PROCEEDINGS

37th ANNUAL GROUP MEETING OF AICRP ON SEED (CROPS)

TECHNICAL PROGRAMME (2022-23)

12-13 April, 2022

VIRTUAL MEETING
HELD THROUGH VIDEO-CONFERENCING

ICAR-Indian Institute of Seed Science
(Indian Council of Agricultural Research)
Mau 275 103 (UP), INDIA
(ISO 9001: 2008 Certified Institute)
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CONTENTS

Session I

Inaugural Session of 37th AGM of AICRP on Seed (Crops)

Date : 12.05.2022 **Time : 10.00 – 11.00**

Chairman	:	**Dr. T.R. Sharma** DDG (CS), ICAR, New Delhi
Co-Chairman	:	**Dr. D. K. Yadava** ADG (Seed), ICAR, New Delhi
Convener	:	**Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	Dr. Vijay R. Shelar, SRO, MPKV, Rahuri Dr. Kalyani Kumari, Scientist, ICAR-IISS, Mau

ICAR-Indian Institute of Seed Science, Mau organized the 25th Annual Breeder Seed Review Meeting and 37th AGM of AICRP on Seed (Crops) through video conferencing mode on 12-13 May, 2022. The Inaugural Session of the meet was Chaired by Dr. T.R. Sharma, Deputy Director General CS), ICAR, New Delhi and Co-Chaired by Dr. D. K. Yadava, ADG (Seed), ICAR, New Delhi. The session was convened by Dr. Sanjay Kumar, Director, ICAR-IISS, Mau.

At the outset, Dr. Sanjay Kumar, Director, ICAR-IISS, Mau welcomed the dignitaries. He briefed about merging of AICRP on NSP (Crops) and ICAR Seed Project into AICRP on Seed (Crops) and arrangements made in this regard for betterment of merged entity during 2021-22.

Dr. D. K. Yadava, ADG (Seed), ICAR, New Delhi in his introductory remarks highlighted the genesis of National Seed Project and the role of two components i.e. quality seed production and seed technology research under AICRP on Seed (Crops). He also briefed the objectives and mandate of aforesaid components and contributions made by this group to Indian seed domain for almost four decades. He also briefed about the status of seed research, seed production, supply system and network in the country along with role of private sector. He appreciated the progress made during last five years and highlighted the challenges for the group in near future, which are mentioned below.

- Addressing breeder seed quality issues and maintenance breeding programmes on project mode
- Inviting private seed sector to collaborate under STR component and preparing collaborative programmes in this regard
- Standards and validity of coated and pelleted seed need to be standardized
- Biosafety issue in nanotechnology and its applications in the domain of seed quality enhancement need to be studied
- Developing seed health standards for major diseases in field crops in order to prepare for upcoming new seed bill

- SMR need to be revised for all 56 field crops

Dr. Sanjay Kumar, Director, ICAR-IISS, Mau presented the progress report, 2021-22 as well as the action taken report (ATR) on recommendations of previous meeting. He appraised about the progress under AICRP on Seed (Crops) in increasing the breeder/ quality seed production and varietal replacement rate, reduction of varietal mismatch and also presented the research highlights under seed production and certification, seed physiology, storage & testing, seed pathology, seed entomology and seed processing themes of STR component of AICRP on Seed (Crops). He highlighted that the breeder seed production during 2021-22 was 1.06 lakh quintals against indent of 0.84 lakh quintals, while the total quality seed production was 4.5 lakh quintals.

Sh. Ashwini Kumar, Joint Secretary (Seeds), Department of Agriculture Cooperation and Farmer's welfare, GOI in his remarks lauded the efforts of ICAR in varietal development. He expressed concern about the availability of breeder seed of new varieties and asked scientists involved in development of new varieties to take lead and involve in seed production through KVKs. He also emphasized that for new varieties, which have potential for licensing, a uniform set of guidelines for fixing the royalty need to be devised. He requested ICAR to notify crop specific guidelines for packaging of breeder seed. The breeder seed quality issues need to be addressed through a group of scientists by making spot visits he opined. He also requested ICAR to constitute special monitoring team for soybean breeder seed crop, development of seed health standards for major seed borne diseases, find the solution for loss of yield in wheat due terminal heat stress through seed technological means. He urged cooperating centres to develop plan for production of planting material with support of DAC&FW. He opined that joint efforts are needed to address the issues such as poor SRR in the states of Jharkhand, Odisha and Bihar with focus on lentil, urd, sunflower, oil palm and soybean. Further, he ensured whole-hearted co-operation from the Ministry and acknowledged that the efforts of ICAR and SAU's are reaching farmers as good quality certified seeds and ultimately resulted in the enhanced productivity of the country.

The Deputy Director General (CS), ICAR, Dr. T.R. Sharma announced the various awards as part of the annual meeting. The best quality seed production centre award SAU, category and ICAR Institute category for the year 2021-22 were bestowed upon ICAR-IIWBR, Karnal and MPKV, Rahuri, respectively whereas PAJANCOA&RI, Karaikal bagged the best STR center award for 2021-22. Similarly, Chairman of the session distributed technology development certificates to scientists of STR component who are engaged in multi-location and multiyear experimentation. In total, six certificates were distributed viz.

1. Integrated approach for enhancing the seed yield and quality in millets
2. Rapid assessment of genetic purity in paddy hybrid cv. JRH 5 through molecular marker
3. Seed thermo-priming for better plant stand establishment and yield under heat stress condition in pigeon pea

4. Molecular detection of seed borne pathogens (BCMV in common bean and PMMV, *C. truncatum, C. coccodes* in capsicum) vis-à-vis seed quality assurance
5. Management of Alternaria early blight in tomato
6. Optimization of aperture size of bottom/grading sieves for processing of new crop varieties

Dr. T.R. Sharma, in his Chairman's address congratulated the entire group for the fairly good job done during 2021-22. He praised the efforts of participating centers including ICAR institutes, SAU's as well as ICAR-IISS, Mau for their critical roles in allowing the national agricultural system to flourish. He emphasized the imminent need for systematic maintenance breeding in field crops for ensuring genetic purity and need to create cold storage facility at zonal level to address the crisis situation. He opined that traditional seed production areas are getting affected due to climate change and hence identification of suitable offseason production sites is necessary. He also stressed on the need for validation and upgradation of field and seed standards and protocols for sample size, physical purity, ODV etc. for various crops. Problem in lifting of seed because of varietal mismatch has to be sorted out by the group and asked centres to make available breeder seed of new varieties in adequate quantities. He also asked the group to develop tissue culture methods for vegetatively propagated crops and treatment of certified seed should be mandatory for all the crops to avoid losses caused by seed borne and soil borne diseases. Role of endophytes /seed borne microorganisms in enhancement of seed vigour needs to be established. He also emphasized the need to prioritize seed requirement in bio-fortified variety and opined that 25% FLDs should come for bio-fortified variety. Mainstreaming of those varieties can only be done by production of good quality seed. He also asked the group to work on following areas.

1. Basic studies in seed biology domain
2. Nutrient homeostasis-how nutrient move during germination
3. Hormonal regulation and ion uptake in seeds
4. Activation of antioxidants and defense systems
5. Seed longevity-molecular mechanisms involved
6. Role of PGPR in biopriming
7. Development of gene chip to detect seed borne pathogens, Multiplexing of diagnostics tools for viruses and seed borne pathogens

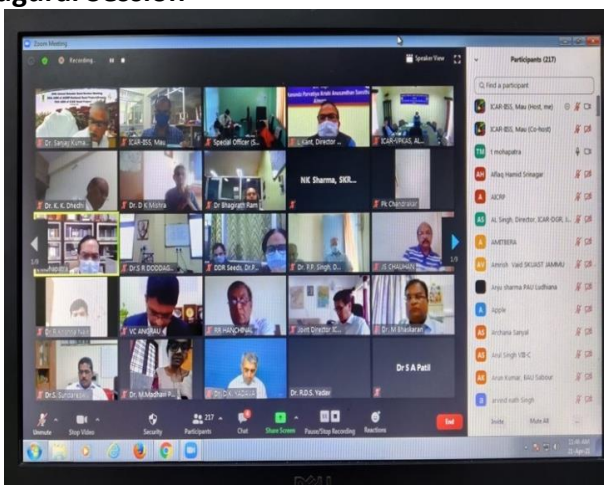
The session ended with vote of thanks by Dr. Arvind Nath Singh, Principal Scientist, ICAR-IISS, Mau.

During the detailed deliberations, following action points were emerged:

- Revision of Seed Multiplication Ratio (SMR) is yet to be notified. In this regard, ICAR-IISS, Mau along shall take necessary steps to submit a proposal for revision of SMR to the CSCB, DAC&FW, GoI at the earliest. **[Action: Director, ICAR-IISS, Mau]**

- The issue of packaging size in breeder seed was discussed and it was observed that uniform packaging size in breeder seed is not being followed across the centres. Indenting agencies were forced to lift either excess or reduced quantities of breeder seed during supply. In this regard, to address this issue a committee may be constituted by ICAR to develop appropriate guidelines for packaging size in breeder seed across various crops. **[Action: Director, ICAR-IISS, Mau & ADG (Seed), ICAR]**
- The primary objective of creation of KVKs is to achieve technology transfer. Seed being the carrier of technology, cooperating centres of AICRP on Seed (Crops) should work in tandem with KVKs and impact on crop yield levels through quality seed need to be worked out. **[Action: Nodal Officers, AICRP on Seed (Crops)]**
- The role of endophytes in seed quality augmentation needs investigation. In this regard, ICAR-IISS, Mau shall take up research programmes in this area. **[Action: Director, ICAR-IISS, Mau]**

Glimpses of Inaugural Session



Session II

Presentation of Seed Technology Research Achievements during 2021-22 by Principal Investigators, Finalization of Technical Programme for 2022-23 and Identification of Technologies by the Panel of Experts

Date : 12.05.2022 **Time : 2.00 – 6.00**

Chairman	:	**Prof. S.K. Rao** Vice-Chancellor, RVSKVV, Gwalior
Co-Chairman	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi
External Experts	:	**Dr. R.R. Hanchinal,** Former Chairperson, PPV&FRA, New Delhi **Dr. S. Rajendra Prasad,** Vice-Chancellor, UAS, Bengaluru **Dr. J.S. Chauhan,** Former ADG (Seed), ICAR, New Delhi **Dr. Malavika Dadlani,** Former Joint Director (Research), ICAR-IARI, New Delhi
Convener	:	**Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	Dr. Susmitha C., Scientist, ICAR-IISS, Mau Dr. Banoth Vinesh, Scientist, ICAR-IISS, Mau

The session was chaired by Prof. S.K. Rao, Vice-Chancellor, RVSKVV, Gwalior and co-chaired by Dr. D.K. Yadava, ADG (Seed), ICAR, New Delhi. Dr. Sanjay Kumar, Director, ICAR-IISS, Mau convened the meeting. The session was graced by external experts' *viz.*, Dr. R.R. Hanchinal, Former Chairperson, PPV&FRA, New Delhi, Dr. S. Rajendra Prasad, Vice- Chancellor, UAS, Bengaluru, Dr. J.S. Chauhan, Former ADG (Seed), ICAR, New Delhi, Dr. Malavika Dadlani, Former Joint Director (Research), ICAR-IARI, New Delhi and Dr. Rahul Chaturvedhi, Pepsico.

The discipline wise presentation of progress report for the year 2021-22 was made by respective Principal Investigators.

S. No.	Discipline	Principal Investigator
1	Seed Production & Certification	Dr. Sandeep K. Lal
2	Seed Physiology, Storage and Testing	Dr. Shiv K. Yadav
3	Seed Pathology	Dr. Atul Kumar
4	Seed Entomology	Dr. Amit Bera
5	Seed Processing	Dr. Ashwani Kumar

Highlights of research progress and recommendations deliberated in the session include:

A. Seed production and certification: Dr. Sandeep Kumar Lal, PS, ICAR-IARI, New Delhi and PI presented the significant findings of 2021-22. In experiment on redefining isolation distance for producing genetically pure hybrid seed of pigeon pea, a distance of 400 m has been recommended. In case of mustard, an isolation distance of 1000 m is recommended, keeping in view the rigorous activity of pollinators in *rabi*; however, it was decided to repeat the experiment this year or when stable CMS line is made available by adopting isolation distance ranging from 600-1000 m for further confirmation and validation. In this context, Dr. S. N. Sinha also suggested for increasing mustard isolation distance due to availability of wild honey bees that can fly up to 1 km distance. Dr. S.K. Chakraborty clarified availability of pure CMS Mustard lines and also suggested to use dominant seedling markers for establishing cross pollination. In experiment on optimization of organic seed production systems of paddy and maize, results across various centers revealed that in case of paddy, state recommended dose of fertilizer performed superior over all the treatments. However, organic method of seed production was found to be better than the control and variety Bharthi performed better under organic seed production systems. In case of maize, no conclusions were made since each center involved in conducting the experiment used different set of maize varieties for the purpose of experimentation. In experiment on seed quality assessment of breeder seed samples, it was recommended that standards for breeder seed samples should be at higher levels than foundation class seed.

B. Seed physiology, Storage & Testing: Dr. Shiv Kumar Yadav, PS, ICAR-IARI, New Delhi & PI presented the highlights pertinent to 2021-22. In the experiment conducted on determining validity period of certified seed lots, results across various centers revealed that the certification tags issued to seed lots will be valid for 9 months and can be revalidated for another 6 months or till they maintain viability ≥ IMSCS. However, in case of crops *i.e.,* castor and chickpea, the germination data was reported to be erratic, and it was decided to repeat the experiment for these crops. In experiment for identification of molecular markers for genetic purity assessment of crop cultivars, SSR marker RM 276 was identified as unique marker for determining the hybrid purity of paddy hybrid JRH-5. In experiment on quantification of seed vigor, results across the centers revealed that seed germination and vigor indices had high significant and positive correlation with field emergence. Hence, seed germination and vigor indices can be considered as perfect and good indicators for assessment of field emergence as well as rapid and low-cost, accurate technology. Therefore, it was suggested to continue the experiment and develop universal scale by fixing minimum cut-off values based on any one or two important seed quality parameters during 2022-2023. In experiment on revalidation of seed vigor and performance of field crops, it has been suggested that revalidation once *i.e.,* RV-I should be allowed (case by case depending upon the crop species), nevertheless second revalidation *i.e.,* RV-II in any of the crop species is not recommended and it was decided to conclude the experiment. In

experiment on assessment of prevalence of revalidated seed lots in the country, based on the data collected from state seed corporations (SSCs), for majority of the crop species no seed lots were received for the purpose of RV-II. Keeping this in view, and in line with the findings of previous experiment it was recommended that, revalidation of seed lots once will be sufficient whereas, RV-II is absolutely not necessary. Dr. Chaturvedi requested to study the physiological changes in terminal heat stress and also suggested to conduct the experiment for atleast two years for fruitful interpretation.

C. Seed Pathology: Dr. Atul Kumar, PS, ICAR-IARI, New Delhi and PI presented the salient achievements for 2021-22. Atlas of seed borne pathogens across the country were prepared highlighting the prevalence of rice bunt, bacterial leaf blight (BLB) in majority of the states of India. Sheath rot and bacterial panicle blight of paddy, and fruit rot of chilli were reported to be the emerging diseases in few pockets in the country. With respect to emerging seed-borne diseases, false smut, brown spot in paddy and spot blotch, head blight in wheat have been reported in different parts of the country. Seed discoloration in paddy was identified as re-emerging disease in paddy leading to reduction in seed germination and quality loss, whereas, potato virus Y (PVY) strain and corm rot of saffron are reported at SKUAST, Srinagar. With respect to major fungi infecting various crop species, prevalence of different fungal species *viz., Alternaria, Curvularia, Fusarium, Helmenthosporium, Penicillium* and *Aspergillus* spp. has been reported across the country. For standardization of seed testing methods, it was recommended that NaOH (0.6%) blotter soak method was found to be effective in increasing pathogen recovery and performed better than standard blotter method. Along with this, universal primers and strain specific primers have been designed for detection of all the strains of PVY. In addition to this, primers for other viruses of potato *viz.,* PVX, PVS, PLRV and PVA were also designed and used for detection of these viruses.

D. Seed Entomology: Dr. Amit Bera, Senior Scientist, ICAR-CRIJAF, Barrackpore and PI presented the achievements for 2021-22. Under experiment on evaluation of solarization treatment on bruchids, it was recommended that solarization of seeds for 6 days for 4h duration per day could effectively manage the infestation of pulse beetle in case of chickpea, bengal gram and green gram. In that context, the Director ICAR-IISS, Mau has insisted centres to give demonstration of technology to check insect pest control in pulses in selective villages. In experiment conducted on surveying and monitoring of insecticide resistance of storage insect pests *viz., Rhyzopertha dominica, Sitophilus oryzae, Tribolium castaneum, Callosobruchus maculatus* and *Callosobruchus analis* in storage godowns, results of various centers revealed that most of the strains showed x3 to x30 resistance compared to respective susceptible strains, suggesting rational scheduling of pesticide use for resistance management of selected storage insect pests. Application of neemazol TS @ 6 ml/kg seed and emamectin benzoate @ 0.3 g/L at 50% pod maturity and pod ripening stages was found to be effective for management of pulse beetle in chickpea, green gram, black gram, pigeon pea and cowpea. Seed treatment using botanical *i.e.,* spinetorum @ 3

ppm, was found to be effective in controlling pulse beetle and performed *on par* with the insecticides *viz.,* emamectin benzoate and deltamethrin.

E. Seed Processing: Dr. Ashwani Kumar, PS, ICAR-IARI, RS, Karnal and PI presented the progress report for 2021-22. Grading sieve size was standardized for new varieties of different crop species. In experiment on management of karnal bunt through mechanical seed processing, a recommendation has emerged, suggesting that 2° slope of deck of the gravity separator and 15 kg per minute rate of feed, for one tonnes per hour processing unit, is recommended for processing of wheat seed for management of Karnal bunt.

Remarks of Prof. S.K. Rao, Chairman

- It was emphasized that all the experiments need to be conducted accurately in a meticulous manner across locations and years, before disseminating the recommendation as a technology.
- With respect to maintaining standards of breeder seed, it is suggested to monitor and scrutinize all BSP centers based on post-control plot treatments and recommended for development of a strict mechanism based on third party inspection for quality control of breeder seed.
- Pertinent to organic seed production systems, it was reiterated there is absolutely no need to choose only notified varieties, any variety suitable for organic cultivation can be selected for the purpose of experimentation.
- It was suggested to the Director, IISS, Mau to develop a mechanism for integrating the recommendations emerging from STR component with the state governments with special emphasis on enlightening farmers on disease and pest outbreak before each cropping season.

Remarks of Co-chairman, Dr. D.K. Yadava

- Highlighted the role of maintenance breeding in the enhancing the quality of breeder seed and suggested that, regular scrutiny of breeder seed production plots by original breeder(s) involved in development of variety could assist in maintaining 100% genetic purity of breeder seed samples.
- Emphasized on revisiting and optimization of seed rates since in majority of the crop species seed rate has been increased in the recent past to the extent of 20-25%.
- Stressed that all SAUs/ ICAR institutes should held accountability and ensure the availability of quality seeds in the public domain and cater the need of farmers.
- Suggested that all the released and notified hybrids of mustard need to be investigated for defining isolation distances for producing genetically pure hybrid seed.

