 20ml/kg seed
- T4: SRDF+seed treatment with Jawahar PSB @ 20 ml/kg seed
- T5: SRDF+seed treatment with Jawahar KSB @ 20 ml/kg seed
- T6: SRDF+seed treatment with Jawahar *Azospirillum* @ 20 ml/kg seed
- T7: SRDF+seed treatment with Jawahar *Pseudomonas* @ 20 ml/kg seed

Note: The seeds will be treated with all liquid inoculum strains @ 20 ml per kg s

Observations to be recorded (Soybean/Chickpea):

- Location details of experimental plot (including GPS coordinates), **including photographs**
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis. Soil chlorophyll, SOC, seed proteins,pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll - **40-50 DAS at first bloom stage/budding stage (SPAD value**)
- Number of nodules/ effective nodules per plant - **30 DAS after sowing**
- Days to first flowering and 50% flowering
- Days to pod formation
- No. of pods/plant

- Seed yield per plant (g) and per plot (kg)
- Seed yield (q /ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) - manual basis
- Seed quality parameters: Seed germination, Vigour indices and Seed health (% infection in blotter method)
- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)Vigour Index - II
- = Germination percent x Average dry weight of 10 seedlings (mg)
- Net monetary returns (Rs.)
- Benefit Cost ratio (Annexure II)

Observations to be recorded (Wheat):

- Location details of experimental plot (including GPS coordinates), **including photographs**
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis. Soil chlorophyll, SOC, seed proteins,pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.
- Field emergence (%) - **upto 15 DAS**
- Plant stand establishment/m^2 - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll - **40-50 DAS at first bloom stage/budding stage (SPAD value**)
- Number of nodules/ effective nodules per plant - **30 DAS after sowing**
- Days to first flowering and 50% flowering
- Days to tiller formation
- No. of tillers/plant
- Seed yield per plant (g) and per plot (kg)
- Seed yield (q /ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) - manual basis
- Seed qualityparameters: Seed germination, Vigour indices and Seed health (% infection in blottermethod)
- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)Vigour Index - II
- = Germination percent x Average dry weight of 10 seedlings (mg)
- Net monetary returns (Rs.)
- Benefit Cost ratio (Annexure II)

Table 5.1: Effect of liquid bio-fertilizers on plant growth and seed yield attributes in soybean

Treatments	Field emergence(%)	Plant stand establishment/m²	Days to			Leaf Chlorophyll content (SPAD value) (40-45 DAS) at first bloom stage/budding stage	Plant heightat (cm)		No. of Pods / plant
			first flowering	50% flowering	Pod formation		30 DAS	Harvest	
T1									
T2									
T3									
T4									
T5									
T6									
T7									
T8									
Mean									
SEm±									
CD(p=0.05)									
CV (%)									

Table 5.2: Effect of liquid bio-fertilizers on seed quality parameters and economic indicators in soybean

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germination (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											
SEm±											
CD(p=0.05)											
CV (%)											

Table 5.3: Effect of liquid bio-fertilizers on plant growth and seed yield attributes in chickpea

Treatments	Field emergence (%)	Plant stand establishm	Days to	Leaf Chlorophyll content (SPAD	Plant height at (cm)	No. of Pods / plant

		ent/m²	first flowering	50% flowering	Pod formation	value) (40-45 DAS) at first bloom stage/budding stage	30 DAS	Harvest	
T1									
T2									
T3									
T4									
T5									
T6									
T7									
T8									
T9									
Mean									
SEm±									
CD(p=0.05)									
CV (%)									

Table 5.4: Evaluation of liquid bio-fertilizers on seed quality parameters and economic indicators in chickpea

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germination (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T											
T6											
T7											
T8											
T9											
Mean											
CD(p=0.05)											
CV (%)											

Table 5.5: Effect of liquid bio-fertilizers on plant growth and seed yield attributes in Wheat

Treatments	Field emergence (%)	Plant stand establishment/m²	Days to			Leaf Chlorophyll content (SPAD value) (40-45 DAS) at	Plant heightat (cm)		No. of tillers / plant
			first flowering	50% flowering	Tiller formation		30 DAS	Harvest	

						first bloom stage/budding stage			
T1									
T2									
T3									
T4									
T5									
T6									
T7									
Mean									
SEm±									
CD(p=0.05)									
CV (%)									

Table 5.6: Effect of liquid bio-fertilizers on seed quality parameters and economic indicators in Wheat

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germination (%)	Vigor indexI	Vigor indexII			
T1											
T2											
T3											
T4											
T5											
T6											
T7											
Mean											
SEm±											
CD(p=0.05)											
CV											

Experiment 6: Enhancing seed yield and quality in off season soybean through applicationof plant growth regulators

Rationale: Generally, the time of planting varies depending on the climatic conditions of the region and the variety to be grown; early or late planting reduces crop yield significantly. Besides,many seed lots may fail to meet the requisite germination standards due to the heavy rains duringharvesting, resulting in severe shortage of quality seeds for planting in the next

season. In such situations, contingency seed production is very much essential, especially in the off-season. Hence,there is a need to identify the suitable planting time for promoting quality seed production duringthe off-season.

Crop	Centers
Soybean (7)	PJTSAU, Hyderabad; UAS, Dharwad; VNMKV, Parbhani; UAS, Bengaluru; JNKVV, Jabalpur; MPKV, Rahuri and PDKV, Akola

The best planting window period for the off-season sowing of soybean was identified in the previous Seed Production and Certification experiments which is given below:

S. No.	Place	Variety	Best planting window for off-season cultivation of soybean
1.	PJTSAU, Hyderabad	JS-335	3rd to 4th week of September
2.	UAS, Dharwad	DSB-34	1st to 4th week of November
3.	VNMKV, Parbhani	MAUS -725	1st to 4th week of November
4.	UAS, Bengaluru	JS-335	1st week of December
5.	JNKVV, Jabalpur	JS 20-116 and JS 20-98	3rd to 4th week of December
6.	MPKV, Rahuri	Sangam and Dhruv	3rd week of January
7.	PDKV, Akola	Amba and Suvarn Soya	-NA-

Plant growth regulator treatments

- **T1**- Control
- **T2**-Salicylic Acid @ 400ppm
- **T3**- Salicylic Acid @ 400ppm
- **T4**-Thiourea@400ppm
- **T5**-Thiourea@800 ppm
- **T6**- NAA@400ppm
- **T7**- NAA@800ppm

Spray Schedule

S1- Flowering stage

S2- Vegetative stage

S3- Both Flowering and vegetative stage

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates), **along with photographs**
- Soil nutrient analysis (pre and post experiment)/ Tissue analysis. Soil chlorophyll, SOC, seed proteins,
- pH, EC, bulk density, organic C, CN ratio, Available N, P, K etc.

- Field emergence (%) – upto **15 DAS**
- Plant stand establishment/m^2 - **15 DAS**
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll - **40-50 DAS at first bloom stage/budding stage (SPAD value)**
- Number of nodules/ effective nodules per plant - **30 DAS after sowing**
- Days to first flowering and 50% flowering
- Days to pod formation
- No. of pods/plant
- Seed yield per plant (g) and per plot (kg)
- Seed yield (q /ha) - whole plot basis
- 1000 seed weight (g)
- Seed recovery (%) - manual basis
- Seed quality parameters: Seed germination, Vigour indices and Seed health (% infection inblotter method)
- Vigour Index - I = Germination percent x Average seedling length of 10 seedlings (cm)Vigour Index - II = Germination percent x Average dry weight of 10 seedlings (mg)
- Net monetary returns (Rs.) and Benefit Cost ratio (Annexure II)

Table 6.1: Effect of Plant growth regulators seed yield attributes in off season soybean

Treatments	Field emergence(%)	Plant stand establishment/m^2	Days to			Leaf Chlorophyll content (SPAD value) (40-45 DAS) at first bloom stage/budding stage	Plant heightat (cm)		No. of pods / plant
			first flowering	50% flowering	Pod formation		30 DAS	Harvest	
Plant Growth regulator treatment (T)									
T1									
T2									
T3									
T4									
T5									
T6									
T7									
Mean									
SEm±									
CD(p=0.05)									
CV (%)									
Spray Schedule (S)									
S1									
S2									
S3									

Mean									
SEm±									
CD									
CV (%)									

Interaction (T × S)									
T1S1									
T1S2									
T1S3									
T2S1									
T2S2									
T2S3									
T3S1									
T3S2									
T3S3									
T4S1									
T4S2									
T4S3									
T5S1									
T5S2									
T5S3									
T6S1									
T6S2									
T6S3									
T7S1									
T7S2									
T7S3									
Mean									
SEm±									
CD									
CV (%)									

Table 6.2: Effect of Plant growth regulators on seed quality parameters and economic indicators in off season soybean

Treatments	Seed yield		Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection)	Net monetary returns (Rs.)	Benefit Cost ratio
	plant (g)	plot (kg)				Germination (%)	Vigor indexI	Vigor indexII			
Plant Growth regulator treatment (T)											
T1											

T2										
T3										
T4										
T5										
T6										
T7										
Mean										
SEm±										
CD (p=0.05)										
CV (%)										
Spray Schedule (S)										
S1										
S2										
S3										

Mean										
SEm±										
CD (p=0.05)										
CV (%)										
Interaction (T × S)										
T1S1										
T1S2										
T1S3										
T2S1										
T2S2										
T2S3										
T3S1										
T3S2										
T3S3										
T4S1										
T4S2										
T4S3										
T5S1										
T5S2										
T5S3										
T6S1										
T6S2										
T6S3										
T7S1										
T7S2										
T7S3										
Mean										
SEm±										
CD (p=0.05)										
CV (%)										

Annexure II

Performa for Calculating Expenditure, Income and BC Ratio for STR Experiments

S. No.	Particulars	Amount (Rs./ha)
A	**Expenditure / Cost**	
1	Recurring cost of imposing the treatment (T1, T2, T3….Tn) (materialistic cost only *i.e.* chemicals, packaging materials, other physical inputs etc.)	
2	Additional labour cost on imposing treatments	
3	Salary component (as per man-days spent for imposing treatments)	
4	Miscellaneous cost	
	Sub total	
5	Interest on working capital (@ 12% per annum for total above, adjusted accordingly as per duration of experiment)	
	Total Expenditure / cost (A)	
B	**Gross income by imposing the treatment**	
1	Seed yield in particular treatment (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income by imposing the treatment (B)	
C	**Gross income in control (T0)**	
1	Seed yield in control (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income in control (C)	
D	**Increase in Gross income by imposing the treatment (B - C)**	
E	**Increase in Net income by imposing the treatment (D - A)**	
F	**BC ratio for imposing the treatment (D/A)**	

Note:

1. The above information needs to be calculated for individual/every treatment
2. Expenditure, income etc. may be calculated on per quintal basis for storage experiment

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
1	ICAR-IARI, New Delhi	Dr. Sandeep K. Lal	Pr. Scientist & PI	pispc.nsp@gmail.com;	9811048932
2	ICAR-IISS, Mau	Dr. Bhojaraja Naik K.	Sr. Scientist & Co-PI	bhojaraja.naik@icar.gov.in; bharana.naik@gmail.com	7975588306
3	BSKKV, Dapoli	Dr. A. V. Mane	DDR (Seed)	ddrbskkv@gmail.com;	9422371926
		Dr. P. P. Patil	ASPO	prashantppatil322@ gmail.com;	8956892213
4	TNAU, Coimbatore	Dr. Nelson Navamaniraj	ASRO (SST)	nelsonnavamaniraj@ tnau.ac.in	9789220924
5	AAU, Jorhat	Dr. Umesh Chandra Kalita	Pr. Scientist	umesh.c.kalita@aau.ac.in,	9435066205
6	UAS, Bangalore	Dr. K. Vishwanath	Seed Research Officer	vishwakoti@gmail.com;	9108925969
7	ICAR RC NEH, Manipur	Dr. I. Meghachandra Singh	Pr. Scientist	jdmn.icar@nic.in;	9436027223
		Dr. Amit kumar	Pr. Scientist	amit4118@gmail.com;	8974630789
		Dr. E. Lamalakshmi	Scientist	elangbamlama@gmail.com;	9366608798, 9774887548
8	CSKHPKV, Palampur	Dr. Rajesh Kanwar	ASRO (SST)	intangiblekanwar07@ gmail.com;	9418317301
9	JAU, Jamnagar	Dr. K. K. Dhedhi	Seed Research Officer	kkdhedhi@jau.in;	94281 25674
10	JNKVV, Jabalpur	Dr. G. K. Koutu	Pr. Scientist	gk_koutu@yahoo.co.in;	9424676726
		Dr. R. Shiv Ramakrishnan	Scientist	shivram.krishnan2008@ gmail.com;	9174056526
11	OUAT, Bhubaneswar	Dr. Simanta Mohanty	ASRO (Seed Production)	simantamohanty@yahoo.com	9437301110
12	PAU, Ludhiana	Dr Inderpreet Dhaliwal	Plant Breeder	dhaliwalinderpreet@ pau.edu; dhaliwalinderpreet@ gmail.com;	9815211669
		Dr Gaurav Khosla	Plant Breeder	goruvkhosla@pau.edu;	9815965404
13	PDKV, Akola	Dr. Amrapali A. Akhare	Associate Professor	atulakhare@yahoo.com;	7020990738
14	PJTSAU, Hyderabad	Dr. K. Prabhavathi	Senior Scientist	konaprabhavati@yahoo.co.in;	9100930127
15	RPCAU, Pusa	Dr. Rajesh Kumar	Associate Professor	rajrau.2007@rediffmail.com;	8809435010

		Dr. Sumeet Kumar Singh	Assistant Professor	sumitiasbhu@gmail.com;	9334792496
16	SKUAST, Srinagar	Dr.Gowhar Ali	Assistant Professor	gowharpbg@gmail.com;	7006353051
		Dr. Aflaq Hamid	Assistant Professor	falak19@gmail.com;	7889617904
17	UAS, Dharwad	Dr. Ravi Hunje	Special Officer (Seeds)	Soseed@uasd.in;	9448301595
		Dr. Vijayakumar. A. G	Seed Production Officer	vijayakumarag@uasd.in;	9482182111
		Dr. Malik Rehan	Technical Officer: STR	malikuasdwd@gmail.com;	9663356479
18	MPKV, Rahuri	Dr. V. R. Shelar	Seed Research Officer	vijayrshelar@yahoo.co.in;	7588604252
19	IGKV, Raipur	Dr. R. K. Verma	Sr. Scientist	nspigkv@gmail.com;	9827167044
20	IARI, New Delhi	Dr. Sudipta Basu	Pr. Scientist	sudipta_basu@yahoo.com;	98711 77651
21	NDUAT, Ayodhya	Dr. S. C. Vimal	Joint Director (Seed & Farms)	scvimalndgpb@gmail.com;	9451955851
22	CSAUAT, Kanpur	Dr. CL Maurya	Head, DSST & I/c STR	clmaurya@csauk.ac.in	9453479077
23	SKNAU, Jobner	Dr. Ashok Meena	ASRO	str.durgapura.jp@gmail.com	8432719252
24	CCSHAU, Hisar	Dr. Axay Bhuker	ASRO	bhuker.axay@gmail.com	9812375695
		Dr. V.S. Mor	ASRO	virendermor@gmail.com	9468337001
25	ICAR-IISS, Mau	Dr. Kalyani Kumari	Scientist	Kalyani.kumari7@gmail.com	7765835577
		Dr. Banoth Vinesh	Scientist	vinesh.banoth511@gmail.com	8309408444
		Dr. Anandan A.	Pr. Scientist	anandanau@yahoo.com	9894227665
		Dr. Shantharaja C.S.	Scientist	shantharaja.cs@icar.gov.in	9008749131
		Dr. Ramya P.	Sr. Scientist	ramyakurian@gmail.com	9008184658
		Dr. Manjanagouda SS	Scientist	mssagron@gmail.com	9381445031
26	PAJANCOA&RI, Karaikal	Dr. T. Ramanadane	Professor	raman_nadane@yahoo.com	9443875443

B. Seed Physiology, Storage, and Testing

Date: 21.04.2023 & 09.05.2023

Chairman : **Dr. Sanjay Kumar**
Director, ICAR-IISS, Mau

Convener : **Dr. Shiv Kumar Yadav**
Principal Investigator/Principal Scientist, ICAR-IARI, New Delhi

The Technical Programme of 'Seed Physiology, Storage & Testing' for the year 2023-24 is formulated based on the deliberations of the findings of the experiments and suggestions made during the pre-workshop meeting held on 21.04.2023 and technical sessions of 38th AGM of AICRP on Seed (Crops) held from 9th to 10th May 2023 at TNAU, Coimbatore. Seven experiments were conducted in the 'Seed Physiology, Storage and Testing' component during 2022-2023 and the experiment wise recommendations finalized are given below;

Recommendations

Experiment 1: To reaffirm the validity periods of certified seeds of field crops (as per the IMSCS regulations), cooperating centres aptly worked out the validity periods for different crops as detailed below, and measures in reference to correspondence to appropriate authorities for consideration are being pursued in this regard.

Crops	Recommendations on maximum period maintaining germination percent above IMSCS based on findings by participating centers
Barley	17 months of Germination >85%
Kabuli Chickpea	14 months of Germination >85%
Lentil	10 months of Germination >75%
Mustard	12 months of Germination >85%
Oat	11 months of Germination >85%
Onion	05 months of Germination >70%
Pigeon pea	13 months of Germination >75%
Sunflower	09 months of Germination >70%

Whereas with respect to crops viz. pearl millet and castor, the experiment will be continued, and millets (finger millet, foxtail millet, and barnyard millet) are proposed for inclusion.

Experiment 2: Hybrid purity testing using molecular markers in public sector hybrids of field crops, molecular markers RM 234 & RM 510 are validated and proposed for the recommendation of hybridity testing of rice hybrid, JRH 8 (CMS 97 A × NPT 29). Whereas w.r.t

Bnlg 1185, SSR marker for genetic purity testing of maize hybrid (MAH 14-5: CAL 1443 × CML 451); Bnlg 1666 for maize hybrid, SMH 5 (BML 6 × IML 187) and PSMP 2089 Pearl millet hybrid, Adishakti (DHLB 8 A × DHLBI 967) will proceed for validation during the coming year. Isozyme markers i.e., zymography of SOD in Maize hybrid, PMH 1 (LM 13 × LM 14) Zymography of POD in Maize hybrids; PMH 1 (LM 13 × LM 14) and PMH 10 (LM 23 × LM 24) developed shall also continue for validation. The centers validating the results of SSR markers MUST compare these results with GOT and shall calculate BC ratio of both these methods.

Experiment 3: Physiological studies and development of priming technologies for enhancing planting value of seed in field crops under optimal and sub-optimal conditions adeptly validated and demonstrated treatments were proposed for recommendation as technologies, which are listed herewith.

Crops	**Recommended Technology**
Cotton	Coating on hydro-primed (12h@25^{O}C) seeds with DAB
Kabuli Chickpea	Coating on hydro-primed seeds with DAB + Bio Grow
Lentil	Coating on hydro primed (8h @ 25^{O}C) seeds with DAB+ Bio Grow
Mustard	Coating on hydro primed (16h @ 20^{O}C) seeds with Bio Phos
Paddy	Coating with *Trichoderma harzianum* @ 15 g / kg of seed

Whereas, regarding standardization and validation, only identified treatments in different crops as mentioned below will be pursued during current year.

Crops	**Recommendations for redoing standardization**
Barley, Oat, Pearl millet, and Sunflower	Only with the identified treatments in different crops by centers.
Maize	Recommendation for redoing validation

Regarding demonstrations of validated priming technologies in delineated crops following treatments will proceed in designated centres.

Crops	**Recommendation for redoing the demonstrations**
Chickpea	1. Seed coating (on hydro-primed seeds (6h @ 20^{O}C) with BioNPK + Drought Alleviating Bacteria (DAB) 2. Seed coating with T. harzianum (CFU – 2 X 10^{6}per gm) @ 15g/kg seed
Field pea	1. Seed coating on hydro primed (10h @ 20^{O}C) seeds with BioGrow
Pigeon pea	• For Moisture Stress: Hydro-priming (10h @ 25^{O}C) • For Salt Stress: Halopriming (6dSm-1 solution of NaCl + CaCl2 for 8h @25^{0}C)
Paddy	Recommended POP Vs Seed treatments; 1. Organic Trichojal @5ml/kg seed /lit organic and 2. Metajal @5ml/kg seed /lit

Experiment 4: Use of nano-particles in enhancing seed quality & storability of seeds, consequent upon issues emerged w.r.t characterization, registration aspects and inconsistent results, referred experiment is proposed for discontinuation and based on collaboration with TNAU, Nanotechnology Unit, a pilot study, "Application of Engineered Nanomaterials for Seed Quality Enhancement" is proposed.

Experiment 5: Influence of terminal heat stress on seed set, seed yield, and quality in field crops, with successful demonstrations of the below-referred technologies in mentioned crops were proposed for the recommendation as technologies.

Crops	Recommended Technology
Paddy	Foliar spray with Salicylic acid @ 400 ppm at vegetative and anthesis stage
Sorghum	Foliar spray with Salicylic acid @ 400ppm at vegetative and anthesis stage
Wheat	Foliar spray with Salicylic acid @ 800 ppm at vegetative and anthesis stage

Whereas, with respect to standardization, the soybean crop is proposed for inclusion with MPKV, Rahuri, PDKV, Akola, VNMKV, Parbhani, JNKVV, Jabalpur and ICAR-IISS, RS, Bengaluru as cooperating centers. However, redoing validation and demonstration studies for one more year is proposed in chickpea, finger millet, and mustard.

Crops	Recommendation for redoing the evaluation
Chickpea	Two sprays of Cycocel (1000 ppm) at vegetative and anthesis stage
Finger millet	Salicylic acid & Thiourea (@400 ppm) at vegetative and anthesis stage

Crop	Recommendation for redoing the demonstration
Mustard	Recommended POP vs Salicylic acid @ 400 ppm at vegetative and anthesis stage

Experiment 6: The aim of this experiment was to fix the universal scale of vigour in terms of Germination Seedling Factor (GSF), the viable seed lots should possess to result in potential field emergence. The values of seed quality/vigour parameters along with GSF in each crop were correlated with field emergence; however, inference from diverse cooperating centres revealed that the highest correlation (0.9-1.0) of FE% was observed with germination per cent across the crops. Hence it was decided to conclude the experiment with the recommendation that germination per cent itself is an invaluable cue and can aid in the vigour-based grouping of seed lots.

Experiment 7: Assessment of the prevalence of revalidated seed lots in the country was mainly for collecting data from seed certification agencies on revalidated seed lots to assess the status of revalidation in the country. The data collected by 11 STR centers pertinent to 24 crop species revealed that revalidation II was reported from only one center (JAU, Junagadh) and is not in vogue in normal circumstances. Revalidation I was also permitted in

specificity to crops considering the storage, behaviour and ambient storage conditions of the location.

Technical Programme 2023-24

Experiment 1: To reaffirm the validity periods of certified seeds of field crops (as per the IMSCS regulations)

Year of Start: 2017-18

Rationale: The aim of IMSCS, is to ensure optimal plant stand in the farmers' fields with supply of quality seed with achievable germinability by the producers. As per the present law of the land, the certification tags issued to the seed lots after procedural formalities are valid for 9 months from the date of first test and can be revalidated for another 6 months till they maintain viability ≥IMSCS on the date of test. This has been causing practical problems for those who are into seed trade as well for the end-users. Therefore, it is required to assess the period till germinability in various crops at different locations that can actually be maintained ≥IMSCS and the status of vigour during variable storage period. So, the findings of this experiment are expected to provide scientific evidence for consideration of revision of validity periods, if required.

Objective: To study the planting values of seeds to examine the prescribed periods of validity of seed lots of some major field crops (2021-22).

