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Seed Tech News

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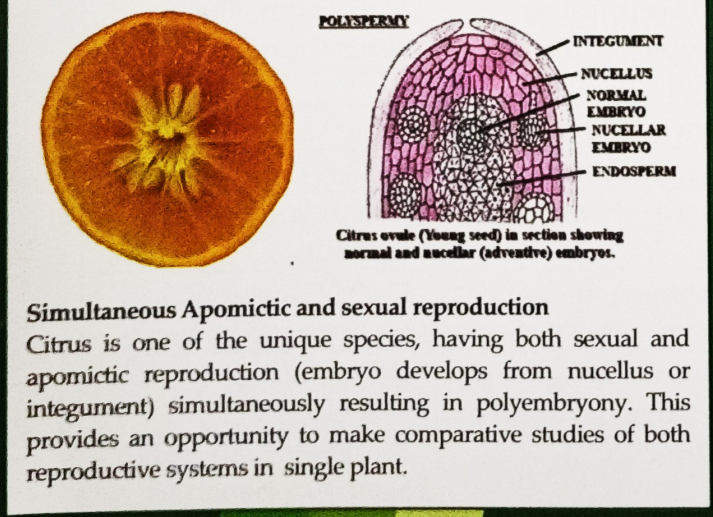


Citrus ovule (Young seed) in section showing normal and nucellar (adventive) embryos.

Simultaneous Apomictic and sexual reproduction

Citrus is one of the unique species, having both sexual and apomictic reproduction (embryo develops from nucellus or integument) simultaneously resulting in polyembryony. This provides an opportunity to make comparative studies of both reproductive systems in single plant.

From President's Desk...

Dear Members,

Greetings from the Secretariat!

The year 2020 has come to an end teaching us many new life lessons and changing our lifestyles forever. In what has come to be known as a 'new normal' the world is finding alternative ways and means to function meaningfully with least human to human contacts. Once again, the importance of the Science, Technology, Innovation (STI) continuum has come to the fore in managing this unprecedented global crisis.

While the pandemic has upset every aspect of human existence, the resilience of the agriculture sector in India has been impressive. As per the first estimates the Nominal GDP in the year 2020-21 is estimated to attain a level of Rs 195.86 trillion, as against Rs 203.51 trillion in 2019-20, showing a growth rate of -3.8 percent, whereas the agriculture sector is estimated to see a growth of 3 percent in 2020-21, as against 4.3 per cent in 2019-20. The pandemic helped catalyze a shift across the agricultural sector with the help of innovative, formal, and digital technologies.

The COVID-19 outbreak and the consequent migration of farm labour expedited farmers' adoption of agri-technology, farm mechanization and app-based crop advisory services, in particular. The public institutions as well as the seed industry rose to the occasion providing on-line and on-farm support in reaching the inputs and marketing through e-mandis.

It is well recognized that the seed security is essential for achieving food security. It is also acknowledged that nutrition security, and not just food security, is crucial for the human wellbeing. Keeping this in view and commemorating the 75th anniversary of the Food and Agriculture Organization (FAO) of the UN, Hon'ble Prime Minister of India released 17 biofortified crop varieties on 16 October, 2020. The National Seed Project of the ICAR is doing a commendable job in popularizing the new improved crop varieties, which are not only high yielding under optimum growing conditions, but also more tolerant to major biotic and abiotic stresses and nutritionally enriched. As a result of these efforts there is an increasing trend in the VRR and SRR of all major field crops and vegetables. The seed professionals, both in the public and private sector will not only have to spread awareness about the benefits of such improved varieties, but also contribute in ensuring timely availability of good quality seeds of such varieties. We believe that "Good seed in good soil yields abundant"!

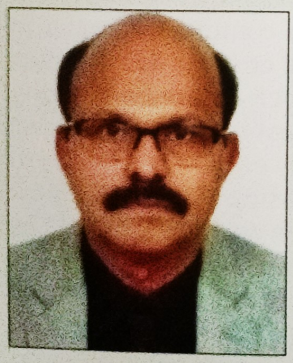
Malavika Dadlani

Seed Tech News

AWARDS AND HONOURS

Dr. Umarani Ranganathan, Professor (Seed Science and Technology), TNAU, Coimbatore received the 'Research, Innovation and Technology Development Award' (Public Sector) during 'India Seeds Awards 2020' by the 'Agriculture Today' Group on 5th December, 2020 for her novel technologies in seed quality enhancement through priming, pelleting, coating and other similar interventions.