Remarks of external experts

Dr. Malavika Dadlani opined that rigorous monitoring of breeder seed production (BSP) plots by any nodal agency (similar to SSCA) is quite necessary and a pre-requisite. Further, it was re-iterated that centers have to take utmost care in carrying out BSP programme and centers that are not performing on a recurring basis may be withdrawn from BSP component of AICRP on Seed (Crops).

Dr. S.N. Sinha opined that in case of farm saved seeds, insect infestation is considered higher than that of quality seed. Hence, one or two recommendations emerged from seed entomology and storage experiments may be demonstrated to the farmers of two or three villages near by ICAR-IISS, Mau to investigate the efficiency of recommendations in case of farm saved seeds. With reference to the experiment on management of karnal bunt through mechanical seed processing, it was suggested that similar experiment may be planned involving more centers in different crops, for identification of novel methods/technologies that could separate insect/ disease infected seeds from healthy seed lots.

Dr. S. Rajendra Prasad, stressed that choosing varieties that suit organic cultivation is a preliminary requisite for optimization of organic seed production systems in all the crops. Further, it was emphasized that strict adherence to maintenance breeding procedures could significantly enhance the quality of breeder seed.

Dr. J. S. Chauhan stated that data should be reported meticulously by all the centers, since inconsistency in recording of data across locations result in erratic and error-prone results with abruptly higher CV values making it difficult to arrive at a conclusion or suitable recommendation from the experiments.

The session came to an end with formal vote of thanks by Dr. Udaya Bhaskar, K. Senior Scientist, ICAR-IISS, Regional Station, Bengaluru.

During the detailed deliberations, following action points were emerged:

1. In order ascertain uniformity in reporting and analysis of data under STR experiments, concerned PIs need to develop data sheets for each experiment and same may be circulated to all centres. **[Action: All concerned PIs]**
2. After validation of findings at multi-locations, concerned PIs shall compile the results and present before the expert panel for finalization of recommendation as a technology. **[Action: All concerned PIs]**
3. In light of quality issues in breeder seed lots, the need was felt for rigorous monitoring of breeder seed production plots by any third party/ nodal agency (similar to SSCA). **[Action: Nodal Officers, AICRP on Seed (Crops) & Director, ICAR-IISS, Mau]**
4. With reference to the experiment on management of karnal bunt through mechanical seed processing, it was suggested that similar experiment may be planned involving more centers in different crops, for identification of novel

methods/technologies that could separate insect/ disease infected seeds from healthy seed lots. **[Action: PI (Seed Processing) & Director, ICAR-IISS, Mau]**

Session III

Panel Discussion on Synergizing Efforts and Prospective Research on Vegetables Seed under AICRP on Seed (Crops)

Date : 13.05.2022 **Time : 10.00 – 12.00**

Chairman	:	**Dr. A.K. Singh** DDG (HS), ICAR, New Delhi
Co-Chairman	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi
Panelists	:	**Dr. H.S. Yogeesha,** PS, ICAR-IIHR, Bengaluru **Dr. Gyandendra Shukla,** CEO, JK Agri Genetics Ltd., Hyderabad **Dr. T.K. Behera,** Director, ICAR-IIVR, Varanasi **Dr. Sanjay Kumar,** Director ICAR-IISS, Mau
Experts	:	**Dr. Vikramadithya Pandey,** ADG (HS-I), ICAR, New Delhi **Dr. S.C. Sati,** VNR Seeds, Raipur **Dr. V.K. Pandita,** Former Head, ICAR-IARI, RS, Karnal
Convener	:	**Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	Dr. Udaya Bhaskar K. Senior Scientist, ICAR-IISS, RS, Bengaluru Dr. Ramya P., Scientist, ICAR-IISS, RS, Bengaluru

The event was Chaired by Dr. A.K. Singh, DDG (HS), ICAR, New Delhi and Co-Chaired by Dr. D.K. Yadava, ADG (Seed), ICAR, New Delhi. Dr. H.S. Yogeesha, PS, ICAR-IIHR, Bengaluru; Dr. Gyanendra Shukla, CEO, JK Agri Genetics Ltd., Hyderabad; Dr. T.K. Behera, Director, ICAR-IIVR, Varanasi; Dr. Sanjay Kumar, Director, ICAR-IISS, Mau were some of the prominent panelists presented their viewpoints during the discussion. The session was also joined by the group of experts viz. Dr. Vikramadithya Pandey, ADG (HS-I), ICAR, New Delhi; Dr. S.C. Sati, VNR Seeds, Raipur and Dr. V.K. Pandita, Former Head, ICAR-IARI, RS, Karnal.

To begin with Dr. Sanjay Kumar, Director, ICAR-IISS, Mau welcomed the dignitaries and presented a perspective for institution of delineated deliberations to enable seed research in vegetable seed domain under AICRP-Seed (Crops).

Dr. D. K. Yadava highlighted the need for prospective vegetable seed research and gave lucid scenario of Indian vegetable domain. In his remarks, with 69 horticultural crops and around 240 varieties, explained about bottlenecks of indenting system, lack of seed testing protocols, field and seed standards especially with release of new hybrids should be focused. He also emphasized about formulation of modalities for enabling vegetable seed

research under the ambit of AICRP-Seed (Crops), so that needs of diverse stakeholders of vegetable seed sector can be addressed.

Dr. H. S. Yogeesha detailed about current status of vegetable seed research and stressed on productivity augmentation i.e. 18.5 t/ha to the tune of world's average productivity, 19.7 t/ha with prospective seed research support. He also deliberated on issues pertinent to seed production under protected cultivation, organic seed production, revisiting of seed certification standards in solanaceous crops and cucurbits where containerized seed production is gaining importance.

Dr. Gyanendra Shukla presented the viewpoint of private vegetable seed sector and explained about enormous opportunities in protected cultivation by addressing issues pertinent to emasculation and pollination. He also emphasized on need to gear up for tackling viral diseases in Tomato, Chilli, Okra and Gourds.

Dr. T.K. Behera, reiterated about strengthening of seed research in horticultural crops, encompassing the same under the umbrella of AICRP Seed (Crops) and promoting innovative research was deliberated.

Dr. Sanjay Kumar emphasized for prospective inter-institutional collaboration and detailed that ICAR-IISS is in collaboration with ICAR-IIHR and ICAR-IIVR for sake of seed research pertinent to horticultural crops especially in areas of seed testing protocols and seed standards formulation. In his remarks, with 65 cooperating centres and 24 STR centres nation-wide, AICRP –Seed (Crops) can serve as an adept platform to instill innovative seed research in horticultural crops. He also highlighted on significant research achievements viz. standardization of vigour tests in vegetables, seed coating, integrated nutrient management aspects in chilli, effect of foliar spray of micronutrients and standardization of planting ratios have been pursued earlier under AICRP-NSP (Crops) platform.

Dr. Vikramadithya Pandey briefed that proactive association of lead seed research centres under horticultural crops viz. ICAR-IARI, vegetable seed division, ICAR-IIVR, ICAR-IIHR and ICAR-IISS should focus on innovative seed research on contemporary problems and supported for pursuance of vegetable crops seed research under the ambit of AICRP-Seed (Crops). He also deliberated on need to institute seed banks and modalities for garnering of funds should be pondered in this regard.

Mr. S. C. Sati presented the private seed sector perspective, where development of practicable & feasible dormancy breaking treatments, improved measures for post-harvest maintenance of seed quality and cryo-preservation of pollen should be given utmost priority in seed research projects formulation.

Dr. V.K. Pandita in his detailed deliberation, referred about efforts for mitigation of climate change and improvement of planting value of horticultural crops is to be focused. Advanced seed research aspects like chlorophyll fluorescence measure to grade seeds, batch seed coating techniques, harmonization of seed standards in tune to OECD, packaging aspects under modified atmospheric storage and revisiting of SMR in root vegetable crops were highlighted for seed research projects formulation under the ambit of AICRP platform.

Dr. A. K. Singh in his Chairman's remarks, detailed about need for raising income of seed stakeholders and horticultural crops can present an adept opportunity to tread in this endeavour. In his deliberations, emphasized on areas of technology up-gradation and up-skilling of farmers, need for partnering and shouldering responsibilities for innovative seed research and novel areas like gene editing with right outlook can kindle necessary impetus required to achieve anticipated targets for the growth of seed sector in balanced manner.

The session ended on right note by having an agenda of action points for enabling a prospective research on vegetable seed sector.

Following recommendations emanated during the deliberations:

1. Seed technological research pertinent to important horticultural crops, to be brought under the ambit of AICRP on Seed (Crops) with proactive association of lead seed research centres of horticultural crops viz. Division of Vegetable Science, ICAR-IARI, New Delhi; ICAR-IIVR, Varanasi; ICAR-IIHR, Bengaluru and ICAR-IISS, Mau.
2. Development of seed testing protocols and formulation field and seed standards especially in the context of released new hybrids should be proceeded with utmost priority in delineated horticultural crops.
3. Experiments on innovative approaches for dormancy release, precise coating, cryo-preservation and measures to tackle viral diseases in vegetables should be instituted under STR component of AICRP on Seed (Crops).

Glimpses of Panel Discussion

SEED TECHNOLOGY RESEARCH TECHNICAL PROGRAMME, 2022-23

A. Seed Production & Certification

Date: 22.04.2022 & 12.05.2022

Chairman	:	**Dr. O.S. Dahiya** Former Head, Dept. of Seed Science & Technology and Member, RAC, ICAR-IISS, Mau
Convener	:	**Dr. Sandeep Kumar Lal,** Principal Investigator/Principal Scientist, ICAR-IARI, New Delhi

General Observations

- It was suggested that those centers which are not conducting the experiment and/ or not reporting the data should be viewed seriously. Similarly, action may be initiated against the centres for delay/ lapses in data reporting.
- **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 benefit cost ratio may be worked out for all the experiments to assess the economic feasibility of the developed technologies.

Important points for the submission of results:

- The centers should follow the technical programme strictly, without any deviation/s and conduct the experiment accordingly.
- **The deadline for the submission of reports should be strictly adhered to (June and December for rabi and kharif experiments, respectively)**
- The centers should furnish meteorological data (monthly mean) and soil analysis report and 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, details about 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 to analyze the precision of the experiment.
- The report submitted by the cooperating centers should be supplemented with high quality photographs.

Contacts of PI and Co-PI

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

Specific observations

- The experiment on preparation of seed production atlas will be concluded and the information generated during 2021-22 will be employed for updating the already available seed production atlas published by ICAR-IISS, Mau.

Recommendations:

1. **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 2022-23

Experiment 1: Standardization of isolation distance in Mustard hybrids

Specific observations: The experiment on standardization of isolation distance in mustard hybrids will be continued by assessing isolation distance up to 1000 m.

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 (4)	ICAR-IARI, Jharkhand; GBPUAT, Pantnagar; NDUAT, Faizabad and RARI, Durgapura

Methodology:

Mustard: A plot size of 2.25 m (width) x 27 m (length) with a spacing of 45 x 15 cm (minimum of 5 rows) 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 centre) each of pollen parent (R line) and female parent (CMS line) will be supplied by Dr. Gurpreet, PAU, Ludhiana (Mob. No.: 9814907951).

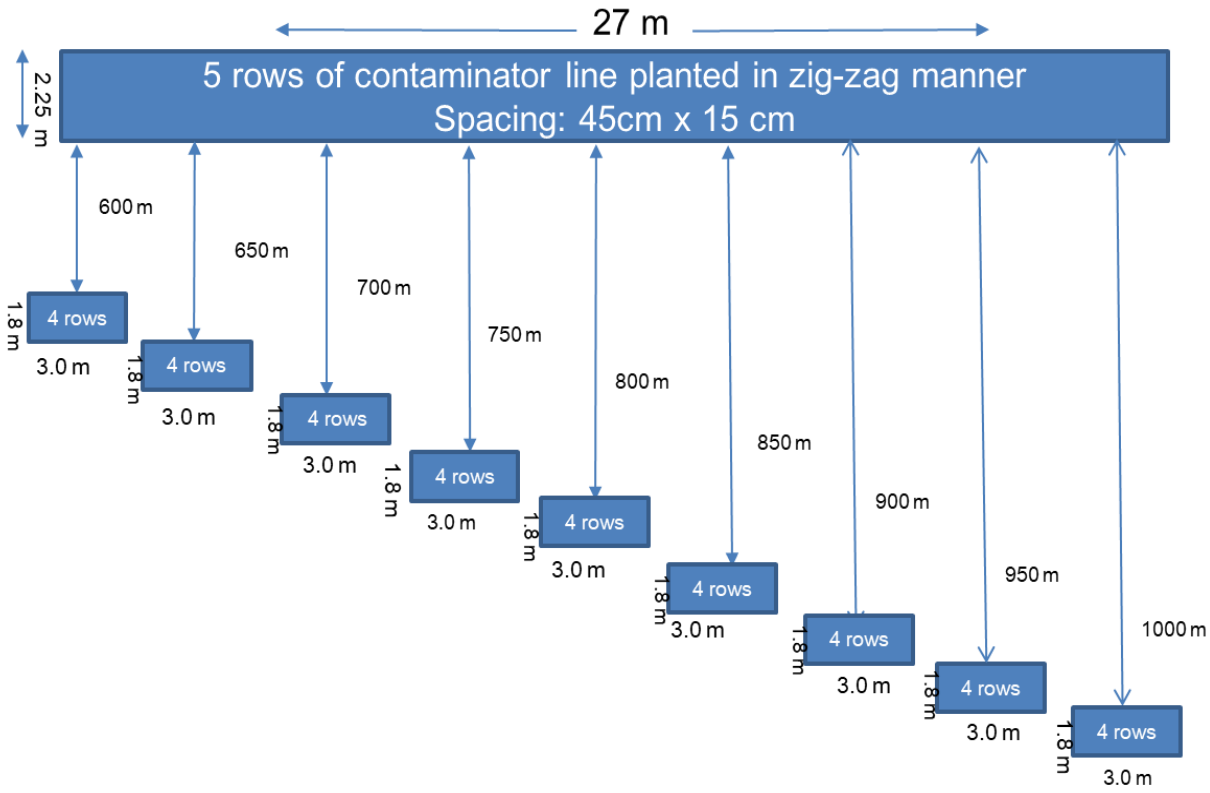


Fig. 1.1: Schematic field layout for standardization of isolation distance in hybrid Mustard

Observation to be recorded (Table 1.1 & 1.2)

- Field emergence (%)
- Plant height at 30 days and at harvest (cm)
- Days to first flowering in parental lines
- Day to 50% flowering in parental lines
- Duration of flowering in parental lines (days)
- Extent of selfing in female line by bagging (per cent seed set upon bagging)
- Seed setting percentage in the female parent (per cent seed set through outcrossing)
- Seed yield / plant (g) – The data may be recorded on 10 plants each in three rows, constituting three replications
- Test weight -1000 seed (g)

Note:

1. The recommended package 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 the pollinating insects. Hence, spraying should be done either before 8 AM 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 (8-10 AM for FN and 2-4 PM for AN) for the visit of insect pollinators during peak flowering stage (>50% flowering). Honeybees carrying pollen from contaminator 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 at same 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 revised isolation distance will be worked out for maintaining genetic purity of seed and enhancing seed quality

Table 1.1: Flowering and seed setting behaviour in parental lines of mustard

Isolation distances/ Parental lines	Field emergence (%)	Days to		Duration of flowering	Extent of selfing in female lines on bagging	Plant height at (cm)		Seed set (%)	Seed yield / plant (g)	Test weight (g)
		First flowering	50% flowering			30 DAS	Harvest			
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 (8-9/ 9-10 AM)	AN (2-3/ 3-4 PM)	FN (8-9/ 9-10 AM)	AN (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

Objective:

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 attributes under organic production systems

Year of start: 2018-19

CROP	CENTRE
Paddy (7)	ICAR RC Meghalaya; ICAR RC NEHR Manipur Centre (Black rice); AAU, Jorhat; IGKV, Raipur; IISS, Mau; PJTSAU, Hyderabad and UAS, Bengaluru
Maize (5)	GBPUAT, Pantnagar; UAS, Dharwad; ICAR RC NEHR Manipur Centre; PJTSAU, Hyderabad and ICAR RC Meghalaya
Ragi (1)	UAS, Bangalore

TREATMENT DETAILS		
No. of treatments: 03		**Replications:** 04
Sowing method		
Direct sowing - 20 x 10 cm (Paddy and Ragi) and 60 x 20 cm (Maize - sown at 3-4 cm depth)		
Treatment details		
T1 - Control (No Fertilizer & Manure)		
T2 - State Recommended Dose of NPK Fertilizer (Inorganic)		
T3 - Organic practices		
Design		Factorial Randomized Block Design
Plot size	**Gross plot size**	3 m × 5.0 m =15.0 m^2
Spacing between plots (Plot Border)		One meter

Cultivar	A set of 3 local/ traditional/ Organic varieties (minimum), which are widely cultivated in the region.
Seed treatment	Seed treatment with biocontrol agents *viz.,* *Trichoderma harzianum* or *Pseudomonas fluorescens*@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 @ 5 ml/ liter or Combination of *P. fluorescens* + *Bacillus subtilis*@ 5 gm/ liter water as a prophylactic measure. **Application schedule of *P. fluorescens* (Paddy)** i. Boot emergence stage ii. 50% panicle emergencestage iii. Pre-harvest stage (15 days prior to harvest) **Application schedule of combination of *P. fluorescens*+ *B. subtilis* (Maize and Ragi)** i.45 DAS ii.60 DAS iii.90 DAS

Observations to be recorded

Paddy and Ragi

i. Field emergence (%)
ii. Plant stand establishment/ m^2
iii. Plant height at 30 days and at harvest (cm)
iv. Days to first flowering
v. Days to 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 per cent - manual basis
xi. Seed quality - Seed germination and Vigour index I
xii. Net monetary returns (Rs.)
xiii. Benefit Cost ratio (BCR) - proforma attached

Maize

i. Field emergence (%)
ii. Plant stand establishment/ m^2
iii. Plant height at 30 days and at harvest (cm)
iv. Days to first flowering
v. Days to 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 per cent - manual basis
xi. Seed quality - Seed germination and Vigour index I
xii. Net monetary returns (Rs.)
xiii. Benefit Cost ratio - proforma attached

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 inorganic 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 T3 - 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 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.