Crops	**Centres**
Castor$	JAU, Junagadh; JNKVV, Jabalpur; PJTSAU, Hyderabad*; OUAT, Bhubaneswar and TNAU, Coimbatore
Pearl millet$	CCSHAU, Hisar; JAU, Junagadh and MPKV, Rahuri
Sorghum@#	PDKV, Akola; TNAU, Coimbatore; VNMKV, Parbhani; and ICAR-IIMR, Hyderabad - only to supply seed
Finger millet@#	UAS, Dharwad; UAS, Bengaluru; OUAT, Bhubaneswar; BSKKV, Dapoli and PJTSAU, Hyderabad*
Barnyard millet@#	JNKVV, Jabalpur; UAS, Raichur; MPKV, Rahuri and RAU TCA, Dholi (**ICAR-IIMR, Hyderabad and UAS, Dharwad)
Foxtail millet@#	**ICAR-IIMR, Hyderabad - only to supply seed; UAS, Raichur; SKNAU, Jobner and JNKVV, Jabalpur
$The experiment to be continued with seeds supplied last year till the germination falls below IMSCS @ Experiment to be initiated with freshly harvested seeds *The centre besides supplying seeds to other centres shall also be conducting experiment #Minimum numbers of seeds supplied to cooperating centres during 2023-24	

**Centers to only supply seeds to other centres

Technical Programme:

Materials:

Seed lots: It is presumed that;

- The cooperating centres who got the packed seeds in 700-gauge polythene from centres identified (in bold text above*), had divided the lot of each variety in two equal parts, packed in Cloth or Jute bags (as per crop specific recommendation) and HDPE bags (all crops) and stored at ambient conditions of respective centres.
- Date of harvesting, Date of first test, Moisture content (%), Germination (%) and validity period (in case of revalidated lots) have been noted as made known to all the cooperating centres by the identified centres* who supplied the seed and or known from where the fresh/revalidated lots were procured, **if not the identified centres kindly ascertain the same to respective cooperating centres.**

Observations to be recorded on seed lots:

The centre will continue to test periodically the stored seed lots and revalidated seed (if germinable ≥IMSCS) lots for;

1. First count (%) and Germination (%) as per ISTA and vigour indices (Abdul Baki and Anderson, 1973) at one month interval for at least 24 months from date of harvesting or at least 18 months of storage or till the germination (%) of seed lots comes below the IMSCS mark.
2. The moisture content (MC) may be taken at three months interval.
3. The seed lots will also be tested for field emergence and final plant stand establishment just before normal sowing time of respective crops (i.e., once in a year at crop specific centres). The final plant stand establishment will be recorded/ taken after 6 weeks of sowing for cotton and all cereal crops, whereas it will be 3-4 weeks after sowing of groundnut and pulses. OR
4. If the germination (%) has fallen or expected to fall below IMSCS in subsequent month, if it is the month other than the normal sowing month, then seedling emergence in trays/pots must be tested immediately when last time the seed lot(s) met the standard germination. The minimum germination percentage as per IMSCS, 2013 is 70% in Castor, 75% in Pearl millet, 75% in Sorghum, 75% in Finger millet, 75% in Barnyard millet and 75% in Foxtail millet.
5. The experiment will be terminated once the germination % reaches below IMSCS or for maximum period of 24 months whichever is earlier.

Kindly note the following for recording the observations and reporting;

1. In this experiment storage period is the most important factor that should always be taken as one of the independent variables (germination will be dependent variable) while analysing the data.
2. Observations to be recorded on minimum four replications of 100 seeds each, except SMC, which will be estimated on dry weight basis as per ISTA recommendations.
3. While calculating vigour indices, average/mean length in centimetre and wet/dry weight in grams of 10 randomly selected seedlings on the day of final count should be taken.
4. The formula to be used uniformly by all the centres; SVI-I= Seedling length (cm) X Germination (%) and SVI-II= Seedling Dry Wt. (g) X Germination (%).
5. Since many centres don't have the cold seed storage facilities, moreover such amenities are largely lacking in seed trade and hence, the experiment was designed to study storability under ambient conditions. Please be sure that you have kept the seed lots at safe, cool/shade and dry place in your labs.
6. The climate data, fortnightly mean minimum & maximum temperature (^{0}C) and RH %, from start of storage till termination of experiment should be furnished and must be used to explaining the results for period of storage at respective participating centres.
7. This experiment must be reported with explanation of the concluding table after writing the results for each crop by every cooperating centre as given below.

Observations MUST be reported are; Germination (%) as per ISTA, Moisture content (%) as per ISTA and fortnightly mean minimum & maximum temperature (^{0}C) and RH %.

Format of table for providing the concluding information of experiment 1

Name of your Centre	:		
Name of the Ist Crop allotted	:		
Name of the varieties supplied & used for storage studies	:	Name of Var. 1	Name of Var. 2
Month of harvest, if available			
Date of first test (MUST)	:		
Germination (%) Status at the time of first test (MUST)	:		
#Max. Numbers of months for which the variety-maintained germination above IMSCS in Jute/cloth Bag	:		
#Max. Numbers of months for which the variety-maintained germination above IMSCS in HDPE Bag	:		

Numbers of days for which the temperature remained ≥35°C during storage	
Numbers of days for which the RH remained ≥ 70% during storage	
Please add similar table for providing details of second crop, if allotted	

#Max. numbers of months to be calculated from the date of FIRST TEST.

Experiment 2: Hybrid purity testing using molecular markers in public sector hybrids of field crops

Year of Start: 2011- 2012

Rationale: Traditionally genetic purity testing is done by Grow-out Tests (GOT), based on morphological assay which is time-consuming, labour intensive and space-demanding. However, it is the most commonly used and internationally accepted method for genetic purity testing. Application of the molecular marker analysis technology has shown potential in cultivar identification and hybrid purity testing of crops. To detect loci in parental inbred and corresponding F_1 is the most important step in seed genetic purity testing of hybrid (F_1). The molecular markers tightly linked with the important agricultural traits would facilitate the purity testing of hybrid/s. The SSR markers have an advantage of co-dominance inheritance, easy scoring of the alleles, reproducibility and accessibility to laboratories. Therefore, the experiment was designed to identify the hybrid specific SSR markers and validation to determine hybrid purity.

Objectives:

1. To validate the identified markers for establishing hybridity in different hybrids of various field crops
2. To assess the efficiency of molecular markers in hybrid purity testing in comparison to the grow-out test (GOT) in various field crops.
3. To identify microsatellites markers for establishing hybridity in new hybrids of various field crops

Crops#		**Centres***
Castor	:	ICAR-IISS, Mau; PAU, Ludhiana and PJTSAU, Hyderabad (ICAR-IIOR, Hyderabad- only to supply the seeds)
Cotton	:	PAU, Ludhiana and RAU, TCA, Dholi
Maize	:	ICAR-IISS, Mau; PAU, Ludhiana; PJTSAU, Hyderabad; SKUAST, Srinagar and UAS, Bengaluru
Paddy	:	AAU, Jorhat; KAU, RARS, Pattambi; JNKVV, Jabalpur; PJTSAU, Hyderabad; PAJANCOA & RI, Karaikal; TNAU, Coimbatore and ICAR-IISS, RS, Bengaluru
Pearl millet	:	JNKVV, Jabalpur; MPKV, Rahuri and NAU, Navsari
Sorghum	:	JNKVV, Jabalpur and PJTSAU, Hyderabad

Sunflower	:	AAU, Jorhat; PJTSAU, Hyderabad; PAJANCOA & RI, Karaikal and UAS, Bangalore

NB: The centres e.g., AAU, Jorhat; JNKVV, Jabalpur and PAU, Ludhiana etc. have additionally been allotted the crops like; castor, cotton and sorghum etc. in which they don't have their own hybrids in these crops. These centres shall only be validating the identified markers if they are provided with required protocol/s, seeds of hybrids and their parental lines by the identifying centre and given some additional contingencies from ICAR-IISS, Mau.

The centers shall try identifying the markers to test the genetic purity for newly developed hybrids in any of the crops mentioned above by their institute/university.

* All the centres will make available, seeds with parental lines of newly released hybrids, if any, by their institute/university to every centre of that crop for identification of new marker/s. Participating centre/s for specific crop/s to also supply seeds and share details of identified markers identified and protocol followed by them with all other centres for validation, in addition to carrying out the proposed research. The results of markers must be compared with results of GOT in all crops and B: C ratio of both these methods is to be calculated.

The cooperating centres of maize MUST also to follow ISTA recommended method of testing of hybrid purity using isozymes as available (Orman *et al.,* 1991).

Details of the markers identified for validation and efficiency testing (Objective 1 & 2)
NB: Two-dimensional DNA sampling strategy shall be compared with screening a minimum of randomly selected 100 seeds/plant samples

Crop	Hybrid (Parents)	New SSR markers identified	Identifying centre
Maize	MAH-14-5 (CAL 1443 and CML 451)	Bnlg 1185	UAS, Bengaluru
	PMH 1 (LM 13 & LM 14)	Zymography of SOD and POD	PAU, Ludhiana
	PMH 10 (LM 23 and LM 24)	Zymography of POD	
	SMH-3 (KDM-125 and KDM-116)	Phi109275, Zca 381, Phi 034, Phi 114, Bnlg 1006, Bnlg 1666 and Bnlg 1523.	SKUAST, Srinagar
	SMH-5 (BML-6 and IML-187)	Bnlg 1666	
Pearl millet	Adishakti (DHLB 8A × DHLBI 967)	PSMP-2089	MPKV, Rahuri
Sorghum	AKSH-644 (AKMS- 30A & AKR-524)	Sb6-42, Sb6-36	PDKV, Akola

	AKSH-727 (AKMS- 30A & AKR-545)		

Details of the markers identified and proceeded for validation during last years' that could not be worked out are required to be validated and tested for efficiency this year (Objective 1 & 2)

Crop	Name of Hybrid	Name of the Marker	Identifying Centre
Paddy	JGLH1	Xa 21 and RM 206	PJTSAU, Hyderabad; PAJANCOA&RI, Karaikal
		RM 105	JNKVV, Jabalpur
	JRH 19	RM 228	JNKVV, Jabalpur; PAJANCOA&RI, Karaikal
Maize	PMH 1	Umc 1798, Bnlg 1036, Umc 2170, Umc 2069 and Bnlg 1297	PAU, Ludhiana
	PMH 10	Umc 1627	
	Palam Sankar Makka-2	Umc 1066	
	MAH-14-5	Bnlg 1520, Bnlg1185, Umc 1288 and Umc1594	UAS, Bengaluru
	HEMA	Phi053, Bnlg 1621, Bnlg 1014, Bnlg1185, Bnlg 238, Bnlg1716, Umc 2246, Umc2084 and Umc1594	
Sunflower	KBSH-78	ORS-57 and ORS-170	UAS, Bengaluru; PAJANCOA&RI, Karaikal
	KBSH-79	ORS-610	
	KBSH-41	ORS-513 and ORS-613	
	KBSH-44	ORS-716	
	KBSH-53	ORS-621 and ORS-811	
	NSH-10	ORS-513, ORS-605 and ORS-337	
Cotton	PDKV Suvarna	BNL 1694, BNL 226, NAU 2000 and BNL 4049	PDKV, Akola
	PKV DH-1		
Castor	DCH 519 (M 574 and DCS 78)	RcDES45	PJTSAU, Hyderabad (ICAR-IIOR, Hyderabad- only to supply the seeds)

Identification of Microsatellites Markers for new Hybrids (Objective 3)

Sincere efforts to identify unique makers to be made by all cooperating centres in Paddy, Maize, Pearl millet, Sunflower, Cotton, Castor, Sorghum and any other crop/s of interest of centre/s where hybrids are available.

Technical Programme:

Materials:

The details of identified markers, protocol followed and seeds of hybrids with parental lines shall be shared among the centres as indicated above. The cooperating centres are requested to contact each other immediately to share seeds and protocols etc. The PI should be informed in case of problem(s), if any (pispnsp@gmail.com). Kindly keep the Director, IISS Mau in the loop for all the correspondences. DNA profiles of parents and hybrids for which they are available at ICAR-NBPGR, New Delhi or in public domain will be used as standard profiles. Also, for varieties/hybrids for which unique polymorphic markers are not available, will be developed through genotyping/GBS, if funds are available from any other source. The details of markers identified by parent institute(s) for their own hybrids, if any and seeds of hybrids and their parents will be supplied by the ICAR-CICR, Nagpur (Contact person: Dr. Santhy V., 9890684572; santhy100@gmail.com) and PDKV, Akola (Contact person: Dr. A.A. Akhare, 9881880083; atulakhare@yahoo.com) for cotton; by PDKV, Akola (Contact person: Dr. A.A. Akhare, 9881880083; atulakhare@yahoo.com) for Sorghum and by ICAR-IIOR, Hyderabad (Contact person: Dr. J. Jawarharlal, 9160451473; spac.iior@icar.gov.in) for Castor; UAS, Bengaluru (Contact person: Dr. Nethra Nagarajappa, 9900244735; nethraharsha@gmail.com) and PAU, Ludhiana (Contact person: Dr. Navjyot Grewal, 9915151165; navjyot_grewal@yahoo.com) for Maize; JNKVV, Jabalpur (Contact person: Dr. R. Shiv Ramakrishnan, 91740 56526; shivram.krishnan2008@gmail.com) and AAU, Jorhat (Contact person: Dr. Sharmila Dutta Deka, 9435351698; sharmila9368@gmail.com) for paddy; UAS, Bengaluru (Contact person: Dr. Nethra Nagarajappa, 9900244735; nethraharsha@gmail.com) for Sunflower; PJTSAU, Hyderabad (Contact person: Dr. P. Bindu Priya, 9494066866; bindupriya.gpb@gmail.com) for Castor and Paddy. In addition to seeds of newly released hybrids and their parental lines from cooperating centres of each crop, each centre will also try to take seeds of the available public sector released hybrids and their parental lines, preferably from the breeding institutes for the purpose of identification of unique molecular markers.

Methodology:

There are standardized methods available for testing of hybrid purity/ hybridity using molecular markers in each crop and will be used for;

1. Genomic DNA extraction by CTAB/modified CTAB method (Taylor *et al.,* 1995; Liu *et al.,* 2003) or Kit method.

2. Quantification of DNA and assessment of DNA quality for each sample on 1.2% agarose gel.

3. PCR analysis using unique markers (e.g., Paddy- Nandakumar *et al.*, 2004, Sundaram *et al.*, 2008; Maize- Mingsheng *et al.*, 2010; Pearl millet- Nagawade *et al.*, 2016; Sunflower- Antonova *et al.*, 2006, Pallavi *et al.*, 2011 and Cotton- Dongre *et al.*, 2011). The protocols may need further standardization for detection of mixtures or off-types using the serial dilution of DNA as template DNA for PCR based detection.
4. The results of molecular marker analysis will be compared with the Grow-Out Test:
   Size of working sample for GOT; The minimum population required for taking the observations shall be 400 plants when minimum genetic purity of ≤99% is required; however, it will also depend on the maximum permissible off-type plants prescribed for the species under consideration in the Indian Minimum Seed Certification Standards. The number of seeds required for raising the crop to obtain the required number of plants shall depend on the germination percentage of the seed sample and hence, seed rate should be adjusted accordingly. Grow out test shall be conducted in specified areas recommended for the hybrid or in off-season nurseries. The standard sample of a hybrid (control) to be obtained from the originating plant breeder / breeding institute, which will be the official standard against which all other samples of the seed of the hybrid will be judged/compared. Standard and recommended agronomic / cultural practices such as field preparation, size of the plot, row length, distance between rows, the distance between the plants, irrigation and fertilization, etc., in respect of the specific crop shall be followed both for the sample in question and its control (standard sample).
   Methods for taking observations: Grow-out test plots must be examined throughout the growing season with emphasis on the period from the flowering to ripening. All plants must be examined keeping in view the distinguishing characters described for the hybrid both in the test crop as well as the control. While taking the observation, the plants showing deviations in characters against the control should be tagged and examined carefully at a later stage to confirm whether they are off-types or not. The number of the total plants and the off-type plants found should be recorded.
   Calculation and interpretation of the results: Percentage of other cultivars, species or aberrant found must be calculated up to one decimal place. While interpreting the results, tolerances should be applied by using the reject number for prescribed standards with reference to sample size. The reject numbers will be; 8, 24, 44 and 64 for sample size of 400 plants if 99, 95, 90 and 85% purity, respectively is targeted.
5. The DNA profiling of all the hybrids along with parents grown as check in GOT plots may be done to validate the findings.

   Size of working sample for GOT; The minimum population required for taking the observations shall be 400 plants when minimum genetic purity of ≤99% is required; however, it will also depend on the maximum permissible off-type plants prescribed for the species under consideration in the Indian Minimum Seed Certification Standards. The

number of seeds required for raising the crop to obtain the required number of plants shall depend on the germination percentage of the seed sample and hence seed rate should be adjusted accordingly. Grow out test shall be conducted in specified areas recommended for the hybrid or in off-season nurseries. The standard sample of a hybrid (control) to be obtained from the originating plant breeder / breeding institute, which will be the official standard against which all other samples of the seed of the hybrid will be judged/compared. Standard and recommended agronomic / cultural practices such as field preparation, size of the plot, row length, distance between rows, the distance between the plants, irrigation and fertilization, etc., in respect of the specific crop shall be followed both for the sample in question and its control (standard sample).

Methods for taking observations: Grow-out test plots must be examined throughout the growing season with emphasis on the period from the flowering to ripening. All plants must be examined keeping in view the distinguishing characters described for the hybrid both in the test crop as well as the control. While taking the observation, the plants showing deviations in characters against the control should be tagged and examined carefully at a later stage to confirm whether they are off-types or not. The number of the total plants and the off-type plants found should be recorded.

Calculation and interpretation of the results: Percentage of other cultivars, species or aberrant found must be calculated up to one decimal place. While interpreting the results, tolerances should be applied by using the reject number for prescribed standards with reference to sample size. The reject numbers will be; 8, 24, 44 and 64 for sample size of 400 plants if 99, 95, 90 and 85% purity, respectively is targeted.

6. For validation studies, two-dimensional DNA sampling strategies may be adopted for purity assay suggested by Nas *et al.* (2002). Thus, a total of 40 DNA bulks representing 20 rows and 20 columns can be used for comparison with GOT. But,
7. Every centre to work out cost effectiveness (C: B ratio) for GOT vis-à-vis molecular markers, taking all components of cost into account and **MUST** include in the report.

Experiment 3: Physiological studies and development of priming technologies for enhancing planting value of seed in field crops under optimal and sub-optimal conditions

Year of start: 2018-19

Rationale: Seed priming, the pre-sowing treatments which lead to a physiological state that enable seed to germinate more efficiently under optimal conditions and enhance emergence even under adverse agro-climatic conditions. Priming involves soaking seed in predetermined amounts of water, solutions of hormones, osmotic agents and salts and drying back to initial moisture content. Some physical treatments (heat, cold, UV, etc.) also provide germination improvement and can be deployed as seed enhancement strategies. Primed seeds are

expected to exhibit faster, vigorous and more synchronized germination under stress conditions. Moreover, there are areas in our country where paddy and maize grown in normal season are chronically affected by various biotic, abiotic and natural calamities. This forces the farmers to grow particularly in a winter season in which these crops normally don't perform better. Exposure to low-temperature stress, during germination and early seedling growth, can negatively affect the initial stand establishment and finally the yields. A better understanding of the metabolic events taking place during the priming treatment and the subsequent germination should help to use this simple and cheap technology in a more efficient way. Any such technology tested positive should be validated at different locations before recommending it for up-scaling. Therefore, this experiment was designed with the following objectives;

Objectives:

1. Standardization of priming technologies for enhancing planting value of seed under optimal and sub-optimal conditions in selected field crops
2. Validation of standardized priming technologies for low-temperature stress during seedling establishment in Maize and Paddy
3. Demonstration of identified priming technologies in different field crops for sub-optimal/stress conditions

1. For standardization of priming technologies		
Crops		**Centres**
Barley	:	CSKHPKV, Palampur; ICAR-IISS, Mau; ICAR-IIWBR, Karnal; PAU, Ludhiana and RAU TCA Dholi
Oat	:	CCSHAU, Hisar; JNKVV, Jabalpur; OUAT, Bhubaneswar; PAU, Ludhiana and RAU TCA Dholi
Pearl millet	:	CCSHAU, Hisar; JAU, Junagadh and PDKV, Akola
Sunflower	:	PDKV, Akola; PJTSAU, Hyderabad; OUAT, Bhubaneswar; TNAU, Coimbatore and UAS, Bengaluru
2. Validation of standardized priming technologies for low temperature stress (LTS) /Organic condition		
Maize (LTS)	:	GBPUAT, Pantnagar; ICAR-IARI, New Delhi and RAU TCA, Dholi
Paddy (LTS)		SKUAST, Srinagar; UBKV, Pundibari and ARS Gudalur in association with ICAR-IARI, RS, Wellington TN/ ICAR-IARI, RBGRC, Aduthurai, TN
Paddy (Organic condition)	:	AAU, Jorhat and ICARRC NEH Region - Manipur Centre;
3. Demonstration of validated priming technologies to be repeated in a minimum of 500sqm for validated treatment along with control/s in the specified stress conditions		
Chickpea	:	CCS HAU, Hisar; ICAR-IISS, Mau; UAS, Raichur and VNMKV, Parbhani

Field pea	:	AAU, Jorhat; CSKHPKV Palampur; ICAR-IISS, Mau; JNKVV, Jabalpur and PAU, Ludhiana
Pigeon pea	:	PAJANCOA&RI, Karaikal; PJTSAU, Hyderabad and UAS, Bengaluru

NB: *Every centre MUST work out the cost effectiveness (B/C ratio) for the best treatment (significantly better than others) and any other that is at par with best, if any (i.e. maximum two treatments) in comparison with control in validation experiment and of validated treatment in comparison with control in demonstration experiment taking all components of cost into account for all crops and to be reported.*

Sub. Experiment I (Objective 1): Standardization/Development of priming technologies for enhancing planting value of seed under optimal and sub-optimal conditions in selected field crops

Year of start: 2021-22

Technical programme:

Materials:

Each centre will use four location specific seed lots i.e., **the fresh and one year old seed (within the acceptable limits of germination) of each of two most popular varieties (preferably one tolerant and other susceptible to sub-optimal condition of their locality) will be taken**, as germinability and other vigour parameters of high quality (Fresh) seeds may not significantly be improved by seed priming technologies. In case of non-availability of aged seeds of same variety, the fresh seeds will be aged by giving recommended accelerated ageing treatments for creating the other (old) lot(s).

Treatment details for standardization:

It is important for you to first know and or identify the stress you would like to address in the target crop/s at your centre and decide the set of treatments, accordingly. *Therefore, all the treatments listed are NEITHER to be tried in every crop NOR for all the stress conditions.*

The soaking (in water or solutions or carriers) seeds of Sunflower, Barley, Pearl millet and Oat is to be done at fixed temperatures; 25°C, 20°C, 30°C and 20°C, respectively. For standardization of priming technologies for enhanced planting value of seed under sub-optimal conditions in field crops, treatment/s as decided for each crop and stress will be standardized in comparison with 2 controls; 1.) Control (Untreated) and 2.) Control (Crop and location specific recommended seed treatment(s) as per package of practices);

3. *Hydropriming*– soaking in pure water without allowing emergence and re-drying to original moisture content (for moisture/ drought stress). Standardization for soaking duration and amount of water will be done.

4. *Matri-conditioning* (Solid matrix priming: SMP) – seeds are mixed and incubated with wet solid water carrier for a certain period and subsequently separated from matrix, rinsed, and dried back (for moisture/ drought stress). Standardization for solid water carrier, amount of water to be added to carrier and duration of soaking will be done.
5. *Osmopriming* – soaking seeds in osmotic solution (polyethylene glycol (PEG) - 6000) with low water potential instead of pure water without allowing emergence and re-drying to original moisture content (for moisture/ drought stress). Standardization for concentration of osmotic solution, amount of osmotic solution and duration of soaking will be done.
6. *Halopriming*– soaking seeds in various salt solutions (to decrease saline intolerance). Standardization for concentration of salt solution, amount of salt solution and duration of soaking will be done.
7. *Thermopriming/Heat treatment* – exposing seeds to temperature not exceeding 45°C, with free air circulation (to increase heat tolerance and kill pathogens). Standardization for temperature and duration of exposure will be done.
8. *Pre-chilling* –keeping the imbibed seeds at a temperature of 5 to 10°C for a period of 5 to 7 days. Standardization for temperature and duration of exposure will be done.
9. *Hormopriming* – seeds imbibition occurs in the presence of plant growth regulators (PGR have direct impact on seed metabolism and can be used to mitigate any type of stress). Standardization for concentration of PGR solution, amount of PGR solution and duration of soaking will be done.
10. *Biopriming* – seed imbibition together with bacterial inoculation (for biotic stress, specifically). Standardization for concentration/dose of inoculants and duration of soaking will be done.

NB: *The initial moisture content of the seeds MUST be recorded and the treated seeds shall have to be dried back to original moisture content.* Under normal/standard (ISTA recommended) growing/testing (no stress) conditions, the control (untreated seeds) could be significantly better over stress treated seeds. *Therefore, adept care is to be taken during conductance of experiment and reporting of results. The treated and dried seeds along with the seeds of both the controls MUST be evaluated for seed quality parameters under standard (ISTA recommended) conditions as well as the targeted stress conditions. The treatment combination giving significantly better values of quality parameters ONLY under stress conditions will be taken as standardized treatment.*

Methodology

A. *Hydropriming* – All the centres shall **standardize the duration of soaking** and **optimal amount of water** in which seeds be soaked for hydropriming. It is important to record initial moisture content, where you also have the weights (g) of seeds in all treatment combinations before start of soaking.

1. The seeds are to be soaked at fixed temperatures as mentioned above for respective crops in different ratios of seed weight (g) to volume (ml) of solution or water (*Wt. of seed /Vol. of water; 1:1/2 (or less) to 1:1.5 (or more)* for variable durations and then evaluated under standard test conditions to know the best period of soaking and amount of water. Start removing the seeds from all treatment combinations for testing after 3hr of soaking and continue removing an interval of not more than 2 hours. Further soaking MUST be stopped once any signs of radicle emergence are noticed. The last 2-hour interval (lag) where the instances of radicle emergence were observed, the time interval for optimal soaking (priming) be further adjusted (fine-tuned). For this soak the fresh seeds separately and keep them for the total period before observing the radicle emergence and after that start removing seeds for testing an interval of not more than 1/2 hour (Total time before the last lag + 30min, one hour, one and half hour).
2. The seeds removed from water/solutions for drying can still be found absorbing water if not wiped properly and or put on germination paper/s with water. It can be observed based on gain in weight and or volume or sometimes we can hear some cracking sound. For this we need to remove the seeds from water (all priming combinations) after completion of each soaking interval and wipe them all thoroughly with filter paper. Spread them uniformly on roll towel paper for 5 minutes and transfer them to dry on other layer of two roll towel papers. This MUST be done to ensure that seeds are not gaining weight/ absorbing water after the period for which they were to be primed/the optimal soaking time and amount of water.
3. The seeds MUST be dried back to initial moisture (air-drying in shade (~25°C for minimum 48h) or in drying cabinet at 35 ± 1°C). Drying under fan must be done in shade by spreading seeds uniformly and individually on germination/ roll towel papers. Drying of the treated seeds till initial moisture levels can be ascertained by weighing the dried seeds that should match with the initial weight (g) of seeds in all treatment combinations taken before start of soaking. Subsequent to drying, seeds are to be subjected for estimation of quality attributes as per ISTA. In this case soaking (priming) stress treatment was given and can also give good results under any other stress (salt/heat) situations.
4. An apt analysis of evaluation/testing data of dried seeds from all treatment combinations will results in identification of the best combination (Interaction) of duration (Factor 1) and amount of water (Factor 2).