Dr Keshavulu Kunusoth, Director, Telangana State Seed & Organic Certification Agency and Vice-President, ISTA, Switzerland, has received 'Policy Leadership Award for The Seeds Sector-2020' during 'India Seeds Awards 2020' by the ' Agriculture Today' Group on 5th December, 2020 for his contribution in several policy reforms in the seed sector at the state and national level. This has resulted in exemplary growth in the areas of seed production, quality control, marketing and cooperation with international organizations.



Dr. Basave Gowda, Special Officer (Seeds), UAS, Raichur received 'Life Time Achievement Award' in the International Web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2020) which was organized by Astha Foundation during 28-30 December, 2020.

Other awardees who received awards during 'India Seeds Awards 2020' by the 'Agriculture Today' Group on 5th December, 2020

Award	Organization/Person
Best CSR Initiative	Kaveri Seeds Company Limited
Best Seed Certification Agency	Telangana State Seed & Organic Certification Agency
Best State in Seed Supply Planning	Uttar Pradesh
Excellence in Seed Infrastructure – Processing	Kaveri Seeds Company
Best Seed Infrastructure – Storage	Gubba Cold Storage
Research, Innovation & Tech Development	Incotec India
Best Seed Testing Laboratory – Private Sector (Vegetables)	Acsen HyVeg
Best Seed Testing Lab – Private (Field Crops)	Nuziveeedu Seeds
Best Seed Testing Laboratory in Public Sector	Maharashtra State Seeds Corporation Ltd.
Farmers Choice Award	Bayer Crop Science
Lifetime Achievement Award – Public Sector	Dr. S.K Rao, Vice-Chancellor, RVSKVV, Gwalior
Lifetime Achievement Award – Private Sector	Dr. M Ramasami, Chairman, Rasi Seeds
Industry Leadership Award for The Seeds Sector-2020	Dr. Mandava Prabhakar Rao, President, National Seed Association of India, and Chairman & Managing Director, Nuziveedu Seeds Limited.

SCIENTIFIC BREAKTHROUGHS (Collated from various sources)

Seed - specific down - regulation of Arabidopsis *CELLULOSE SYNTHASE* 1 or 9 reduces seed cellulose content and differentially affects carbon partitioning

High amounts of cellulose can negatively affect crop seed quality and therefore, diverting carbon partitioning from cellulose to oil, protein and/or starch via molecular breeding may improve seed quality. To determine the effect of seed cellulose content reduction on levels of storage compounds, *Arabidopsis thaliana CELLULOSE SYNTHASE1 (AtCESA1)* and *AtCESA9* genes, which both encode cellulose synthase subunits, were individually down-regulated using seed-specific intron-spliced hairpin RNA (hpRNAi) constructs. The selected seed-specific *AtCESA1* and *AtCESA9* Arabidopsis RNAi lines displayed reduced cellulose contents in seeds, and exhibited no obvious visual phenotypic growth defects with the exception of a minor effect on early root development in *AtCESA1* RNAi seedlings and early hypocotyl elongation in the dark in both types of RNAi line. The seed-specific down-regulation of *AtCESA9* resulted in a reduction in seed weight compared to empty vector controls, which was not observed in *AtCESA1* RNAi lines. In terms of effects on carbon partitioning, *AtCESA1* and *AtCESA9* RNAi lines exhibited distinct effects. The down-regulation of *AtCESA1* led to a ~3% relative increase in seed protein content ($P = 0.04$) and a ~3% relative decrease in oil content ($P = 0.02$), but caused no alteration in soluble glucose levels. On the contrary, *AtCESA9* RNAi lines did not display a significant reduction in seed oil, protein or soluble glucose content. Taken together, our results indicate that the seed-specific down-regulation of *AtCESA1* causes alterations in seed storage compound accumulation, while the effect of *AtCESA9* on carbon partitioning is absent or minor in Arabidopsis. For more details of the research, refer to the published paper in the July 2020 issue of Plant Cell Reports at https://doi.org/10.1007/s00299-020-02541-z

The ROS-associated programmed cell death causes the decline of pollen viability recovered from cryopreservation in Paeonia *lactiflora*