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

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

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

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

Treatments / Parameters	Field emergence (%)	Field stand establishment / m2	Plant height at (cm)		Days to		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 (T)									
T1									
T2									
T3									
Mean									
SEm±									
CD									
CV (%)									
Interaction effects									

V1TI									
V2T1									
V3T1									
V4T1									
V1T2									
V2T2									
V3T2									
V4T2									
V1T3									
V2T3									
V3T3									
V4T3									
Mean									
SEm±									
CD									
CV (%)									

Table 2.2: Effect of organic nutrient management on seed quality parameters and economic indicators 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 (T)						
N1						
N2						
N3						
Mean						
SEm±						
CD						
CV (%)						
Interaction effects						
V1TI						
V2T1						
V3T1						
V4T1						
V1T2						
V2T2						
V3T2						
V4T2						
V1T3						

V2T3						
V3T3						
V4T3						
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)									
T1									
T2									
T3									
Mean									
SEm±									
CD									
CV (%)									
Interaction effects									
V1TI									
V2T1									
V3T1									
V4T1									
V1T2									
V2T2									
V3T2									
V4T2									
V1T3									
V2T3									
V3T3									
V4T3									
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 (%)	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 (T)						
N1						
N2						
N3						
Mean						
SEm±						
CD						
CV (%)						
Interaction effects						
V1TI						
V2T1						
V3T1						
V4T1						
V1T2						
V2T2						
V3T2						
V4T2						
V1T3						
V2T3						
V3T3						
V4T3						
Mean						
SEm±						
CD						
CV (%)						

Experiment 3: Seed quality assessment of breeder seed samples.
(To be done in collaboration with QSP unit of the respective Centre)

Objective:

- To assess the seed quality of the breeder seed produced.
- To explore the possibility of formulation of seed standards for breeder seed

Rationale: It is mentioned in the IMSCS that "Breeder seed shall be genetically so pure as to

guarantee that in the subsequent generation i.e., certified foundation seed class shall conform to the prescribed standards of genetic purity. The other quality parameters, such as pure seed, inert matter, germination and oil content (sunflower crop) shall be indicated on the label on actual basis". However, the minimum standards have not been fixed for the breeder seed though it is assumed that the standards should be higher that the Foundation/ Certified seed class.

Year of start: 2019-20

S. No.	CENTRE	CROP (s)
1.	CSKHPKV, Palampur	Wheat, Black gram and Mustard
2.	PAU, Ludhiana	Paddy, Wheat, Black gram and Mustard
3.	GBPUAT, Pantnagar	Pigeon pea and Soybean
4.	JNKVV, Jabalpur	Paddy, Wheat, Chickpea and Soybean
5.	MPKV, Rahuri	Rabi Sorghum, Chickpea, Soybean and Green gram
6.	PDKV, Akola	Rabi Sorghum, Chickpea, Soybean and Cotton
7.	UAS, Bangalore	Paddy Hybrid (parental lines), Sunflower Hybrid (parental lines) and Groundnut
8.	TNAU, Coimbatore	Paddy, Green gram and Groundnut
9.	OUAT, Bhubaneswar	Paddy and Groundnut
10.	PAJANCOA & RI, Karaikal	Paddy
11.	VNMKV, Parbhani	Chickpea and Soybean
12.	PJTSAU, Hyderabad	Paddy and Pigeon pea
13.	CCSHAU, Hisar	Wheat and Mustard

Methodology:

- The Seed Technology Research Unit (Seed Production and Certification group) will procure the samples of breeder seed produced during the kharif and Rabi season. The seed produced during the kharif and rabi season will be supplied by the end of December and May, respectively through the QSP unit.
- The background information on crop variety, area sown, location details (including GPS coordinates), meteorological data, date of sowing, date of harvest, pest and disease infestation during crop growth, seed yield (q/ha) and any other relevant information shall be furnished along with the breeder seed samples.
- The grow out test for *kharif season* seed samples may be conducted during January-February
- At many places, off season grow out test for *rabi* crops may not be possible. Hence, the GOT may be conducted 30 - 40 days before the onset of rabi season at such centres.
- Since the genetic purity of the breeder seed is expected to be 100%, **the number of plants to be observed should be fixed at minimum of 8000.**
- The observation on the off types may be recorded on the basis of morphological

characters of the variety, which may be confirmed by involving the concerned breeder for inspection.

- The number of crops will be capped at 2 per season and number of crop varieties will be restricted to a maximum of eight (all the crops included) during a calendar year.
- The centers should furnish meteorological data (monthly mean) and interpret the results so as to analyze the environmental variations between the centers
- The results submitted by the cooperating centers should be supplemented with high quality photographs.
- **All Nodal Officers of QSP/ STR will be responsible for conduct and reporting of results in this regard.**

Observations to be recorded: GPS Coordinates of the BSP plot, Plant population, percent off types, percent genetic purity (GOT) and other seed quality parameters (Seed Moisture content, Physical purity including ODVs, Germination per cent and Seed Health test, including the names and per cent infection seed borne fungi/ insect-pest infestation, if any)
Expected Outcome: It will help in assessment and documentation of seed quality status of breeder seed produced at SAUs and ICAR Institutes, which can facilitate the setting up benchmark levels for breeder seed quality.

Table 3.1: Background information about breeder seed production

S. No.	Location details (including GPS coordinates)	Crop	Variety	Area Sown (ha)	Date of sowing	Date of harvest	Pest & Disease infestation during crop growth	Seed yield (q/ha)	Any other relevant information
1.									
2									
3.									

Table 3.2: Seed quality assessment of breeder seed samples

Location	Crop	Variety	Plant population (No.)	Off types (%)	Genetic purity (%)	Physical Purity (%)	ODVs (No.)	Seed Moisture content (%)		Germination (%)		Seed Health test (seed borne fungi/ insect-pest infestation)
								Initial	Sowing time	Initial	Sowing time	
***Summer* season**												
***Kharif* season**												

***Rabi* season**												

Experiment 4: 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 (9)	**Small seeded** - UAS, Bengaluru; UAS, Raichur and PJTSAU Hyderabad **Medium seeded** - MPKV, Rahuri; ICAR-IARI, Jharkhand and RARI, Durgapura **Large seeded** - ICAR-IARI, New Delhi; CCSHAU, Hisar and PDKV Akola
Wheat (8)	ICAR-IARI New Delhi; PAU, Ludhiana; MPKV, Rahuri; ICAR-IARI, Jharkhand; RARI, Durgapura; JNKVV Jabalpur; IGKV Raipur and ICAR-IISS, Mau

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% less than 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	**5**
Replications	**4**
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 20:40:20kg/ha N: P: K, respectively based on soil test or State Recommended Dose of Fertilizer.
ii. Apply Zinc Sulphate@25 kg/ 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.

WHEAT	
Cultivar	**Any popular cultivar of the respective zone /centre**
Test weight (1000 seed wt.)	**30-35 g**
No. of treatments	**5**
Replications	**4**
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 the seed rate.**
Total plots	**20 (Area- 200 m^2)**
Sowing: Direct sowing, depth of sowing: 5-6 cm	

Note:

i. Seed treatment with Thiram or Captan or Carbendazim or Mancozeb at 2 / kg of seed 24 hours before sowing to control the soil borne disease.
ii. Apply FYM 10 to 12 t/ ha, 10 to 15 days prior to sowing supplemented with 120:60:40 kg/ 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 split applied at two dosages.
iii. Weeding to be done 45-60 DAS or weedicides like 2, 4 D, Avadex or Nitrofen (Tok E-25) for controlling weeds like *Chenopodium* sp, *Angallis* sp. *Asphodelus* sp. *Phalaris* sp.
iv. 5-6 irrigations should be given at critical growth stages viz. Crown root initiation, tillering, jointing, flowering, milk and dough which come at 21-25 days after sowing (DAS), 45-60 DAS,

60-70 DAS, 90-95 DAS, 100-105 DAS and 120-125 DAS, respectively.

v. In case white ants or other pests are a problem, Aldrin 5% or BHC 10% dust at the rate of 25 kg/ha should be applied to the soil after the last ploughing or before planking.

Observations to be recorded

- Field emergence (%)
- Plant stand establishment/ m^2
- Plant height at 30 DAS and at harvest (cm)
- Days to first flowering
- Days to 50 % flowering
- Seed yield/ plant (g)
- Seed yield (q/ ha)
- 1000 seed weight (g)
- Graded seed yield (q/ha)
- Seed recovery (%)
- 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

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

Table 4.1: Effect of differential seed rates on plant growth and seed yield attributes

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

Table 4.2: Effect of differential seed rates on seed quality and economic indicators

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								

Experiment 5: 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; ICAR RC NEHR, Manipur Centre and TNAU, Coimbatore
Soybean (5)	ICAR-IARI, New Delhi; GBPUAT, Pantnagar; MPKV, Rahuri; JNKVV, Jabalpur and UAS, Bengaluru
Chickpea (5)	ICAR-IARI, New Delhi; MPKV, Rahuri; PDKV, Akola; JNKVV, Jabalpur and RARI, Durgapura

Seed Treatments:

- T1: Control
- T2: Thiram + Bavistin (2:1) @ 3g/kg in combination with *Rhizobium*
- T3: Anabaena Rh
- T4: Thiram + Bavistin (2:1) @ 3g/kg in combination with Anabaena Rh
- T5: Anabaena Laxa
- T6: Thiram + Bavistin (2:1) @ 3g/kg in combination with Anabaena Laxa
- T7: BF1-4 Cyanobacterium consortium
- T8: Thiram + Bavistin (2:1) @ 3g/kg in combination with BF1-4
- T9: Anabaena Tr
- T10: Thiram + Bavistin (2:1) @ 3g/kg in combination with AnTr

Note: The seeds will be coated with PGPR strains at Division of Microbiology, ICAR-IARI, New Delhi (Dr. Radha Prasanna, Professor)

MAIZE	
No. of treatments	10
No. of replications	3
Design	RBD (Randomized Block Design)
Plot Size (m)	5.0 x 3.0 (15m^2)
Spacing (cm)	75 x 25
Total plots	30 (Area - 450 m^2)
Sowing: Direct seed sowing @ 20 kg seed/ ha; Spacing of 75 x 25cm; prepare ridges at 75cm spacing	
Seed requirement 100 seed wt. - 33 g (approx.) 1 plot- 4 rows, 5 m each i.e. 25 plants per row and 4x25 plants/ plot i.e. 100 plants/ plot. We need to sow at least 30 seeds/ row (assuming 80% field emergence) Hence, seed reqt. / plot = 4x30= 120 seeds (40 g) Total seed reqt. for 30 plots = 30x 120= 3600 seeds (11.88 kg), which can be adjusted to 1.3 kg/ center	

Total requirement for five centres - 6.5 kg

Note:

i. Apply FYM 10 t/ ha, 10-15 days prior to sowing, supplemented with 165:75:75kg/ ha N: P: K dose, respectively based on soil test or State Recommended Dose of Fertilizer

ii. Apply Zinc Sulphate@25 kg/ ha

iii. 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	V_4 (four leaf stage)	25
3	V_8 (eight leaf stage)	30
4	V_T (tasseling stage)	25

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

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates)
- 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 (%)
- Plant stand establishment/m^2
- Plant height at 30 DAS and at harvest (cm)
- Leaf chlorophyll – 30 DAS at V10-VT stage (SPAD value)
- Days to first flowering
- Days to 50 % flowering
- No. of cobs/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
- 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 (proforma attached)

	Soybean
No. of treatments	**10**
Replications	**3**
Design	**RBD (Randomized Block Design)**
Plot Size (m)	**5.0 x 2.25**

Spacing (cm)	**45x5**
Total plots	**30 (Area - 337.5 m^2)**
Sowing: Direct sowing @ 70 kg seed / ha, Direct sowing; depth of sowing: 4-5 cm	
Seed requirement 100 seed wt.- 12 g (approx.) 1 plot - 5 rows, 5 m each i.e., 100 plants/ row and 5x100 plants/ plot i.e., 500 plants/ plot We need to sow at least 200 seeds/ row Hence, seed reqt. / plot = 5x200= 1000 seeds (120 g) Total reqt for 30 plots-30 x 1000= 30000 seeds (3.6 kg), which can be adjusted to 4.0 kg/ centre Total requirement for five centres – 20 kg	
Note: i. Apply FYM @5 t/ ha, 10 to 15 days prior to sowing supplemented with 20:60:20 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 1.5 kg a.i. /ha for controlling early flush of weeds.	

Observations to be recorded:

- Location details of experimental plot (including GPS coordinates)
- 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 (%)
- Plant stand establishment/m^2
- 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
- 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 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.)
- Benefit Cost ratio (proforma attached)

CHICKPEA	
No. of treatments	**10**

Replications	**3**
Design	**RBD (Randomized Block Design)**
Plot Size (m)	**5.0 x 2.0**
Spacing (cm)	**30 x10**
Total plots	**30 (Area- 300 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 reqt. / plot = 6x100= 600 seeds (150 g) Total reqt for 30 plots –30 x 600= 18000 seeds (4.5 kg), which can be adjusted to5.0 kg/ centre Total requirement for five centres -25 kg	
Note: vi. 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. vii. Apply Zinc Sulphate@25 kg/ ha viii. 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. ix. 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)
- 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 (%)
- Plant stand establishment/m^2
- 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
- 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 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 (proforma attached)

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

Table 5.1: Effect of PGPR seed coating on plant growth and seed yield attributes in Maize

Treatments	Location details (including GPS coordinates)	Soil nutrient analysis		Field emergence (%)	Plant stand establishment/m^2	Days to		Leaf Chlorophyll content (SPAD value) at V10-VT stage(30 DAS)	Plant height at (cm)		No. of cobs / plant
		Pre	Post			First flowering	50% flowering		30 DAS	Harvest	
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
T9											
T10											
Mean											

Table 5.2: Effect of PGPR seed coating on seed quality parameters and economic indicators in maize

Treatments	Seed yield/ plant (g) and per plot (kg	Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection in blotter)	Net monetary returns (Rs.)	Benefit Cost ratio
					Germination (%)	Vigor index I	Vigor index II			
T1										
T2										
T3										
T4										
T5										
T6										
T7										
T8										
T9										
T10										

Mean										

Table 5.3: Effect of PGPR seed coating on plant growth and seed yield attributes in soybean

Treatments	Location details (including GPS coordinates)	Soil nutrient analysis		Field emergence (%)	Plant stand establishment/m^2	Number of 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
		Pre	Post						30 DAS	Harvest	
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											

Table 5.4: Effect of PGPR seed coating on seed quality parameters and economic indicators in soybean

Treatments	Seed yield/ plant (g) and per plot (kg	Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection in blotter)	Net monetary returns (Rs.)	Benefit Cost ratio
					Germination (%)	Vigor index I	Vigor index II			
T1										
T2										
T3										
T4										
T5										
T6										
T7										
T8										
Mean										

Table 5.5: Effect of PGPR seed coating on plant growth and seed yield attributes in chickpea

Treatments	Location details (includin	Soil nutrient analysis	Field emergence	Plant stand establ	Number of nodules	Acetylene reducti	Leaf Chlorophyll content	Plant height at (cm)	No. of Pods

	g GPS coordinates)	Pre	Post	(%)	ishment/m^2	/ effective nodules per plant	on assay (ARA)	(SPAD value) (40-50 DAS) at first bloom stage/budding stage	30 DAS	Harvest	/ plant
T1											
T2											
T3											
T4											
T5											
T6											
T7											
T8											
Mean											

Table 5.6: Effect of PGPR seed coating on seed quality parameters and economic indicators in chickpea

Treatments	Seed yield/ plant (g) and per plot (kg	Seed yield (q/ha)	Seed recovery (%)	Test weight 1000 seeds (g)	Seed quality			Seed health (% infection in blotter)	Net monetary returns (Rs.)	Benefit Cost ratio
					Germination (%)	Vigor index I	Vigor index II			
T1										
T2										
T3										
T4										
T5										
T6										
T7										
T8										
Mean										

Proforma 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

List of Co-operating Scientists

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B. Seed Physiology, Storage and Testing

Date: 23.04.2022 & 12.05.2022

Chairman	:	**Dr. K. Sivasubramanian** Former Dean, CoA&RI, Madurai, TNAU, Coimbatore
Convener	:	**Dr. Shiv Kumar Yadav,** Principal Investigator/Principal Scientist, ICAR-IARI, New Delhi

General Observations

In 'Seed Physiology, Storage and Testing' theme, a total of eight experiments conducted during 2021-2022, where experiment numbers; third, fourth and fifth were with three, four and two sub-experiments, respectively. However, no centre reported for sub-experiment number four under the experiment number four. Based on the deliberations on the findings of these experiments by cooperating centres with the scientists and experts present online, the following decisions were taken for finalization of experiments and inclusion in the Technical Programme for the Year 2022-23.

1. The performance of revalidated seed lots in relation to parameters of seed vigour and yield carried out under experiment 7 in six crops viz. paddy, wheat, chickpea, pigeon pea, soybean and mustard revealed reduction of various traits in revalidated/aged seed lots as compared fresh seed lots in all the crops across most of the cooperating centres. The results were in conformation of findings under experiment 1 during previous 3-4 years. **The decision to terminate the experiment 7 was taken with the recommendation that we should avoid revalidations to the extent possible, specifically the revalidation for second time as it has the drastic effect on seed planting values**.
2. 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.
3. **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, 2023 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 2022-23 (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 2022-23 before the SPST group from 15 to 20 April, 2023. Further, experimental progress at centre shall be reviewed by PI/ Co-PI as and when necessary.** *Please don't combine results/conclusion of all crops allotted to your centre in a particular experiment.*
4. **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 thereof. 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 each table number separately in body of text.
h. Be sure about describing the results and or making concluding statements, "From this experiment a conclusion can be drawn as the revalidated lots are as good as the fresh lots and significant differences were not noticed between them in almost all the observations recorded" but does the sentence match with the CD values?
i. 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.
j. 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.
k. 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.
l. Note that while calculating vigour indices, average/mean length in centimetres and dry weight in gram 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.**

m. 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.

n. 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. **Technique/Methodology:**
4. **Conclusion:** Please include advantage over the existing
5. **Name/s of Scientist/s involved from your centre:**

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 4.5: Seed quality parameters in different treatments of different Nano particles **(**Without full stop in end**);** 4 is experiment number and 5 is the table number you are reporting. 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 '**'. Just providing monthly mean weather data without indicating its effect on results is of no use. Explain the abbreviation/s used there in the tables. Running the **Spell Check is 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, Directorate, 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.

Contacts of PI and Co-PI

Theme	PI/ Co-PI	Email ID	Mob. No.
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

Technical Programme for the Year 2022-23

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

Specific observations: Recommendations on the validity periods for crops; The final results of the experiments conducted during 2019-20 and 2020-21 on Wheat, Paddy, Maize, Sorghum, Chickpea, Cotton, Castor, Soybean and Groundnut from cooperating centres were compiled and aptly worked out the validity periods for different crops. It was suggested to communicate the

crop specific recommendation/s of the total acceptable validity periods for notification to appropriate authorities. The experiment was extended during 2021-22 to nine new crops; Barley, Kabuli Chickpea, Lentil, Mustard, Oat, Onion, Pearl millet, Pigeon pea and Sunflower would continue at identified centres with the same objective. All the cooperating centres MUST correlate the germination results with packaging materials and prevailing environment at storage conditions. The cooperating centres would record the data strictly as per the technical programme and report the final outcome in the given format.