B. Other priming/seed quality enhancement (SQE) treatments –The period, temperature and drying specified above may be the same for all other (Halo/Osmo/SMP etc.) priming treatments except that of making solutions of different concentrations. Moreover, the soaked and dried seeds (from all combinations) are to be evaluated under standard test (Control) conditions as well as under target stress condition/s (all treatment combinations) to find out best combination at maximum stress. Various priming/ pre sowing seed treatments are related with tolerance to various stresses by modulating hormone

homeostasis together with alterations of ion uptake and accumulation between shoots and roots e.g. seeds primed with ascorbic acid, salicylic acid, GA_3 and kinetin with salt tolerance; exogenously supplied phytohormones with salinity stress; polyamines-priming and spermidine pre-treatment with drought tolerance etc. have been reported in various crops. The broad procedure for conduct of various priming/seed quality enhancement (SQE) treatments have been mentioned below;

i. *Osmopriming* –The polyethylene glycol (PEG), mannitol, sorbitol and glycerol etc. compounds can be used to prepare solutions of required osmotic potential. Polyethylene glycol (PEG) is a polymer of ethylene oxide with a molecular weight of less than 50,000. PEG has the following structure: -(CH2-CH2-O)n-. Since large molecular size of PEG prevents its penetration into the seed thus avoiding induction of potential cytotoxic effect and reduction of osmotic potential within seed. PEG can also be effectively used in the pot-culture experiment. Plants can be grown in pot culture by following normal cultural practices till the desired stage. Then PEG solution can be used to irrigate the soil. Consider the soil moisture for applying the desired level of PEG, as soil moisture will dilute the PEG solution applied. Regularly monitor the soil moisture content through the volumetric method and soil water potential through the tensiometric method. The most commonly used PEG -6000 shall ONLY be used for standardization with and testing in PEG solutions of various concentrations as given table below;

Table: Osmotic potential of PEG - 6000 at 25ºC (Michel & Kaufmann, 1973).

*PEG6000 (g/kg)	Osmotic potential		PEG6000 (g/kg)	Osmotic potential	
	Bars	MPa		Bars	MPa
50	-0.5	-0.05	250	-7.3	-0.73
100	-1.5	-0.15	300	-10.3	-1.03
150	-3.0	-0.30	350	-13.7	-1.37
200	-4.9	-0.49	400	-17.6	-1.76

NB: These relationships can vary depending on the source of the specific PEG used.

***Precautions:** Do not use different lots of PEG in one experiment and MUST measure the final solution osmotic potential. It is also worth to mention that the values of water potential together with duration of the priming treatment should always needed to be adjusted to species, cultivar, and even seed lots.

For emergence studies, the drought/moisture stress could be created by calculating and thus controlling the water supply in trays/pots/field so as to **maintain the moisture content ≥ 20% to ≤ 40%**. For moisture stress studies in laboratory, soaking seeds in PEG 6000 solutions of desired levels of osmotic potential (ψ) at 25°C and testing them in solution/s prepared by adding required quantifies of PEG 6000 for desired levels of (ψ) water availability to be used; e.g. soaking in water stress equivalent to Permanent Wilting Point (-1.5MPa), available water equivalent to 75% of Field Capacity (-0.39MPa), available water equivalent to

50% of Field Capacity (-0.76MPa) available water equivalent to 25% of Field Capacity (-1.15MPa) and drying.

Imposition of moisture stress

Both soil and plant water status need to be quantified at desired interval during the entire experimental period using gravitometric method and tensiometric method (for soil moisture and Relative water content measurement (for plant water status measurement)

1. Fill the tension-meter cup with the water and insert the tension-meter inside the soil up to 30 cm in depth
2. Tensio-metric soil water potential was measured daily.
3. Install tensiometer in triplicates for each experiment.
3. Periodically refill the cup of the tension-meter.
4. Plant will face extreme stress in case of sandy loam soil at or above 55 Kpa.
5. Schedule irrigation in accordance with the stress levels required and soil moisture availability (as reflected from tension-metric reading)

Gravimetric approach for imposition of moisture stress

Materials: Post or battery containers, garden soil, sand and manure, mobile weighing devices, seed/plant material, rain-out-shelter (ROS) or polythene sheet covered on net house

Procedure:

1. Weight the empty pots and record the accurate weight for each pot (**A**)
2. Fill the pots with soil: farmyard manure mixture in the ratio of 2:1:1: or 2:1 ratio of soil: farmyard manure mixture. While filling the pots, makes sure that the soil mixture is not compacted
3. Weight the pot along with soil (**B**) and deduct the empty pot weight to obtain the dry soil weight (**C**)

   C=B-A
4. Carefully flood the pot with water (not splashing the soil from the pot). Allow it for overnight to drain excess water and attain field capacity (FC).
5. Take the pot weight after saturation (**D**) and deduct empty pot weight (A) to get full soil weight (E) at field capacity.

   E=D-A
6. Subtract the dry soil weight from the full soil weight to get the amount of water required to attain 100% FC **(E-C).**
7. Sow seeds of the crop under investigation in the pots. Maintain two to four seedlings in each pot and water regularly to maintain the moisture level at desired level of FC viz. 100% FC, 75%% FC, 60% FC etc. Ensure to protect the pots from rains or any other source of water by keeping them under rain out shelter (ROS).
8. At four or six-leaf Stage or at good foliage, impose drought stress by withholding irrigation (please refer the diagrammatic representation given below). Weight the pots at regular intervals to monitor water status at different FCs. Replenish the water every time by

adding the required amount of water depending on the loss of water occurred previously and also based on the set FC value. The amount of water to be replenished to maintain the required FC in the containers can be arrived at based on the formula given below.

To maintain 100% FC, X ml of water is required. Therefore, to maintain Y% FC, it is

$$Y\%\ FC = \frac{Y\% \times X \text{ ml of water}}{100\%}$$

For example, the amount of water required to maintain 100% FC= 200ml

Therefore, the amount of water required to maintain 80% FC= $\frac{80 \times 200\text{ml}}{100}$ =160 ml

NB: The pot size relative to plant size is important.

The plants under different treatments are to be grown for a week or longer depending on the crops. During this period, soil water potential (Mpa) and osmotic potential (Mpa) are measured with Dew Point Potentiometer and Osmometer, respectively. Similarly, Relative water content (RWC%) is quantified according to Bars and Weatherly (1962) to assess the tissue water status and Electrical conductivity (EC%) is quantified to assess the stress-induce cell damage.

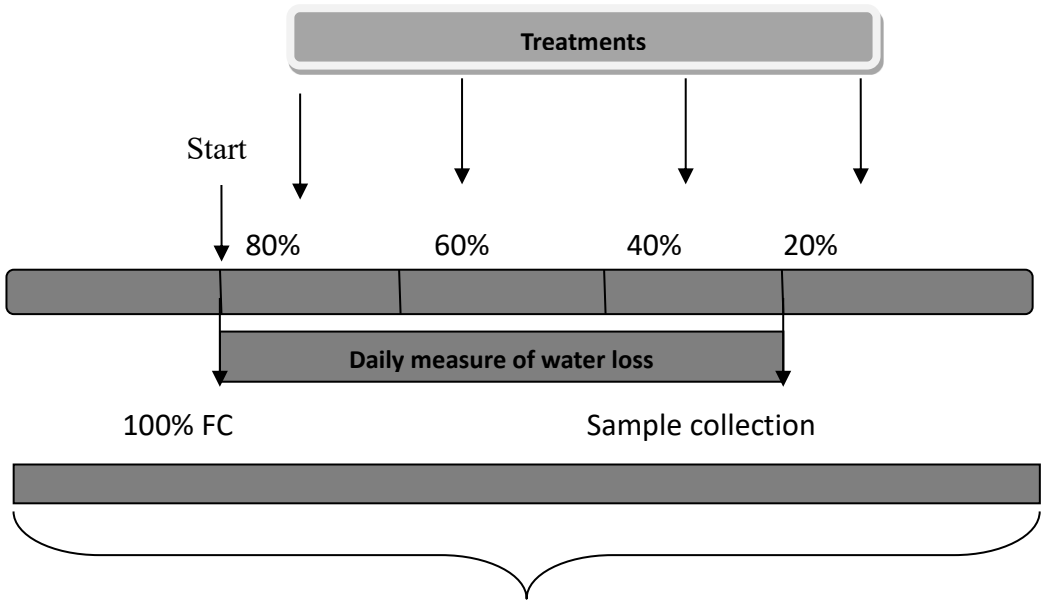


Figure: Diagrammatic representation of gravimetric approach followed for imposing precise levels of moisture stress/drought.

ii. *Halopriming*– Depending upon the crop, location of centre (soil) and target stress, solutions of different concentrations of the inorganic salts such as $CaCl_2$, NaCl, or KCl, or KNO_3, or K_3PO_4, or KH_2PO_4, or $MgSO_4$, or $ZnSO_4$could be used for priming the seeds. The priming/osmopriming with any of these salts alone or in combinations with different concentrations needs to be tried. The dried seeds from all treatment combinations along with both the controls shall be tested under standard test

conditions as well as under target stress condition/s at would be required for standardization. For example, testing primed seeds in 0.2% of Potassium nitrate (KNO_3) solution: The germination substratum to be moistened with a 0.2 percent solution of KNO_3, prepared by dissolving 2 gm KNO_3 in one litre of water. The substratum is saturated at the beginning of the test. After putting 100X4 seeds keep them incubator and use water for moistening it after that, if required.

Preparing the solutions of required Electrical conductivity (EC): Though there are several methods for the preparation of solutions with specified Electrical conductivity (EC). Some suggests the easiest way is to use the relationship: 640mg per liter of either NaCl or $CaCl_2$= 1ds/m. you could also use the molar concentration of either salt to make your calculation, remembering that 10mM of NaCl or $CaCl_2$ =1ds/m. We need to homogenize the water after dissolution of salts and test EC. However, subtract the EC of original water from the EC to be developed for calculation of the quantity of salts to be added. Given below are probable quantities of NaCl + $CaCl_2$ salts to be used for preparation of solutions of different ECs.

Table: EC of different salt solutions at 20°C (1 dS/m = 1 mmho/cm).

*Solution	EC (dS m^{-1})	Weight (g) of NaCl	+	Weight (g) of $CaCl_2$	EC (dS m^{-1})
10 mM NaCl	1.0	0.59 g	+	1.12 g	2
100 mM NaCl	9.8	1.17 g	+	2.22 g	4
500 mM NaCl	42.2	1.75 g	+	3.33 g	6
10 mM KCl	1.2	2.34 g	+	4.44 g	8
10 mM CaCl2	1.8	2.63 g	+	4.99 g	9
10 mM MgCl2	1.6	2.92 g	+	5.55 g	10
50 mM MgCl2	8.1	*** Strongly recommended to use trial and error method**			

The trays/pots/fields with >2 to <6dSm conductivity of the saturation extract of soils may be considered good to study the salinity. Prepare salt solution of desired EC using NaCl and $CaCl_2$ for salts stress studies in the laboratory.

Methods of imposing salinity stress

- Conducting experiments in naturally salt affected soils to assess salt tolerance of genotype is more reliable and easier to perform.
- Care should be taken to avoid variation in salinity levels within a field.
- In pot culture experiments, a mixture of NaCl, Na_2SO_4 and $CaCl_2$ in 2:1:1 ratio, resulting in Na:Ca and Cl:SO_4in 4:1 ratio should be mixed with the soil or added through nutrient solution.
- The EC of soil solution needs to be measured to quantify the salinity level. Often only NaCl at required concentration (Table above) is used along with nutrient solution to impose salt stress on the plant.

Though there are several methods for the preparation of solutions with specified Electrical conductivity (EC). Some suggests the easiest way is to use the relationship: 640mg per liter of either NaCl or $CaCl_2$= 1ds/m. you could also use the molar concentration of either salt to make your calculation, remembering that 10mM of NaCl or $CaCl_2$ =1ds/m. We need to homogenize the water after dissolution of salts and test EC. However, subtract the EC of original water from the EC to be developed for calculation of the quantity of salts to be added. Given below are probable quantities of NaCl + $CaCl_2$ salts to be used for preparation of solutions of different ECs.

iii. *Thermopriming/Heat treatment* – Exposure of seeds to different temperatures (30, 35, 40, and 45°C) for different periods (6, 12, 24, 36 and 48 hr) and testing of all treatment combinations and both the controls under standard test conditions as well as under heat stress condition/s (above the standard temperature with an increment of 5°C till 45°C) would be required for standardization. E.g. standard temperature for testing barley germination is 20°C so the testing of all treatment combinations for standardization at higher temperatures would be done at 25°C, 30°C, 35°C, 40°C, and 45°C, whereas for standardization at lower temperatures testing would be done at 15°C, and 20°C.

iv. *Pre-chilling* –The replicates of seeds shall be placed in contact with the moist substratum and kept at a low temperature for an initial period before they are removed to the standard temperature for germination. Seeds are kept at a temperature between 5°C and 10°C for an initial period of up to seven days. In some cases, it may be necessary to extend the pre-chilling period or to re-chill. The pre-chilling period is not included in the germination test period.

   Use **germinators set at different temperatures (Say between 15°C to 40°C)** or **sowing dates to be adjusted** (prepone/postpone) as per the prevailing climate **(mean temperature of ≤16°C for cold stress and ≥37°C for heat stress)** at respective centres for temperature stress studies.

v. *Hormopriming* – The regulators commonly used for hormopriming are: **abscisic acid, auxins, gibberellins, kinetin, ethylene, polyamines, and salicylic acid (SA)**. *Each of these has specific role in crops and action differs with concentrations*. For example; Gibberellic Acid (GA_3) method is recommended for *Avena sativa*, *Hordeum vulgare*, *Secale cereale*, and *Triticum aestivum* for seed quality enhancement by breaking the dormancy. Where, the germination substratum may be moistened with a 500-ppm solution of GA_3, prepared by dissolving 500 mg GA_3 in one litre of water. When the dormancy is weaker, 200 ppm may be enough. When it is stronger, up to 1000 ppm solution may be used. Depending upon the required effect the regulator/s and their concentrations need to be tried for standardization.

vi. *Biopriming* – Application of biopriming agents is very critical. Hydration of seeds infected with pathogens during priming can result in a stronger microbial growth and consequently impair plant health. However, applying antagonistic microorganisms during priming is an ecological approach to overcome this problem. Moreover, some

bacteria used as biocontrol agents are able to colonize rhizosphere and support plant in both direct and indirect way after germination stage. Biopriming could be a much more effective approach to disease management than other techniques such as pelleting and film coating, if devised, designed and tested sensibly. Biopriming with plant growth-promoting bacteria (PGPB), *Pseudomonas fluorescens* isolates, rhizobacteria etc. has been reported to enhance plant growth and resistance. For standardization effect of various biopriming/ biocontrol agents needs to be evaluated under different stress conditions. For example: seed coating (on hydroprimed seeds and on dry seeds) can be done with *T. harzianum* (**CFU –** 2 X 10^6per gm) @ 15 g / kg seed by mixing 15g in 50 ml of water and applied on 1 kg of seed uniformly. Shade drying the seeds for 20 – 30 minutes before testing/sowing; Seed coating (on hydroprimed seeds and on dry seeds) with cold adoptive PGPB and seed coating (on hydroprimed seeds and on dry seeds) can be done with *T. viride* (**CFU –** 2 X 10^9per gm) @ 10 g / kg seed by mixing 10g in 50 ml of water and applied on 1 kg of seed uniformly. Shade drying the seeds for 20 – 30 minutes before testing/sowing. *CFUs in any of the microbial consortium must be confirmed before treatment. Everyone must follow the guidelines for coating and testing of microbial consortia as supplied by the developer*.

vii. *Matri-conditioning* (Solid matrix priming: SMP) – The basic rule in SMP is to use solid medium that allows seeds to hydrate slowly and simulates natural imbibition process occurring in the soil. The vermiculite, perlite, peat moss, coir or peat, charcoal, sand, clay, and some commercially offered substrate such as Celie or Micro Cell are exemplary solid carries that could be applied in solid matrix priming. However, any materials that possess specific physical and chemical features such as; low matrix potential, minimal water solubility, high water holding capacity and surface area, no toxicity to seeds, and ability to adhere to seed surface can be utilized as matrices. In order to obtain the best priming performance, time of treatment and optimal water content must be determined separately for each matrix. Thus, use of matrices and their combinations to be standardized.

Observations:

Seeds of the all crops after treatments are to be tested along with both the controls under specific stress conditions (Drought/moisture, salinity and temperature) as mentioned above. Effect of the treatments on biotic stress (fungal infections) is also to be recorded. For additional studies, if interested, on biotic (fungal) stress sowing in sick plots and or inoculating with the target fungus can be done. Following observations are to be recorded in all treatment combinations.

- Moisture content (ISTA) before and after treatment
- Time (hrs) for maximum numbers of radicle emergence (≥2mm) **- optional**
- First count %

- Germination % (ISTA)
- Vigour index-I & II (Abdul Baki and Anderson, 1973)
- Incidence of seed borne pathogens (%)
- Seedling/Field emergence (%)

Sub. Experiment II (Objective 2): Validation of standardized priming technologies for low-temperature stress during seedling establishment in Maize and Paddy

Year of start: 2018-19
Technical programme:

Materials: Two most prevailing varieties in each crop are to be taken.

Microbial consortia (Biophos, Drought Alleviating Bacteria (DAB) & cold adoptive Plant Growth–Promoting (rhizo) Bacteria (PGPB) etc.) for priming and abiotic stress mitigation to be supplied by the Coordinating Unit, ICAR-IISS, Mau, and organics; *Trichojal, Metajal & Beauverijal* for treatment to be made available by AAU, Anand, please. The methodology for microbial consortia treatments will be followed as mentioned below.

Method/dosage of treatment of microbial consortia and for the treatment with Biophos & Drought Alleviating Bacteria;

1. Dosage for 1/2 acre sowing area: Dilute 50 ml of formulation in 500 ml water. Add sugar or sucrose @ 10%. This quantity is sufficient to treat seeds required ½ acre.
2. Dilute required quantity of specific formulation as per seed requirement of particular plot size @ 1:10 ratio (microbial formulation: water) and add sugar or sucrose @ 10 % of final volume.
3. The bacterial suspension is then sprinkled on the seeds and the seeds are slowly but thoroughly mixed to have a uniform coating. Leave it for 30 minutes
4. Then the seeds are spread uniformly for drying on a gunny bag or cement floor in shade for 30-45 minutes avoiding direct sunlight.
5. In case of direct seeded paddy the seeds may be treated while in transplanted paddy, root dip treatment should also be given.

Treatments:

1. Control (Untreated)
2. Control (Recommended PoP)
3. Crop-specific treatments for validation, as mentioned below

Name of Crop	Name of the Treatments (In addition to 2 controls)
Paddy (LTS)	For low-temperature stress: 1. Seed coating with cold adoptive PGPB

Maize (LTS)	For low-temperature stress: 1. Primed with GA_3 (@100ppm) followed by DAB + Biophos– as mentioned above 2. Seed coating on hydroprimed (30h @ 25^{O}C) seeds with *T. harzianum*@15g / kg seed. 3. Seed coating with cold adoptive PGPB
Paddy	For Organic Conditions: *1. Metajal and 2. Trichojal* each @5ml/kg seed /lit.

NB: The participating centre/s may include any other beneficial treatment/s (max. 2) based upon literature or their experience

Laboratory observations (before and after treatments):

- Seed Moisture content (ISTA)
- Time (hrs) for maximum numbers of radicle emergence (≥2mm) **- optional**
- First count %
- Germination % (ISTA)
- Vigour index-I & II (Abdul Baki and Anderson, 1973)

Field observations: To be observed in a minimum of 5 randomly selected plants or panicles/cobs /rep/treatment from # 3 to 9.

1. Speed of emergence (JD Maguire, 1962)
2. Final plant stand establishment (%) after 5 weeks
3. Total number of tillers
4. Number of productive/effective tillers
5. Plant height (cm)
6. Panicle or cob length (cm)
7. Total number of seeds/panicle or cob
8. Number of empty seeds/panicle or cob
9. Seed set %
10. 1000 seed weight of seed produced (g)
11. Plot yield (kg)
12. Harvest Index
13. Evaluation of quality (as per ISTA) of seed produced (all laboratory observations as mentioned above)

Following are to be observed only for control and one significantly better treatment and any other treatment at par with it.

14. α-amylase activity in seed produced **- optional**
15. Total soluble sugar content in seed produced **- optional**
16. EC of seed leachates in seed produced **- optional**
17. Cost: benefit ratio of the best treatment in each crop identified at your centre - **MUST**

Sub. Experiment III (Objective 3): Demonstrations of identified priming technologies in different field crops for sub-optimal/stress conditions

Year of start: 2020-21

Objective: To demonstrate the benefits of identified priming technologies in different field crops for sub-optimal/stress conditions

Technical programme:

Materials: Two most prevailing varieties are to be taken.

Treatments:

1. Control (Untreated), 2. Control (Recommended PoP) + Crop Specific validated treatment as mentioned below

Name of Crop	Name of the Treatments (In addition to 2 controls)
Chickpea	1. Seed coating (on hydro-primed seeds (6h @ 20^{O}C) with BioNPK + Drought Alleviating Bacteria (DAB) 2. Seed coating with *T. harzianum* (CFU – 2 X 10^{6}per gm) @ 15g/kg seed
Field pea	Seed coating on hydro-primed (10h @ 20^{O}C) seeds with Biogrow
Pigeon pea	For Moisture Stress: Hydro-priming (10h @ 25^{O}C)
	For Salt Stress: Halopriming (6dSm^{-1} solution of NaCl + $CaCl_2$ for 8h @25^{0}C)

Planting/Sowing Conditions: The treated and untreated (control) seeds are to be planted in at least 500 sqm each at the time when **mean temperatures are expected ≤16^{o}C for cold stress and ≥37°C for heat stress for a mini. of 10 days after sowing**. Therefore, all the centres would record and provide the daily climate data of appox. 15 days i.e. 2-3 days before sowing to 11-12 days after sowing. For demonstrations under salt stress the **plot should have EC ≥4dSm**. Plants show moisture stress by a number of symptoms. Unfortunately, by the time most of these appear, it may be too late and the damage already done. The effect of moisture stress is more severe between 45 to 60 days after sowing. Most of crops start showing symptoms of moisture stress if the soil moisture content falls below 40%.

As you all may know that field capacity is the water content of a soil after gravitational drainage over approximately a day. The suction that defines this value varies from soil to soil, but is generally in the range of – 10 to –33 kPa (−1/3 bar). The volumetric soil moisture content remaining at field capacity is about 15 to 25% for sandy soils, 35 to 45% for loam soils, and 45 to 55% for clay soils. Fine-textured soils retain higher amounts of water (~26%–32% v/v) than the coarse textured soils (10%–15% v/v) at the permanent wilting point. Therefore, water needs will depend up on the crop/s as well as the type of soil.

Hence, the moisture stress can be created by limiting availability of water between 20 to 40% of the total water requirement during the growing periods by each crop. Else, for demonstrations **under moisture stress the plot should be maintained to have soil moisture content ≥20% to ≤40%**. All the centres taking up moisture stress experiments **MUST weekly assess the soil moisture content using oven method from sowing till 9th week of crop growth**. Please use the formula for calculation of MC% given below;

$$\text{Soil moisture content (\%)} = \frac{\text{Weight of the moist soil - Weight of the dry soil}}{\text{Weight of the dry soil}} \times 100$$

You may also use Karl Fischer titration method for determination of exact moisture content. The recommended package and practices are to be followed for raising good crop.