Cryopreservation, as a biotechnological means for long-term preservation of pollen, has been applied to many species. However, after cryopreservation, the viability of pollen significantly decreases via a mechanism that is not completely clear. In this study, the pollen of *Paeonia lactiflora,* which exhibits significantly reduced viability after liquid nitrogen (LN2) storage, was used to study the relationship among pollen viability, programmed cell death (PCD) and reactive oxygen species (ROS). The apoptosis rate was increased significantly in pollen with decreased viability after cryopreservation, and the changes in ROS generation and hydrogen peroxide (H_2O_2) were consistent with the apoptosis rate. Correlation analysis results showed that the apoptosis rate is positively correlated with ROS generation and H_2O_2 content. In addition, ascorbic acid (AsA), glutathione (GSH) and ascorbic acid reductase (APX) levels were significantly correlated with ROS and H_2O_2. After LN_2 preservation for 8 months, the exogenous antioxidants AsA and GSH at appropriate concentrations significantly decreased H_2O_2 content, inhibited PCD indicator levels, and increased cryopreserved pollen viability. These observations suggest that PCD occurred in pollen during LN_2 preservation for 1–8 months and was induced by the accumulation of ROS in pollen after cryopreservation, thus explaining the main reasons for the reduction in pollen viability after cryopreservation in LN_2. For more details of the research, refer to the published paper in the July 2020 issue of Plant cell reports and can be obtained at https://doi.org/10.1007/s00299-020-02540-0

An LRR-only protein regulates abscisic acid-mediated abiotic stress responses during *Arabidopsis* seed germination

The large family of leucine-rich repeat (LRR) proteins plays a role in plant immune responses. Most LRR proteins have multiple functional domains, but a subfamily is known to possess only the LRR domain. The roles of these LRR-only proteins in *Arabidopsis* remain largely uncharacterized. Now, researchers have identified 44 LRR-only proteins in *Arabidopsis* and phylogenetically classified them into nine sub-groups. They characterized the function of *LRRop-1*, belonging to sub-group V. *LRRop-1* encodes a predominantly ER-localized LRR domain-containing protein that is highly expressed in seeds and rosette leaves. Promoter motif analysis revealed an enrichment in binding sites for several GA-responsive and stress-responsive transcription factors. The *lrrop-1* mutant seeds showed enhanced seed germination on medium containing abscisic acid (ABA), paclobutrazol and NaCl compared to the wild type (WT), demonstrating higher abiotic stress tolerance. Also, the *lrrop-1* mutant seeds have lower levels of endogenous ABA, but higher levels of gibberellic acid (GA) and jasmonic acid-Ile (JA-Ile) compared to the WT. Furthermore, lrrop-1 mutant seeds imbibed with ABA exhibited reduced expression of ABA-responsive genes compared to similarly treated WT seeds, suggesting suppressed ABA signaling events in the mutant. Furthermore, chromatin immunoprecipitation (ChIP) data showed that DNA BINDING1 ZINC FINGER6 (DOF6), a negative regulator of seed germination, could directly bind to the *LRRop-1* promoter and up-regulate its expression. These results show that *LRRop-1* regulates ABA-mediated abiotic stress responses during *Arabidopsis* seed germination. For more details of the research, refer to the published paper in the July 2020 issue of Plant Cell Reports at https://doi.org/10.1007/s00299-020-02538-8

The seed-specific heat shock factor A9 regulates the depth of dormancy in *Medicago truncatula* seeds via ABA signalling

During the later stages of seed maturation, two key adaptive traits are acquired that contribute to seed lifespan and dispersal, longevity and dormancy. The seed-specific heat shock transcription factor A9 is an important hub gene in the transcriptional network of late seed maturation. Here, researchers demonstrate that HSFA9 plays a role in thermotolerance rather than in ex situ seed conservation. Storage of *hsfa9* seeds of Medicago truncatula and Arabidopsis had comparable lifespan at moderate storage relative humidity (RH), whereas at high RH, *hsfa9* seeds lost their viability much faster than wild type seeds. Furthermore, researchers show that in *M. truncatula*, M*thsfa9* seeds acquired more dormancy during late maturation than wild type. Transient expression of M*tHSFA9* in hairy roots and transcriptome analysis of M*thsfa9* Tnt1 insertion mutants identified a deregulation of genes involved in ABA biosynthesis, catabolism and signalling. Consistent with these results, M*thsfa9* seeds exhibited increased ABA levels and higher sensitivity to ABA. These data suggest that in legumes, *HSFA9* acts as a negative regulator of the depth of seed dormancy during seed development via the modulation of hormonal balance. For more details of research, refer to the published paper in the October 2020 issue of Plant cell and Environment at https://doi.org/10.1111/pce.13853