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**
Barley	:	CCSHAU, Hisar; CSKHPKV, Palampur; ICAR-IISS, Mau; PAU, Ludhiana; RAU TCA Dholi and ***ICAR-IIWBR, Karnal****
Castor@ (30000)#	:	JAU, Jamnagar; JNKVV, Jabalpur; ***PJTSAU, Hyderabad****; OUAT, Bhubaneswar and TNAU, Coimbatore
Kabuli Chickpea	:	CCSHAU, Hisar; ***MPKV, Rahuri^*** and PJTSAU, Hyderabad
Lentil	:	AAU, Jorhat; ICAR-IISS, Mau; ***JNKVV, Jabalpur^*** and RAU TCA Dholi
Mustard	:	CAZRI, Jodhpur; CCSHAU, Hisar and ***NDUAT, Faizabad****
Oat	:	CSKHPKV, Palampur; JNKVV, Jabalpur; PAU, Ludhiana; OUAT, Bhubaneswar; RAU TCA Dholi; ***SKUAST, Srinagar^*** and UBKV, Cooch Behar
Onion	:	JNKVV, Jabalpur; MPKV, Rahuri; ***PJTSAU, Hyderabad^*** and UAS, Bengaluru
Pearl millet	:	CCSHAU, Hisar; JAU, Jamnagar; MPKV, Rahuri and ***SKNAU, Jobner****

Pigeon pea : ***PAU, Ludhiana^***; PDKV, Akola; PJTSAU, Hyderabad and UAS, Dharwad

Sunflower : BSKKV, Dapoli; PJTSAU, Hyderabad; OUAT, Bhubaneswar; TNAU, Coimbatore and ***UAS, Bengaluru^***

@The crop is taken up once again to confirm the results of previous years

*The centre besides supplying seeds to other centres shall also be conducting experiment

#Minimum numbers of seeds supplied to cooperating centres by the identified* centre

^Identified center - provided seeds to other cooperating centers & also conducting experiment

**Centre to only supply seed 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 Gunny/Cloth bags and HDPE bags and stored at ambient conditions of respective centres.
- All the cooperating centres have in their store(s), sufficient seeds of minimum two most popular varieties in each crop that were sent last year by the centres identified. AND
- The cooperating centres may still have in their store(s), sufficient revalidated (once or twice) seeds of minimum two most popular varieties in each crop that they have been evaluating and has still the viability ≥IMSCS. May continue taking observations on these lots, if satisfied with the outcome that it is in line of the rationale of the experiment.
- 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, than 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 85% in Barley, 85% in Kabuli Chickpea, 75% in Lentil, 85% in Mustard, 85% in Oat, 70% in Onion, 75% in Pearl millet, 75% in Pigeon pea and 70% in Sunflower.
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 explain the results for period of storage at respective participating centres.
7. This experiment must be reported with explanation of 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 Gunny/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

Specific observations: It was decided that the SSR marker, RM 276 validated during the year under report for paddy hybrid, JRH-5 is recommended for commercial use. The other markers that have been identified in the crops; Paddy, Maize and Castor, and markers identified during previous years by other centres but not validated till this year in the crops; Paddy, Maize, Sunflower & Cotton etc. must be validated during 2022-23 at other cooperating centres and at the identifying centre as well. Centres which have identified the marker/s in hybrid/s shall supply sufficient quantity seeds of hybrid/s and their parental lines and also share details of identified markers/protocol with all other cooperating centres for validation, if not done during previous year/s. The centres validating the results of SSR markers must compare these results with GOT in all crops and shall calculate C:B ratio of both these methods. Efforts for identification of microsatellites markers and SNP markers for new hybrids in crop/s to continue, including Castor where no polymorphic markers have been found till 2021-22.

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
Cotton	:	PAU, Ludhiana; PDKV, Akola 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 and TNAU, Coimbatore
Pearl millet	:	JNKVV, Jabalpur; MPKV, Rahuri and NAU, Navsari
Sorghum	:	JNKVV, Jabalpur; PDKV, Akola and PJTSAU, Hyderabad
Sunflower	:	AAU, Jorhat; PJTSAU, Hyderabad 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.

* 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 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 C: B 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 during 2021-22 for validation and efficiency testing (Objective 1 & 2)

Crop	Hybrid (Parents)	New SSR markers identified	Identifying centre
Maize	MAH-14-5 (CAL 1443 and CML 451)	Bnlg 1144, Bnlg 1124, Bnlg161 and Bnlg1360	UAS, Bengaluru
	HEMA (NAI 137 and MAI 105)	Bnlg 238, Bnlg1716, Umc 2246 and Umc2084	
	PMH 1 (LM 13 & LM 14)	Bnlg 1036, Umc 2170, Umc 2069 and Bnlg 1297	PAU, Ludhiana
Paddy	JRH 8 (CMS 97 A and NPT 29)	RM 510	JNKVV, Jabalpur
Castor	DCH 519 (M 574 and DCS 78)	RcDES45	PJTSAU, Hyderabad

Details of the markers identified during 2020-21 for validation and efficiency testing (Objective 1 & 2)

Crop	Name of Hybrid	Name of the Marker	Identifying Centre
Paddy	JGLH1	Xa 21 and RM 206	PJTSAU, Hyderabad
		RM 105	JNKVV, Jabalpur
	AAUH3	RM 234, RM 206, RM 236 and RM 216	AAU, Jorhat
	JRH 19	RM 228	JNKVV, Jabalpur
Maize	PMH 1	Umc 1798	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 and Umc1594	
Sunflower	KBSH-78	ORS-57 and ORS-170	UAS, Bengaluru
	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	PDKV, Akola
	PKV DH-1	2000 and BNL 4049	

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. P. R. Vijaya Kumari, 9822572302; rachelvk123@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. D. Shashibhushan, 8919409933; **danamshashi@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, 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 strategy is to 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.

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

Specific observations: Under this experiment, priming technologies for enhancing planting value of seed under optimal and sub-optimal conditions in some field crops; Chickpea, Kabuli Chickpea, Paddy, Field pea, Lentil, Mustard, Cotton and Specialty Maize, where validated treatments were demonstrated in larger plots at different centres. The validated treatments resulted in significantly higher seed planting values than the controls may be recommended in Mustard, Paddy and Pigeon pea, only after conformation to have conducted the demonstrations by maintaining conditions of moisture/heat/salt stresses. The information was collected from the cooperating centres and it was concluded that the demonstrations of validated treatments will continue in all the crops this year as well, as final recommendations in want of proper conductance of trial could not be made. Moreover, all the cooperating centres to conduct proper demonstration and each shall calculate C: B ratio this year. The priming technologies for low temperature stress during seedling establishment and organic production that were standardized in Maize and Paddy during 2020-21, shall be repeated for validation along with calculation of C: B ratios for each crop and condition. The sub-experiment on development of priming technologies for enhancing planting value of seed under optimal and sub-optimal conditions in field crops; Barley, Oat, Pearl millet and Sunflower shall continue during 2022-23.

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, Jamnagar 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

Maize	:	GBPUAT, Pantnagar; ICAR-IARI, New Delhi and RAU TCA, Dholi
Paddy	:	AAU, Jorhat; ICAR RC NEH Region - Manipur Centre; SKUAST, Kashmir, Srinagar; and UBKV, Cooch Behar

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
Cotton	:	MPKV, Rahuri and PDKV, Akola
Field pea	:	CSKHPKV Palampur; ICAR-IISS, Mau; JNKVV, Jabalpur and PAU, Ludhiana
Kabuli Chickpea	:	MPKV, Rahuri; PAU, Ludhiana; PDKV, Akola and UAS, Raichur
Lentil	:	AAU, Jorhat and JNKVV, Jabalpur
Mustard	:	CCS HAU, Hisar; ICAR-CAZRI, Jodhpur and ICAR-IARI, New Delhi
Paddy	:	GBPUAT, Pantnagar; OUAT, Bhubaneswar; TNAU, Coimbatore; UAS, Bengaluru and UBKV, Cooch Behar

Pigeon pea : AAU, Jorhat; PAJANCOA&RI, Karaikal and PJTSAU, Hyderabad
Specialty Maize : ICAR-IARI, New Delhi and RAU TCA, Dholi

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 (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): 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. **fresh and one year old seed (within the acceptable limits of germination) of each of two 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. *Matric-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* – seed imbibition occurs in 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 microbial 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. T*he 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. S*tart 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. T*he 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. T*he 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 result 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^{o}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 needs to be quantified at desired interval during the entire experimental period using gravimetric 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. Weigh 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, while filling the pots, makes sure that the soil mixture is not compacted
3. Weigh 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). Weigh 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.

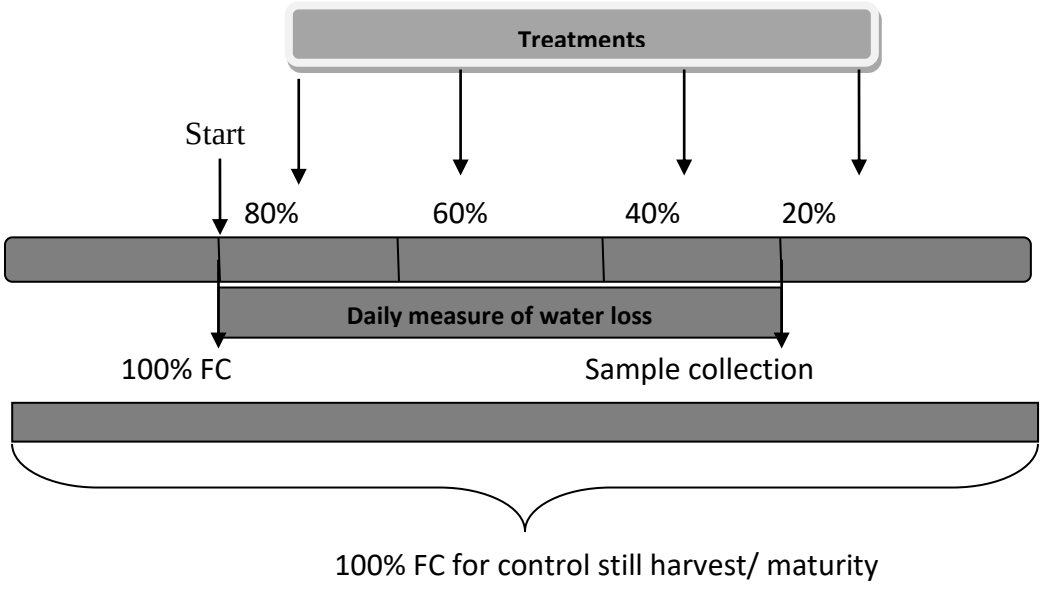

Figure: Diagrammatic representation of gravimetric approach followed for imposing precise levels of moisture stress/drought.

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 easy 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_4 in 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.

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 4*5°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. *Matric-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, Draught Alleviating Bacteria (DAB) & cold adoptive Plant Growth–Promoting (rhizo) Bacteria (PGPB) etc.) for priming and abiotic stress mitigation to be supplied by the Coordination Unit, ICAR-IISS, Mau, and organics; *Trichojal, Metajal & Beauverijal* for treatment to be made available by AAU, Jorhat, 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	For low temperature stress: 1. Seed coating on hydroprimed (30h @ 25^{O}C) seeds with *Trichoderma harzianum* @15g / kg seed. 2. Primed with GA_3 (@100ppm) followed by DAB + Biophos – as mentioned above 3. Seed coating with cold adoptive PGPB For organic conditions: 1. Seed treatment with organic *Trichojal* @5ml/kg seed /lit. 2. Seed treatment with organic *Metajal* @5ml/kg seed /lit. 3. Seed treatment with organic *Beauverijal* @5ml/kg seed /lit.
Maize	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

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
Kabuli Chickpea	1. Seed coating on hydro primed (4h @ 20^{O}C) seed with DAB+ Biogrow
Paddy	1. Seed coating on hydroprimed (30h @ 25^{O}C) seeds with *Trichoderma harzianum* @15g / kg seed.

Field pea	1. Seed coating on hydroprimed (10h @ 20^{O}C) seeds with Biogrow
Lentil	1. Seed coating on hydroprimed (8h @ 25^{O}C) seeds with DAB+ Bio grow
Mustard	1. Seed coating (on hydro primed (16h @ 20^{O}C) seeds) with Biophos
Cotton	1. Seed coating (on hydro primed (12h @ 25^{O}C) seeds) with Drought Alleviating Bacteria
Specialty Maize	1. Seed hydropriming (17hrs 25^{0}C) alone or with dry dressing with thiram
Pigeon pea	1. For Moisture Stress: Hydro-priming (10h @ 25^{O}C) 1. 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 500Sqm 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;

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

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: Use of nano-particles in enhancing seed quality and storability of seeds

Specific observations: Since none of NP treatment combinations was reported to be standardized by any cooperating centre therefore the studies, "To standardize the optimum concentration of different nano-particles for seed treatment in Wheat and Maize" will continue during 2022-23 at all centres. Similarly, validation of the optimum concentrations of different nano-particles of NPs that were found effective during 2020-21 in chickpea and paddy will continue with identified NP treatment concentrations. Most effective NPs and their doses will be evaluated along with control and C: B ratio must be worked out. All the cooperating centres involved in validation also to record additional observations on toxicity to roots by different concentrations of all the nano-particles. It was also decided that the demonstration of effective treatment/s reported in Onion and Soybean during previous years should be done in larger plots and calculation of pertinent C: B ratios for NP treatment/s in all the three crops have to be done.

Year of start: 2016-17

Rationale: Application of nano materials for agriculture is relatively new as compared to their use in biomedical and industrial sectors. Nanomaterials are very tiny particles, size ranging from 1 nano meter (one-billionth of a metre) to 100 nano meter. In modern agriculture, sustainable production and efficiency are unimaginable without the use of agrochemicals, fertilizers etc.

Nanotechnology has the potential to increase food quality, plant protection, detection of plant and animal diseases, monitoring of plant growth, global food production and improving seed quality. As the literature suggest that both ROS and aquaporins play important roles in enhancing seed germination. Nano seed treatments could enhance α-amylase activity, resulting in higher soluble sugar content for supporting seedlings growth. However, differences in seedling sensitivities depending on the concentrations and the types of NPs are also reported in different crops. Thus, it is imperative to explore the use of nanoparticles as seed treatment can speed up germination, increases seedling vigour and strength, limit the fructification of disease causing fungal spores, improve seed quality and storability in various field crops. Therefore, this experiment was designed with the following objectives.

Objectives:

1. To standardize the optimum concentration of different nano-particles for seed treatment in Wheat and Maize.
2. To validate the effect of different nano-particle treated seeds on seed quality parameters and effect on storability of Pigeon pea, Paddy and Chickpea.
3. To demonstrate the enhanced planting value of validated nano-particle treated seeds of Onion and Soybean.

Crops		**Centres**
1. For standardization of optimum concentration of different NP's (Objective -1)		
Maize	**:**	BSKKV, Dapoli; CSKHPKV Palampur; **PAU, Ludhiana*** and RAU TCA, Dholi
Wheat	**:**	**CCS HAU, Hisar*;** GBPUAT, Pantnagar; MPKV, Rahuri and PDKV, Akola
2. Validation of optimum concentration of different NP's (Objectives -2)		
Chickpea	**:**	ICAR- IISS, Mau; JNKVV, Jabalpur; UAS, Dharwad and UAS, Raichur; (**HAU, Hisar*;** To supply seed only)
Paddy	**:**	AAU, Jorhat; KAU, RARS, Pattambi; PAJANCOA&RI, Karaikal and PJTSAU, Hyderabad **(PAU, Ludhiana***; To supply seed only)
Pigeon pea	**:**	AAU, Jorhat; PAJANCOA&RI, Karaikal; PAU, Ludhiana; UAS, Bengaluru and VNMKV, Parbhani **(ICAR-IARI, New Delhi***; To supply seed only)
3. Demonstrations of NP priming technologies (Mini. 500sqm for Treat. & Ctrl.) (Objectives -3)		
Onion	**:**	**MPKV, Rahuri***; JNKVV, Jabalpur; AAU, Anand and NDUAT, Faizabad
Soybean	**:**	GBPUAT, Pantnagar; **JNKVV, Jabalpur*;** NAU, Navsari; PDKV, Akola and VNMKV, Parbhani.

***Nodal Officers/In-Charges, NSP/STR of identified centres, if needed shall supply seeds of required quantity and quality to TNAU, Coimbatore after assessment of initial seed quality and the information/ observations recorded to be shared with all concerned.**
#TNAU, Coimbatore to assess moisture content, treat the seeds, assess seed quality status after treatment and supply the treated seeds along with information/ observations recorded to participating centres.

Technical programme:

Availability of Seed Materials and Treatments:
The Nodal Officers/In-Charges, NSP/STR of identified centres to kindly ensure the **timely supply of required quantities of seeds (total) of two varieties each in all crops to TNAU, Coimbatore for treatment with desired nanoparticles.** The details of treatments have been mentioned below under different sub experiments. TNAU, Coimbatore shall treat all the seeds with desired nanoparticles and send the proportionate seed in proper packaging to all the cooperating centres of each crop. In case of any problems contact the PIs and NP seed treatment related issues, Dr. C. Vanitha, Assistant Professor, SST, TNAU, Coimbatore (+91-9080461717; cvani_seed@yahoo.co.in) may be contacted**,** please**.**

NB: To address the issue of safety issue, this year as well, all centres to evaluate seedlings for sensitivity to different concentrations of various NPs at seed germination stage. However, the cooperating centres are given options to take observations as deemed fit, till the competent body of GoI issues approved guidelines in this regard, in collaboration with other scientists of appropriate disciplines on effect on NPs on health of plants, soil, environment, humans, animals, insects, microbes, etc.

Sub. Experiment I (Objective 1): To standardize the optimum concentration of different nano-particles for seed treatment in Wheat and Maize

Year of start: 2021-22

Materials and Methods:
Crops and Varieties: Minimum one predominant variety in each crop is to be taken for studies/treatments by every participating centre. In case of Wheat two centres; GBPUAT, Pantnagar and CCSHAU, Hisar will work on one variety while the two centres; MPKV, Rahuri and NDUAT, Faizabad will work another one variety. The sufficient quantity of seeds of both these varieties is to be supplied by the CCS HAU, Hisar centre to TNAU, Coimbatore for treatment. In case of Maize two centres; PAU, Ludhiana and RAU TCA, Dholi will work on one variety while

the two centres; BSKKV, Dapoli and CSKHPKV Palampur will work another one variety. The sufficient quantity of seeds of both these varieties is to be supplied by the PAU, Ludhiana centre to TNAU, Coimbatore for treatment.

- Designated centres/scientists will send the required quantities of seed for NP treatments to TNAU Coimbatore.
- Seeds will be dried to safe and uniform moisture level before treatment and directly treated with the listed combinations of NPs in a plastic or glass jar by mixing thoroughly for even distribution.
- The TNAU Coimbatore centre will only assess the seed moisture content before and after treatments and communicate to respective centres with treated seeds.

Treatments:

Formulations**:** Dry & Wet (Both)

Forms: Bulk and Nano (Both).

Nano-particles: Zinc oxide, Titanium dioxide and Silicon dioxide

Dosage: Controls -2 (Untreated & Recommended PoP): 50, 100, 250, 500 and 750ppm

Replication: Three (Minimum of 100 seeds each)

Observations taken: The treated seed along with 2 controls (1. Untreated and 2. Recommended PoP) of one variety each by respective centres shall be evaluated for various seed quality parameters;

1. Time (hrs) for maximum numbers of radicle emergence (≥2mm)
2. Seed germination (%) (ISTA)- First count and final count
3. Increase or decrease in abnormal and dead seeds over control in different conc. of NPs.
4. Increase or decrease in seedling root and shoot length over control in different conc. of NPs.
5. Seedling vigour index I and II (Abdul Baki and Anderson, 1973)
6. Electrical conductivity of seed leachate (µS/cm/g)
7. Total dehydrogenase activity (A_{480} nm)
8. Seed health (infection and infestation)
9. Field emergence %
10. Final plant stand establishment (%)

Sub. Experiment-II (Objective 2): To validate the effect of different nano-particles on seed quality parameters and effect on storability of NP treated seeds in Pigeon pea, Paddy and Chickpea

Year of start: 2020-21

Technical programme:

Materials:

The CCS HAU Hisar centre would only supply sufficient quantity of seeds of minimum two chickpea varieties to TNAU, Coimbatore for NP treatments as given below. The TNAU, Coimbatore after the treatment shall divide the chickpea seeds in equal halves and send treated seeds of one chickpea variety to JNKVV, Jabalpur and UAS, Dharwad while the treated seeds of other chickpea variety to UAS, Raichur and ICAR- IISS, Mau for further studies.