Laboratory observations (before and after treatments):

- Seed Moisture content (ISTA)
- Time (hrs) for maximum numbers of radicle emergence (≥2mm) **– Optional**
- First count %
- Germination % (ISTA)
- Vigour index-I & II (Abdul Baki and Anderson, 1973)

Field observations:

1. Final plant stand establishment (%) after 5 weeks - (Observations to be taken on seedlings/plants in control as well as treatment plots at randomly selected 4 places in 5-meter row lengths)
2. Plant height (cm) of 5 plants each at randomly selected 4 places in plots.
3. Total number of pods/plant in 5 plants each at randomly selected 4 places in plots.
4. Total number of seeds/pod in 5 pods/plant each at randomly selected 4 places in plots.
5. Per plant yield in 5 plants each at randomly selected 4 places in plots.
6. 1000 seed weight of seed produced (4 replications from each plot)
7. Plot yield (kg), 8. Harvest Index, 9. Evaluation of quality (as per ISTA) of seed produced and 10. Cost: Benefit ratio **- MUST**

Experiment 4: Influence of terminal heat stress on seed set, seed yield and quality in field crops

Year of start: 2017-18

Rationale: Climate is rapidly changing and can disrupt food availability, reduce access to food, and affect food quality. Heat (high temperatures) stress will be the prime abiotic constraint, under the current and climate change scenario in future. Although, heat obstruct productivity at all crop growth stages, the extent of damage at reproductive phase of crop growth, mainly

the seed filling phase, is critical and causes considerable yield losses as well as the quality of seed produced. It could substantially affect the seed yields by reducing seed size and number, eventually affecting the commercial trait '1000 seed weight' and seed quality. There are various strategies for improvement of seed yield and quality under high temperature stress. A well-integrated genetic and agronomic management option may be good option to enhance tolerance to heat. Recently, emphasis has been placed on exploiting prompt and inexpensive means of obtaining satisfactory yields under heat-stress conditions, which is very much expected in times to come. One of the pragmatic approaches could be the exogenous use/spray of heat stress alleviating compounds, inorganic salts, natural and synthetic plant growth regulators and stress signaling molecules having specific properties and roles to improve yields and germination in a number of agri-horticultural crops.

Objectives:

1. To standardize the treatments for mitigations of adverse effects of heat stress in soybean
2. To validate the standardized treatments for mitigations of adverse effects of heat stress in chickpea and finger millet
3. To demonstrate the most efficient treatment validated for mitigating heat stress in mustard

Crops		Centers
1. Standardization of treatments for mitigations of adverse effects of heat stress (Objective -1)		
Soybean	:	MPKV, Rahuri; PDKV, Akola; VNMKV, Parbhani; JNKVV, Jabalpur and ICAR-IISS, RS, Bengaluru
2. Validation of standardized heat stress mitigation technologies (Objectives -2)		
Chickpea	:	CCS HAU Hisar; MPKV, Rahuri and UBKV Cooch Behar
Finger millet	:	ICAR-IISS, RS, Bengaluru; PDKV, Akola; OUAT, Bhubaneswar and PJTSAU, Hyderabad
3. Demonstrations of validated heat stress mitigation technologies (Mini. 500sqm for Treat. & Ctrl.) (Objectives -3)		
Mustard	:	CCS HAU Hisar; PAU, Ludhiana; BSKKV, Dapoli; ICAR-CAZRI, Jodhpur and ICAR-IISS, Mau

Sub. Experiment I (Objective 1): To standardize the treatments for mitigations of adverse effects of heat stress in soybean

Year of start: 2023-24

Technical programme:

Materials:

One early maturing and one medium maturing variety will be taken for the study.

Methodology:

1. Set 1: In soybean, the experiment in open field conditions (where growth chamber facilities for elevated temperature are not available) is to be conducted by one sowing in the last week of November and another during the first week of January shall be taken. Dates of sowings and harvestings shall be recorded. The climatic data also collected and correlated with the results.
2. Set 2: Where growth chamber facilities for elevated temperature are available, the experiment will also be conducted at normal temperature requirements of that crop and 5°C elevated temperature conditions were maintained from anthesis onwards.

Mitigation Treatments combinations for soybean

1. Control (No spray)
2. Control (Water spray)
3. 6- Benzyl Adenine Purine @ 300 ppm
4. Salicylic acid @ 50 ppm
5. Indole Acetic Acid @ 100 ppm
6. Naphthalene Acetic Acid@ 100 ppm
7. Thiourea @ 1000 ppm
8. Cycocoel @ 200 ppm
9. Ethrel @ 100 ppm
10. Gibberellic acid @ 100 ppm

Spray Schedule for Soybean

- Control (Without spray)
- Vegetative stage (V5-V7 stage)
- Flowering stage (R2: Full bloom stage)
- Pod filling stage (R5: Beginning seed stage)

Note:

1. Please don't mix or store Cycocel in aluminium containers or use any aluminium equipment.
2. Avoid using biomass/straw or seeds for feed or food until 6 weeks of a spray of these chemicals.

Observations in Soybean Experiment: To be observed (Trait 2 to 8 at physiological maturity) in minimum of 5 randomly selected plants or pods/rep/treatment

1. Days to pod formation
2. Plant height

3. Time taken to reach harvest maturity
4. Number of unfilled pods
5. Total number of pods
6. Average number of seeds/pod
7. Chlorophyll content index (CCI: SPAD)
8. 1000 seed weight
9. Plot yield (kg)
10. Harvest Index
11. Cost to Benefit ratio of the best treatment in each crop identified at your centre - **MUST**
12. Evaluation of quality of seed produced (as per ISTA).

NB: *Every centre MUST work out the cost effectiveness (C/B ratio) for the best treatment (significantly better than others) and any other that is at par with best, if any (maximum two treatments) in comparison with control taking all components of cost into account for all crops in this experiment and report.*

Sub. Experiment II (Objective 2): To validate the standardized treatments for mitigations of adverse effects of heat stress in chickpea and finger millet

One most popular variety of chickpea and finger millet (ragi), recommended for normal dates of sowing will be 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 to be conducted by sowing both the crops thrice; normal, late and very late sowing dates. The dates may differ depending upon the location of centre with respect to a particular crop. Hence, the sowing dates may be adjusted accordingly (experiment may be conducted with normal date of sowing and two more sowings at 15-20 days intervals, thereafter). Dates of sowings and harvestings shall be recorded. The climatic data also collected and correlated with the results.
2. Set 2: Where growth chamber facilities for elevated temperature are available, the experiment will also be conducted at normal temperature requirements of that crop and 5°C elevated temperature conditions were maintained from anthesis onwards.

Mitigation treatments for crops:

1. Control
2. Cycocel (1000ppm) - for Chickpea
3. Salicylic acid (400 ppm) – for finger millet
4. Thiourea (400 ppm) – for finger millet

Spray Schedule:

1. Control (Without spray)
2. Vegetative (35-40 days after sowing) followed by spray at anthesis stage

Note:

1. Please don't mix or store Cycocel in aluminium containers or use any aluminium equipment.
2. Avoid using biomass/straw or seeds for feed or food until 6 weeks of a spray of these chemicals.

Observations: To be observed (Trait 2 to 8 at physiological maturity) in minimum of 5 randomly selected plants or pods/rep/treatment

1. Days to pod/ panicle formation
2. Plant height
3. Time taken to reach harvest maturity
4. Chickpea: Number of unfilled pods
5. Finger millet: Length of finger
6. Finger millet: Number of panicles/plant
7. Finger millet: Total number of tillers/plant
8. Finger millet: Number of productive tillers/plant
9. Chickpea: Total number of pods
10. Finger millet: Seed set %
11. Average number of seeds/pod/ finger
12. Chlorophyll content index (CCI: SPAD)
13. 1000 seed weight
14. Plot yield (kg)
15. Harvest Index
16. Cost to Benefit ratio of the best treatment in each crop identified at your centre - **MUST**
17. Evaluation of quality of seed produced (as per ISTA).

NB: *Every centre MUST work out the cost effectiveness (C/B ratio) for the best treatment (significantly better than others) and any other that is at par with best, if any (maximum two treatments) in comparison with control taking all components of cost into account for all crops in this experiment and report.*

Sub. Experiment III (Objective 3): To demonstrate the most efficient treatment validated for mitigating heat stress in mustard

Technical programme:

Materials:

One most popular variety recommended for normal dates of sowing will be taken for the study.

Methodology for Sowing

Each cooperating centre shall sow the crop in two blocks of at least 500Sqm each. One/two block/s would serve as untreated/recommended (control/s) and other would be treated/sprayed twice; Vegetative (35-40 days after sowing or transplanting) + Anthesis stage (Days to anthesis will vary from crop to crop and location to location).

Treatment for demonstrations:

1. Control (Untreated)
2. Control (Recommended PoP, if any)
3. Crop Specific validated Mitigation treatment as mentioned below

Name of Crop	**Name of the Treatments (In addition to control/s)**
	Two Sprays of following at: 1. Vegetative and 2. Anthesis stage
Mustard	Salicylic acid @ 400 ppm

Observations recorded:

Observation to be taken on plants in control as well as treatment plots at randomly selected 4

places in 5 meter row lengths.

1. Days to silique formation -50% of plants each at randomly selected 4 places in plots
2. Plant height (cm) of 5 plants each at randomly selected 4 places in plots at physiological maturity.
3. Total number of silique per plant in 5 plants each at randomly selected 4 places in plots at physiological maturity.
4. Time taken to reach harvest maturity--50% of plants each at randomly selected 4 places in plots
5. Total number of seeds per silique in 5 silique of each plant at randomly selected 4 places in each plots.
6. Per plant yield in 5 plants each at randomly selected 4 places in plots.
7. 1000 seed weight of seed produced (4 replications from each plot)
8. Plot yield (kg)
9. Harvest Index
10. Benefit cost ratio - **MUST**
11. Evaluation of quality (as per ISTA) of seed produced

NB: *Every centre MUST work out the cost effectiveness (C/B ratio) for validated treatment in comparison with control in demonstration experiment taking all components of cost into account for all crops and report.*

Experiment 5: Development of Digital Weed Seed Atlas: Ready Reckoner for Weed Seed Identification

Year of start: 2023-24

Technical programme:

Rationale: Weed seeds as concomitant admixtures always affect the physical purity of seed lots. Seed collection, seed illustrations, and descriptions of seed morphology have been valuable tools in identifying unknown seeds. Accurate identification of crop and weed seed contaminants is necessary for the correct labelling of seeds moving in the seed trade. Identification of weed seeds is essential for seed quality analysis for the Orange International seed lot certificate and Blue International seed sample certificate, routine seed quality analysis, seed certification, etc., and ISTA accreditation of seed testing laboratory. But, in the Indian context, only limited resources are available that can aid seed analysts in identifying these weed seed contaminants in seed lots. Digital weed seed atlas is one such attempt, consisting of digital seed images and descriptions of species based on morphological keys, which shall effectively supplement seed analysis for easy identification and significantly improves the efficiency of the seed testing laboratories, thereby increasing the efficacy of Indian seed quality assurance regime *per se*. Hence it was thought to develop weed seed atlas.

Methodology

Gross Seed Morphological Keys for Seed Identification

Use of seed morphological keys as identification cues enable cataloguing in this endeavour. Apart from these morphological characteristics, seed anatomical (internal morphology) and seedling morphological information generated pertaining to these species can supplement the identification process.

In dicotyledonous seeds, the most useful clues for recognition of seeds were usually the shape, size, and peculiarities of the surface (testa ornamentation), attached appendages and their nature, colour, surface irregularities, including pittings, grooves, and other types of sculpturing. Among monocots, most useful characteristics include gross morphology of spikelet; floret; nature of upper and lower glumes; rachilla and its position; nature and shape of lemma and palea; presence/absence of sterile florets in a spikelet; shape and colour of caryopsis; nature of attached appendages (awns, bristles, spines); surface ornamentations on lemma and palea or caryopsis, etc. would serve as most critical features for identification of species.

Below referred illustration clearly indicates the metric and characteristic cues information to be recorded for each targeted weed seed species.

Example: *ISTA Universal List of Species: Cuscuta spp.*

ISTA Universal List

Cuscuta **spp.** *(Convolvulaceae)*
Seed.

General shape: oval to round

Normal size: 0.8-1.5 mm L x 0.8-1.5 mm W x 0.8-1.5 mm D

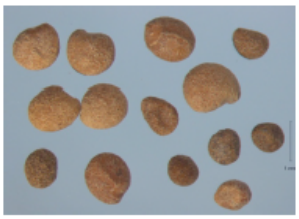
Color: yellow to brown.

Texture: finely to coarsely rough, granular or reticulate.

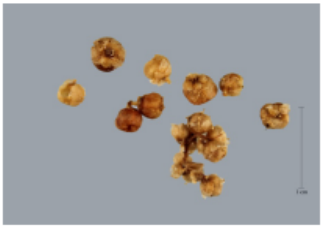
Distinguishing features: seed globular and slightly angular in cross section. The seed has two flattened, ventral faces and a convex, dorsal face. The hilum is a rather big smooth, lighter area in the corner of the seed.

Embryo: embryo coiled in one or two rotations.

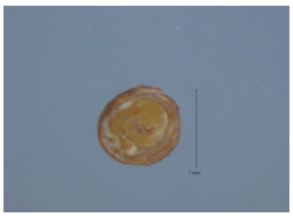
Note: parasitic plants



Seeds of *Cuscuta* spp.



Fruits of *Cuscuta* spp.



Cross section of seed showing embryo and nutritive tissue

Images by SNES-GEVES

Work Plan:

- The cooperating centres shall collect the prevalent weeds from the fields (including farmers' fields) of respective crop/s assigned to the centres and characterize them so as anybody can identify the weed seeds based upon the description given with photographs by each centre. The cooperating centres shall also create a weed seed herbarium for which they will retain at least 2500 seeds and send the same numbers of seeds of each of weed species to the PI and Coordinating unit.
- Cataloguing of crop-associated weeds (Initially objectionable weed species and weeds associated with major crop species will be targeted, **annexure below**), herbarium preparation of referred weed plants, digitalization of various phases of dispersal unit right from maturation on mother weed plant until being associated with unprocessed seed.

- Capturing of high-resolution images depending on the availability of necessary equipment, if not enabling digitalization at a centralized facility by the collection of requisite samples.
- Digital database preparation, validation, and making it available in the public domain for further improvement.

Annexure: Seed Standards [weed seeds (max.)] as per Indian Minimum Seed Certification Standards in field crops

Crop	Total weed seeds		Objectionable weed seeds		Remarks (Objectionable weed seeds)
	Foundation	Certified	Foundation	Certified	
Barley	10/kg	20/kg			
Paddy	10/kg	20/kg	2/kg	5/kg	Wild Rice *(Oryza sativa* L. var . *fatua* Prain)
Wheat	10/kg	20/kg	2/kg	5/kg	*Convolvulus arvensis Phalaris minor*
Maize	None	None	-	-	-
Sorghum	5/kg	10/kg	-	-	-
Pearl millet	10/kg	20/kg	-	-	-
Chickpea	None	None	-	-	-
Black gram	5/kg	10/kg	-	-	-
Green gram	5/kg	10/kg	-	-	-
Pigeonpea	5/kg	10/kg	-	-	-
Castor	None	None	-	-	-
Groundnut	None	None	-	-	-
Mustard	10/kg	20/kg	5/kg	10/kg	*Argemone mexicana*
Safflower	5/kg	10/kg	None	None	*Carthamus oxyacantha*
Soybean	5/kg	10/kg			
Sunflower	5/kg	10/kg	None	None	*Orobanche cumana*
Cotton	5/kg	10/kg			
Berseem	10/kg	20/kg	5/kg	10/kg	*Chicorium intybus*
Lucerne	10/kg	20/kg	5/kg	10/kg	*Cuscuta spp.*
Napier grass (slips)	-	-	None	None	*Cirsium arvense Cuscuta spp.*

					Sorghum halepense *Agropyron repens* *Convolvulus arvensis*
Oats	10/kg	20/kg	2/kg	5/kg	*Avena fatua*

NB: Our target is not just to develop the weed seed atlas of objectionable weed seeds

Crops	**Centres**
Barley	CSKHPAU, Palampur; CCSHAU, Hisar; GBPUAT, Pantnagar; IIWBR, Karnal
Paddy	JNKVV, Jabalpur; OUAT, Bhubaneswar; PAJANCOARI, Karaikal; PAU, Ludhiana; PJTSAU, Hyderabad; UAS, Dharwad; AAU, Jorhat; ICAR-IARI, New Delhi
Wheat	PAU, Ludhiana; CSKHPAU, Palampur; CCSHAU, Hisar; GBPUAT, Pantnagar; IIWBR, Karnal;
Maize	PAU, Ludhiana; IIMR, Ludhiana; IARI, New Delhi; UAS, Bangalore; UAS, Dharwad; PJTSAU, Hyderabad
Sorghum	UAS, Bangalore; UAS, Dharwad; TNAU, Coimbatore; SKNAU, Jobner; IIMR, Hyderabad
Pearl millet	SKNAU, Jobner; ICAR-CAZRI, Jodhpur;
Chickpea	JNKVV, Jabalpur; UAS, Bengaluru; GBPUAT, Pantnagar; UAS, Dharwad
Black gram	TNAU, Coimbatore; MPKV, Rahuri
Green gram	GBPUAT, Pantnagar; UAS, Dharwad
Pigeon pea	UAS, Bengaluru; PDKV, Akola; PJTSAU, Hyderabad; JNKVV, Jabalpur
Castor	JAU, Junagadh, ICAR-IIOR, Hyderabad
Groundnut	UAS, Bengaluru; TNAU, Coimbatore; ICAR-DGR, Junagarh
Mustard	CCSHAU, Hisar; GBPUAT, Pantnagar; JNKVV, Jabalpur
Safflower	MPKV, Rahuri; UAS, Bengaluru; SKNAU, Jobner and VMMKV, Parbhani
Soybean	JNKVV, Jabalpur; PDKV, Akola; ICAR-IISR, Indore; ICAR-IISS, RS, Bengaluru and VNMKV, Parbhani
Sunflower	UAS, Bengaluru; OUAT, Bhubaneshwar
Cotton	ICAR-CICR, Nagpur; PDKV, Akola; MPKV, Rahuri
Berseem	ICAR-IGFRI, PAU, Ludhiana
Lucerne	ICAR-IGFRI, SKNAU, Jobner
Oats	CSKHPAU, Palampur; CCSHAU, Hisar; PAU; Ludhiana

Experiment 6: Evaluation of seed quality attributes and storage potential of bio-fortified varieties in major field crops

Year of start: 2023-24

Technical programme:

Rationale: Realizing the importance of nutritional quality, the research efforts of NARES led to the development and release of many bio-fortified varieties of different crops. Bio-fortified varieties are enriched with a diverse profile of nutrients and assume great significance for nutritional security. The recent initiative i.e., 'National Nutrition Strategy' by the NITI Aayog, Govt. of India, would also provide impetus to utilize these bio-fortified varieties more effectively towards achieving 'Kuposhan Mukt Bharat'. In this regard, information on the influence of bio-fortification on the seed quality attributes, especially on seed storability with enhanced nutrients in fortified varieties, is scarce. Hence, it is proposed to evaluate bio-fortified varieties' seed quality status and storage potential in major crops. *Rice, Wheat, Maize, Pearl millet, Mustard, etc.*

Crops	**Biofortified varieties source centers**	**Centers**
Rice	NRRI, Cuttack ICAR-IIRR, Hyderabad	PAJANCOARI, Karaikal; PJTSAU, Hyderabad; PAU, Ludhiana; OUAT, Bhubaneswar and UAS, Dharwad
Wheat	ICAR-IIWBR, Karnal; PAU, Ludhiana; ICAR-IARI, New Delhi	PAU, Ludhiana; PDKV, Akola; ICAR-IIWBR, Karnal; GBPUAT, Pantnagar and JNKVV, Jabalpur
Maize	ICAR-IARI, New Delhi; ICAR-VPKAS, Almora	UAS, Bengaluru; MPKV, Rahuri, TNAU, Coimbatore and CSKHPAU, Palampur
Pearl millet	CCSHAU, Hisar; MPKV, Rahuri; VNMKV, Parbhani	CCSHAU, Hisar; VNMKV, Parbhani; SKNAU, Jobner and JAU, Junagadh
Mustard	ICAR-IARI, New Delhi	GBPUAT, Pantnagar; ICAR-IARI, New Delhi; UBKV, Pundibari and ICAR-CAZRI, Jodhpur
Quantities of seeds to be supplied/procured: Rice, Wheat: 2 kg (1 kg each in poly-lined & cloth/jute bag container); Maize: 3 kg (1.5 kg each in the respective container); Pearl millet: 1 kg (500 g each in the respective container); Mustard: 1 kg (500 g each in the respective container) *Rice and Pearl millet: ICAR-IISS, Mau will coordinate the supply of seed.* *Wheat: PAU, Ludhiana will coordinate the supply of seed.*		

Maize and Mustard: ICAR-IARI, New Delhi will coordinate the supply of seed.

Materials

Freshly harvested seeds of all the bio-fortified varieties released by institutes/SAUs to be procured from the concerned institute/SAU by respective cooperating centres. The centres may seek help of Project Cooperating Unit, ICAR-IISS, Mau, if required, in pursuing the procurement of bio-fortified varieties. The cooperating centres shall also take at-least one non-fortified popular variety/hybrid (as control) of selected crops and will use for the evaluation of initial seed quality and storability till the germination % reaches below IMSCS.

Methodology

No. of varieties	One popular and at least two bio-fortified varieties shall be used for each crop by each centre.
Containers/ Packaging materials	1. Recommended / commercially used packaging material (poly-lined & cloth/jute bag) of that particular region (1 kg capacity) for specific crop/commodity 2. HDPE baglets of 1 kg capacity
Quantity of seeds	At least 1 kg of seeds per variety / container
Replications	Four
Design	FCRD
Period of evaluation	Bimonthly

The weather parameters that prevailed during seed storage may be correlated with the seed storability of bio-fortified and non-fortified popular varieties/hybrids for evaluation.

Observations to be taken:

- Initial Seed quality traits will be evaluated in fresh seeds, and germination/vigour indices observations will be taken at two months intervals, till germination reaches below IMSCS or for a period of maximum 24 months.
- Seed moisture content (%) [Initial and thereafter for every three months]
- First count, Germination %, and Vigour Indices [Monthly intervals]
- Field emergence (%) (during the time of planting window and /or during the preceding month when germination falls below IMSCS)
- Seed Health {Insect infestation (%); Live and dead insects found (No./Kg of seed) and cataloguing of infested insects // seed pathogen infection identification (if any)}

Pro-forma for Calculating Expenditure, Income and BC Ratio for STR Experiments

Sl.	Particulars	Amount (Rs./ha)
A	**Expenditure / Cost**	
1	Recurring cost of imposing the treatment (T1, T2, T3….Tn) (materialistic cost only *i.e.* chemicals, packaging materials, other physical inputs etc.)	
2	Additional labour cost on imposing treatments	
3	Salary component (as per man-days spent for imposing treatments)	
4	Miscellaneous cost	
	Sub total	
5	Interest on working capital (@ 12% per annum for total above, adjusted accordingly as per duration of experiment)	
	Total Expenditure / cost (A)	
B	**Gross income by imposing the treatment**	
1	Seed yield in particular treatment (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income by imposing the treatment (B**)**	
C	**Gross income in control (T_0)**	
1	Seed yield in control (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income in control (C)	
D	**Increase in Gross income by imposing the treatment (B - C)**	
E	**Increase in Net income by imposing the treatment (D - A)**	
F	**BC ratio for imposing the treatment (D/A)**	

Note:

1. The above information needs to be calculated for individual/every treatment
2. Expenditure, income etc. may be calculated on per quintal basis for storage experiment

Guidelines pertinent to adept reporting

- It was decided that the reports only with few tables without any write up and conclusions and just copying from the TP and mentioning the crop stage/in progress/will take it up next season will not be accepted for inclusion in reports.
- It is also reiterated that every cooperating centre shall conduct the experiments allocated STRICTLY as per the technical programme of the year. It has been decided that all the centres to send the complete reports of the results obtained/storage data recorded till 31st March, 2024 or completion of *Rabi* experiment/s, whichever is earlier. The last date for receiving mails with the reports including conclusions of all the allotted experiments for 2023-24 appended (ONLY ONCE) will depend on the dates of AGM and shall be communicated by the ICAR-IISS, Mau. It has also been decided that all centres shall present "ONLINE" the salient achievements of all the experiments allocated during the year 2023-24 before the SPST group during 15 to 20 April, 2024. *Please don't combine results/conclusion of all crops allotted to your centre in a particular experiment.*

➢ **Kindly;**

a. Note that many observations have been mentioned in TP to be recorded in different experiments, but every observation may not have the direct relevance to the targeted outcome. Objective of considering the additional observations than actually required to meet the purpose is that the experimentation could also result in good publications of the scientists and their students working in SPST experiments under STR.
b. Take/involve your centre/self only in those experiments where you are comfortable conducting them in terms of facilities and expertise, please.
c. Understand fully the experiment by critically reading the Technical Programme! Is it standardization, validation or demonstration experiment?
d. Report the outcome of results only in line with the Technical Programme. It is very important to address the problematic data, if there are deviations in results than the expected and or established facts, discuss the issue with peers and or PI, don't report it but redo the experiment, as may be needed.
e. Note that there is no need to mention the details of standard methodologies of observations that are to be recorded strictly as per technical programme. However, you must mention if you have done some necessary modifications in standard protocol/s or used any new method/s for taking any planned observation/s, giving reasons. For example you are reporting germination (Initial, Final & Towel Paper); the explanation of particularly Towel Paper, if it is different will be required.
f. Note that no conclusions can be drawn only on mean tables and you must first understand the requirement of data analysis.
g. Prepare appropriate **table of means separately for each parameter** studied and MUST mention the CD & CV values for all factors and their interactions. Don't forget to give tables/figures/plates a suitable, clear, descriptive title and number. Then properly

describe results of each parameter referring to each table number separately in body of text.

h. Note that the best treatment in standardization or validation experiments could only be one, but you can recommend more if they are at par with the best.

i. Look what are you reporting/sending? Those who have not been allotted any experiment please don't report previous year's results for sake of reporting. The reports of experiments that were allotted to center/s, 1-2 years back and reported this year doesn't have any meaning than to create confusion.

j. Note that all the observations in every crop/experiment to be recorded on minimum four replications of 100 seeds each, except SMC, which will be estimated on dry weight basis as per ISTA recommended methods.

k. Note that while calculating vigour indices, average/mean length in centimetres and wet/dry weight in grams of 10 randomly selected seedlings on the day of final count should be taken. The formula to be used uniformly by all the centres; SVI-I= Mean Total Seedling Length (cm) X Germination (%) and SVI-II= *Mean Seedling Dry Wt. (g) X Germination (%). ***All centres shall take the weight of 10 properly dried seedlings in grams (g seedlings^{-10}) from each replication of all treatment combinations.**

l. Note that the files should be saved separately for each experiment allotted to your centres with name of centre, experiment. Sub-experiment number in TP of SPST and crop e.g. IARI New Delhi- Content Page, IARI New Delhi- Expt. 1. Lentil, IARI New Delhi- Expt. 1. Mustard & IARI New Delhi- Expt. 4.1. Wheat). Similarly, every centre shall have to share the raw data in separate excel file/s/sheet/s for each experiment. The excel sheet for feeding data of each experiment will be made available by the PI.

m. There will be as many files as the numbers of experiments and numbers of crops in each experiment. Please mention in tabular form the contact details of all concerned Scientist/s with SPST experiment/s on first page, details of experiments allotted and conducted under SPST at your centre on second page and note on recommendation of technology, if any on third page of Content Page file (As per the formats given below).