Close arrangement of *CARK3* and *PMEIL* affects ABA-mediated pollen sterility in *Arabidopsis thaliana*

Abscisic acid (ABA) signaling is a vital plant signaling pathway for plant responses to stress conditions. ABA treatment can alter global gene expression patterns and cause significant phenotypic changes. Researchers investigated the responses to ABA treatment during flowering in *Arabidopsis thaliana*. Dipping the flowers of *CARK3* T-DNA mutants in ABA solution, led to less reduction of pollen fertility than in the wild type plants (Col-0). Researchers demonstrated that *PMEIL*, a gene located downstream of *CARK3*, directly affects pollen fertility. Due to the close arrangement of *CARK3* and *PMEIL*, *CARK3* expression represses transcription of *PMEIL* in an ABA-dependent manner through transcriptional interference. This study uncovers a molecular mechanism underlying ABA-mediated pollen sterility and provides an

example of how transcriptional interference caused by close arrangement of genes may mediate stress responses during plant reproduction. For more details of the research, refer to the published paper in November 2020 issue of Plant Cell and Environment at https://doi.org/10.1111/pce.13871

INNOVATIVE SEED DISTRIBUTION SYSTEM

Technological Interventions for Efficient Seed Distribution During Covid-19

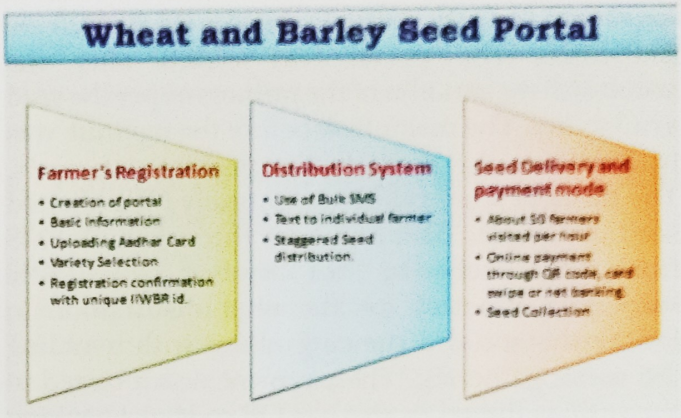
GP Singh, CN Mishra, Umesh Kamble, Poonam Jasrotia and Amit Sharma

ICAR-Indian Institute of Wheat and Barley Research, Karnal-132001 (Haryana) (www.iiwbr.org)

ICAR-Indian Institute of Wheat and Barley Research, Karnal has enhanced its presence in the farmers' field with the development and deployment of wheat varieties like DBW187 (Karan Vandana) and DBW222 (Karan Narendra). These varieties have been handpicked by the wheat farmers' of different states. The institute used to sell its seed to the farmers by organizing Kisan Melas in the previous years. However, this year was different with the government restriction on peoples gathering due to Covid19.

In order to supply the quality seed of recent wheat and barley varieties viz., DBW187, DBW222, DDW47 and DWRB137, the institute created the wheat and barley seed portal for the farmers. The seed portal was designed and made available during the September month and the interested farmer has to fill his name, village, district and state. He has to upload his aadhar card and select the variety and quantity of seed to be purchased. After that he will receive an OTP to his mobile and a message that his order has been registered with the IIWBR. The guidelines for registration were circulated by the Director himself through various digital platforms (https://www.facebook.com/1143475089/videos/10223580557039030/).

About 5000 farmers from different states like Haryana, Punjab, U.P., Bihar and Rajasthan



5,000 farmers pick new wheat varieties

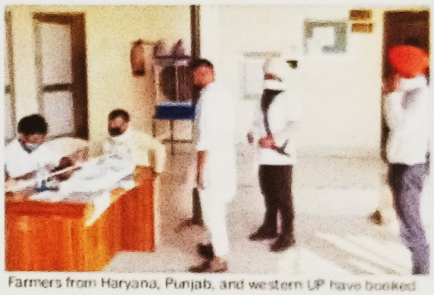
Karan Vandana, Karan Narendra promise high yield

PARVEEN ARORA

KARNAL, OCTOBER 20

High-yielding varieties Karan Vandana, known as DBW-187, and Karan Narendra, known as DBW-222, are the prime choice of farmers for the upcoming wheat season.