The PAU, Ludhiana centre would only supply sufficient quantity of seeds of minimum two paddy varieties to TNAU, Coimbatore for NP treatments as given below. The TNAU, Coimbatore after the treatment shall divide the paddy seeds in equal halves and send treated seeds of one paddy variety to PJTSAU, Hyderabad and KAU, RARS, Pattambi while the treated seeds of other paddy variety to AAU, Jorhat and PAJANCOA&RI, Karaikal for further studies.

The ICAR-IARI, New Delhi centre would only supply sufficient quantity of seeds of minimum two pigeon pea varieties to TNAU, Coimbatore for NP treatments as given below. The TNAU, Coimbatore after the treatment shall divide the pigeon pea seeds in equal halves and send treated seeds of one pigeon pea variety to AAU, Jorhat and PAU, Ludhiana while the treated seeds of other pigeon pea variety to UAS, Bengaluru and PAJANCOA&RI, Karaikal for further studies.

The TNAU Coimbatore centre will only assess the seed moisture content before and after treatments and communicate to respective centres with treated seeds. The selected concentrations of NP treatments those gave better results for improving the plating values in both the crops that will be validated for quality enhancement as well as storability studies till 18 months.

Treatments:

The selected concentrations of NP treatments those gave better results in both the crops are given below;

Name of Crop	**Name of the Treatments + 2** Controls (untreated & Recommended PoP)
Paddy	1. Dry Bulk SiO_2 @100 ppm 2. Dry Bulk ZnO @ 500 ppm 3. Dry Nano SiO2 @500ppm 4. Dry Nano TiO_2 @100ppm 5. Dry Nano TiO_2 @250ppm 6. Dry Nano TiO_2 @500ppm 7. Dry Nano ZnO @ 750 ppm

	8. Wet Bulk TiO_2 @750ppm
	9. Wet Bulk ZnO @ 250ppm
Chickpea	1. Dry Bulk SiO_2 @100 ppm
	2. Dry Bulk ZnO @ 500 ppm
	3. Dry Nano SiO2 @500ppm
	4. Dry Nano TiO_2 @100ppm
	5. Dry Nano TiO_2 @250ppm
	6. Dry Nano TiO_2 @500ppm
	7. Dry Nano ZnO @ 750 ppm
	8. Wet Bulk TiO_2 @750ppm
	9. Wet Bulk ZnO @ 250ppm
Pigeon pea	1. Nano particle SiO_2 @ 50 ppm
	2. Nano particle SiO_2 @ 100 ppm
	3. Nano particle ZnO @ 500 ppm

A. Observations for validation of enhancement in planting value

Laboratory (before and after treatments**):**

- Seed moisture content (ISTA)
- Time (hrs) for maximum numbers of radicle emergence (≥2mm)
- First count %
- Germination % (ISTA)
- Increase or decrease in abnormal and dead seeds over control in different conc. of NPs.
- Increase or decrease in seedling root and shoot length over control in different conc. Of NPs.
- Vigour index-I & II (Abdul Baki and Anderson, 1973)

Field observations:

- Field emergence (%) – (to be recorded in all four replications in each treatment)
- Final plant stand establishment (%)– (to be recorded in all four replications in each treatment)
- Seed yield (g/plot)
- Percent increase/decrease in yield
- Increase/ decrease in cost of best treatment over control
- C:B ratio **- MUST**

B. Observations for studying the storability (Max. 18 months of storage)

At monthly interval:

1. Seed germination (%) (ISTA)- First count and final count

2. Increase or decrease in abnormal and dead seeds over control in different conc. of NPs.
3. Increase or decrease in seedling root and shoot length over control in different conc. of NPs.
4. Seedling vigour index I and II (Abdul Baki and Anderson, 1973)
5. Seed health (infection and infestation)

At three months interval:

1. Seed moisture content (ISTA)
2. Seedling emergence (%) in sand/soil AND/OR Field emergence (%)
3. Final plant stand establishment (%) just before normal sowing time of respective crops (i.e. once in a year at crop specific centres).
4. Electrical conductivity of seed leachate (µS/cm/g)

NB: *A minimum of four number of replications; two/four rows with 100/50 seeds, per replication are must for field evaluation studies.* **The experiment will be terminated once the germination % reaches 5% below IMSCS or completion of 18 months of storage.**

Sub. Experiment-III (Objective 3): To demonstrate the enhanced planting value of validated nano-particle treated seeds of Onion and Soybean.

Technical programme:

Materials: Two most prevailing varieties are to be taken.

Treatments:

The MPKV, Rahuri centre would supply the seeds of two onion varieties each sufficient for demonstration at all the four centres in at least 500sqm to TNAU, Coimbatore for NP treatment as given below. The TNAU, Coimbatore after the treatments shall divide the seeds of both the onion varieties in four equal parts and send treated seeds of these two varieties to MPKV, Rahuri; JNKVV, Jabalpur; AAU, Anand and NDUAT, Faizabad for demonstrations. The MPKV, Rahuri shall also send sufficient quantity of untreated seeds of both the onion varieties separately to all the four centres for planting/ transplanting in control plots of at least 500sqm each.

The JNKVV, Jabalpur centre would supply the seeds of two Soybean varieties each sufficient for demonstrations at all the four centres in at least 500sqm to TNAU, Coimbatore for NP treatment as given below. The TNAU, Coimbatore after the treatments shall divide the seeds of both the Soybean varieties in four equal parts and send treated seeds of these two varieties to JNKVV, Jabalpur; NAU, Navsari ; GBPUAT, Pantnagar; and PDKV, Akola for demonstrations. The

JNKVV, Jabalpur shall also send sufficient quantity of untreated seeds of both the Soybean varieties separately to all the four centres for planting in control plots of at least 500sqm each. Thus following t**reatments will be used in demonstration:**

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

Name of Crop	**Name of the Treatments (In addition to 2 controls)**
Soybean	1. Nano particle ZnO @ 500 ppm
Onion	1. Nano particle TiO2 @ 250 ppm

Planting: The treated, untreated (control 1) and crop specific recommended (control 2) seeds are to be planted in at least 500Sqm each at the normal sowing time. The recommended package and practices are to be followed for raising good nursery and crop/s.

Laboratory observations (before and after treatments):

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

Field observations: (Observations to be taken on seedlings/plants in control as well as treatment plots at randomly selected 4 places in 5 meter row lengths)

1. Field emergence % / Seedling emergence % in nursery of onion
2. Final plant stand establishment (%) after 4 weeks in soybean / - Percent seedling survived in nursery of onion after 5 weeks (Seedling ready for transplanting)
3. Plant height (cm) of 5 plants each at randomly selected 4 places in plots.
4. Soybean: Total number of pods/plant in 5 plants each at randomly selected 4 places in plots.
5. Soybean: Total number of seeds/pod in 5 pods/plant each at randomly selected 4 places in plots.
6. Soybean: Per plant yield in 5 plants each at randomly selected 4 places in plots.
7. Soybean: 1000 seed weight of seed produced (4 replications from each plot)
8. Onion: Average bulb wt. (5 bulbs each at randomly selected 4 places in plots)
9. Plot seed/bulb (onion) yield (kg)
10. Harvest Index
11. Soybean: Evaluation of quality (as per ISTA) of seed produced

12. Cost: Benefit ratio - **MUST**

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 in validation experiment and validated treatment in comparison with control in demonstration experiment taking all components of cost into account for all crops and report.*

Experiment 5: Influence of terminal heat stress on seed set, seed yield and quality in field crops

Specific observations: Studies to evaluate the adverse effect of heat stress and its mitigation during the reproductive phase in chickpea and finger millet would continue. The decision of conducting demonstrations during 2022-23, w.r.t. validated treatment/s in mustard, paddy, sorghum and wheat in delineated size of plot along with calculation of relatable C: B ratio in each crop was also taken.

Year of start: 2017-18

Rationale: Climate is rapidly changing and can disrupt food availability, reduce access to food, and affect food quality. The projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events and reductions in water availability may all result in reduced agricultural productivity. 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 evaluate the adverse effect of heat stress and its mitigation during the reproductive phase in chickpea and finger millet.
2. To demonstrate the most efficient treatment validated for mitigation of heat stress in the wheat, mustard, paddy and sorghum.

Crops		**Centres**
1. Evaluation of adverse effects of heat stress & its mitigation (Objective -1)		
Chickpea	:	CCSHAU, Hisar; UAS, Raichur and VNMKV, Parbhani
Finger millet	:	ICAR-IISS, RS, Bengaluru; PDKV, Akola and PJTSAU, Hyderabad
2. Demonstrations of validated heat stress mitigation technologies (Mini. 500sqm for Treat. & Ctrl.) (Objectives -2)		
Mustard	:	CCS HAU Hisar; ICAR-CAZRI, Jodhpur; MPKV, Rahuri and UBKV Cooch Behar
Paddy	:	BSKKV, Dapoli; OUAT, Bhubaneswar; PAJANCOA&RI, Karaikal and PAU, Ludhiana
Sorghum	:	PDKV, Akola; TNAU, Coimbatore; UAS, Dharwad and VNMKV, Parbhani
Wheat	:	GBPUAT, Pantnagar; ICAR-IISS, Mau; JAU, Jamnagar; JNKVV, Jabalpur; PDKV, Akola and RAU, TCA, Dholi

Sub. Experiment I (Objective 1): To evaluate the adverse effect of heat stress and its mitigation during the reproductive phase in chickpea and finger millet.

Year of start: 2021-22

Technical programme:

Materials:

One most popular chickpea and finger millet (ragi) variety 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 each crop 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:

1. Control
2. Salicylic acid (800 ppm)
3. Salicylic acid (400 ppm)
4. Ascorbic acid (10 ppm)
5. KCl (1%)
6. Thiourea (400 ppm)
7. Cycocel (please ensure that *a.i.* concentration should not exceed 1250 ppm)
8. KNO3 @ 0.3%

Spray Schedule:

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

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. 1000 seed weight

13. Plot yield (kg)
14. Harvest Index
15. Cost to Benefit ratio of the best treatment in each crop identified at your centre - **MUST**
16. 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 demonstrate the most efficient treatment validated for mitigation of heat stress in the wheat, mustard, paddy and sorghum.

Technical programme:

Materials:
One most popular variety recommended for normal dates of sowing in each crop will be taken for the study.

Methodology for Sowing/Planting of Crops (Wheat, Sorghum, Paddy and Mustard):
Each cooperating centre shall sow/plant the respective crop/s 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). The recommended package and practices are to be followed for raising good crop.

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
Wheat	Salicylic acid @ 800 ppm
Sorghum	Salicylic acid @ 400ppm
Paddy	Salicylic acid @ 400 ppm
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 booting/spike/ear/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 spike/ear/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 spike/ear/silique in 5 spikes/ears/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 6: Quantification of the Seed Vigour in Field Crops Using a Universal Scale

Specific observations: The aim of this study was to fix the minimum levels of vigour in terms of Germination Seedling Factor (GSF), the viable seed lots should possess to result in potential field emergence i.e. performance under field conditions and or in storability. The values of seed quality/vigour parameters along with GSF in each crop were correlated with field emergence by the cooperating centres revealed that seed germination test and seedling vigour indices tests were better correlated with field emergence than with GSF. Since these tests are conducted in routine and are simple, low-cost and fast, therefore it is recommended that the efforts to develop universal scale (fixing minimum cut off) based upon any one or two seed quality/ vigour parameters to be made in 2022-23 by taking as many number of lots as possible.

Year of start: 2020-21

Rationale: Germination testing remains the principle, and internationally accepted, criterion for knowing the germination potential of seed lot. Even high germinating seed lots may differ substantially in field emergence when sown at the same time in the same field, and/or may differ in performance and during storage in the same environment. Then the question arises, why there is difference in field performance and or storability? These differences could be caused by another component of seed quality, seed vigour. But, seed testing laboratories only perform vigour tests at the request of the client. Though, vigour testing is equally important to know the ability of those seeds to produce normal seedlings under less than optimum or adverse growing conditions. Hence, research on quantification of the seed vigour is required not only to provide more information about which seed production practices impair seed vigour, and the steps necessary to improve the vigour status of seed lots, but also to know the minimum levels of vigour the viable seed lots should possess to result in potential performance under field conditions and or in storage. Therefore, this experiment was designed with the following objectives;

Objective:

- Reliable estimation and comparative evaluation of vigour in seed lots of field crops

Crops		**Centres**
Chickpea	:	ICAR-IARI, New Delhi; NDUAT Faizabad and UAS, Dharwad
Cotton	:	ICAR-CICR, Nagpur and PDKV Akola
Maize	:	CSKHPKV, Palampur and RAU, TCA, Dholi
Mustard	:	ICAR-CAZRI, Jodhpur; UBKV Cooch Behar and VNMKV, Parbhani
Paddy	:	ICAR-IISS, Mau; PAJANCOA & RI, Karaikal and TNAU, Coimbatore
Pigeon pea	:	ICAR-IARI, New Delhi; NDUAT Faizabad and UAS, Raichur
Soybean	:	MPKV, Rahuri and UAS, Bengaluru
Sunflower	:	JAU, Jamnagar and UAS, Bengaluru
Wheat	:	ICAR-IISS, Mau; JNKVV, Jabalpur and PAU, Ludhiana

Technical Programme:

Materials: Centres must collect maximum numbers of seed lots in selected crops from their own sources, but not less than 15 seed lots in any crop or species. Half of the seed lots (minimum 5) should have max. 20% less germination than IMSCS and rest of the lots should have germination ≥IMSCS. Say in wheat germination as per IMSCS is 85% so we can have 15 lots with 65, 67, 72, 80, 82, ... 85, 85, 87, 88, 89, 90, 90, 91, 95 & 98% germination.

Observations to be recorded:

1. Maximum % of radicles (≥2mm) emerged after hrs (Time may vary from var. to var.)

2. Germination % (ISTA), 4 replications.
3. Total Seedling Length (TSL) or Total Seedling Wt (TSW*) were taken on at least 10 normal seedlings per replication on Final Count Day. Calculate average TSL or TSW. *Fresh or Dry Wt.
4. Field Emergence % (at least 4 Replications of 100 seeds each).
5. Final Plant Stand % (to be recorded between 45 to 60 days after sowing) in an area required for sowing of 4 Replications of 100 seeds at the recommended spacing in each crop.

Methodology: Correlation (r) needs to be calculated among following observations

a) MRE% and FE (%) of the each seed lot and mean of seed lots.
b) GSF (Seedling lt. basis) and FE (%) of the each seed lot and mean of seed lots.
c) GSF (wt. basis) and FE (%) of the each seed lot and mean of seed lots.
d) G (%) and FE (%) of the each seed lot and mean of seed lots.
e) VI -I and FE (%) of the each seed lot and mean of seed lots.
f) VI -II and FE (%) of the each seed lot and mean of seed lots.
g) FPS and FE (%) of the each seed lot and mean of seed lots.

Calculations of GF & SF:

- Germination and seedling weight or length will be converted to Germination Factor (**GF**) and Seedling Factor (**SF**), respectively.
- Let there be 10 seed lots of wheat under study.
- Let the G (%) of these be: 85, 97, 86, 98, 88, 96, 89, 90, 87, 92.
- Convert G% into Germination Factor by dividing by 100, to bring all values between 0 and 1.0
- Let germination of seed lot *1* and *2* be 85% and 97%.
- Therefore, GF will be 0.85 and 0.97.
- TSL or TSW: Let the highest TSW of Lot 10 lots be 0.25 mg.
- Let the TSW of lot 1 and 2 are 0.20 mg and 0.21 mg.
- Therefore, SF of seed lots 1 and 2 will be 0.20 / 0.25 = 0.80 and 0.21 / 0.25 = 0.84
- Now, Germination Seedling Factor (**GSF**) will be;
    - Lot 1: 0.85 X 0.80 = 0.680 ; Lot 2: 0.97 X 0.84 = 0.8148 or 0.815

NB: Kindly calculate the GSF carefully. Compare the **correlation (r) with FE** with all seed quality and vigour parameters including, Factors (GF/SF) **for each lot separately and means of all lots**. Finally the quantified value of vigour is to be recommended for each crop.

All the centres should look and report the data so as we could be fix the minimum cut (value) of any quality or vigour parameter and recommend that as universal scale in each crop. Given below is an example of calculations made in wheat based on the accepted standards. The

calculations are done by assuming that 85% (IMSCS) of 100 kg (SR) seeds with 1000 seed weight of 44g would germinate and could give 1931818 numbers of plants/ha, however considering spacing (22.5X10) there could optimally be 444444 numbers of plants/ha. That means we expect only 23% plant stand out of all those emerged from 100kg could be sufficient. We also know that mortality in cereals typically ranges from 5 to 20 per cent and if take it 20% then a minimum 43% field emergence should result in optimal harvests from wheat fields. But we have to verify and recommend such value/s for any quality or vigour parameter to be accepted as universal scale in each crop.

Experiment VII. Assessment of prevalence of revalidated seed lots in the country

Specific observations: The experiment was mainly for collection of data from seed certification agencies on revalidated seed lots to assess the status of revalidations at ground level in the country. The data on prevalence of revalidated seed lots was collected from 11 state seed certification agencies out of 25 certification agencies in the country by 13 cooperating centres out 24 regular and 10 volunteer centres in 25 crops also supplemented the findings of experiment 1 and 7. Since, the data on prevalence of revalidated seed lots for many important crops was not collected by any cooperating centre from any certification agency, therefore it was decided that complete data on prevalence of revalidated seed lots SHALL be collected by all the centres for all the major crops from every certification agency and private seed industries present in their areas.

Year of Start: 2021-22

Rationale: The experiment "To reaffirm the validity periods of certified seeds of field crops (as per the IMSCS regulations)" was proposed three years back to assess the longevity of the seeds in different crops retain germination ≥IMSCS upon which the certificates for revalidations could be issued by the certification agencies. But, there is hardly any data available which suggests how seed lots of specific varieties in different crops are actually offered for revalidation. Therefore, to supplement the findings and recommendations of the above experiment it was considered necessary to collect data on all the crops for assessment of prevalence of revalidated seed lots in the country.

Objective:

- To collect the data from Seed Certification Agencies on prevalence of revalidated seed lots in the country

Crops **Centres**

All the dominant/imp crops of each state : All the STR Centres

Methodology: The data of minimum last five years is to be collected from Seed Certification Agencies and private seed industries present in their areas by all the centres in the proforma given below.