First Page of Content Page File from Each Centre

Contact details of all concerned Scientist/s with SPST experiment/s

Name of the Centre	**:**	
Name of the Lead Scientist associated	**:**	
Contact Details of the Lead Scientist associated	**:**	
Names of the Other Scientists associated, if any	**:**	
Contact of the Other Scientists associated, if any	**:**	

Name of the Nodal Officer/ Special Officer Seeds	**:**	
Contact Details of the Nodal Officer/Special Officer Seeds	**:**	
Name of the Director/ Director Research of Institute/University	**:**	
Contact Details of the Director/ Director Research of Institute/University		

Second Page of Content Page File from Each Centre
Brief note on recommendation of technology, if any

1. **Title of the technology:**
2. **Introduction of the problem addressed:**
3. **Inventor(s) Name and contact details of Scientist/s involved from your centre**:
4. **Brief Description of the technology** (**Technique/Methodology):**
5. **Cost of development of technology:**
6. **Readiness of technology for commercialization:**
7. **Challenges associated with the technology, if any:**
8. **Commercial potential of technology** (Please include advantages over the existing)**:**
9. **Geographical potential:**
10. **IP to be filed (if any):**
11. **Proposed Terms & Conditions for Commercialization:**

Third Page of Content Page File from Each Centre
Details of experiments allotted and conducted under SPST at..... (Name of Your Centre)

Sr. No.	Sr. No. as per TP	Crop (e.g.)	Allotment Year as per TP	Year of Conduct	Season of Conduct	*Status of Expt. At Centre	Date of Submission of full Report of Expt.
1.	1.	Lentil					
2.	1.	Mustard					
3.	4.1	Wheat					
4.	4.2	Paddy					
5.	5.2	Wheat					
6.	6.	Maize					
7.	7.	Onion					

***If the status indicated as – "in progress" here, there is no need to prepare a separate file for that experiment and submit, Please.**

Also note the important points below:

- **Adherence to the time for reporting is must and be prepared for making centre wise presentations on salient findings during the year under report.**
- **Reports for sake of reporting are discouraged:**
  It is reiterated that the complete reports in all respects should be prepared on analysed data and submitted timely. **Mere writing experiment in progress and or copying from the technical programme and putting some values in tables and sometimes only mean tables and not writing anything in the name of report is highly undesirable and has been viewed very seriously.** In general, the designs used for analysis of laboratory experiments is completely randomized design (CRD) and for field experiments is randomized complete block design (RCBD). Depending upon the numbers of treatment combinations factorial structure could also be employed. For testing hypotheses about the mean of a small sample drawn from a normally distributed population when the population standard deviation is unknown e.g. for demonstrations "Student's t-test" can be used. **First understand the objective of experiment and anticipate the outcome and then prepare report accordingly.** Don't repeat the results that you have already validated and reported in a particular crop. However, it is advised to discuss with the peers and statisticians of your organization for use of deemed fit designs.
- **Uniformity in reporting:**
  It has been noticed that the different centres use different format for reporting. It was decided that every centre should report as per the following headings; **Name of the Centre, Number and Name of the Experiment (It should be the same as in TP and NOT the Number at which you conducted/reported at/from your centre), Crop/s (Report separate for separate crops), No need to write objectives. Materials used (justifying, if it is different than the TP), Treatments given (justifying, if it is different than the TP), Methods of treatments, Observations recorded, Methods of recording observation (MUST), Results (separate tables/figs./plates for separate experiment/s and crop/s) with proper elaboration of each table numbers, Salient Findings of the year OR Conclusions, Suggestion, if any.** Centres should give the explanations while jotting down concluding remarks on the results of the year/s.
- **Submission of highlights and Slides:**
  For highlighting the Salient Finding(s) of your centre by PIs in the workshop, it is also desired that each centre shall submit 1-2 slides each for each crop in every experiment they were involved during the year/s under report on or before 15th April next year.
- **Relook at the report before you submit:**
  It is advised to all the centres to see the report of previous year/s. Also look out for legends/ headings of Table/s. DO refer the table number individually in the body of text of the results. Similarly for headings of figures and plates, the repetition of same data in chart/diagram causes confusion only, moreover photos/plates without any significance are meaningless. Avoid copying tables directly from excel, if you have do please check to

rows columns are proper. Do see the data for uniformity before and after decimal in the tables (No need to have more than four figures in total!). Write C.D. (p=0.05) and SEd± etc. uniformly. Mark the critical value of 'r' at 5% and at 1% with '*' or '**'. Providing monthly mean weather data without indicating its effect on results is useless. Explain the abbreviation/s used there in the tables. Running the **Spell Check is a must before submission.**

- **Confirmation by each centre:**
  Every scientist/staff associated with STR, AICRP-NSP at each centre shall critically read this document and confirm within a week, through email to PI (pispnsp@gmail.com) with copy to Coordinating Unit, ICAR-IISS, Mau (seednsp@gmail.com) that they have understood the programme fully and shall conduct the experiments as proposed. Please feel free to discuss with your peers and or PI for clarifications, if any.

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
1	ICAR-IARI, New Delhi	Dr. Shiv Kumar Yadav	Pr. Scientist & PI	pispnsp@gmail.com	9868273684
2	ICAR-IISS, Mau	Dr. Udaya Bhaskar K.	Sr. Scientist & Co-PI	udaya9252@gmail.com	9557935499
3	TNAU, Coimbatore	Dr. Nelson Navamaniraj	ASRO (SST)	nelsonnavamaniraj@tnau.ac.in	9789220924
4	AAU, Jorhat	Dr. Sharmila Dutta Deka	Pr. Scientist	sharmila.deka@aau.ac.in;	9435351698
5	UAS, Bangalore	Dr. N. Nethra	ASRO	nethraharsha@gmail.com;	9900244735
6	ICAR RC NEH, Manipur	Dr. I. Meghachandra Singh	Pr. Scientist	jdmn.icar@nic.in;	9436027223
7	CSKHPKV, Palampur	Dr K C Dhiman	Pr. Scientist	karam_dhiman@yahoo.co.in;	9418035580/ 7018803179
8	JNKVV, Jabalpur	Dr. R. Shiv Ramakrishnan	ASRO	shivram.krishnan2008@gmail.com;	9174056526
9	KAU, RARS, Pattambi	Dr. Vidhu Francis	ASPO	vidhu.francis@kau.in	9847236616
10	OUAT, Bhubaneswar	Dr. Simanta Mohanty	ASRO (Seed Production)	simantamohanty@yahoo.com;	9437301110
11	PAU, Ludhiana	Dr Navjyot Kaur	ASRO	navjyot_grewal@yahoo.com;	9915151165
12	PDKV, Akola	Dr. Amrapali A. Akhare	Associate Professor (CAS)	atulakhare@yahoo.com;	7020990738
13	PJTSAU, Hyderabad	Dr. P. Bindu Priya	ASRO	bindupriya.gpb@gmail.com;	94940 66866
14	RPCAU, Pusa	Dr. Rajesh Kumar	Associate Professor	rajrau.2007@rediffmail.com;	8809435010
		Dr. Sumeet Kumar Singh	Assistant Professor	sumitiasbhu@gmail.com;	9334792496
15	SKUAST, Srinagar	Dr Aflaq Hamid	Assistant Professor	falak19@gmail.com;	7889617904

		Dr Gowhar Ali	Assistant Professor	gowharpbg@gmail.com;	7006353051
16	UAS, Dharwad	Dr. Ravi Hunje	Special Officer (Seeds)	Soseed@uasd.in;	9448301595
		Dr. Vijayakumar. A. G	SPO	vijayakumarag@uasd.in;	9482182111
		Dr. Malik Rehan	Technical Officer	malikuasdwd@gmail.com;	9663356479
17	UBKV, Pundibari	Dr. Nipa Biswas	Assistant Professor	biswas.nipa92@gmail.com;	9800536748
18	MPKV, Rahuri	Dr. B. D. Patil	ASRO (Seed Physiology)	bdpatil47@gmail.com;	7588371029
19	IARI, New Delhi	Dr. Sangita Yadav	Pr. Scientist	sangitaydv19@gmail.com;	9868273681
		Dr. Monika A. Joshi	Professor	monikashat622@gmail.com;	99100 26346
20	CCSHAU, Hisar	Dr. Axay Bhuker	ASRO	bhuker.axay@gmail.com	9812375695
		Dr. Punith Raj MS	ASRO	hodsstnew@gmail.com	9632369953
21	GBPUAT, Pantnagar	Dr. M.K. Karnwal	ASRO	karan.mk30@gmail.com	9639778002
		Dr. Omvati Verma	SRO	dr_omvati@rediffmail.com	7055283663
22	ICAR-CICR, Nagpur	Dr. V. Santhy	Pr. Scientist	santhy100@gmail.com	9890684572
23	ICAR-IIMR, Hyderabad	Dr. Sooganna	Scientist	sooganna@millets.res.in	9540331656
24	CSAUAT, Kanpur	Dr. CL Maurya	Head, DSST & I/c STR	clmaurya@csauk.ac.in	9453479077
25	PAJANCOA&RI, Karaikal	Dr. T. Ramanadane	Professor	raman_nadane@yahoo.com	9443875443
26	ICAR-IIWBR, Karnal	Dr. Umesh R. Kamble	Scientist	umeshiari@gmail.com	8545811456
27	ICAR-IISS, Mau	Dr. Kuldip	Scientist	Kuldip@icar.gov.in	9736526049
		Dr. Banoth Vinesh	Scientist	vinesh.banoth511@gmail.com	8309408444
		Dr. Sripathy K.V.	Scientist	kudekallu2@gmail.com	8005202449
		Dr. Vanishree G.	Senior Scientist	vanishreeg@gmail.com	7093394389

C. Seed Pathology

Date: 26.04.2023 & 09.05.2023

Chairman : **Dr. Sanjay Kumar**
Director, ICAR-IISS, Mau

Convener : **Dr. Atul Kumar**
Principal Investigator & PS, ICAR-IARI, New Delhi

Technical programme 2023-24

Experiment 1: Monitoring and detection of seed borne diseases of significance in major field crops

Objectives:

1) Identification and documentation of important seed borne diseases.
2) Monitoring of emerging diseases of seed borne nature.
3) Detection of seed borne viruses of pulses and soybean
4) Identification of disease prone areas (state wise)

Year of start: 2021-22
Status: Continued for 2023-24

Crop (a): Paddy - Bunt, Bacterial Leaf Blight, False smut, Dirty Panicle/Grain discolouration, Bakanae/ Foot rot, Bacterial Panicle Blight, Brown spot, Udbatta

Centres: ICAR-IISS, Mau; AAU, Jorhat; SKUAST, Srinagar; TNAU, Coimbatore; CSKHPAU, Palampur; PAJANCOA, Karaikal; MPKV, Rahuri; ICAR-IARI, New Delhi; DRPCAU, Pusa; PAU, Ludhiana; CCSHAU, Hisar; PJTSAU, Hyderabad; AAU, Anand; GBPUA&T, Pantnagar; OUAT, Bhubneshwar and IARI (RS), Karnal (16)

Methodology

- **Detection Technique:** Standard NaOH seed soak method (0.2%) has to be followed for detection of bunt infection in rice samples. Minimum seed sample size is 100 from all the sources by covering the popularly grown rice varieties. Mention the range of bunt infection for each location.
- **Disease scoring:** Recording the diseases in farmers' fields and seed production plots and score the diseases as per the SES scale for rice crop. (https://www.clrri.org/ver2/uploads/SES_5th_edition.pdf). Minimum number of fields to be visited is 50 per location.
- Meteorological data should be incorporated for correlation studies.
- Seed-borne pathogens responsible for seed discoloration have to be reported.
- Impact of seed borne fungi on germination (normal seedlings) and seedlings with primary infection (part of abnormal seedlings category) and seed rot has to be

reported.

- Correlation of associated pathogens with seed germination (normal seedlings) and seedlings with primary infection (part of abnormal seedlings category) is specified separately.
- Monitoring of any other seed borne disease of importance as per centre has to be recorded.

Note: *Already supplied data sheet to be followed.*

1. *Observe for the incidence of unreported pathogens and diseases of seed-borne nature.*
2. *Information on symptoms, causal organism and factors affecting development of the particular diseases (all about epidemiology) is to be supplemented with photographs.*
3. *Sensitization drive of farmers shall be made at hot spots for the management of rice bunt with awareness for safe storage and significance of replacement of varieties.*
4. *Prepare a map depicting the surveyed locations*
5. *Provide the photographs showing the associated seed-borne pathogens.*
6. *Compile and prepare the disease distribution map of the state*

Crop (b): Wheat - Karnal bunt, Loose smut, Ear cockle, Spot Blotch and Head Blight

Centres: ICAR-IISS, Mau; CCSHAU, Hisar; PAU, Ludhiana, GBPUAT, Pantnagar; CSKHPAU, Palampur; RARI, Durgapura; IARI New Delhi; MPKV, Rahuri; ICAR-IISS, Mau and IARI (RS), Karnal (10)

Note:

1) For each crop, respective centre will compile and prepare the disease distribution map of the state based upon the last 5 years data.
2) Sensitization drive of farmers shall be made at hot spots for the management of Karnal bunt disease of wheat with awareness for safe storage and replacement of varieties.

Methodology:

- **Detection Technique:** Standard NaOH seed soak method (0.2%) has to be followed for bunt in seed samples. Minimum seed sample size is of 100 from all the sources by covering the popularly grown wheat varieties.
- For ear cockle, visual observation and standard water soak method has to be followed.
- Recording of loose smut incidence under field conditions by GOT.
- Recording of head smut incidence under field conditions as per standard rating scale.

Note:

1) *Sensitization drive of farmers shall be made at hot spots for the management of Karnal bunt of wheat with awareness for safe storage and significance of replacement of varieties.*
2) *Prepare a map depicting the surveyed locations*
3) *Provide the photographs showing the associated seed-borne pathogens.*

4) *Compile and prepare the disease distribution map of the state*

Crop (c): Soybean- Purple seed stain, Pod rot, Anthracnose, *Phomopsis* blight, Downy mildew

Centre: RARI, Durgapura; JNKVV, Jabalpur; MPKV, Rahuri; VNMKV, Parbhani and PJTSAU, Hyderabad (5)

Methodology

- A minimum of 100 seed samples from all the sources by covering the popularly grown soybean varieties.

Note

1) *Prepare a map depicting the surveyed locations of the state.*
2) *Provide the photographs showing the associated seed-borne pathogens of significance.*
3) *Compile and prepare the disease distribution map of the state*

Crop (d): Groundnut - Seed rot, Collar Rot and Stem rot

Centre: AAU, Anand; MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur; TNAU, Coimbatore; OUAT, Bhubaneshwar (6)

Methodology:

- Minimum seed sample size is 100 from all the sources by covering the popularly grown groundnut varieties.

Note

1) *Prepare a map depicting the surveyed locations.*
2) *Provide the photographs showing the associated seed-borne pathogens of significance.*
3) *Compile and prepare the disease distribution map of the state*

Crop (e): Chickpea: Wilt, Grey Mould, *Ascochyta* blight

Centre: MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur and ICAR-IARI, New Delhi (4)

Methodology:

- A minimum number of seed sample size is 100 from all the sources by covering the popularly grown chickpea varieties.

Note

1) *Prepare a map depicting the surveyed locations.*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state*

Crop (f): Ragi - Seed borne diseases/mycoflora

Year of start: 2020-21

Centre: PJTSAU, Hyderabad; MPKV Rahuri; JNKVV Jabalpur; TNAU, Coimbatore; IISS (RS) Bengaluru (5)

Methodology:

- A minimum number of seed sample size is 100 from all the sources by covering the popularly grown ragi varieties. Reporting the range of infection.

Note

1) *Prepare a map depicting the surveyed locations*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state*

Experiment 2: Studies on seed health status of farmers saved seeds

Objective: To determine the health status of seed samples from the farmers own saved seeds
Year of start: 2000
Status: Continued for 2023-24

Crop (a): Wheat
Centres: ICAR-IISS, Mau; CCSHAU, Hisar; PAU, Ludhiana; GBPUAT, Pantnagar; CSKHPAU, Palampur; RARI, Durgapura; RPCAU, Pusa; MPKV, Rahuri and IARI (RS) Karnal (9)
Methodology:

- **Detection Technique:** Standard NaOH seed soak method (0.2%) has to be followed for detection of Karnal bunt in seed samples. Minimum seed sample size is 100 from all the sources by covering the popularly grown wheat varieties.
- For ear cockle, visual observation and standard water soak method has to be followed.
- Incidence of loose smut is to be recorded under field conditions by GOT.

Note:

1) *Sensitization drive of farmers shall be made at hot spots for the management of Karnal bunt of wheat with awareness for safe seed storage and significance of replacement of varieties.*
2) *Prepare a map depicting the seed sample locations.*
3) *Provide the photographs showing the associated seed-borne pathogens.*
4) *Compile and prepare the disease distribution map of the state*
5) *Information of storage conditions.*

Crop (b): Soybean
Centre: RARI, Durgapura; JNKVV, Jabalpur; MPKV, Rahuri; VNMKV, Parbhani and PJTSAU, Hyderabad (5)
Methodology

- A minimum of 100 seed samples from all the sources by covering the popularly grown varieties. Seed health is to be determined by employing standard blotter method (ISTA, 1996) and visual inspection of seeds.
- The per cent recovery of the important seed-borne pathogens (*Macrophomina phaseolina, Fusarium oxysporum, Colletotrichum dematium* (*C. truncatum*), *Cercospora kikuchii, Fusarium* sp., *Diaporthe* sp.) in farmers own saved seed shall be recorded based on the observations of 400 seeds / sample.

- Symptoms of SMV has to be recorded both in field and seed samples.
- Impact of seed borne fungi on germination- Normal seedlings, abnormal seedlings with primary infection and seed rot has to be reported.
- Correlation of associated seed-borne pathogens with seed germination, normal seedlings and seedlings with primary infection is specified separately.

Note

1) *Prepare a map depicting the seed sample locations.*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state.*
4) *Information of storage conditions.*

Crop (c): Rice

Centres: ICAR-IISS, Mau; AAU, Jorhat; TNAU, Coimbatore; CSKHPAU, Palampur; PAJANCOA, Karaikal; MPKV, Rahuri; ICAR-IARI, New Delhi; DRPCAU, Pusa; PAU, Ludhiana; CCSHAU, Hisar; PJTSAU, Hyderabad; AAU, Anand; SKAUST, Srinagar; OUAT, Bhubaneshwar and IARI (RS), Karnal (15)

Methodology

- **Detection Technique:** Standard NaOH seed soak method (0.2%) has to be followed for bunt in rice seed samples. Minimum seed sample size is 100 from all the sources by covering the popularly grown rice varieties. Reporting the range of infection for each location.
- Seed borne pathogens responsible for seed discoloration have to be reported.
- Impact of seed borne fungi on germination- Normal seedlings, abnormal seedlings with primary infection and seed rot has to be reported.
- Correlation of associated seed borne pathogens on seed germination, normal seedlings and seedlings with primary infection is specified separately.

Note

1) *Prepare a map depicting the seed sample locations.*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state.*
4) *Provide the information of the crop (upland or lowland).*
5) *Information of storage conditions.*

Crop (d): Groundnut

Centre: AAU, Anand; MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur; TNAU, Coimbatore and OUAT, Bhuvneshwar (6)

Methodology:

- Seed health is to be determined by employing visual inspection of seeds and standard blotter method (ISTA, 1996)
- Minimum seed sample size is 100 from all the sources by covering the popularly grown

varieties.

- Impact on seed germination: Normal seedlings, abnormal seedlings with primary infection and seed rot have to be reported.
- Correlation of associated seed borne pathogens with seed germination, normal seedlings and seedlings with primary infection is specified separately.

Note

1) *Prepare a map depicting the seed sample locations*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state*
4) *Provide the information of the crop (upland or lowland).*
5) *Information of storage conditions.*

Crop (e): Chickpea

Centre: MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur and ICAR- IARI, New Delhi (4)

Methodology:

- Seed health has to be determined by employing standard blotter method (ISTA, 1996) and visual inspection of seeds.
- A minimum number of seed sample size is 100 from all the sources by covering the popularly grown chickpea varieties. Reporting the range of seed borne infection.
- Impact on seed germination- Normal seedlings, abnormal seedlings with primary infection and seed rot has to be reported.
- Correlation of associated seed borne pathogens on seed germination, normal seedlings and seedlings with primary infection is specified separately.

Note

1) *Prepare a map depicting the seed sample locations.*
2) *Provide the photographs showing the associated seed-borne pathogens.*
3) *Compile and prepare the disease distribution map of the state.*
4) *Provide the information of the crop (upland or lowland).*
5) *Information of storage conditions.*

Crop (f): Ragi

Year of start: 2020-21

Centre: PJTSAU, Hyderabad; MPKV, Rahuri; JNKVV, Jabalpur; TNAU, Coimbatore (4)

Methodology:

- Seed health has to be determined by employing standard blotter method (ISTA, 1996) and visual inspection of seeds.
- A minimum number of seed sample size is 100 from all the sources by covering the popularly grown varieties. Reporting the range of infection.
- Impact on seed germination (normal seedlings) and seedlings with primary infection (part of abnormal seedlings category) and seed rot has to be reported.
- Correlation of associated pathogens on seed germination (normal seedlings) and

seedlings with primary infection (part of abnormal seedlings category) is specified separately.

Note: *Prepare a map depicting the selected locations; Provide the photographs showing the associated pathogen.*

Experiment 3: Standardization of detection methods for seed-borne pathogens of significance

Objective: To work out the efficacy of different techniques for the detection of seed-borne pathogens of significance prevalent in a particular region.

Year of start: 2008
Status: Continued for 2023-24

Centres: TNAU, Coimbatore; JNKVV, Jabalpur; SKUAST, Srinagar; PJTSAU, Hyderabad and ICAR-IARI, New Delhi (5)

Note:

- *Provide the photographs showing the associated pathogens.*
- *The protocol found effective should be documented step by step with critical information on temperature, humidity, light cycles, substrate, incubation period, identification under stereoscopic binocular and characteristics of pathogen to draw the conclusions and must be compared with the standard protocol of ISTA.*
- *If the ISTA protocol is not available for the subjected pathogen, a protocol be developed and standardized which gives the maximum recovery of the pathogen.*
- *If required, serological and nucleic acid based techniques must also be developed and standardized.*

Experiment 4: Management experiments

New experiment 4a: Exploring new generation systemic fungicide molecules for false smut free seed production in rice
Objectives:

1) To test the efficacy of novel systemic fungicide molecules on the growth and sporulation of false smut pathogen and seed quality parameters in rice under *in vitro* conditions.
2) To test the efficacy of novel systemic fungicide molecules against rice false smut disease under field conditions.

Year of start: 2022-23
Status: Continued for 2023-24
Crop: Paddy

Centre: ICAR-IISS, Mau; TNAU, Coimbatore; PJTSAU, Hyderabad; PAJANCOA, Karaikal; ICAR-IARI, New Delhi; AAU, Jorhat; OUAT, Bhubaneshwar and PAU, Ludhiana (8)

Materials and Methods:

The **best performing/efficient three fungicides** under *in vitro* conditions were forwarded/ selected for field studies.

Treatment details

S. No.	Fungicide	Dosage (g or ml/lit of water)
1.	Trifloxystrobin 25% + Tebuconazole 50% WG	0.4
2.	Fluopyram 17.7% + Tebuconazole 17.7% SC	0.8
3.	Picoxystrobin 12% +Propiconazole 7% SC	2.0
4.	Propiconazole 25EC (Standard check)	1.0
5.	Untreated control	--

Variety: Any local popular susceptible variety
Design: Randomized Block Design (RBD)
Plot size: 20 m^2
Replications: Five

The fungicides will be applied as seed treatment and foliar spray at recommended dose. Each fungicide will be sprayed twice, first at panicle initiation stage and second at early flowering stage /50% flowering. Disease incidence and severity will be assessed at the time of harvest as per the SES for rice (https://www.clrri.org/ver2/uploads/SES_5th_edition.pdf).