Around 5,000 farmers from Haryana, Punjab, and western UP have booked these varieties on the online seed portal started by the Indian Institute of Wheat and Barley Research (IIWBR) here a few days ago to avoid mass gathering of farmers in the wake



Farmers from Haryana, Punjab, and western UP have booked these varieties on an online seed portal. SAVED #SEED

'BETTER CHAPATI QUALITY'

registered on the portal during 15.09.2020 to 23.09.2020. The portal was closed after the successful registration of the farmers as per the seed availability. The major task before the institute was to distribute the seeds to the registered farmers. The farmers were called on to receive the allotted seed on specific date and time through bulk SMS from 17th October to 23rd October 2020. There were five counters for the seed distribution to follow the social distancing along with avoiding the social gathering. The payment was received in the various digital modes like QR code, net banking or card swipe. More than 6000 kg seeds were provided to the farmers through this system. The farmers were really happy and satisfied to receive the seed of recent varieties conveniently in the time of Covid19. The story has also been published by the Indian Council of Agricultural Research on its website (https://icar.org.in/content/technological-interventions-efficient-seeds-distribution-during-covid-19-pandemic) 8

WISDOM SHARING

Seed Technology –Some Researchable Issues, Areas, Gaps and Concerns

Dr. V. Sankaran, Former GM [QC, P, and M]-NSC and Ex-Director, PE&QM, Krishidhan Seeds; email: sankaran510@gmail.com

1. Standardization of Seed Vigor Tests for Uniform Adoption by STLs in India:

Seed / Seedling Vigor is an important parameter of seed quality. But, in view of its complex nature, even ISTA has been finding it difficult to prescribe precise standardized testing procedures for seed vigour for many crops. As of now, only eight crops are covered in the ISTA Rules 2020 under five vigour test methods as follows:

[a] Conductivity Test [CT] for *Glycine max*- Soybean, *Pisum sativum* -Garden Peas only [excluding *Petit-pot* vars], *Cicer arietinum* - Gram , *Phaseolus vulgaris*-French beans, *Raphanus sativus*-Radish; [b] Accelerated Ageing Test[AAT] for Soybean; [c] Radicle Emergence Test for *Zea mays* -Maize, Radish, *Brassica napus* [Oilseed]-Argentine canola;*Triticum aestivum* L. subsp. *aestivum* (excluding dormant seed lots); [d] TZ test for Soybean and [e] Controlled Detioration Test for *Brassica* spp.

The Hand Book of Seed Testing [1993] lists the following as the possible vigour tests –but, not specifying the crops: [a] Growth Tests; [b]Electrical Conductivity; [c] Accelerated Ageing Test; [d]Brick Gravel Test; [e] Paper Piercing Test; and [e]Cold Test- for maize- the last four being in the nature of Stress Tests.

However, several tests for seed vigor estimation are reported in the literature; and when required the Labs follow one or the other method, as per their own facilities, judgment, confidence, experience, convenience, etc.

Therefore, in the Indian context, there is an urgent need to standardize a set of Seed Vigour Tests for the important crops in Indian seed program which may be published with full information by the ICAR/ DAC, GoI for uniform adoption by the Laboratories in the country.

It is proposed to create a 'Special Core Team' by the ICAR-DAC /GoI, specifically for the purpose, with a clear time frame for completing the task.

2. Developing / Standardizing Seed Testing Procedures –especially for Germination:

For a number of commercially important crops, such as Tinda [Indian squash], Ajwain, Tamarind and Drumstick [*Moringa oleifera*] and medicinal plants viz., Ashwagandha *[Withania somnifera]*, Giloy [*Tinospora cordifolia]*, Kalmegh *[Andrographis paniculata*], Muskdhana *[Abelmoschus moschatus*], Neem, Sarpagandha *[Rawolfia serpentina]*, Sattavari [*Asparagus racemosus*] and Tulsi [*Ocimum* spp] Seed Certification Standards are prescribed in the Indian MSCS [2013], but seed testing protocols are neither provided in the ISTA Rules [2020] nor in the Hand Book of Seed Testing [1993]. This needs special attention at least for Germination test prescriptions. Hence, research programmes be designed for the purpose.

3. **Verification and Confirmation of Germination Test Specifications & Recommendation to ISTA:**

For the following crops, the Hand Book of Seed Testing [1993] has the Specifications for Germination Test. But they are not covered even in the ISTA Rules [2020]. Therefore, it would be better to review/verify and confirm those specifications and recommend them to ISTA for inclusion in the ISTA Rules: Barnyard Millet, Little Millet, Moth Bean, Niger, Dharaf grass, Dinanath grass, Marvel grass, Rice bean, Setaria grass, Teosinte, Dhaincha, Mungra [Rat tail radish], Snake gourd and Amaranthus. For these crops, Seed Certification Standards have already been prescribed in the Indian MSCS [2013]. India can take the lead and contribute to ISTA for including them in the ISTA Rules.