Name of the Crop: ..... (Separate table for each crop please)

Names of Varieties:

Name of the Centre:					**Name of the Agency/Company:**				
Years	**NVA-C (1)***	**NLA-C (2)**	**NOL-RVI (3)**	**NAL-RVI (4)**	**NOL-RVII (5)**	**NAL-RVII (6)**	**T. Lots (2+4+6)**	**PCO- RVI (4/2)X100**	**PCO- RVII (6/2)X100**
2021-22									
2020-21									
2019-20									
2018-19									
2017-18									
2016-17									
Total									

***NB:** 1. No. of Varieties accepted for initial certification: NVA-C, 2. No. of Lots accepted for initial certification: NLA-C, 3. Total Numbers of lots offered for revalidation (RV-I): NOL-RVI, 4. Total Numbers of lots accepted for revalidation (RV-I): NAL- RVI, 5. Total Numbers of lots offered for revalidation (RV-II): NOL-RVII, 6. Total Numbers of lots accepted for revalidation (RV-II): NAL- RVII, 7. Total numbers Lots accepted (Certification+ RVI+RVII): T. Lots, 8. Percent of certified lots offered RVI : PCO- RVI (NAL- RVI /NLA-C)X100 and 9. Percent of certified lots offered RVII: PCO- RVII.

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:

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

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C. Seed Pathology

Date: 22.04.2022 & 12.05.2022

Chairman : **Dr. Mohan S. Bhale**
Former PI (Seed Pathology)
JNKVV, Jabalpur

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

General Observations

- It was suggested that those centers which are not conducting the experiment and/ or not reporting the data should be viewed seriously. Similarly, action may be initiated against the centres for delay/ lapses in data reporting.
- **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 benefit cost ratio may be worked out for all the experiments to assess the economic feasibility of the developed technologies.

Important points for the submission of results:

- The centers should follow the technical programme strictly, without any deviation/s and conduct the experiment accordingly.
- 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 to analyze the precision of the experiment.
- The report submitted by the cooperating centers should be supplemented with high quality photographs.

Contacts of PI and Co-PI

Theme	PI/ Co-PI	Email ID	Mob. No.
Seed Pathology			
PI	**Dr. Atul Kumar** Principal Scientist DSST, ICAR-IARI, New Delhi	atulpathiari@gmail.com	7703820583
Co-PI	Nominated later on	-	-

Recommendations:

1. Alkali blotter method (Modified blotter method, blotter soaked in NaOH 0.6% and incubated at 25^0C at 12 h alternate light and dark period) has been recommended for detection of seed borne infections of *Fusarium sp., Macrophomina sp., Alternaria sp.* in black gram. The recovery of pathogens was better i.e. 19-30 % as compared to standard blotter method (5-12 %).
2. For management of purple blotch and stemphylium blight in onion, seed dressing with *Trichoderma viride* @ 10 g/ kg seed followed by two foliar sprays of tebuconazole or difenconazole @ 0.1 % after disease initiation at 10-15 days interval was found to give maximum seed germination and field emergence, minimum per cent disease incidence (PDI) and maximum seed yield of onion.
3. For better quality and storability in soybean seeds, pre-sowing seed treatments with Carboxin 37.5% + Thiram 37.5% (Vitavax Power) @ 3g/kg followed by two pre-harvest sprays with Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at seed development and seed maturity stages is recommended.
4. Black gram /green gram seeds treated with captan @ 0.25% and stored in poly lined gunny bag at ambient temperature exhibited germination per cent above IMSCS, better seedling vigour, field emergence and nil infection of *Macrophomina phaseolina* and *Colletotrichum dematium* up to 11 month of storage. It was found to be suitable for safe seed storage and to prolong the shelf life of seeds.
5. Multiplex PCR method for detection of viruses in common bean has been developed at SKAUST Srinagar. The designed primers for the identified viruses were first used to amplify their respective targets in uniplex PCR assay with predicted size. The presence of all the three viruses viz., BCMV (BCMV 1 and BCMV 2), BCMNV and CIYVV were identified successfully. The respective PCR products of predicted size for corresponding viruses with 442bp for BCMV 1, 661bp for BCMV 2, 834bp for BCMNV and 1443bp for CIYVV were observed. The results of multiplex PCR of all the three viruses viz., BCMV (442bp for BCMV 1and 661bp for BCMV 2), BCMNV (834bp) and CIYVV (1443bp) were visualized by using gel electrophoresis on gel documentation system.

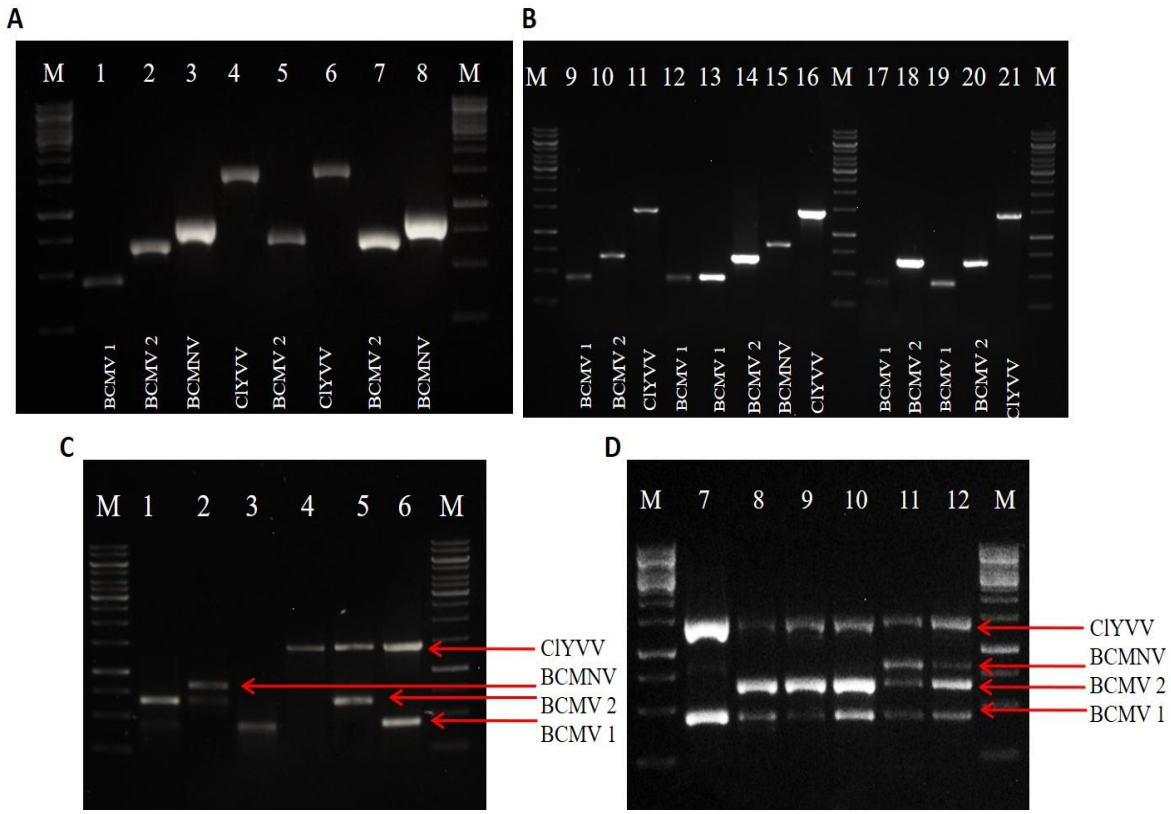

Fig. 1. RT-PCR confirmation of identified viruses by using newly designed virus specific primers. **A** and **B,** represents amplicons of identified viruses from lane 1 to 21, BCMV 1 (442bp), BCMV 2 (661bp), BCMNV (834bp) and ClYVV (1443bp). **C** and **D,** duplex/ multiplex RT-PCR for simultaneously detection of all the identified viruses. lane 1 to 12 represents duplex/ multiplex amplified products of identified viruses. M is 1Kb molecular marker

Technical programme 2022-23

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

Objectives

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

Year of start : 2021-22
Status : Continued

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

Centres: AAU, Jorhat; SKUAST, Srinagar; TNAU, Coimbatore; CSKHPAU, Palampur; PAJANCOA&RI, Karaikal; MPKV, Rahuri; ICAR-IARI, New Delhi; DRPCAU, Pusa; PAU,

Ludhiana; CCSHAU, Hisar; PJTSAU, Hyderabad; AAU, Anand; GBPUA&T, Pantnagar; OUAT, Bhubaneshwar and IARI, RS, Karnal (15)

Methodology

- **Detection Technique:** Standard NaOH seed soak method to be followed for bunt in rice seed samples. Minimum seed sample size is 100 from all the sources, covering the popularly grown rice varieties. Mention the range of infection for each location.
- **Disease scoring:** Record the disease in farmer's field and seed production plots and score the diseases as per the SES for rice (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 are to be reported.
    - Impact on germination (normal seedlings) and seedlings with primary infection (part of abnormal seedlings category) and seed rot be reported.
    - Correlation of association of pathogen with seed germination (normal seedlings), and seedlings with primary infection (part of abnormal seedlings category) are to be specified separately.
    - Monitoring of any other seed borne disease of importance, as per centre.

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 disease (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, Spot Blotch and Head Blight

Centres: CCSHAU, Hisar; PAU, Ludhiana; GBPUAT, Pantnagar; CSKHPAU, Palampur; RARI, Durgapura; IARI, New Delhi; MPKV, Rahuri and IARI, RS, Karnal (8)

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 rice bunt and Karnal bunt of wheat with awareness for safe storage and significance of replacement of varieties.

Methodology:

- **Detection technique:** Standard NaOH seed soak method to be followed for bunt in seed samples. Minimum seed sample size of 100 from all the sources, covering the popularly grown wheat varieties.
- For ear cockle, visual observation and standard water soak method to be followed.
- Record loose smut incidence under field conditions by GOT.
- Record 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

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

Methodology

- A minimum of 100 seed samples from all the sources should be collected, covering the popularly grown 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 (d): Groundnut- Collar Rot, Seed rot

Centres: AAU, Anand; MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur and TNAU, Coimbatore (5)

Methodology:

- Minimum seed sample size is 100 from all the sources, covering the popularly grown 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 (e): Chickpea- Wilt, Grey Mould, Stemphylium blight, Ascochyta blight
Centres: MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur and PJTSAU, Hyderabad (4)
Methodology:

- Minimum seed sample size is 100 from all the sources, covering the popularly grown 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- Blast and other seed borne diseases/mycoflora
Year of start: 2020-21
Centres: PJTSAU, Hyderabad; MPKV Rahuri; JNKVV Jabalpur; TNAU, Coimbatore and ICAR-IISS, RS, Bengaluru (5)
Methodology:

- Minimum seed sample size is 100 from all the sources, covering the popularly grown varieties. Report the range.

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:

1. To determine the health status of seed samples from the farmers own saved seeds

Year of start : 2000
Status : Continued
Crop (a) : **Wheat**
Centres: CCSHAU, Hisar; PAU, Ludhiana; GBPUAT, Pantnagar; CSKHPAU, Palampur; RARI, Durgapura; RPCAU, Pusa; MPKV, Rahuri and IARI, RS, Karnal (8)
Methodology:

- **Detection Technique:** Standard NaOH seed soak method to be followed for bunt in seed samples. Minimum seed sample size is 100 from all the sources, covering the popularly grown wheat varieties.
- For ear cockle, visual observation and standard water soak 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 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

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

Methodology

- A minimum of 100 seed samples from all the sources, 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* spp., *Diaporthe* spp.) in farmers own saved seed shall be recorded based on the observations of 400 seeds / sample.
- Symptoms of SMV be also recorded both in field and seed samples.
- Impact on germination- Normal seedlings, abnormal seedlings with primary infection and seed rot to be reported.
- Correlation of association of pathogen 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: AAU, Jorhat; TNAU, Coimbatore; CSKHPAU, Palampur; PAJANCOA&RI, Karaikal; MPKV, Rahuri; ICAR-IARI, New Delhi; DRPCAU, Pusa; PAU Ludhiana; CCS HAU Hisar; PJTSAU, Hyderabad; AAU, Anand; SKAUST, Srinagar; OUAT, Bhubneshwar and IARI, RS, Karnal (14)

Methodology

- **Detection Technique:** Standard NaOH seed soak method to be followed for bunt in rice seed samples. Minimum seed sample size is 100 from all the sources, covering the popularly grown rice varieties. Report the range of infection for each location
- Seed borne pathogens responsible for seed discoloration to be reported.
- Impact on germination-Normal seedlings, abnormal seedlings with primary infection and seed rot to be reported.

- Correlation of association of pathogen with seed germination, normal seedlings and seedlings with primary infection is specified separately.

Note

1) *Prepare a map depicting the seed sample location*
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

Centres: AAU, Anand; MPKV, Rahuri; RARI, Durgapura; JNKVV, Jabalpur and TNAU, Coimbatore (5)

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, covering the popularly grown varieties.
- Impact on germination-Normal seedlings, abnormal seedlings with primary infection and seed rot to be reported.
- Correlation of association of pathogen 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

Centres: MPKV, Rahuri; RARI, Durgapura; PJTSAU, Hyderabad and JNKVV, Jabalpur (4)

Methodology:

- Seed health be determined by employing standard blotter method (ISTA, 1996) and visual inspection of seeds
- Minimum seed sample size is 100 from all the sources, covering the popularly grown varieties. Report the range.
- Impact on germination-Normal seedlings, abnormal seedlings with primary infection and seed rot to be reported.
- Correlation of association of pathogen with seed germination, normal seedlings and seedlings with primary infection is to be 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
Centres: PJTSAU, Hyderabad; MPKV Rahuri; JNKVV, Jabalpur and TNAU, Coimbatore (4)

Methodology:

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

1. 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
Centres: TNAU, Coimbatore; JNKVV, Jabalpur; SKUAST, Srinagar; ICAR-IISS, RS, Bengaluru and ICAR-IARI, New Delhi (5)

Note:

- *Provide the photographs showing the associated pathogen.*
- *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 need to 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: Monitoring of seed borne viruses in soybean and pulses and standardization of methods for detection through biological, serological and molecular techniques

Objectives

2. To identify the seed borne viruses in the samples obtained from various parts of the country.
3. To develop and standardize the nucleic acid-based techniques for detection of seed borne viruses.

Year of start : 2009
Status : Continued
Pathogen : Soybean Mosaic Virus/ other viral diseases
Centres: AAU, Anand; SKAUST Srinagar; IARI, New Delhi; MPKV, Rahuri and JNKVV, Jabalpur (5)
Note:

1) For identification of seed borne viruses in different crops, the other cooperating centers are directed to supply the samples to IARI, New Delhi and SKAUST, Srinagar.
2) Samples of leaves and /or seeds may be sent, for determination of viruses.

Experiment 5: Management experiments

New experiment 5a: 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 *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
Crop: Paddy
Centres: TNAU, Coimbatore; PJTSAU, Hyderabad; PAJANCOA, Karaikal; IARI, New Delhi; AAU, Jorhat; OUA&T, Bhubaneswar(6)

Materials and Methods:

First year (2022-23)

Objective 1: Testing 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

Seed material: Any popular susceptible variety of the region

Fungicides: As listed in treatment details

Treatment details for *in vitro* studies

S. No.	Fungicide	Dosage (g/ml)
1.	Azoxystrobin 18.2%+Difenoconazole 11.4% SC	1.0
2.	Trifloxystrobin 25% + Tebuconazole 50% WG	0.4
3.	Propiconazole 13.9%+Difenconazole 13.9% EC	0.5
4.	Picoxystrobin 12% + Propiconazole 7% SC	2.0
5.	Metiram 55% + Pyraclostrobin 5% WG	2.0
6.	Fluopyram 17.7% + Tebuconazole 17.7% SC	0.8
7.	Azoxystrobin 16.7% + Tricyclazole 33.3% SC	1.0
8.	Propiconazole 25EC	1.0
9.	Untreated control	-

Techniques to be adopted:

a) Poisoned food technique for assessing impact on the growth of the pathogen.

b) Spore germination assay for assessing impact on the sporulation of the pathogen.

c) Paper towel method for seed quality parameters–Treat 1kg paddy seeds with recommended doses of fungicides separately, by maintaining 1kg untreated seeds as control. Evaluate the treated seeds for seed germination and vigour indices on the next day after seed treatment. Replicate each treatment four times and use 100 seed for each replication. Record germination (%), root and shoot length (cm) and work out vigour indices (SVI-I & SVI-II)

Second and Third Year (2023-24 and 2024-25)

Objective 2: Testing the efficacy of novel systemic fungicide molecules against rice false smut disease under field conditions

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

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/m^2
2. Per cent false smut infected spikelets/panicle
3. Disease severity
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 5 (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

Pathogen : Soybean: *Macrophomina phaseolina*
Chickpea: *Fusarium oxysporum, Rhizoctonia bataticola*
Groundnut: *Sclerotium rolfsii, Aspergillus flavus, A. niger*

Centres:

Soybean-JNKVV Jabalpur; VNMKV, Parbhani; MPKV, Rahuri; ICAR-IISS, RS, Bengaluru and GBPUA&T, Pantnagar (5)

Chickpea – JNKVV Jabalpur; MPKV, Rahuri; RARI, Durgapura; PAU, Ludhiana; AAU, Anand and GBPUA&T, Pantnagar (6)

Groundnut- PJTSAU, Hyderabad; MPKV, Rahuri; RARI, Durgapura and AAU, Anand (4)

Methodology

First Year (2022- 2023)

Objective 1: 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's/ ICAR institutes concerned

Second Year (2023-2024)

Objective 2: 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 seed 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.

b) <u>Pot culture experiments – methodology and biometric observation to be furnished</u>

Third Year (2024-2025)

Objective 3: 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. **<u>Methodology including seed treatment and time and no. of foliar spray to be furnished</u>**

N.B.:

Beejamrit, Jeevamrit, will be supplied by RARI, Durgapura centre.

Cow urine will be procured by each centre themselves.

Kunab Jal will be supplied to every participating centre by GBPUAT, 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 6: Development of seed health standards for important seed borne diseases in crops

Objective:

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

Year of start : 2020-21
Status : Continued
Crop : Soybean

Target disease: Purple seed stain caused by *Cercospora kikuchii*

Centres: JNKVV, Jabalpur; PJTSAU, Hyderabad; MPKV, Rahuri and IARI, New Delhi (4)

- Detailed data sheet and methods available with centre and some modifications in conduct of the experiment has been suggested which will be informed by JNKVV, Jabalpur center as soon as possible.

Experiment 7: 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 seed borne 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 Initiation : 2021-22

Status : Continued

Crops : Rice, Pigeon pea, Green gram, Black gram, Groundnut and Soybean

I. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of Rice (Blast, False smut, Brown spot, Sheath rot, Bakanae)

Centres: PJTSAU, Hyderabad; TNAU, Coimbatore; PAJANCOA, Karaikal; DRPCAU, Pusa, Bihar; GBPUA&T, Pantnagar; AAU, Jorhat; PAU, Ludhiana; AAU, Anand; CCSHAU, Hisar; SUKAST, Kashmir; MPKV Rahuri; OUAT, Bhubneshwar; IARI, New Delhi and IARI, RS, Karnal (14)

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

Materials and methods:

Seed material: Rice seeds of any variety susceptible to one or more seed borne diseases (Preferably multiple disease susceptibility)

Fungicides: As listed in treatment details

No. of replications: 4

No. of seeds/replication: 100

Technique to be adopted:

1. Standard blotter method
2. Paper towel method

Methodology:

1. Treat 1kg paddy seeds with X dose of fungicides separately, by maintaining 1kg untreated seeds as control.
2. Evaluate the treated seeds after seed treatment (next day) for seed health and quality parameters.