Data to be recorded:

1. Percent false smut infected panicles per m^2
2. Per cent false smut infected spikelets per panicle
3. Per cent Disease severity (Per cent smutted panicles per m^2 × Per cent smutted balls per panicle)
4. Grain yield
5. Cost benefit ratio

Disease incidence (percent false smut infected panicles/m^2 and infected spikelets/panicle) and severity will be calculated by using the International Rice Research Institute's Standard Evaluation System.

Experiment 4(b): Development of eco-friendly low-cost input / indigenous technology for the production of disease-free soybean, chickpea and groundnut seeds.

Objective : To sustain the quality and viability of seed by reducing seed borne infections

Year of start : 2022-2023
Crop : Soybean, chickpea and groundnut
Variety: Local
Centres and Pathogens

S. No.	Crop	Pathogen	Centres
1.	Soybean	*Macrophomina phaseolina*	JNKVV, Jabalpur; VNMKV, Parbhani, MPKV, Rahuri and GBPUA&T, Pantnagar (04)
2.	Chickpea	*Fusarium oxysporum, Rhizoctonia bataticola*	JNKVV, Jabalpur; MPKV, Rahuri; RARI, Durgapura; PAU, Ludhiana; AAU, Anand and GBPUA&T, Pantnagar (06)
3.	Groundnut	*Sclerotim rolfsii, Aspergillus flavus*	PJTSAU, Hyderabad; MPKV, Rahuri; RARI, Durgapura; AAU, Anand and OUAT, Bhubneshwar (05)

Methodology
First Year (2022- 2023)
Objective: To assess the *in-vitro* efficacy of bioagents and organic products against the growth of the pathogens
Treatment details

Treatment No.	Treatment	Technique to be adopted	Doses
T_1	*Trichoderma asperellum**	Dual culture	-
T_2	*Pseudomonas fluorescens**	Dual culture	-
T_3	Beejamrit	Poison Food technique	2%, 5%
T_4	Jeevamrit		
T_5	Kunab Jal		
T_6	Chemical check (Carboxin 37.5% WS + Thiram 37.5%WS)	Poison Food technique	0.3%
T_7	Control		

- Commercial formulation of the SAU/ ICAR institute concerned

Second Year (2023-2024)
Objective: To evaluate the impact of bioagents and organic products on the seed quality parameters

Techniques to be adapted

a) **Paper towel method-** Evaluate the treated seeds for seed germination and vigour on the next day after seed treatment. Replicate each treatment four times and use 100 seeds for each replication. Observe the seed quality parameters after 7 days of incubation and record number of seeds germinated (normal seedlings), seedling length (Root length

+Shoot length), number of seeds infected, distribution (%) and frequency of seed mycoflora.

Third Year (2024-2025)

Objective: To validate the bioagents and organic products for the production of disease-free seed under field condition

The **best performing four treatments** on the seed quality parameter will be evaluated for the production of healthy seed under field condition. **Methodology including seed treatment and time and no. of foliar spray to be furnished**

Kunap Jal will be supplied to every participating centre by Pantnagar.

Natural Farming Inputs

Protocol

1. Bijamrit

***Bijamrti* (for 10 kg seed)**		
Sr. No.	**Ingredients**	**Quantity required**
1.	Fresh cow dung (desi breed)	500 g
2.	Fresh cow urine (desi breed)	500 ml
3.	Lime	10 g
4.	Soil (rhizospheric soil of Bunyan tree)	100 g
5.	Water	2 litre

2. Jeevamrit

Jeevamrit		
Sr. No.	**Ingredients**	**Quantity required**
1.	Fresh cow dung (desi breed)	10 kg
2.	Fresh cow urine (desi breed)	10 litre
3.	Soil (rhizospheric soil of Bunyan tree)	500 g
4.	Pulse flour	1 kg
5.	Jaggary / Sugarcane juice	2 kg/ 4 litre
6.	Water	200 litre

Experiment 5: Development of seed health standards for important seed borne diseases in crops.

Objectives:

- To initiate systematic studies for the development of standards
- To expand the scope of bringing new seed borne diseases under Indian Seed Act to facilitate quality seed production.
- To standardize uniform techniques for wider adaptability at national level.

Year of start: 2020-21

Status: Continued for 2023-24

Crop: To be decided by centres

Target Diseases: To be decided by centres from amongst disease for which field standards are available.
Centres proposed: JNKVV, Jabalpur; PJTSAU, Hyderabad; MPKV, Rahuri; PAU, Ludhiana; GBPUA&T, Pantnagar and ICAR-IARI, New Delhi (06)

Experiment 6: Systematic studies for evaluation of alternative chemicals and microbial consortia for effective management of seed-borne pathogens of major crops

Project rationale: Several seed-borne pathogens are known to be associated with paddy seeds causing seed rot and seedling mortality in nursery. Seed treatment is the best option to protect the nursery from these seedborne pathogens. The seed dressing fungicides that are used for this purpose for the past few decades are going to be banned in near future and there is a need of identification of best suited and cost-effective seed dressing fungicide(s) to protect rice nurseries from seed and seedling associated pathogens.
Year of start: 2021-22
Status: Continued for 2023-24

Crops: Paddy, Pigeon pea, Green gram, Black gram, Groundnut, Soybean
I. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of Paddy (Blast, Brown spot, False smut, Sheath rot, Bakanae as per disease severity at centres)
Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of paddy.
Centres and pathogens

Centre	Disease	Pathogen
PJTSAU, Hyderabad; AAU, Anand; OUAT, Bhubaneshwar	Blast	*Pyricularia grisea*
RPCAU, Pusa; TNAU, Coimbatore; PAJANCOA, Karaikal; MPKV, Rahuri; GBPUA&T, Pantnagar; AAU, Jorhat; ICAR-IISS, Mau	Brown spot	*Helminthosporium oryzae*
RPCAU, Pusa; MPKV, Rahuri; ICAR-IISS, Mau	False smut	*Ustilaginoidea virens*
RPCAU, Pusa; MPKV, Rahuri; PAU, Ludhiana; IARI, New Delhi	Sheath rot	*Sarocladium oryzae*
CCSHAU, Hisar; IARI (RS), Karnal; PAU, Ludhiana	Bakanae	*Fusarium moniliforme*

Materials and methods:
Seed material: Susceptible rice variety
Fungicides: As listed in treatment details
Techniques adopted: Pot culture
Seed treatment details (Pathogen: As per the centre)

1. Seed treatment with pathogen+Propiconazole 13.9%+Difenconazole 13.9% EC (Taspa) @ 1ml/kg seed

2. Seed treatment with pathogen+Azoxystrobin 18.2% + Difenconazole 11.4% SC (Amistar top) @ 1ml/kg seed
3. Seed treatment with pathogen+Picoxystrobin 6.78% +Tricylcazole 20.33% SC (Galileo Sensa) @ 1ml/kg seed
4. Seed treatment with pathogen+ Trifloxystrobin @25% + Tebuconazole 50% WG (Nativo) @ 0.5ml/kg seed
5. Seed treatment with pathogen + Carbendazim 50% WP (Standard Check) @ 2 gm/kg seed
6. Untreated seeds
7. Pathogen treated seeds

Methodology

Pots of 5 kg capacity filled with sterilized soil and seeds were prior inoculated with test pathogen @ 10^6 conidia/ml and allowed to air dry for 24 hours. Further seeds were again treated with test fungicides and allowed for drying under shaded conditions. Next day, the seeds will be sown by maintaining pathogen treated and untreated controls.

Field Emergence (%)

The field emergence test was conducted by randomly selecting hundred seeds from each treatment in two replications and sown at 4 – 5 cm depth in the well-prepared seedbed with adequate moisture content. The number of seedlings that emerged above the ground after the prescribed days after sowing was evaluated and considered normal seedlings. Field emergence was expressed as a percentage.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

Observations to be recorded:

Per cent emergence, per cent seedling mortality and per cent disease incidence will be recorded at 15, 30 and 45 days after sowing. Shoot length (cm), root length (cm) and dry weight (g/plant) will be recorded at 45 days after sowing under controlled conditions.

II. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of pigeon pea (Wilt, Root rot)

Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of pigeon pea.

Centres and Pathogens

Centre	Disease	Pathogen
PJTSAU, Hyderabad; TNAU, Coimbatore; MPKV, Rahuri	Wilt	*Fusarium udum*
MPKV, Rahuri	Root rot	*Macrophomina phaseolina*

Materials and methods:

Seed material: Susceptible redgram variety

Fungicides: As listed in treatment details

Techniques adopted: Pot culture

Seed treatment details (Pathogen: *Fusarium udum* and *Macrophomina phaseolina*)

1. Seed treatment with pathogen+Difenconazole 5% + Fluxapyraxod 7.5% SC (Sercadis Plus) @ 1ml/kg seed
2. Seed treatment with pathogen+ Thiophanate methyl 45% + Pyraclostrobin 5% FS (Xelora)@ 1ml/kg seed
3. Seed treatment with pathogen+ Penflufen 13.28% +Trifloxystrobin 13.2% FS (Ever Golxtend) @ 1ml/kg seed
4. Seed treatment with pathogen+ Carbendazim 50% WP (Standard check) @ 2gm/kg seed
5. Untreated seeds
6. Pathogen treated seeds

Methodology

Pots of 5 kg capacity filled with sterilized soil and redgram seeds were prior inoculated with test pathogen (*Fusarim udum* and *M. phaseolina*) @ 10^6 conidia/ml and allowed to air dry for 24 hours. Further seeds were again treated with test fungicides and allowed for drying under shaded conditions. Next day, the seeds will be sown by maintaining pathogen treated and untreated controls.

Field Emergence (%)

The field emergence test was conducted by randomly selecting hundred seeds from each treatment in two replications and sown at 4 – 5 cm depth in the well-prepared seedbed with adequate moisture content. The number of seedlings that emerged above the ground after the prescribed days after sowing was evaluated and considered normal seedlings. Field emergence was expressed as a percentage.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

Observations to be recorded:

Per cent emergence, per cent seedling mortality and per cent disease incidence will be recorded at 15, 30 and 45 days after sowing. Shoot length (cm), root length (cm) and dry weight (g/plant) will be recorded at 45 days after sowing under controlled conditions.

III. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of green gram and black gram (Root rot)

Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of green gram and black gram.

Centres and pathogens

Centre	Disease	Pathogen
A. Green gram		
PJTSAU, Hyderabad; TNAU, Coimbatore; MPKV, Rahuri; VNMKV Parbhani; PAJANCOA, Karaikal; AAU, Anand; OUAT, Bhubaneshwar; CCSHAU, Hisar; AAU, Jorhat; PAU, Ludhiana	Root rot	*Macrophomina phaseolina*
B. Black gram		
PJTSAU, Hyderabad; TNAU, Coimbatore; PAJANCOA, Karaikal; PAU, Ludhiana	Root rot	*Macrophomina phaseolina*

Materials and methods:

Seed material: Susceptible green gram and black gram variety

Fungicides: As listed in treatment details

Techniques adopted: Pot culture

A. Seed treatment details for green gram (Pathogen: *Macrophomina phaseolina*)

1. Seed treatment with pathogen+ Penflufen 13.28% + Trifloxystrobin 13.2% FS (Ever Golxtend) @ 1ml/kg seed
2. Seed treatment with pathogen+ Pyraclostrobin 5% + Metiram 55% WG (Cabriotop) @ 1g/kg seed
3. Seed treatment with pathogen+ Propiconazole 13.9% + Difenconazole 13.9%EC (Taspa) @ 1ml/kg seed
4. Seed treatment with pathogen+ Carbendazim 50% WP (Standard check) @ 2g/kg seed
5. Untreated seeds
6. Pathogen treated seeds

B. Seed treatment details for black gram (Pathogen: *Macrophomina phaseolina*)

1. Seed treatment with pathogen+ Penflufen + Trifloxystrobin (Ever Golxtend) @ 1ml/kg seed
2. Seed treatment with pathogen+ Pyraclostrobin 5% + Metiram 55% WG (Cabriotop) @ 2g/kg seed
3. Seed treatment with pathogen+ Fluxapyraxod (Systiva) 33.3%@ 1.5 ml/kg seed
4. Seed treatment with pathogen+ Carbendazim 50% WP (Standard check) @ 2gm/kg seed
5. Untreated seeds
6. Pathogen treated seeds

Methodology:

Pots of 5 kg capacity filled with sterilized soil and greengram/blackgram seeds were prior inoculated with test pathogen (*M. phaseolina*) and allowed to air dry for 24 hours. Further

seeds were again treated with test fungicides and allowed for drying under shaded conditions. Next day, the seeds will be sown by maintaining pathogen treated and untreated controls.

Field Emergence (%)

The field emergence test was conducted by randomly selecting hundred seeds from each treatment in two replications and sown at 4 – 5 cm depth in the well-prepared seedbed with adequate moisture content. The number of seedlings that emerged above the ground after the prescribed days after sowing was evaluated and considered normal seedlings. Field emergence was expressed as a percentage.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

Observations to be recorded:

Per cent emergence, per cent seedling mortality and per cent disease incidence will be recorded at 15, 30 and 45 days after sowing. Shoot length (cm), root length (cm) and dry weight (g/plant) will be recorded at 45 days after sowing under controlled conditions.

IV. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of groundnut (Seed & collar rot and stem rot)

Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of groundnut

Centres and Pathogens

Centre	Disease	Pathogen
PJTSAU, Hyderabad; TNAU, Coimbatore; PAJANCOA, Karaikal; AAU, Anand; OUAT, Bhubaneshwar; MPKV, Rahuri, PAU Ludhiana	Seed & collar rot	*Aspergillus niger*
PJTSAU, Hyderabad; AAU, Anand	Stem rot	*Sclerotium rolfsii*

Materials and methods:

Seed material: Susceptible groundnut variety

Fungicides: As listed in treatment details

Techniques adopted: Pot culture

Seed treatment details (Pathogen: *Aspergillus niger* and *Sclerotium rolfsii*)

1. Seed treatment with pathogen+ Penflufen 13.28% + Trifloxystrobin13.2% FS (Ever Golxtend) @ 1ml/kg seed
2. Seed treatment with pathogen+ Pyraclostrobin 13.3% + Epoxyconazole 5% SE (Opera) @ 0.75 ml/kg seed
3. Seed treatment with pathogen+ Thiophanate methyl 45% + Pyraclostrobin5% FS (Xelora) @ 1ml/kg seed
4. Seed treatment with pathogen+ Carboxin 37.5% WS + Thiram 37.5% WS (Vitavax power) @ 3gm/kg seed
5. Untreated seeds

6. Pathogen treated seeds

Methodology

Pots of 5 kg capacity filled with sterilized soil and groundnut seeds were prior inoculated with test pathogen (*A.niger* and *Sclerotium rolfsii*) and allowed to air dry for 24 hours. Further seeds were again treated with test fungicides and allowed for drying under shaded conditions. Next day, the seeds will be sown by maintaining pathogen treated and untreated controls.

Field Emergence (%)

The field emergence test was conducted by randomly selecting hundred seeds from each treatment in two replications and sown at 4 – 5 cm depth in the well-prepared seedbed with adequate moisture content. The number of seedlings that emerged above the ground after the prescribed days after sowing was evaluated and considered normal seedlings. Field emergence was expressed as a percentage.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

Observations to be recorded:

Per cent emergence, per cent seedling mortality and per cent disease incidence will be recorded at 15, 30 and 45 days after sowing. Shoot length (cm), root length (cm) and dry weight (g/plant) will be recorded at 45 days after sowing under controlled conditions.

V. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of Soybean (Charcoal rot and anthracnose)

Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of Soybean

Centres and Pathogens

Centre	Disease	Pathogen
PJTSAU, Hyderabad; MPKV, Rahuri; GBPUA&T, Pantnagar, JNKVV, Jabalpur; PAU, Ludhiana	Charcoal rot	*Macrophomina phaseolina*
PJTSAU, Hyderabad; MPKV, Rahuri; GBPUA&T, Pantnagar, JNKVV, Jabalpur	Anthracnose	*Colletotrichum dematium*

Materials and methods:

Seed material: Susceptible soybean variety

Fungicides: As listed in treatment details

Techniques adopted: Pot culture

Seed treatment details (Pathogen: *Macrophomina phaseolinal* and *Collectotrichum dematium*)

1. Seed treatment with pathogen+ Thiophanate methyl 45% + Pyraclostrobin 5% FS (Xelora) @ 1ml/kg seed
2. Seed treatment with pathogen+ Pyraclostrobin 13.3% + Epoxyconazole 5% SE (Opera) @ 1.5 ml/kg seed

3. Seed treatment with pathogen+ Penflufen + Trifloxystrobin (Ever Golxtend) @ 1ml/kg seed
4. Seed treatment with pathogen+ Fluxapyraxod 33.3% FS (Systiva) @ 1. ml/kg seed
5. Seed treatment with pathogen + Carboxin 37.5% WS + Thiram 37.5% WS (standard check) @ 3 gm/kg seed
6. Untreated seeds
7. Pathogen treated seeds

Methodology

Pots of 5 kg capacity filled with sterilized soil and soybean seeds were prior inoculated with test pathogen (*Macrophomina phaseolina* and *Collectotrichum dematium*) @ 10^6 conidia/ml and allowed to air dry for 24 hours. Further seeds were again treated with test fungicides and allowed for drying under shaded conditions. Next day, the seeds will be sown by maintaining pathogen treated and untreated controls.

Field Emergence (%)

The field emergence test was conducted by randomly selecting hundred seeds from each treatment in two replications and sown at 4 – 5 cm depth in the well-prepared seedbed with adequate moisture content. The number of seedlings that emerged above the ground after the prescribed days after sowing was evaluated and considered normal seedlings. Field emergence was expressed as a percentage.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

Observations to be followed:

Per cent emergence, per cent seedling mortality and per cent disease incidence will be recorded at 15, 30 and 45 days after sowing. Shoot length (cm), root length (cm) and dry weight (g/plant) will be recorded at 45 days after sowing under controlled conditions.

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
1	ICAR-IARI, New Delhi	Dr. Atul Kumar	Pr. Scientist & PI	atulpathiari@gmail.com	7703820583, 9013440112
2	TNAU, Coimbatore	Dr. T. Anand	ASRO (Seed Pathology)	anandpath10@ yahoo.com;	98651 35089
3	AAU, Jorhat	Dr. Devanushi Dutta	Junior Scientist (Seed Path.)	devanushi.dutta@ aau.ac.in,	9706257258
4	CSKHPKV, Palampur	Dr Shikha Sharma	ASRO (Seed Pathology)	shi.bha.80@gmail.com;	8360746470, 9418509491
5	IARI, New Delhi	Dr. Nagamani Sandra	Scientist	nagamani.iari@gmail.com;	8447683077

6	IARI-RS, Karnal	Dr. Manoj Kumar Yadav	Scientist	m.yadav14@gmail.com;	8598808425
7	JNKVV, Jabalpur	Dr. Ashish Kumar	Scientist	ashishashish2612@ gmail.com;	9981113633
8	OUAT, Bhubaneswar	Dr. Manoj Kumar Rout	ASRO (Seed Pathology)	routmanoj6@gmail.com	9938793431
9	PAU, Ludhiana	Dr Anju Bala	ASRO (Seed Pathology)	anjusharma@pau.edu;	8146557690
10	PJTSAU, Hyderabad	Dr. B.Rajeswari	SRO (Seed Pathology)	rajeswari_bodduluri@ rediffmail.com;	9912655843
		Dr. M.Madhavl	ASRO (Seed Pathology)	madhagonii@gmail.com;	9491953603
11	RPCAU, Pusa	Dr. C.S. Chaudhary	Assistant Professor	cshekhar@rpcau.ac.in; csrau07@gmail.com;	9931536043
12	SKUAST, Srinagar	Dr. Aflaq Hamid	Assistant Professor	falak19@gmail.com;	7889617904
		Dr. Gowhar Ali	Assistant Professor	gowharpbg@gmail.com;	7006353051
13	MPKV, Rahuri	Dr. S. R. Zanjare	SRO (Seed Pathology)	srzanjare1967@gmail.com;	9422921771
		Dr. A. V. Suryawanshi	ASRO (Seed Pathology)	avsseed@gmail.com;	8275033779
14	SKNAU, Jobner	Dr. Tarun Kumar Jatwa	ASRO (Seed Pathology)	Tkjatwa.path@sknau.ac.in	9461553414
15	GBPUAT, Pantnagar	Dr. Rashmi Tewari	ASRO (Seed Pathology)	rashmipnt@gmail.com	9412100770
16	PAJANCOA&RI, Karaikal	Dr. C. Jeylakshmi	Professor	drcjeya@gmail.com	9442131504
17	VNMKV, Parbhani	Dr. A. T. Daunde	ASRO (Seed Pathology)	atdaunde@gmail.com	7588082008
18	CCSHAU, Hisar	Dr. Swathi Mehra	ASRO (Seed Pathology)	hodsstnew@gmail.com;	
19	ICAR-IISS, Mau	Dr. Gopi Kishan	Scientist	gopik0956@gmail.com	9982568300
		Dr. S. Aravindan	Scientist	aravindgobi@gmail.com	7538995223

D. Seed Entomology

Date: 21.04.2023 & 10.05.2023

Chairman : **Dr. Sanjay Kumar**
Director, ICAR-IISS, Mau

Convener : **Dr. Amit Bera**
Senior Scientist, ICAR-CRIJAF, Barrackpore

Technical programme 2023-24

Experiment 1: Survey and evaluation of seed health status of farmers' saved seed with respect to insect infestation (to be combined with pathology / storage).

A portion of the sample should be taken from pathology/physiology group for detecting insect damage in seed, type of insect infesting seed as being done earlier under the experiment. Farmer's practice to store/protect seed should also be recorded.

Objectives

- To know the type of insect and its level of infestation under farmer's storage condition.
- Impact of insect infestation on seed quality
- Farmer's practice, if any, to store / protect seeds from insect damage.

Year of start: 2006

All NSP centers including voluntary centers will do the experiment

Methodology: About 500 g of seeds of crop/ variety will be collected from farmers / seed producers before sowing on payment or gratis. While collecting sample's specific location should be recorded through GPS. Information on category of farmer (Large, medium and small as per land holding) should also be taken. **Centres with both entomologist and pathologist should work in collaboration. Assigning sample number before seed health test will help to correlate insect infestation and fungal infection (if any) after getting results of seed health test by both entomologist and pathologist.** Each centre should collect seed samples of three major crops of that area and minimum 100 samples from each crop should be collected. Sample should be collected following appropriate sampling procedure so that entire zone can be covered within 2-3 years. While collecting seed a questionnaire will also be filled to know crop / variety, period and conditions of storage, treatments, if any, source of seed, if it is not farmers - saved one. The following observations are to be recorded.

1. Storage period
2. Seed moisture content (%)
3. Live insect, its species

4. Damage in 400 seeds including internal infestation
5. Germination (%)
6. Vigour test

Experiment 2: Demonstration of 'Efficacy of commercially available Neem products against storage insect-pests during storage under ambient condition'

Crop	Centre	Packaging Size
Wheat	MPKV, Rahuri	40Kg
Paddy	AAU, Jorhat	30kg
Cowpea	TNAU, Coimbatore	4kg
Green gram	OUAT, Bhubaneswar; UAS, Dharwad	8kg
Chickpea	IISS, Mau	30kg
Sorghum	PDKV, Akola	5kg
Pigeon pea	PJTSAU,Telengana	4kg
Black gram	PAJANCOA, Karaikal	8 kg
Field pea	CSAUAT, Kanpur	24 kg

Objectives

1. To demonstrate the efficacy of commercial Neem formulations against major storage insect-pests damaging seeds and storability of treated seeds.

Treatments

A. Insecticides/botanicals

1. Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed)
2. Neemoz - Gold (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation/kg seed)
3. Deltamethrin @ 1ppm (2.8EC @0.04 ml/kg of seed)
4. Untreated control

B. Packaging Material: Jute bag/recommended packaging material for certified seed

Replications: 3 **Design:** CRD

Method: Freshly harvested and untreated certified seed (recommended packaging size of certified seed) with very high percentage of germination and low moisture content (<10%) will be taken for each treatment. Seed should be treated with required quantity of neem formulations @7.5ml/kg ensuring uniform coating. Deltamethrin should be diluted in 5 ml water to treat 1 kg of seed. After drying in shade, seeds will be packed and kept in storage godown under ambient condition. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Observations

Observation to be recorded

- Seed germination, seed moisture
- Insect infestation (% kernel damage and types of insect)
- Presence / Absence of insects (live and dead)

Observations will be made on every 3 months for a total period of 12 months or loss of germination below IMSCS, whichever is early. **Benefit Cost ratio should also be worked out for each treatment.**

Experiment 3: Demonstration of 'Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient condition'.

Objectives:

1. To demonstrate the efficacy of spinetoram against major storage insect-pests damaging seeds and storability of treated seeds.