Data to be recorded:

1. No. of seeds germinated (normal seedlings)

2. Seedling length (root length +shoot length)
3. No. of seeds infected
4. Type of fungi observed
5. Frequency of fungi observed

Treatment details:

S. No.	Fungicide	Dosage (ml/or g) per kg seed	Label claim status
1.	Propiconazole 13.9% + Difenconazole 13.9% EC (Taspa)	1ml	Yes
2.	Azoxystrobin 18.2% + Difenconazole 11.4% SC (Amistartop)	1ml	Yes
3.	Picoxystrobin 6.78% + Tricylcazole 20.33% SC (Galileo Sensa)	1ml	Yes
4.	Trifloxystrobin @25% + Tebuconazole 50% WG (Nativo)	0.5 ml	Yes
5.	Carbendazim 50% WP (Standard Check)	2g	Yes
6.	Control	-	-

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

Centres: PJTSAU, Hyderabad; MPKV, Rahuri and TNAU, Coimbatore (3)
Year of Initiation: 2021-22
Objectives: To test the efficacy of novel fungicides on seed health and seed quality parameters of Pigeon pea.
Materials and methods:
Seed material: Pigeon pea seeds of any variety susceptible to one or more seed borne diseases (Preferably multiple disease susceptibility)
Fungicides: As listed in treatment details
No. of replications: 4
No. of seeds/replication: 100
Technique to be adopted:

1. Standard blotter method
2. Paper towel method

Methodology:

1. Treat 1kg pigeon pea seeds with X dose of fungicides separately by maintaining 1kg untreated seeds as control.
2. Evaluate the treated seeds after seed treatment (next day) for seed health and quality parameters.

Data to be recorded:

1. No. of seeds germinated (normal seedlings)
2. Seedling length (root length + shoot length)
3. No. of seeds infected
4. Type of fungi observed
5. Frequency of fungi observed

Treatment details:

S. No.	Fungicide	Dosage (ml/g) per kg seed	Label claim status
1.	Difenconazole 5% + Fluxapyraxod 7.5% SC (Sercadis Plus)	1ml	-
2.	Thiophanate methyl 45% + Pyraclostrobin 5% FS (Xelora)	1ml	-
3.	Penflufen 13.28% +Trifloxystrobin 13.2% FS (Ever Golxtend)	1ml	-
4.	Carbendazim 50% WP (Standard check)	2g	Yes
5.	Control	-	-

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

Crop : Black gram

Centres: PJTSAU, Hyderabad; PAJANCOA, Karaikal; TNAU, Coimbatore; RARI, Durgapura and PAU, Ludhiana (5)

Crop : Green gram

Centres: PJTSAU, Hyderabad; PAJANCOA, Karaikal; TNAU, Coimbatore; RARI, Durgapura; AAU, Jorhat; MPKV, Rahuri and CCSHAU, Hisar (7)

Year of Initiation : 2021-22

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

Materials and methods:

Seed material: Green gram and Black gram seeds of any variety susceptible to one or more seed borne diseases (Preferably multiple disease susceptibility)

Fungicides: As listed in treatment details

No. of replications: 4

No. of seeds/replication: 100

Technique to be adopted:

1. Standard blotter method
2. Paper towel method

Methodology:

1. Treat 1kg green gram and black gram seeds with X dose of fungicides separately by maintaining 1kg untreated seeds as control.
2. Evaluate the treated seeds after seed treatment (next day) for seed health and quality parameters.

Data to be recorded:

1. No. of seeds germinated (normal seedlings)
2. Seedling length (Root length + Shoot length)
3. No. of seeds infected
4. Type of fungi observed
5. Frequency of fungi observed

Treatment details: Green gram

S. No.	Fungicide	Dosage (ml/g) per kg seed	Label claim status
1.	Penflufen 13.28% +Trifloxystrobin 13.2% FS (Ever Golxtend)	1ml	-
2.	Pyraclostrobin 5% + Metiram 55% WG (Cabriotop)	1g	Yes
3.	Propiconazole 13.9% + Difenconazole 13.9%EC (Taspa)	1ml	-
4.	Carbendazim 50% WP (Standard check)	2g	-
5.	Control	-	-

Treatment details: Black gram

S. No.	Fungicide	Dosage ml/kg per kg seed	Label claim status
1	Penflufen + Trifloxystrobi (Ever Golxtend)	1ml	-
2.	Pyraclostrobin 5% + Metiram 55% WG(Cabriotop)	2g	Yes
3.	Fluxapyraxod (Systiva) 33.3%	1.5 ml	-
4.	Carbendazim 50% WP (standard check)	2g	-
5.	Control	-	-

IV. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of Groundnut (Collar Rot, Seed rot)

Centres: PJTSAU, Hyderabad; PAJANCOA, Karaikal, TNAU, Coimbatore; RARI, Durgapura; AAU, Anand and MPKV Rahuri (6)

Year of initiation: 2021-22

Objective: To test the efficacy of novel fungicides on seed health and seed quality parameters of Groundnut (Wilt, Grey Mould, Stemphylium blight)

Materials and methods:

Seed material: Groundnut seeds of any variety susceptible to one or more seed borne diseases (Preferably multiple disease susceptibility)

Fungicides: As listed in treatment details

No. of replications: 4

No. of seeds/replication: 100

Technique to be adopted:

1. Standard blotter method
2. Paper towel method

Methodology:

1. Treat 1kg groundnut seeds with X dose of fungicides separately by maintaining 1kg untreated seeds as control.
2. Evaluate the treated seeds after seed treatment (next day) for seed health and quality parameters.

Data to be recorded:

1. No. of seeds germinated (normal seedlings)
2. Seedling length (Root length + Shoot length)
3. No. of seeds infected
4. Type of fungi observed
5. Frequency of fungi observed

Treatment details:

S. No.	Fungicide	Dosage (%) (g/ml) kg seed	Label claim status
1.	Penflufen 13.28% + Trifloxystrobin13.2% FS(Ever Golxtend)	1ml	Yes
2.	Pyraclostrobin 13.3% + Epoxyconazole 5% SE (Opera)	0.75 ml	Yes
3.	Thiophanate methyl 45% + Pyraclostrobin5% FS (Xelora)	1ml	Yes
4.	Carboxin 37.5% WS + Thiram 37.5% WS (Vitavax power)	3g	Yes
5.	Control	-	-

V. Project title: Effect of seed dressing fungicides on seed and seedling associated pathogens of Soybean (Purple seed stain, Pod rot, Charcoal Rot, Anthracnose)

Centres: JNKVV, Jabalpur; PJTSAU, Hyderabad; MPKV, Rahuri; IARI, New Delhi; GBPUA&T, Pantnagar and VNMKV, Parbhani (6)

Year of initiation: 2021-22

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

Materials and methods:

Seed material: Seeds of any soybean variety susceptible to one or more seed borne diseases (Preferably multiple disease susceptibility)

Fungicides: As listed in treatment details

No. of replications: 4

No. of seeds/replication: 100

Technique to be adopted:

1. Standard blotter method
2. Paper towel method

Methodology:

1. Treat 1kg soybean seeds with X dose of fungicides separately by maintaining 1kg untreated seeds as control.
2. Evaluate the treated seeds after seed treatment (next day) for seed health and quality parameters.

Data to be recorded:

1. No. of seeds germinated (normal seedlings)
2. Seedling length (root length + shoot length)
3. No. of seeds infected
4. Type of fungi observed
5. Frequency of fungi observed

Treatment details:

S. No.	Fungicide	Dosage ml/ or g per kg seed	Label claim status
1.	Thiophanate methyl 45% + Pyraclostrobin 5% FS (Xelora)	1ml	Yes
2.	Pyraclostrobin 13.3%+ Epoxyconazole 5% SE (Opera)	1.5ml	Yes
3.	Penflufen + Trifloxystrobin (Ever Golxtend)	1ml	Yes
4.	Fluxapyraxod 33.3%FS (Systiva)	1.5ml	Yes
5.	Carboxin 37.5% WS + Thiram 37.5% WS (standard check)	3g	Yes

S. No.	Fungicide	Dosage ml/ or g per kg seed	Label claim status
1.	Thiophanate methyl 45% + Pyraclostrobin 5% FS (Xelora)	1ml	Yes
2.	Pyraclostrobin 13.3%+ Epoxyconazole 5% SE (Opera)	1.5ml	Yes
6.	Control	-	-

Note:

1. **Changes in the fungicide molecule and others if any can be done in due course as well. Commercially available microbial consortia can be used**
2. **Approximately 1.5 of kg seed is required for conduct of trial for one crop and all chemicals are available online. Seeds are to be preserved for further studies in polylined gunny bags.**

List of Co-operating Scientists

S. No.	Centre	Name	Designation	Email ID	Mob. No.
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18	ICAR-IISS, Mau	Dr. S. Aravindan	Scientist	aravindgobi@gmail.com	7538995223

D. Seed Entomology

Date: 26.04.2022 & 03.05.2022

Chairman : **Dr. S. N. Sinha**
Principal Scientist & Former HOD, IARI Regional Station, Karnal

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

General Observations

- It was suggested that those centers which are not conducting the experiment and/ or not reporting the data should be viewed seriously. Similarly, action may be initiated against the centres for delay/ lapses in data reporting.
- **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 benefit cost ratio may be worked out for all the experiments to assess the economic feasibility of the developed technologies.
- Experiment No. 2 on 'Effect of solarization on bruchids (pulse beetle) infestation and quality of pulse seeds' and Experiment No. 4 on 'Evaluation of pre-harvest spraying of insecticides and botanicals for management of pulse beetle (*Callosobruchus* sp.)' will be concluded.

Important points for the submission of results:

- The centers should follow the technical programme strictly, without any deviation/s and conduct the experiment accordingly.
- 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 to analyze the precision of the experiment.

Contacts of PI and Co-PI

Theme	PI/ Co-PI	Email ID	Mob. No.
Seed Entomology			
PI	**Dr. Amit Bera** Senior Scientist ICAR-CRIJAF, Barrackpore	amitbera.iari@gmail.com	9732709874
Co-PI	**Dr. Anjitha George** Senior Scientist ICAR-IISS, RS, Bengaluru	Anjitha.S@icar.gov.in; anjithakitty@gmail.com	8623937913

Recommendations:

1. Solarization of seeds (properly dried) in clear polythene (700 gauge) packet (5cm thick seed layer) for 6 days (4 h on each day) during summer sunny days can reduce insect damage and maintain higher seed germination up to 9-12 months of storage in chickpea, green gram and black gram.
2. Pre-harvest spraying of neem formulation (containing 10000 ppm azadirachtin) @6ml/L at 50% pod maturity and maturity stage can be used for controlling field infestation of pulse bruchid and subsequent adult emergence during storage of pulse seeds (green gram, chickpea, black gram, and pigeon pea).

Technical programme 2022-23

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

Specific observations:

- 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.**
- 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 samples 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 Efficacy of commercially available Neem products against storage insect-pests during storage under ambient condition

Crop	Centre
Wheat	MPKV, Rahuri; CSAUAT, Kanpur; NDUAT, Faizabad
Paddy	AAU, Jorhat; OUAT, Bhubaneswar; PJTSAU, Telangana; PAJANCOA, Karaikal
Cowpea	UAS, Bangalore; TNAU, Coimbatore
Green gram	SKNAU, Jobner, OUAT, Bhubaneswar; UAS, Dharwad
Chickpea	IISS, Mau; UAS, Dharwad; PDKV,Akola
Sorghum	TNAU, Coimbatore; PDKV, Akola
Pigeon pea	NDUAT, Faizabad; MPKV, Rahuri, PJTSAU,Telengana
Black gram	AAU, Assam; PAJANCOA, Karaikal
Field pea	CSAUAT, Kanpur

Objectives

1. To evaluate commercial Neem formulations against major storage insect-pests damaging seeds.
2. Study of the storability of treated seeds.

Treatment

A. Insecticides/botanicals

1. Neemazal T/S (Azadirachtin 10,000 ppm) @25 ppm (2.5 ml formulation/kg seed)
2. Neemazal T/S (Azadirachtin 10,000 ppm) @50 ppm (5.0 ml formulation/kg seed)
3. Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed)

4. Neemoz - Gold (Azadirachtin 10,000 ppm)@25 ppm (2.5 ml formulation/kg seed)
5. Neemoz - Gold (Azadirachtin 10,000 ppm)@50 ppm (5.0 ml formulation/kg seed)
6. Neemoz - Gold (Azadirachtin 10,000 ppm)@75 ppm (7.5 ml formulation/kg seed)
7. Deltamethrin @ 1ppm (2.8EC @0.04 ml/kg of seed)
8. Untreated control

B. Packaging Material: Gunny bag-lets of 2 kg capacity

Replications: 3 **Design:** CRD

Method: One kg of freshly harvested and untreated certified seed with very high percentage of germination and low moisture content (<10%) will be taken for each treatment. Required quantity of neem formulations in case of 2.5ml formulation/kg seed may be diluted in 2.5 ml water to treat 1 kg of seed for proper coating if required. Other doses (5ml or 7.5ml/kg) should not be diluted in water. 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 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)

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 treatments.**

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

Objectives:

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

Year of start: 2019

Crop	Centre
Wheat	IISS, Mau; CSAUAT, Kanpur
Paddy	AAU, Jorhat; PJTSAU, Telangana; PAJANCOA, Karaikal
Pigeon pea	PDKV, Akola; PJTSAU,Telengana; NDUAT, Faizabad

Cowpea	UAS, Bangalore; TNAU, Coimbatore; UAS, Dharwad
Mung bean	SKNAU,Jobner; OUAT, Bhubaneswar, TNAU, Coimbatore
Chickpea	MPKV, Rahuri; JAU, Jamnagar; UAS, Dharwad
Pearl millet	JAU, Jamnagar
Sorghum	MPKV, Rahuri; PDKV, Akola
Black gram	PAJANCOA, Karaikal; UAS, Bangalore
Field pea	CSAUAT, Kanpur; NDUAT, Faizabad

Treatment:

A. Chemical

1. Spinetoram @ 1ppm (Delegate 11.7%SC @8.5mg /kg seed)
2. Spinetoram @ 2ppm (Delegate 11.7%SC@ 17mg/kg seed)
3. Spinetoram @ 3ppm (Delegate 11.7%SC @25.6mg /kg seed)
4. Flupyradifurone @2 ppm (Sivanto prime 200SL @0.01ml/kg seed)
5. Flupyradifurone @4 ppm (Sivanto prime 200SL @0.02ml/kg seed)
6. Flupyradifurone @8 ppm (Sivanto prime 200SL @0.04ml/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: Gunny bag-lets 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 treatments.

Experiment 4: Integrated approach for management of Pulse beetle (*Callosobruchus* sp.)

Objectives

1. To evaluate various combination treatments against Pulse beetle
2. Study of the storability of treated seeds.

Crop	Centre
Pigeon pea	PDKV, Akola; UAS, Bangalore; PJTSAU, Hyderabad
Green gram	OUAT, Bhubaneswar and JAU, Jamnagar
Chickpea	MPKV, Rahuri; NDUA&T, Faizabad
Black gram	TNAU, Coimbatore; PAJANCOA, Karaikal

Treatments:

T1- Pre-harvest spray of Neemazal T/S 10000ppm @6ml/L at 50% maturity and maturity and Solarization of fresh seeds in clear polythene (700 gauge) packet for 4 h for 6 days

T2- Pre-harvest spray of Neemazal T/S 10000ppm @6ml/L at 50% maturity and maturity and seed treatment with Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed)

T3- Pre-harvest spray of Neemazal T/S 10000ppm @6ml/L at 50% maturity and maturity and seed treatment with Diatomaceous earth @ 5g/ kg seed + Desiccant (MgSO4@ 5/kg seed)

T4- Pre-harvest spray of Emamectin benzoate 5SG @ 0.3g/L at 50% maturity and maturity and Solarization of fresh seeds in clear polythene (700 gauge) packet for 4 h for 6 days

T5-Pre-harvest spray of Emamectin benzoate 5SG @ 0.3g/L at 50% maturity and maturity and seed treatment with Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed)

T6- Pre-harvest spray of Emamectin benzoate 5SG @ 0.3g/L at 50% maturity and maturity, and seed treatment with Diatomaceous earth @ 5g/ kg seed + Desiccant (MgSO4@5g/kg seed)

T7- Solarization of fresh seeds in clear polythene (700 gauge) packet for 4 h for 6 days and seed treatment with Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed)

T8- Solarization of fresh seeds in clear polythene (700 gauge) packet for 4 h for 6 days and seed treatment with Diatomaceous earth @ 5g/ kg seed + Desiccant (MgSO4@5g/kg seed)

T9- Untreated control

Packaging Material: Polylined Gunny bag-lets of 2 kg capacity

Replications: 3 **Design:** CRD

Methodology: For pre-harvest spraying seed crop should be grown with standard package of practices. Plot size should be 5m x 3m or more (with 3 replication) to get required quantity seed (9 kg for treatment 1-3 and 9 Kg for treatment 4-6) for combination treatments. Harvest the crop leaving border rows. After threshing and drying, seed should be kept in cloth bag ensuring protection from cross infestation before undertaking second treatment. For combination treatments with solarization treatment (T1) three kg seed (moisture content <10%) obtained from pre-harvest spray with neemazal should be solarized following methodology described in exp-2 on solarization. During solarization, thickness of seed layer inside seed packet should be kept at 5 cm. The temperature outside/inside of packets should be recorded each day before and after the solarization. Maximum temperature inside the packet during solarization should also be recorded. After treatment, the seed should be kept under ambient conditions ensuring prevention of cross infestation. For T2, treat three kg seed (moisture content <10%) obtained from pre-harvest spray with Neemazal T/S (Azadirachtin 10,000 ppm) @75 ppm (7.5 ml formulation /kg seed) without any dilution. After drying in shade, seeds will be packed and kept in room under ambient temperature. For T3, treat three kg seed (moisture content <10%) obtained from pre-harvest spray with Diatomaceous earth @ 5g/ kg seed + Desiccant (MgSO4@5g/ kg of seed). after proper drying After drying in shade, seeds will be packed and kept in room under ambient temperature.

Follow same procedure for T4, T5 and T6 obtaining seed from pre-harvest spray with Emamectin benzoate 5SG @ 0.3g/L.

For T7 & T8 refer to already given procedure.

After completion of treatments, seeds will be packed in polyline gunny bags and kept in room under ambient temperature. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Observations

- 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. **Cost benefit ratio should also be worked out for each treatment.**

Experiment 5: Studies on the effect of Entomopathogens and inert dust on storage insect pests and seed quality during storage under ambient condition.

Specific observations: The experiment will conducted in existing format and new centres will be included in this experiment. PJTSAU, Telagana will send required formulations on payment basis.

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.