Year of start: 2023

Crop	Centre	Packaging Size
Wheat	IISS, Mau	40Kg
Paddy	PJTSAU, Telangana	30kg
Pigeon pea	PDKV, Akola	4kg
Cowpea	UAS, Bangalore; UAS, Dharwad	4kg
Green gram	TNAU, Coimbatore	8 kg
Chickpea	MPKV, Rahuri;	30kg
Pearl millet	JAU, Junagadh	2kg
Sorghum	SKNAU, Jobner	5kg
Black gram	PAJANCOA, Karaikal	8 kg
Field pea	CSAUAT, Kanpur	24 kg

Treatment:

A. Chemical

1. Spinetoram @ 3ppm (Delegate 11.7%SC @25.6mg /kg seed)
2. Deltamethrin @ 1.0 ppm (Deltamethrin 2.8EC@ 0.04 ml/kg seed)
3. Untreated control

B. Packaging Material: Jute bag/recommended packaging material for certified seed

Replications: 3 **Design:** CRD

Method: Freshly harvested certified seed (recommended packaging size of certified seed) with very high percentage of germination and low moisture content (<10%) will be taken for each treatment. Required quantity of pesticides will be diluted in water to make total volume

of 5 ml for treating 1 kg of seed for proper coating. After drying in shade, seeds will be packed and kept in storage godown under ambient condition. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Observations:

Observation to be recorded

- Seed germination, seed moisture
- Insect infestation (% kernel damage and types of insect)
- Presence / Absence of insects (live and dead)

Benefit cost ratio should also be worked out for each treatments.

Experiment-4: Studies on the effect of Entomopathogens and inert dust on storage insect pests and seed quality during storage under ambient condition.

Objectives:

1. To evaluate the effect of Entomopathogens and inert dust against major storage insect-pests damaging seeds.
2. Study of the storability of treated seeds.

Crop	Centre	Test insect
Maize	TNAU, Coimbatore; RPCAU, Dholi	*S. oryzae*
Wheat	IISS, Mau; RPCAU, Dholi; CSAUAT, Kanpur	*S. oryzae*
Paddy	PJTSAU, Hyderabad; PAJANCOA, Karaikal; RPCAU, Dholi; AAU, Jorhat; OUAT, Bhubaneswar	*R. dominica*
Cowpea	UAS, Bangalore; UAS, Dharwad	*C. maculatus*
Black gram	UAS, Bangalore; PAJANCOA, Karaikal; AAU, Jorhat	*C. maculatus*
Chickpea	MPKV, Rahuri; JAU, Junagadh; PDKV, Akola	*C. maculatus*
Green gram	TNAU, Coimbatore; SKNAU,Jobner; OUAT, Bhubaneswar; CCSHAU, Hisar	*C. maculatus*
Pearl millet	JAU, Junagadh; SKNAU,Jobner	*R. dominica*
Sorghum	MPKV, Rahuri; NAU, Navsari	*R. dominica*
Pigeon pea	PDKV, Akola; UAS, Dharwad; NAU, Navsari	*C. maculatus*
Field pea	CSAUAT, Kanpur	*C. maculatus*

A. Treatment:

1. *Beauveria bassiana* commercial product (CFU: 1.0 X10^8) @ 10g /kg seed
2. *Beauveria bassiana* commercial product @20g /kg seed
3. *Metarhizium anisopliae* commercial product (CFU: 1.0 X10^8) @10g /kg seed
4. *Metarhizium anisopliae* commercial product (CFU: 1.0 X10^8) @20g /kg seed

5. *Beauveria bassiana* commercial product (CFU: 1.0 X10^8) @ 10g /kg seed +Diatomaceous earth @ 5g /kg seed
6. *Beauveria bassiana* commercial product (CFU: 1.0 X10^8) @20g /kg seed +Diatomaceous earth @ 5g /kg seed
7. *Metarhizium anisopliae* commercial product (CFU: 1.0 X10^8) @10g /kg seed +Diatomaceous earth @ 5g /kg seed
8. *Metarhizium anisopliae* commercial product (CFU: 1.0 X10^8) @20g /kg seed +Diatomaceous earth @ 5g /kg seed
9. Deltamethrin@1ppm
10. Untreated control

Packaging Material: HDPE bags

Replications: 3 **Design: CRD**

Method: One kg of freshly harvested certified seed with very high percentage of germination and low moisture content (<10%) will be taken for each treatment and treated with the appropriate dose of entomopathogens and seeds will be shaken manually for approximately 2 minutes to achieve uniform distribution of the conidial powder with the seed mass. Seeds will be packed and kept in room under ambient temperature. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Bio-assay-After one day, samples of 50 g each, were taken from each treatment with replication and placed in glass vials (8 cm height and 5 cm diameter). Five pairs of 1-3 day old adults were introduced into each glass vial, covered with muslin cloth to provide sufficient aeration. Dead adults were counted after 3, 5 and 7 days of exposure. Dead insects were then incubated in a plastic box with high RH. (approximately 100%) to observe the outgrowth of fungus. The vials will be left at the same conditions for a further 50 days to assess progeny production (F1) of insects.

Observation to be recorded at every three months interval:

- Seed germination, seed moisture
- Insect infestation (% kernel damage and types of insect)
- Presence / Absence of insects (live and dead).
- F1 Progeny production

Experiment 5: Studies on efficacy of plant based neutral silica on storage insects and seed quality during storage under ambient condition

Objectives:

1. To evaluate the effect of plant-based silica against major storage insect-pests damaging seeds.
2. Study of the storability of treated seeds.

Year of modification: 2023

A. Treatments:

T_1 - Neutral silica @ 2500 ppm (2.5g/Kg)

T_2 - Neutral silica @ 3000 ppm (3 g/Kg)

T_3 - Neutral silica @ 3500 ppm (3.5g/Kg)

T_4 - Diatomaceous earth @ 5g/kg seed

T_5- Deltamethrin@1 ppm

T_6- Untreated control

B. Packaging Material: HDPE bags

Replications: 3 **Design:** CRD

Crop	Centre
Wheat	IISS, Mau; RPCAU, Dholi
Paddy	TNAU, Coimbatore; AAU, Jorhat; OUA&T, Bhubaneswar; PJTSAU, Hyderabad
Pearl millet	JAU, Junagadh; SKNAU,Jobner
Sorghum	NAU, Navsari
Black gram	UAS, Bangalore; UAS, Dharwad; PAJANCOA, Karaikal
Cowpea	PDKV, Akola; UAS, Dharwad
Chickpea	MPKV, Rahuri; JAU, Junagadh
Green gram	UAS, Bangalore; AAU, Jorhat; CSAUAT, Kanpur
Pigeon pea	PJTSAU, Hyderabad; PDKV, Akola
Field pea	CSAUAT, Kanpur; RPCAU, Dholi

Methodology: Freshly harvested certified seed with very high percentage of germination and low moisture content (<10%) will be taken for each treatment. One kg seeds for each replication of the treatment will be treated with the required quantity of test material. After uniform mixing, seed should be packed in HDPE bags and kept in room under ambient condition. The temperature and relative humidity of the room will be recorded on weekly basis. Control will also be kept under ambient conditions.

Observations

Residual toxicity: Take out 100 g of treated seed, release 10 adult insects *Rhizopertha dominica /Sitophilus oryzae, Callosobruchus chinensis* or important insects depending upon the crop and record mortality after 1, 3, 5 and 7 days after release of test insect and thereafter, every 3 months for a total period of 12 months or loss of germination below IMSCS, whichever is early.

Observation to be recorded

- Seed germination, seed moisture content

- Insect infestation (% kernel damage and types of insect)
- Presence / Absence of insects (live and dead)

Observations will be made on every 3 months for a total period of 12 months or loss of germination below IMSCS, whichever is early

Experiment 6: Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient condition. (New Experiment)

Objectives:

1. To evaluate newer molecules against major storage insect-pests damaging seeds.
2. Study of the storability of treated seeds.

Year of start: 2023

Crop	Centre
Wheat	IISS, Mau; CCSHAU, Hisar; CSAUAT, Kanpur
Paddy	PJTSAU, Telangana; AAU, Jorhat; OUA&T, Bhubaneswar
Pigeon pea	PJTSAU,Telengana; PDKV, Akola
Cowpea	UAS, Bangalore; UAS, Dharwad
Green gram	TNAU, Coimbatore; OUA&T, Bhubaneswar; CSAUAT, Kanpur
Chickpea	MPKV, Rahuri; UAS, Dharwad,
Pearl millet	JAU, Junagadh, SKNAU, Jobner
Sorghum	MPKV, Rahuri; PDKV, Akola
Black gram	TNAU, Coimbatore, UAS, Bangalore; PAJANCOA, Karaikal
Groundnut	JAU, Junagadh
Field pea	CSAUAT, Kanpur
Horse gram	IISS-RS, Bangalore.

Treatment:

A. Chemical

1. Broflanilide @ 1 ppm (300 SC @3.33 mg /kg seed)
2. Broflanilide @ 2 ppm (300 SC @6.66 mg/kg seed)
3. Broflanilide @ 3 ppm (300 SC @9.99 mg /kg seed)
4. Dinotefuran @ 1 ppm (20SG @5 mg/kg seed)
5. Dinotefuran @ 2 ppm (20SG @10 mg/kg seed)
6. Dinotefuran @ 3 ppm (20SG @20 mg/kg seed)
7. Emamectin benzoate @ 2ppm (Proclaim 5SG @40.0 mg/kg seed)
8. Deltamethrin @ 1.0 ppm (Deltamethrin 2.8EC@ 0.04 ml/kg seed)
9. Untreated control

B. Packaging Material: Jute bag of 2 kg capacity

Replications: 3 **Design:** CRD

Method: One kg of freshly harvested certified seed with very high percentage of germination and low moisture content (<10%) will be taken for each treatment. Required quantity of pesticides will be diluted in water to make total volume of 5 ml for treating 1 kg of seed for proper coating (if required). After drying in shade, seeds will be packed and kept in room under ambient temperature. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Observations:

Residual toxicity: Take out 100 g of treated seed, release 10 adult insects *Rhyzopertha dominica / Callosobruchus chinensis* or important insects depending upon the crop and record mortality after 3,7 and 15 days and thereafter, every 3 months for a total period of 12 months or loss of germination below IMSCS, whichever is early.

Observation to be recorded

- Seed germination, seed moisture
- Insect infestation (% kernel damage and types of insect)
- Presence / Absence of insects (live and dead)

Benefit cost ratio should also be worked out for each treatment.

Proceedings of meeting on 10.05.2023

Experiment No. 1 on 'Survey & evaluation of seed health status of farmers' saved seed' will be continued in its existing format. Survey should be done following proper sampling procedure. **Specific location of sample collection should be recorded through GPS. Centres with both entomologist and pathologist should work in collaboration. Assign sample number before seed health test and try to correlate seed health after getting results of seed health test by both entomologist and pathologist.**

Experiment No. 2 "**Efficacy of commercially available neem products on storage pest management during storage under ambient condition**" will be concluded. Three years' multi-location results clearly indicate that seed treatment with neem formulations containing 10000ppm azadirchtin @ 7.5ml/Kg seed as seed protectant can provide effective management of storage insects infesting cereal (wheat, paddy, and sorghum) and pulse (pigeon pea, chickpea, cowpea and black gram) seeds under different agro-climatic conditions without impairing seed germination up to 6-9 months of storage. **These findings will be validated through demonstration at various centres.**

Experiment No. 3 on '**Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient condition'** will be concluded. Three years' multi-location results clearly indicate that seed treatment with spinetoram @ 3 ppm (11.7%SC @25.6mg /kg seed as seed protectant can provide effective management of storage insects infesting cereals (wheat, paddy, sorghum and pearl millet) and pulses (pigeon pea, chickpea, cowpea, green gram, black gram and field pea) seeds under different agro-climatic conditions without

impairing seed germination up to 9-12 months. **These findings will be validated through demonstration at various centres.**

Experiment No. 4 on 'Integrated approach for management of Pulse beetle **(*Callosobruchus* sp.) during storage under ambient condition'** will be discontinued due to inconsistent results across the locations over the years.

Experiment No. 5 on **"Studies on the effect of Entomopathogens and inert dust on storage insect pests and seed viability during storage under ambient condition"** will be continued in existing format. **PJTSAU, Telagana will send required formulations on payment basis**.

Experiment No. 6 on '**Studies on efficacy of plant based neutral silica on storage insects and seed quality during storage under ambient condition'** will be conducted with **modification of doses of neutral silica** and new crops and centres have been assigned. Required quantity of Neutral silica will be supplied by IIRR, Hyderabad and PJTSAU, Telagana will coordinate the delivery to different centres.

New experiment on 'Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient condition' will be conducted with two newer insecticides i.e Broflanilide 300SC and Dinotefuran 20SG.

Pro-forma for Calculating Expenditure, Income and BC Ratio for Seed Entomology Experiments

A. For laboratory experiments

S. No.	Items	Amount (Rs.)
A	**Expenditure / Cost**	
1	Recurring cost on imposing the treatment	
a	Cost of packaging material / ton of seed	
b	Cost of insecticide treatment/ ton of seed	
c	Any other cost	
2	Salary component (as per man-days spent for imposing treatments)	
3	Miscellaneous cost	
	Sub total	
4	Interest on working capital (@ 12% per annum for total above, adjusted accordingly as per duration of experiment)	
	Total Expenditure / cost (A)	
B	**Gross income by imposing the treatment**	
1	Price / sale value of seed (Rs./ton)	
2	Price/ value of grain (Rs./ ton)	
	Gross Income by imposing the treatment (B) (B1-B2)	
	BC ratio for selling as seed (B/A)	
C	**Loss due to insect infestation**	
1	Seed damage loss due to insect (enumerate % damage in control to quantum per ton) (Say %	

	damage in control is 15.0%, quantum of damaged seed will be 150 kg/ton)	
2	Monetary loss due to seed damage (Rs./ton) (C1 X B1)	
	BC ratio (considering only seed damage) (C2/A)	

A. For field experiments

Sl.	Particulars	Amount (Rs./ha)
A	**Expenditure / Cost**	
1	Recurring cost of imposing the treatment (T1, T2, T3….Tn) (materialistic cost only *i.e.* chemicals, packaging materials, other physical inputs etc.)	
2	Additional labour cost on imposing treatments	
3	Salary component (as per man-days spent for imposing treatments)	
4	Miscellaneous cost	
	Sub total	
5	Interest on working capital (@ 12% per annum for total above, adjusted accordingly as per duration of experiment)	
	Total Expenditure / cost (A)	
B	**Gross income by imposing the treatment**	
1	Seed yield in particular treatment (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income by imposing the treatment (B)	
C	**Gross income in control (T_0)**	
1	Seed yield in control (q/ha)	
2	Price / sale value of seed (Rs./q)	
	Gross Income in control (C)	
D	**Increase in Gross income by imposing the treatment (B - C)**	
E	**Increase in Net income by imposing the treatment (D - A)**	
F	**BC ratio for imposing the treatment (D/A)**	

Note:

3. The above information needs to be calculated for individual/every treatment
4. Expenditure, income etc. may be calculated on per quintal basis for storage experiment

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
1	ICAR-IARI, New Delhi	Dr. Amit Bera	Sr. Scientist & PI	amitbera.iari@gmail.com	9732709874

2	ICAR-IISS, Mau	Dr. Anjitha George	Sr. Scientist & Co-PI	Anjitha.S@icar.gov.in; anjithakitty@gmail.com	8623937913
3	ICAR-IIVR, Varanasi	Dr. Arvind Nath Singh	Pr. Scientist & Co-PI	arvindnathsingh@gmail.com	9450725652
4	TNAU, Coimbatore	Dr. Preetha	ASRO (Seed Ento.)		
5	UAS, Bangalore	Dr. Manja Naik	ASRO (Seed Ento.)	naik_196710@yahoo.com;	7338305680
6	JAU, Jamnagar	Prof. R. P. Juneja	I/c ASRO	rajkumarjuneja19@gmail.com;	99249 39602
7	PDKV, Akola	Dr. G. K. Lande	ASRO	gajannan1975@gmail.com;	7588962199
8	PJTSAU, Hyderabad	Dr. A. Padmasri	ASRO (Seed Ento.)	padmasri_1972@rediffmail.com;	9000791123
9	RPCAU, Pusa	Dr. G. S. Giri	Assistant Professor	gsgiri@rpcau.ac.in;	9568228227
10	UAS, Dharwad	Dr. Ravi Hunje	Special Officer (Seeds)	Soseed@uasd.in;	9448301595
		Dr. Vijayakumar. A. G	SPO	vijayakumarag@uasd.in;	9482182111
		Dr. Malik Rehan	Technical Officer: STR	malikuasdwd@gmail.com;	9663356479
11	MPKV, Rahuri	Prof. R. S. Bhoge	ASRO (Seed Ento.)	bhogerashmi@gmail.com;	9921373793
12	PAJANCOA&RI, Karaikal	Dr. T. Ramanadane	Professor	raman_nadane@yahoo.com	9443875443
13	CSAUAT, Kanpur	Dr. CL Maurya	Head, DSST & I/c STR	clmaurya@csauk.ac.in	9453479077
14	SKNAU, Jobner	Dr. Birbal Bairwa	ASRO	str.durgapura.jp@gmail.com	8960361811
15	AAU, Jorhat	Dr. BC Nath	ASRO	bharat.c.nath@aau.ac.in	9864743751

E. Seed Processing

Date: 26.04.2023 & 10.05.2023

Chairman : **Dr. Sanjay Kumar**
Director, ICAR-IISS, Mau

Convener : **Dr. Ashwani Kumar**
Principal Investigator/ Principal Scientist
ICAR-IARI, Regional Station, Karnal

Special mention:
All the centers were asked again to increase the number of varieties/ hybrids and include the newer ones to maximum extent possible. For Statistical Analysis Complete Randomized Block Design may be adopted.

Recommendations:

1. Optimum bottom/ grading sieve size for processing new crop varieties
In the present era of high yielding crop varieties/ hybrids, there is need to modify the size of the bottom/ grading screen to improve the quality and quantity of the seed and to meet the physical purity standards set under IMSCS. These modifications are based on the data generated by different centers of AICRP on Seed (Crops) on various crops as per the following table.

Centre	Crop / Seed Size (categories)	Variety	Sieves used (mm)	IMSC Recommended Sieve Size (mm)	Standardized Sieve Size (mm)	Seed Recovery (%)
	Paddy					
ICAR-IARI RS, Karnal	Medium slender	PB 1847	2.2, 2.1, 1.9, 1.8, 1.6s	1.80 s	1.90 s	91.3
	Medium slender	PB 1885		1.80 s	1.90 s	88.1
	Small seeded	PS 1853		1.70 s	1.60 s	93.4
TNAU, Coimbatore	Coarse/ Bold	ADT 37	2.4, 2.2, 2.0,1.8, 1.7s	1.85 s	2.20 s	86.6
	Medium slender	ADT 53	1.8, 1.7, 1.65, 1.6, 1.5s	1.80 s	1.50 s	80.1
PAJANCOA & RI, Karaikal	Small seeded	RNR 15048	1.85, 1.8, 1.7, 1.6, 1.55, 1.5s	1.70 s	1.55 s	98.4
	Small seeded	VGD 1	1.7, 1.65, 1.6, 1.55, 1.5s	1.70 s	1.55 s	95.8

	Small seeded	Improved Samba Mahsuri	1.8, 1.7, 1.6, 1.55, 1.5s	1.70 s	1.55 s	99.1
	Small seeded	KKL(R)	2.0, 1.85, 1.7, 1.6, 1.55, 1.5s	1.70 s	1.55 s	99.1
PDKV, Akola	Small seeded	PKV HMT	1.8, 1.6, 1.4, 1.2s	1.70 s	1.60 s	92.1
	Small seeded	PDKV Tilak	1.8, 1.6, 1.4s	1.70 s	1.60 s	88.6
	Medium seeded	Co 51	2.0, 1.8, 1.6, 1.4s	1.80 s	1.80 s	85.7
	Medium seeded	MTU 1001	2.0, 1.8, 1.6, 1.4s	1.80 s	1.80 s	87.2
	Small seeded	Sakoli 9	1.8, 1.6, 1.4, 1.2s	1.70 s	1.60 s	87.5
	Medium seeded	PDKV Kisan	2.0, 1.8, 1.6, 1.4s	1.80 s	1.80 s	90.8
	Medium seeded	Suwarna		1.80 s	1.80 s	94.0
	Bold seeded	MTU 1010		1.85 s	1.85 s	86.2
UAS, Raichur	Small seeded	Gangavathi Sona	2.2, 2.0, 1.8, 1.6, 1.4s	1.70 s	1.40 s	96.3
	Medium seeded	RNR 15048		1.80 s	1.60 s	93.0
	Bold seeded	MTU-1010		1.85 s	1.80 s	93.0
	Wheat (*Triticum aestivum*)					
ICAR-IARI RS, Karnal	Bold seeded	HI 1628	3.2, 2.8, 2.4, 2.2, 2.1s	2.30 s	2.40 s	87.3
	Bold seeded	HI 1620		2.30 s	2.40 s	89.2
	Bold seeded	HD 3298		2.30 s	2.40 s	90.0
PAU Ludhiana	Bold seeded	PBW 824	2.5, 2.4, 2.3, 2.1, 1.9s	2.30 s	2.30 s	88.9
	Bold seeded	PBW 826		2.30 s	2.30 s	91.5
	Chickpea					
UAS, Dharwad	Medium seeded	BGD 111-1	7.25, 6.5, 6.0, 5.25, 5.0r	5.50 r	6.00 r	85.0
PDKV, Akola	Medium seeded	PDKV Kanchan	7.0, 6.5, 6.0, 5.5, 5.0r	5.50 r	6.00 r	91.9
	Medium seeded	Jaki 9218	7.5, 7.0, 6.5, 6.0, 5.5r	5.50 r	6.50 r	88.5
	Medium seeded	PDKV Kanak		5.50 r	6.50 r	87.9
	Bold seeded	PKV Kabuli-2	9.0, 8.5, 8.0, 7.5, 7.0r	6.00 r	8.00 r	81.4
	Bold seeded	PKV Kabuli-4	10.0, 9.5, 9.0, 8.5, 8.0, 7.5r	6.00 r	9.00 r	79.4
MPKV, Rahuri	Bold seeded	Vishal	7.0, 6.5, 6.0, 5.5, 5.0r	6.00 r	7.00 r	87.7
	Bold seeded	Digvijay		6.00 r	7.00 r	88.4

	Bold seeded	Phule Vishwaraj		6.00 r	7.00 r	88.5
	Soybean					
UAS, Dharwad	Small seeded	DSb 34	3.50, 3.75, 4.00, 4.30. 4.40s	4.00 s	3.75 s	82.8
MPKV, Rahuri	Medium seeded	KDS 753	4.75, 4.50, 4.00, 3.75, 3.50s	4.00 s	4.75 s	87.3
	Medium seeded	KDS 726		4.00 s	4.75 s	88.1
	Maize					
UAS, Bengaluru	Medium seeded	MAH 14-138	7.00, 6.75, 6.50, 6.25, 6.00r	6.40/ 7.00 r	6.50 r	94.5
	Pigeon pea					
UAS, Bengaluru	Bold seeded	BRG 5	4.5, 4.75, 5.0 5.5, 6.00r	4.75 r	5.00 r	92.2
PDKV, Akola	Medium seeded	BSMR 853	5.0, 4.75, 4.5, 4.0r	4.50 r	4.50 r	87.8
	Medium seeded	AKT 881	5.5, 5.0, 4.75, 4.5, 4.0r	4.75 r	4.75 r	91.0
	Bold seeded	BSMR 736		4.75 r	5.00 r	81.8
	Bold seeded	PKV Tara		4.75 r	5.00 r	82.4
	Bold seeded	Maruthi		4.75 r	5.00 r	83.2
	Medium seeded	PDKV Ashlesha		4.75 r	4.75 r	88.9
	Green gram					
UAS, Raichur	Medium seeded	TRCRM147	3.2, 3.0, 2.8, 2.6, 2.4s	2.80 s	2.60 s	90.5
PAJANCOA & RI, Karaikal	Medium seeded	VBN 5	3.2, 3.0, 2.8, 2.7, 2.5s	2.80 s	2.50 s	92.1
	Medium seeded	Co 8		2.80 s	2.70 s	85.2
	Black gram					
TNAU, Coimbatore	Bold seeded	VBN 11	3.6, 3.4 .3.2, 3.0, 2.8, 2.5s	2.80 s	3.20 s	92.3
PAJANCOA & RI, Karaikal	Medium seeded	VBN 10	3.4 .3.2, 3.0, 2.8, 2.7, 2.5s	2.80 s	2.70 s	89.9
	Bold seeded	VBN 11		2.80 s	3.00 s	87.5
UAS, Raichur	Bold seeded	BDU 12	3.6, 3.4, 3.2, 3.0, 2.8s	2.80 s	3.20 s	89.5
	Bold seeded	TRCRU 22		2.80 s	3.00 s	92.6
	Dhaincha					
ICAR-IARI RS, Karnal	Bold seeded	CSD 137	2.2, 2.1, 2.0, 1.9, 1.8 s	---	2.00 s	87.2

PAJANCOA & RI, Karaikal	Medium seeded	Local	2.2,2.0, 1.8, 1.7, 1.6, 1.5s	---	1.60 s	78.8
	Field bean					
UAS, Bengaluru	Medium seeded	HA 5	7.0, 6.5, 6.0, 5.5, 5.0r	6.50 r	6.00 r	93.6
	Finger millet					
UAS, Bengaluru	Medium seeded	KMR 630	1.4, 1.3, 1.2, 1.1, 1.0r	1.40 s	1.20 r	91.2
	Sunflower					
UAS, Bengaluru	Medium seeded	CMS 1103 A	3.0, 2.8, 2.4, 1.85, 1.8s	2.40 s	2.40 s	92.9
	Bold seeded	RHA 92	3.25, 3.0, 2.8, 2.4, 1.85s	2.40 s	2.80 s	91.6
UAS, Raichur	Small seeded	CMS-38 A	2.2, 2.0, 1.8, 1.6, 1.4s	1.80* s	2.00 s	91.7
	Small seeded	R-127-1		1.80* s	1.80 s	92.2
	Small seeded	RGM-49		1.80* s	1.80 s	90.6

Technical programme 2023-24

Experiment 1: Optimum sieve size and type of screen for grading seeds of different crop varieties and hybrids including their parents.