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:

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

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, Jamnagar; PDKV, Akola	*C. maculatus*
Green gram	TNAU, Coimbatore; SKNAU,Jobner; OUAT, Bhubaneswar	*C. maculatus*
Pearl millet	JAU, Jamnagar; SKNAU,Jobner	*R. dominica*
Sorghum	MPKV, Rahuri; NAU, Navsari	*R. dominica*
Pigeon pea	PDKV, Akola; UAS, Dharwad; NAU, Navsari; NDUAT, Faizabad	*C. maculatus*
Field pea	CSAUAT, Kanpur; NDUAT, Faizabad	*C. maculatus*

New experiment:

Experiment 6: Studies on efficacy of plant based neutral silica on storage insects and seed quality during storage under ambient condition

Specific observations: During 2022-23, the experiment will be conducted by the lead centres on pilot basis. Required quantity of Neutral silica will be supplied by Dr. Mohibbe Azam, Principal Scientist, IIRR, Hyderabad.

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 start: 2022

A. Treatments:

T_1 - Neutral silica @ 1000 ppm
T_2 - Neutral silica @ 1500 ppm
T_3 - Neutral silica @ 2000 ppm
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**
Pigeon pea	PJTSAU, Hyderabad
Green gram	UAS, Bangalore
Chickpea	MPKV, Rahuri
Paddy	TNAU, Coimbatore
Wheat	IISS, Mau

1) **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

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

A. For laboratory experiments

S.	**Items**	**Amount (Rs.)**

No.		
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:

5. The above information needs to be calculated for individual/every treatment
6. 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	TNAU, Coimbatore	Dr. R. Arulprakash	ASRO (Seed Ento.)	avrarulprakash@gmail.com;	95974 81060, 94427 47516
4	UAS, Bangalore	Dr. Manja Naik	ASRO (Seed Ento.)	naik_196710@yahoo.com;	7338305680
		Mrs. Jyothi B L	STO	jyothibl@yahoo.co.in;	9481245045
		Dr. T.M. Ramanappa	Special Officer (Seeds)	ramantm@gmail.com;	9448975828
		Dr. Gangaraju N.	ASPS	gangaraj005@gmail.com;	7619165182
5	JAU, Jamnagar	Prof. R. P. Juneja	I/c ASRO	rajkumarjuneja19@gmail.com;	99249 39602
6	PDKV, Akola	Dr. G. K. Lande	ASRO	gajannan1975@gmail.com;	7588962199
7	PJTSAU, Hyderabad	Dr. A. Padmasri	ASRO (Seed Ento.)	padmasri_1972@rediffmail.com;	9000791123
8	RPCAU, Pusa	G. S. Giri	Assistant Professor	gsgiri@rpcau.ac.in;	9568228227
9	UAS, Dharwad	Dr. J.H. Hilli	Special Officer (Seeds)	Soseed@uasd.in;	9448497353
		Dr. Vijayakumar. A. G	SPO	vijayakumarag@uasd.in;	9482182111

		Dr. Malik Rehan	Technical Officer: STR	malikuasdwd@gmail.com;	9663356479
		Dr. Tippanavar	Professor	tippannavarcm@uasd.in;	
10	MPKV, Rahuri	Prof. R. S. Bhoge	ASRO (Seed Ento.)	bhogerashmi@gmail.com;	9921373793
11	ICAR-IISS, Mau	Dr. Arvind Nath Singh	Pr. Scientist	arvindnathsingh@gmail.com	9450725652
12	PAJANCOA&RI, Karaikal	Dr. T. Ramanadane	Professor	raman_nadane@yahoo.com	9443875443
13	CSAUAT, Kanpur	Dr. C.B. Singh Gangwar	SRO	cbgangwar7@gmail.com	9450935223

E. Seed Processing

Date : 26.04.2022 & 12.05.2022

Chairman : **Dr. R.T. Kaushal**
Ex-PI (Seed Processing)
PDKV, Akola

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

General Observations

- It was suggested that those centers which are not conducting the experiment and/ or not reporting the data should be viewed seriously. Similarly, action may be initiated against the centres for delay/ lapses in data reporting.
- **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.**

Important points for the submission of results:

- The centers should follow the technical programme strictly, without any deviation/s and conduct the experiment accordingly.
- 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 to analyze the precision of the experiment.

Contacts of PI and Co-PI

Theme	PI/ Co-PI	Email ID	Mob. No.
Seed Processing			
PI	**Dr. Ashwani Kumar** Principal Scientist ICAR-IARI, RS, Karnal	ashakmash@gmail.com	9416251530
Co-PI	**Dr. Dhanya V.G.** Scientist ICAR-IISS, Mau	dhanya.vg@icar.gov.in; vg.dhanya9@gmail.com	8810699850

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.

Crop/ Centre	Seed Size (categories)	Variety	Sieves used (mm)	IMSCS Recommended Sieve Size (mm)	Standardized Sieve Size (mm)	Seed Recovery (%)
Paddy						
ICAR-IARI, RS, Karnal	Medium slender	PB 1718	2.2, 2.1, 1.9, 1.8, 1.6 s	1.80 s	1.90 s	90.9
	Medium slender	PB 1692		1.80 s	1.90 s	92.5
	Medium slender	PB 1609		1.80 s	1.90 s	93.6
TNAU, Coimbatore	Coarse/ Bold	CR 1009 Sub 1	2.2, 2.0, 1.85 1.8, 1.7s	1.85 s	2.00 s	90.0
	Medium slender	ADT 45	2.0, 1.85, 1.8, 1.7, 1.65 s	1.80 s	1.85 s	86.1
PAJANCOA &RI, Karaikal	Small seeded	BPT 5204	1.85, 1.8, 1.7, 1.6, 1.55s	1.70 s	1.55 s	97.9
	Bold	CR 1009 Sub 1	2.2, 2.0, 1.85 1.8, 1.7 s	1.85 s	2.00 s	98.7
PDKV, Akola	Small seeded	PKV Tilak	2.0, 1.8, 1.6, 1.4, 1.2 s	1.70 s	1.60 s	84.2
	Small seeded	PKV HMT		1.70 s	1.60 s	86.2
	Small seeded	RTN 5		1.70 s	1.60 s	83.8
	Medium seeded	PDKV Kisan	2.20, 2.0, 1.8, 1.6, 1.4 s	1.80 s	1.80 s	92.3
	Medium seeded	Sakoli– 6		1.80 s	1.80 s	87.9
	Medium seeded	MTU 1001		1.80 s	1.80 s	88.6
	Medium seeded	CO 51		1.80 s	1.80 s	84.6
	Medium seeded	Suwarna		1.80 s	1.80 s	86.7
	Medium seeded	Sakoli– 9		1.80 s	1.80 s	90.3
	Medium seeded	MTU 1010		1.80 s	2.00 s	85.2
UAS, Raichur	Small Seeded	GGV-05-01	2.2, 2.0, 0 1.8, 1.6, 1.40 s	1.70 s	1.40 s	99.3
	Small Seeded	RR 15048		1.70 s	1.60 s	96.0
	Medium seeded	MTU 1010		1.80 s	1.80 s	96.0
Wheat (*T. aestivum*)						
ICAR-IARI RS, Karnal	Bold seeded	HD 3226	3.2, 2.8, 2.4, 2.2, 2.1s	2.30 s	2.40 s	88.8
	Bold seeded	HI 1620		2.30 s	2.40 s	89.6
	Bold seeded	HI 1628		2.30 s	2.40 s	88.7
PAU	Bold seeded	Unnat PBW	2.5, 2.4, 2.3,	2.30 s	2.30 s	85.7

Ludhiana		550	2.1, 1.9s			
	Bold seeded	Unnat PBW 343		2.30 s	2.30 s	90.9
	Medium seeded	PBW 1 Zn		2.10 s	2.30 s	91.3
Wheat (T. durum)						
ICAR-IARI RS, Karnal	Bold seeded	WHD 896	3.2, 2.8, 2.4, 2.2, 2.1s	2.30 s	2.40 s	95.3
	Bold seeded	WHD 943		2.30 s	2.40 s	94.7
Chickpea						
UAS, Raichur	Small Seeded	Supper Annigeri	4.75, 5.00, 5.50, 6.00 r	5.00 r	4.75 r	93.50
	Medium seeded	NBeG 49	5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00 r	5.50 r	6.00 r	92.81
	Medium seeded	NBeG 47		5.50 r	5.50 r	98.49
UAS, Dharwad	Medium seeded	BGD 111-1	5.00, 5.50, 6.00, 6.75, 7.25r	5.50 r	6.00 r	90.88
PDKV, Akola	Medium seeded	PDKV Kanak	4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0r	5.50 r	6.50 r	84.6
	Medium seeded	PDKV Kanchan		5.50 r	6.00 r	90.7
	Medium seeded	Jaki 9218		5.50 r	6.50 r	87.1
	Bold seeded	PDKV Kabuli-2	7.50, 8.0, 8.5, 9.0, 9.5, 10.0 r	6.00 r	8.50 r	96.2
	Bold seeded	PDKV Kabuli-4		6.00 r	9.00 r	79.7
MPKV, Rahuri	Bold seeded	Vishal	5.0, 5.5, 6.0, 6.5, 7.0 r	6.00 r	6.50 r	88.51
	Bold seeded	Digvijay		6.00 r	6.50 r	88.35
	Bold seeded	Phule Vishwaraj		6.00 r	6.50 r	88.40
Soybean						
UAS Raichur	Medium seeded	JS 335	4.75, 4.50, 4.30, 4.00, 3.75s	4.00 s	3.75 s	83.90
UAS, Dharwad	Medium seeded	DSb 24	4.40, 4.30, 4.00, 3.75, 3.50s	4.00 s	3.75 s	95.69
MPKV, Rahuri	Medium seeded	Phule Sangam (KDS 726)	4.75, 4.50, 4.0, 3.75, 3.50s	4.00 s	4.75 s	71.00
	Medium seeded	Phule Kimaya (KDS 753)		4.00 s	4.75 s	73.33

Maize						
UAS, Bengaluru		MAH 14-138	6.00, 6.25, 6.50, 6.75, 7.0r	6.40/ 7.00 r	6.50 r	94.05
UAS, Raichur	Medium seeded	RCRMH-3	6.50, 7.00, 7.50, 8.00r	6.40/ 7.00 r	7.00 r	94.25
Pigeon pea						
UAS, Bengaluru	Bold seeded	BRG 5	4.5, 4.75, 5.0 5.5, 6.00r	4.75 r	5.00 r	91.79
PDKV, Akola	Medium seeded	BSMR 736	6.0, 5.50 5.0, 4.75 4.50, 4.00 r	4.00 r	5.00 r	89.10
	Medium seeded	BSMR 853		4.00 r	4.50 r	91.91
	Bold seeded	PKV Tara		4.75 r	5.00 r	86.0
	Medium seeded	AKT 8811		4.00 r	4.75 r	86.00
	Bold seeded	Maruthi		4.75 r	5.00 r	80.32
UAS Raichur	Small seeded	GRG 152	3.50, 3.75, 4.00, 430, 4.50 r	4.00 r	3.75 r	89.31
Black gram						
TNAU, Coimbatore	Bold seeded	VBN 9	3.4 .3.2, 3.0, 2.8, 2.7s	2.70 s	3.20 s	87.3
	Bold seeded	VBN 10		2.70 s	3.20 s	91.7
PAJANCOA & RI, Karaikal	Medium seeded	ADT 6	3.4 .3.2, 3.0, 2.8, 2.7, 2.5s	2.70 s	2.70 s	87.0
	Bold seeded	VBN 8		2.70 s	3.0 s	91.2
Dhaincha						
ICAR-IARI RS, Karnal	Bold seeded	CSD 37	2.2, 2.1, 2.0, 1.9, 1.8 s	---	2.00 s	90.4
PAJANCOA & RI Karaikal	Medium seeded	Local	2.2, 2.0, 1.85, 1.7, 1.6, 1.5 s	---	1.60 s	80.6
UAS, Raichur	Bold seeded	Local	1.4, 1.6, 1.8, 2.0, 2.2 s	---	2.00 s	91.4
Field bean						
UAS, Bengaluru	Medium seeded	HA 5	5.0, 5.5, 6.0, 6.5, 7.0 r	6.50 r	6.00 r	92.93
Finger millet						
UAS, Bengaluru	Medium seeded	KMR 340	1.4, 1.3, 1.2, 1.1, 1.0r	1.40 s	1.20 r	91.21
Sunflower						
UAS, Bengaluru	Medium seeded	RHA 92	3.25, 3.0, 2.8, 2.4, 1.85 s	2.40 s	2.80 s	90.96
		CMS 1103 A		2.40 s	2.40 s	92.39
Sunhemp						
UAS, Raichur	Medium Bold seeded	JRJ-610	1.6, 1.8, 2.0, 2.2, 2.4	---	2.00 s	88.7

2. Management of Karnal bunt in wheat seed through mechanical processing

2°slope of deck of the gravity separator and 15kg per minute rate of feed, for one tonne per hour capacity (1 TPH) processing unit, is recommended for processing of wheat seed for efficient removal of *Karnal* bunted seed.

Technical programme 2022-23

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

Specific observations: 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.

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 and PAJANCOA&RI, Karaikal
Wheat	:	ICAR-IARI, RS, Karnal and PAU Ludhiana
Chickpea	:	MPKV, Rahuri; UAS Dharwad; UAS, Raichur; PDKV, Akola
Black gram	:	TNAU, Coimbatore and PAJANCOA&RI, Karaikal
Pigeon pea	:	UAS, Bengaluru; UAS, Raichur and PDKV, Akola
Soybean	:	UAS, Dharwad; UAS, Raichur and MPKV, Rahuri
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

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 the 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

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.

List of Co-operating Scientists

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Session IV

Plenary Session

Date : 13.05.2022 **Time : 12.15 – 2.00**

Chairman	:	**Dr. S.A. Patil** Former Chairman, Farmers Commission of Karnataka & Former Director, ICAR-IARI, New Delhi
Co-Chairman	:	**Dr. T.R. Sharma** DDG (CS), ICAR, New Delhi
Convenors	:	**Dr. D.K. Yadava** ADG (Seed), ICAR, New Delhi **Dr. Sanjay Kumar** Director, ICAR-IISS, Mau
Rapporteurs	:	Dr. Bhojaraja Naik K., Scientist, ICAR-IISS, RS, Bengaluru Dr. Shantharaja C.S., Scientist, ICAR-IISS, RS, Bengaluru

The session was Chaired by Dr. S.A. Patil, Former Chairman, Farmers Commission of Karnataka & Former Director, ICAR-IARI, New Delhi and Co-Chaired by Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi. 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 and delegates present during the plenary session of AGM of AICRP on Seed (Crops).

Principal Investigators of five STR disciplines presented the finalized recommendations of 2021-22 and technical programme for 2022-23. Dr. Sandeep K. Lal, PI (Seed Production & Certification) summarized technical programme of each experiment and suggested few theme areas for new experiments such as., revisiting of field and seed standards in field crops, controlled & target specific release coating technologies in seed production to mitigate biotic and abiotic stresses, Optimization of seed rate and planting geometry for enhancing seed yield and hybrid seed production technology in crops like pigeon pea. It was decided to continue the experiment on standardization of isolation distance in mustard hybrid with pure seeds. The quality of breeder seed should be monitored for the varieties of SAUs and ICAR institutes specifically for ODV's. Atlas of quality seed production should be prepared only in paddy. Dr. Lal also proposed 3 new experiments on optimization of seed rate and planting geometry in wheat and chickpea under normal sown condition, development of controlled & target specific release coating technologies for management of biotic and abiotic stresses in quality seed production,

and identification of pest and disease-free zones for quality seed production of soybean and green gram.

Dr. Shiv K. Yadav, PI (Seed Physiology, Storage and Testing) informed that the experiment 7 will be discontinued. Cost: benefit ratio for hybrid purity testing by molecular markers should be calculated. Heat and moisture stress conditions should be standardized and all centers should follow uniform standards in conducting experiments on alleviation of heat/moisture stress through priming technologies.

Dr. Atul Kumar, PI (Seed Pathology) informed that all the seven experiment under the theme will continue. The experiment 5a on impact of different storage conditions on longevity of *Macrophomina phaseolina/ Colletotrichum dematium* and 5b on management of purple blotch and Stemphylium blight of onion will be concluded and replaced with new objectives.

Dr. Amit Bera, PI (Seed Entomology) informed that two experiments on effect of solarization on bruchids (Expt. 2) and evaluation of pre-harvest spraying of insecticides and botanicals (Expt. 4) will be concluded and recommendations were finalized. One new experiment 'Studies on efficacies of plant based neutral silica on storage insects and seed quality' have been proposed.

Dr. Ashwani Kumar, PI (Seed Processing) informed that all the three experiments under the group will continue. Recommendations were communicated to DAC&FW regarding variety-wise sieve size for processing of new crop varieties.

Dr. D.K. Yadava, ADG (Seed), ICAR, New Delhi suggested that seed health is an important aspect of New Seed Bill, hence seed pathology experiments should be encouraged to include as many crops as possible. Focus should be given for development of handy tools to diagnose seed-borne diseases in the field itself; revision of the IMSCS for seed health standards to harmonize with the standards of OECD. He insisted on supporting state agriculture universities to strengthen their infrastructure facility required for production of breeder and quality seeds under RKVY project. Thanked all the dignitaries for participation and successful conduct of the meeting.

Dr. T. R. Sharma, DDG (Crop Science), ICAR, New Delhi showed his concern for lack of research on basic science in the group. Through capacity building programme of AICRP on Seed many trainings were conducted, hence information should be collected on individuals continue to work in different sectors of seed production and supply. Dr. Sharma also stressed upon deliberation with seed industry and stake holders, and outcomes of the meeting and their implementation on priority. He also expressed his concern for not accomplishing the targets in seed production by many centers and emphasized for strict action against the defaulters.

In recognition of outstanding contribution made five scientific staff of AICRP on Seed viz., Dr. Muthusamy Bhaskaran, Dr. Simanchal Sahu, Dr. Chandrashekar Baburao Salunkhe, Dr. C. P. Sachan and Dr. Umesh Kumar Singh were felicitated on the account of superannuation from government service during the year 2022.

Dr. S. A. Patil, Former Chairman, Farmers Commission of Karnataka & Former Director, ICAR-IARI, New Delhi, Chairman of plenary session emphasized the need to formulate the seed technological research programme by taking into consideration the real problems of farmers. The science part of seed technology should be emphasized and it should be integrated with plant breeding and biotechnology. Depending on the volume of seed handled by each centres, create storage structures which should match to the international standards. Efforts should be made to popularize the Indian varieties globally and export-oriented seed production activities given importance. He emphasized the need to strengthen the seed production and supply system in horticultural crops and exploit the potentiality of horticulture seed sector. He opined that a special programme for oil seed crops should be initiated to boost the seed production of oil crops by taking nutrition into consideration by encouraging the crops like safflower, olive and mustard; Budgetary provision for seed realm should be increased.

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

During the detailed deliberations, following action points were emerged from the discussions:

1. For the experiment on 'Hybrid purity testing using molecular markers in public sector hybrids of field crops' cost: benefit ratio should be calculated by taking all the components of cost into account **[Action: Concerned STR centres & PI (Seed Physiology, Storage and Testing)]**
2. In a light of implementation of 'New Seed Bill', more focus should be given to develop seed health standards for important seed borne diseases of all the field crops. **[Action: PI (Seed Pathology)]**

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STR – AICRP on Seed (Crops)

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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) Monitoring Team for 2022-23

Kharif season: Sept. / Oct. 2022; *Rabi* season: Feb. / Mar. 2023

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Calendar of Events for QSP & STR

S. No.	Event	Last date for completion of task	
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)	2nd or 3rd week of April	

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