Year of start: 2010-11 (continuous in nature)

Objectives:

1. Crop-wise classification of varieties in seed chain with respect to their seed size (small, medium and bold).
2. To standardize the size and type of grading sieve.

Crop **Centres**

Paddy : ICAR-IARI, RS, Karnal; TNAU, Coimbatore; PDKV, Akola, PAJANCOA&RI, Karaikal and UAS, Raichur

Wheat : ICAR-IARI, RS, Karnal and PAU Ludhiana

Chickpea : MPKV, Rahuri; UAS Dharwad; PDKV, Akola

Black gram : TNAU, Coimbatore and PAJANCOA&RI, Karaikal

Green gram : UAS, Raichur and PAJANCOA&RI, Karaikal

Pigeon pea : UAS, Bengaluru; UAS, Raichur and PDKV, Akola

Soybean : UAS, Dharwad; UAS, Raichur, MPKV, Rahuri and PDKV, Akola

Maize : UAS, Bengaluru and UAS, Raichur

Finger millet : UAS, Bengaluru

Field bean	:	UAS, Bengaluru
Sunflower	:	UAS, Bengaluru
Dhaincha	:	ICAR-IARI, RS, Karnal; UAS, Raichur and PAJANCOA&RI, Karaikal
Sunnhemp	:	UAS, Raichur
Safflower	:	UAS, Raichur

Treatments

Crop: As above

Machine: Standard sieve shaker (specifications as per ISTA)

Sieve sizes: Grading sieve:

a. Recommended sieve (as per IMSCS)

b. Two sieves above the recommended sieve

c. Two sieves below the recommended sieve

Procedure

Unprocessed seed of each crop variety will be procured from reliable source. Specified quantity of unprocessed seed material will be sieved using sieve shaker for 3-5 minutes at the rate of 25-30 strokes per minute. Seed material retained over each grading sieve will be tested for observation on seed quality. The screen that retains maximum seeds with superior seed quality will be considered as optimum.

Observations

1. Recovery (%)
2. Seed size: Length, breadth & thickness (mm)
3. First count (%)
4. Germination (%)
5. Physical purity (%)
6. 1000 seed weight (g)
7. Moisture content (%)

Experiment 2: Assessment of postharvest deterioration of soybean seed quality.

Objective: To access the stage wise postharvest losses in seed quality parameters

Crop		**Centres**
Soybean	:	Dr. PDKV, Akola; UAS Raichur and MPKV, Rahuri

Year of start: 2021-22

Treatments

Technical Programme

I) Varieties: 1. JS 335: Common for all centers

2. Centre wise one local variety existing in seed chain

II) Threshing methods

1. Multi-crop thresher with concave clearance: 20-25mm and alternate stud adjustment
2. Combine harvester at 700 rpm drum speed

III) Sample: Minimum 3 seed lots of each threshing methods

Categorization of harvested seeds on the basis of Moisture content:

Category I: ≤15%

Category II: >15%

IV) Testing of Seed Quality Parameters

i) Immediately after threshing

ii) Just prior to processing operations

iii) During processing operations

1. After Cleaning
2. After Size Grading
3. After Gravity Grading

iv) During storage at ambient conditions

Samples of processed seeds may be drawn from lower most two layers separately from godowns itself at an interval of 15 days till the sowing time and mention the stack height also.

Observations

1. Moisture content (%)
2. Damaged seed (%) (broken, cracked) by visual observation and chemical test (NaOCl test)/ radiography
3. 100 seed weight
4. Seed health status (Insect damage)
5. Physical purity (%)
6. First count (%)
7. Germination (%)
8. Electrical Conductivity (µS/cm/g of seed)

Expected Output

- Identification of postharvest stage contributing maximum losses to germination.
- Optimization of post-harvest operations.

Experiment No. 3: Performance evaluation of solar tunnel dryer for drying of soybean seed

Objective: i. Standardization of drying parameters for soybean seed drying in solar tunnel dryer

ii. To study the effect of drying on seed quality parameters.

Year of start: 2023-24

Crop: Soybean

Center: Dr. PDKV, Akola, UAS, Raichur and MPKV, Rahuri

Technical Programme

Treatments

I) Varieties : 1. JS 335

2. One ruling variety

II) Drying methods

1. Control (Sun drying)
2. Drying in solar tunnel dryer

III) Moisture content:.

1. Existing moisture content (7 seed lots)

IV) Thickness of seed bed

1. 10 mm

Observations

i. Inside and outside Temperature, ^{0}c
ii. Inside and outside Relative humidity, %
iii. Air velocity at inlets & outlets
iv. Moisture removed, %
v. 100 seed weight, g
vi. Germination Test, g
vii. Vigor index I and II
viii. Physical purity, %

Expected Output

1. Viability of solar tunnel dryer for drying of soybean seed.

Probable beneficiaries of the outcome of this work

i. Seed growers
ii. Farm Producer companies
iii. Farmers

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
1	IARI-RS, Karnal	Dr. Ashwani Kumar	Pr. Scientist & PI	ashakmash@gmail.com;	9416251530
2	ICAR-IISS, Mau	Dr. P. Shivamma	Scientist	psm9604@gmail.com	7892328746
3	TNAU, Coimbatore	Dr. Nelson Navamaniraj	ASRO (SST)	nelsonnavamaniraj@tnau.ac.in	9789220924
4	UAS, Bangalore	Dr. K. Vishwanath	SRO	vishwakoti@gmail.com;	9108925969
		Dr. B. Basavaraju	ASPO	Basavaraja.sst@gmail.com;	9980254891

5	PDKV, Akola	Dr. V. N. Mate	ASRO	matevn13@rediffmail.com;	9404082367
6	RPCAU, Pusa	Dr. (Er.) Jaya Sinha	ASRO	jaya.sinha@rpcau.ac.in	6206047381
7	UAS, Dharwad	Dr. Ravi Hunje	Special Officer (Seeds)	Soseed@uasd.in;	9448301595
		Dr. Vijayakumar. A. G	SPO	vijayakumarag@uasd.in;	9482182111
		Dr. Malik Rehan	TA (STR)	malikuasdwd@gmail.com;	9663356479
8	CSAUAT, Kanpur	Dr. CL Maurya	Head, DSST & I/c STR	clmaurya@csauk.ac.in	9453479077
9	UAS, Raichur	Dr. Umesh Hiremath	Asst. Prof	umesh3980@gmail.com	9886911524
10	PAU, Ludhiana	Dr Inderpreet Dhaliwal	SRO	dhaliwalinderpreet@pau.edu; dhaliwalinderpreet@gmail.com;	9815211669
		Dr. T.P. Singh	ASPO	tpsingh@pau.edu	9872428072
		Dr. Gaurav Khosla	Asst. Prof.	goruvkhosla@pau.edu;	9815965404
11	MPKV, Rahuri	Dr. V. R. Shelar	Seed Research Officer	vijayrshelar@yahoo.co.in;	7588604252
		Dr. K.C. Gagare	ASPO	kailasgagareseed@gmail.com	7588695359

Session V

Plenary Session

Date: 13.05.2022 **Time: 2.30 to 4.30 PM**

Chairman	:	**Dr. R.R. Hanchinal** Former Chairperson, PPV&FRA, New Delhi
Co-Chairman	:	**Dr. M. Bhaskaran** Former VC, TNOU & Chairman, RAC, ICAR-IISS, Mau
Convenors	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi **Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	Dr. Udaya Bhaskar K., Senior Scientist, ICAR-IISS, RS, Bengaluru Dr. Vijayakumar A.G., SPO, Seed Unit, UAS, Dharwad

The session was Chaired by Dr. R. R. Hanchinal, Former Chairperson, PPV & FRA New Delhi, and Co-Chaired by Dr. M. Bhaskaran, Former VC, TNOU & Chairman, RAC, ICAR-IISS, Mau. Dr. D. K. Yadava, ADG (Seed), ICAR, New Delhi, and Dr. Sanjay Kumar, Director, ICAR-IISS, Mau, convened the session. At the outset, Dr. Sanjay Kumar welcomed the dignitaries present during the plenary session of the AGM of AICRP on Seed (Crops). The session proceedings commenced with presentations of principal investigators of respective STR themes, where the finalized recommendations for 2022-23 and the technical programme for 2023-24 were accentuated upon. In succession, recommendations that emerged from all of the technical sessions were deliberated and consolidated for chalking out the action plan.

Both chair and co-chair emphasized the need to formulate research programmes by considering the extant problems to mitigate seed issues for the benefit of seed stakeholders. It was further emphasized that each cooperating center should gear up to create ultra-modern storage facilities and laboratories of international standards and funds for this should also be sought under various government schemes. In recognition of outstanding contribution made five scientific staff of AICRP on Seed (Crops) viz., Dr. S.S. Jakhar, CCSHAU, Hisar; Dr. R.B. Yadav, SVPUAT, Meerut and Er. Ashok Asuti, UAS, Dharwad were felicitated on the account of superannuation from government service during the year 2023.

The session ended with a formal vote of thanks by Dr. Arvind Nath Singh., Principal Scientist, ICAR- IISS, Mau.

Contacts of Principal Investigators and Co-Principal Investigators
STR – AICRP on Seed (Crops)

Theme	PI/ Co-PI	Email ID	Mob. No.
Seed Production & Certification			
PI	**Dr. Sandeep K. Lal** Principal Scientist DSST, ICAR-IARI, New Delhi	pispc.nsp@gmail.com	9811048932
Co-PI	**Dr. Bhojaraja Naik K.** Senior Scientist ICAR-IISS, RS, Bengaluru	bhojaraja.naik@icar.gov.in; bharana.naik@gmail.com	7975588306
Seed Physiology, Storage & Testing			
PI	**Dr. Shiv K. Yadav** Principal Scientist DSST, ICAR-IARI, New Delhi	pispnsp@gmail.com	9868273684
Co-PI	**Dr. Udaya Bhaskar K.** Senior Scientist ICAR-IISS, RS, Bengaluru	udaya.kethineni@icar.gov.in; udaya9252@gmail.com	9557935499
Seed Pathology			
PI	**Dr. Atul Kumar** Principal Scientist DSST, ICAR-IARI, New Delhi	atulpathiari@gmail.com	7703820583
Co-PI	**Dr. Gopi Kishan** Scientist ICAR-IISS, Mau	gopi.kishan1@icar.gov.in; gopik0956@gmail.com	9982568300
Seed Entomology			
PI	**Dr. Amit Bera** Senior Scientist ICAR-CRIJAF, Barrackpore	amitbera.iari@gmail.com	9732709874
Co-PI	**Dr. Arvind Nath Singh** Principal Scientist & Head Division of Vegetable Protection ICAR-IIVR, Varanasi	arvind.singh@icar.gov.in	9450725652
Co-PI	**Dr. Anjitha George** Senior Scientist ICAR-IISS, RS, Bengaluru	anjitha.george@icar.gov.in; anjithakitty@gmail.com	8623937913
Seed Processing			
PI	**Dr. Ashwani Kumar** Principal Scientist ICAR-IARI, RS, Karnal	ashakmash@gmail.com	9416251530
Co-PI	**Dr. P. Shivamma** Scientist ICAR-IISS, Mau	psm9604@gmail.com	7892328746

Note: All centres shall communicate the experimental results timely to concerned PIs & Co-PIs with a copy to the Coordination Unit of AICRP on Seed (Crops).

AICRP on Seed (Crops)

AICRP on Seed (Crops) Monitoring Team for 2023-24
(*Kharif* season: Sept. / Oct. 2023; *Rabi* season: Feb. / Mar. 2024)

Zone / NSP centres	Name/ Address/ Convener & Member		Email	Mobile No.
Northern Zone: Group I SKUAS&T, Srinagar; SKUAS&T, Jammu; CSKHPKV, Palampur; PAU, Ludhiana; IIMR, Ludhiana	**Dr. K.S. Baig, VNMKV, Parbhani**	**Convener**	**khizerbaig1@rediffmail.com**	**7304127810**
	Dr. Anandan A., ICAR-IISS, RS, Bengaluru	Member	anandanau@yahoo.com	9894227665
	Dr. Gowhar Ali, SKUAST, Srinagar	Member	gowharpbg@gmail.com	9419001395
	Dr. Nethra N., UAS, Bengaluru	Member	nethraharsha@gmail.com	9900244735
	Dr. Ashish Kumar, JNKVV, Jabalpur	Member	ashishashish2612@gmail.com	7999268815
	Dr. Kuldip, ICAR-IISS, Mau	Member	Kuldip@icar.gov.in	9736526049
Northern Zone: Group II CCSHAU, Hisar; GBPUAT, Pantnagar; IIWBR, Karnal; VPKAS, Almora; DSST, IARI, Delhi/ Karnal; SVBPUA&T, Meerut; IIMR, Delhi	**Dr. R. Umarani, TNAU, Coimbatore**	**Convener**	**seedunit@tnau.ac.in**	**9842775257**
	Dr. Omvati Verma, GBPUAT, Pantnagar	Member	dr_omvati@rediffmail.com	9411159389
	Dr. Rajesh R. Dhutmal, VNMKV, Parbhani	Member	dhutmalvnmkv@gmail.com	7038091004
	Dr. Gaurav Khosla, PAU, Ludhiana	Member	goruvkhosla@pau.edu	9815965404
	Dr. Aravindan S., ICAR-IISS, RS, Bengaluru	Member	aravindan.s@icar.gov.in	7538995223
Western Zone I SKRAU, Bikaner; CAZRI, Jodhpur; IGFRI, Jhansi; RVSKVV, Gwalior; RARI, Jaipur; DRMR, Bharatpur	**Dr. K. Madhusudhan, UAS, Bengaluru**	**Convener**	**sosnsp@gmail.com**	**9972842642**
	Dr. Amrapali A. Akhare, PDKV, Akola	Member	ddrseed@yahoo.com	9881880083
	Dr. A.K. Meena, RARI, Durgapura	Member	akmeena.pbg@sknau.ac.in	8432719252
	Dr. Yagnesh Viradiya, SDAU, SK Nagar	Member	yagneshvir@gmail.com	9537624428
	Dr. Gopi Kishan, Scientist, ICAR-IISS, Mau	Member	gopik0956@gmail.com	8510053445
Western Zone II JAU, Junagadh /Jamnagar; DGR, Junagadh; AAU, Anand; SDAU, SK Nagar; AU, Kota; NAU, Navsari; MPUAT, Udaipur	**Dr. Ravi Hunje, UAS, Dharwad**	**Convener**	**ravihunje@gmail.com**	**9448301595**
	Dr. Sangita Yadav, ICAR-IARI, New Delhi	Member	sangitaydv19@gmail.com	9868273681
	Dr. I. Swarnalata, PJTSAU, Hyderabad	Member	inapanuri.72@gmail.com	8008477021
	Dr. R.P. Juneja, JAU, Junagadh	Member	rajkumarjuneja19@gmail.com	9924939602
	Dr. Sumeet Kumar Singh, RPCAU, Pusa	Member	sumitiasbhu@gmail.com	9334792496
	Dr. Sripathy K.V., ICAR-IISS, RS, Bengaluru	Member	kudekallu2@gmail.com	8005202449
Eastern Zone: Group I NDUAT, Faizabad; IISR, Lucknow; CSAUAT, Kanpur; IIPR,	**Dr. Vijay R. Shelar, MPKV, Rahuri**	**Convener**	**vijayrshelar@yahoo.co.in**	**8329938350**
	Dr. A.S. Bhanvadia, AAU, Anand	Member	nodalofficerseed@aau.in	9375059249
	Dr. Atul Kumar, ICAR-IARI, New Delhi	Member	atulpathiari@gmail.com	7703820583

Zone / NSP centres	Name/ Address/ Convener & Member		Email	Mobile No.
Kanpur; BHU, Varanasi; IISS, Mau	Dr. Vishwanath Koti, UAS, Bengaluru	Member	vishwakoti@gmail.com	9108925969
	Dr. Anjani Kumar Singh, SKUAST, Jammu	Member	anjaniiari@yahoo.co.in	9419171123
	Dr. Manjanagouda S. S., ICAR-IISS, RS, Bengaluru	Member	mssagron@gmail.com	9381445031
Eastern Zone: Group II RPCAU, Pusa; BAU, Sabour, BAU, Ranchi; CRIJAF, Barrackpore; BCKV, Nadia	**Dr. T. Ramanadane, PAJANCOA&RI, Karaikal**	**Convener**	**raman_nadane@yahoo.com**	**9443875443**
	Dr. V.S. Mor, CCSHAU, Hisar	Member	hodsstnew@gmail.com	9468337001
	Dr. Imtiyaz Ahmed, UAS, Raichur	Member	imtu.ahmed4823@gmail.com	8951523063
	Dr. Arun Kumar, BAU, Sabour	Member	arunphdsst@gmail.com	9006240983
	Dr. Deepanshu Jayaswal, ICAR-IISS, Mau	Member	jayaswaldeepanshu@gmail.com	7065079257
Central Zone I IISR, Indore, PDKV, Akola; MAU, Parbhani; MPKV, Rahuri, VSI, Pune; KKV, Dapoli	**Dr. J.B. Patel, JAU, Junagadh**	**Convener**	**jbpatelvasai38@gmail.com**	**7984196389**
	Dr. Sanjay Kumar Singh, JNKVV, Jabalpur	Member	sanjayiivr@gmail.com	9407884019
	Dr. Aflaq Hamid, SKUAST, Srinagar	Member	falak19@gmail.com	7889617904
	Dr. P.P. Patil, BSKKV, Dapoli	Member	prashantppatil322@gmail.com	8956892213
	Dr. Shika Sharma, CSKHPKV, Palampur	Member	shi.bha.80@gmail.com	8360746470
	Dr. Anjitha George, ICAR-IISS, RS, Bengaluru	Member	anjithakitty@gmail.com	8623937913
Central Zone II JNKVV, Jabalpur; CICR, Nagpur; IGKVV Raipur; OUAT, Bhubaneswar; NRRI, Cuttack	**Dr. Rakesh K. Kapila, CSKHPKV, Palampur**	**Convener**	**rkkapila@gmail.com**	**9418101452**
	Dr. V. Santhy, ICAR-CICR, Nagpur	Member	santhy100@gmail.com	9890684572
	Dr. D.A. Chauhan, NAU, Navsari	Member	megaseed.nau@gmail.com	9426559819
	Dr. P.B. Singh, MPUAT, Udaipur	Member	pbsingh13@yahoo.co.in	7727854001
	Dr. Manoj Kumar Rout, OUAT, Bhubaneshwar	Member	routmanoj6@gmail.com	9938793431
	Dr. Shantha Raja C.S., ICAR-IISS, RS, Bengaluru	Member	shantharaja.cs@icar.gov.in	9008749131
North Eastern Zone UBKV, Pundibari; AAU, Jorhat; ICAR RC NEH Meghalaya (Manipur, Barapani, Nagaland & Tripura centres) and CAU, Imphal	**Dr. Sandeep K. Lal, ICAR-IARI, New Delhi**	**Convener**	**skl_nsp@yahoo.com**	**9811048932**
	Dr. Ashwani Kumar, ICAR-IARI, RS, Karnal	Member	ashakmash@gmail.com	9416251530
	Dr. Pramesh Khoyumthem, CAU, Imphal	Member	pramesh_kh@rediffmail.com	7005196639
	Dr. Vakeswaran V., TNAU, Coimbatore	Member	vakeswaran@gmail.com	9952176477
	Dr. Banoth Vinesh, ICAR-IISS, Mau	Member	vinesh.banoth511@gmail.com	8309408444
Southern Zone I ICAR-CCARI, Goa; UAHS, Shimoga; UAS, Dharwad; UAS, Raichur; PJTSAU, IIRR, IIMR, IIOR, Hyderabad	**Dr. Shiv K. Yadav, ICAR-IARI, New Delhi**	**Convener**	**pispnsp@gmail.com**	**9868273684**
	Dr. Sudipta Basu, ICAR-IARI, New Delhi	Member	sudipta_basu@yahoo.com	9871177651
	Dr. Amit Bera, ICAR-CRIJAF, Barrackpore	Member	amitbera.iari@gmail.com	9732709874
	Dr. Krishna Naik K., ANGRAU, Guntur	Member	ramavath_kagri@rediffmail.com	9440203026

Zone / NSP centres	Name/ Address/ Convener & Member		Email	Mobile No.
and ANGRAU, Guntur	Dr. G.K. Lande, PDKV, Akola	Member	gajannan1975@gmail.com	7588962199
	Dr. Ramya P., ICAR-IISS, RS, Bengaluru	Member	ramyakurian@gmail.com	9008184658
Southern Zone II	**Dr. R.S. Shukla, JNKVV, Jabalpur**	**Convener**	**shukla.rs90@gmail.com**	**9424676727**
UAS, Bangalore; TNAU,	Dr. Vijaya Kumar A.G., UAS, Dharwad	Member	vijayakumarag@uasd.in	9739982111
Coimbatore; SBI, Coimbatore;	Dr. Jawaharlal J., ICAR-IIOR, Hyderabad	Member	jawaharlaljatoth@gmail.com	9160451473
PAJANCOA & RI, Karaikal and KAU,	Dr. R. Shiva Ramakrishnan, JNKVV, Jabalpur	Member	shivram.krishnan2008@gmail.com	9174056526
Thrissur /Pattambi	Dr. Bharath Chandra Nath, AAU, Jorhat	Member	bharat.c.nath@aau.ac.in	9864743751
	Dr. Bhojaraja Naik K., ICAR-IISS, RS, Bengaluru	Member	bharana.naik@gmail.com	8792695917

Calendar of Events for QSP & STR

S. No.	Event	Last date for completion of action	
Calendar of Events for Breeder Seed Production		***Kharif***	***Rabi***
1.	Placement of breeder seed indents to Director of Agriculture by the State Government & State Public Seed Producing Agencies.	15th December of previous year	31st May of year
2.	Submission of indents to DAC&FW & SAU's	15th January	15th June
3.	Communication of indents by DAC&FW to ICAR Headquarters.	28th February	15th July
4.	Communication of Breeder Seed Production Plan in BSP-1 by Project Coordinator (Crop) to DAC&FW and ADG (Seed), ICAR	15th May	15th September
5.	Communication of the BSP-2 by the concerned Breeder to DAC&FW and ADG (Seed), ICAR	After 15 days of the actual planting	After 15 days of the actual planting
6.	Communication of the BSP-3 by the concerned breeder to DAC&FW and ADG (Seed), ICAR	After 15 days of actual inspection by the Joint Monitoring team	After 15 days of actual inspection by the Joint Monitoring team
7.	Communication of the final production figures of breeder seed by the ICAR in BSP-4 to DAC&FW	15th February	15th July
8.	Communication of the Allocation of Breeder seed by DAC&FW to Director of Agriculture and concerned indenter's	31st March	15th September
9.	Lifting of Breeder Seed Production by indenters	30th May	30th October
10.	Communication of the lifting details of breeder seed against the GOI allotment to DAC&FW by states and other agencies	After 15 days of the cut-off-date	After 15 days of the cut-off-date
11.	Submission of Breeder Seed Production activity to ICAR-IISS, Mau	30th June	30th January
12.	Monitoring of Breeder Seed Production by ICAR-IISS team	Month of Sept. /Oct.	Month of Feb. / Mar.
13.	Submission of Monitoring Team Report to ICAR-IISS, Mau	31st March	
14.	Communication of yearly Breeder Seed Production status to ICAR-IISS, Mau (production, shortfall / mismatch & non-lifting)	30th December	
15.	Annual Breeder Seed Review Meeting by ICAR Seed Division	3rd week of January	
Calendar of Events for Seed Technology Research Experiments under AICRP on Seed (Crops)			
1.	Communication of technical programme for STR experiment to centres	May of the year	

2.	Submission of status report of experiments	15th of August	15th of December
3.	Monitoring status of experiments by ICAR-IISS team	Month of Sept. /Oct.	Month of Feb. /Mar.
4.	Submission of yearly experimental results to PI's and ICAR-IISS, Mau- field and storage experiments	31st January	31st July
5.	Submission of Monitoring Team Report to ICAR-IISS, Mau	First week of March	
6.	Annual Group Meeting of AICRP on Seed (Crops)	1st or 2nd week of April/ May	

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

भाकृअनुप
ICAR

ICAR-Indian Institute of Seed Science
(Indian Council of Agricultural Research)
Mau 275 103 (UP), INDIA
(ISO 9001: 2008 Certified Institute)
www.seedres.icar.gov.in