4. **Hybrid seed production on GMS fertile female parent plants by emasculation & pollination:**

In the F1 hybrid seed production involving GMS female parent, the 'Fertiles' in the female parent, usually about 45-50% of the female population, are uprooted/removed. In this type of F1 seed production, instead of uprooting the 'Fertiles', why not produce F1 seed by emasculating and pollinating the Fertiles in the GMS female parent population using the Male parent pollen. This will be in addition to the standard practice of pollinating the remaining 50% Steriles in the female parent. Emasculating and pollinating the 'Fertiles' in the GMS female parent would double the F1 seed yield from the same unit area, thereby not only increasing the seed producer's income but also helping in reducing the area under the concerned GMS based hybrid seed production. To decide on this issue, the hybrid seed produced on the GMS Fertiles has to be critically compared with that produced on the GMS Sterile female parent plants for perfect similarity for 'hybridity', phenotypic expression, productivity, and agronomic features.

5. **Enhancing the Ovule to Seed - conversion ratio:**

In the valuable and expensive varieties / hybrid parents, identify the crop specific methods to enhance the production of healthy ovules and their conversion to good seed leading to higher seed yield which will further lead to increased seed availability at reduced seed prices. This has more relevance in the potentially low seed yielding genotypes.

6. **Formulae for Seed Replacement Rates [SRR] and Variety Replacement Rates [VRR]:**

SRR and VRR are the two important concepts in planning and implementing the Seed Programs. Taking the various relevant factors into account, one may prescribe a certain SRR or VRR for the farmer to follow, in terms of the number of years for renewing the seed instead of using 'farm-saved seed' and or replacing the variety with newer ones. However, in the ground level, assessment of the actual happening / achievement is quite a complex issue involving several factors; the issue getting more complex with the increase in the number of farmers, land area, geographical jurisdiction, extent of CS-QS availability of the relevant variety etc. Though great emphasis is often laid on SRR/VRR, there is no authentic Formula [in public domain] which takes into account all the relevant factors, to estimate the actual SRR / VRR that is being achieved. Therefore, developing the Formulae / Methodologies for estimating the SRR/VRR is an area for the research group to work upon.

7. **Standardization of cob moisture estimation methodology:**

Seed Testing Procedures / Rules prescribe the precise methodology for estimating seed moisture content. Moisture meters are designed with different concepts, principles and operating procedures to estimate the seed moisture. But, in hybrid maize seed production [especially commercial single cross seed production], cob moisture becomes relevant to facilitate decision on harvesting at full physiological maturity [to ensure maximum physiological quality – germination / vigour], de-husking, bin/batch drying and shelling. There is no officially announced procedure for cob moisture testing nor has any research data emerged on the subject. As a result, the hybrid maize seed industry is adopting own assessment methods based on their experience. This being an important aspect, research designed to evaluate and prescribe standard maize cob moisture testing is worth taking up.

8. Estimate of Normal Seedlings expected from Hard Seeds:

Authentic information is still not available on how much/how many of the 'Hard Seeds' usually found during 'Lab Germination Test' [in Leguminosae and Malvaceae] are capable of producing Normal Seedlings. Yet, as per the present Labelling and Certification Standards/Rules, irrespective of the extent of 'Hard Seeds' counted, their percent is added to Normal Seedlings and declared as 'Germination including Hard Seeds'. Hence, this needs study and confirmation.

9. Insect Damage -Estimation Procedure:

Estimation procedure to be followed in STLs is needed to take care of the various forms of insect damage. The issue is complex because it has several dimensions to take into account. Broadly, the various forms / types of insect damage that may be seen in the seed lots / seed samples are as follows:

a) only eggs -one or more on one or more seeds; all alive or all dead or some alive and some dead – [is there any technique to determine whether an egg is alive or dead?];

b) only larvae – one or more, all alive or all dead or some alive and some dead; sometimes hidden inside the seed webs formed by the insect;

c) only pupae- one or more, all alive or all dead or some alive and some dead-[is there any technique to determine whether a pupa is alive or dead?]; sometimes hidden inside the seed webs ;

d) only adults- one or more, all alive or all dead or some alive and some dead;

e) combination of two or more of [a] to [d] above;

f) one or more seeds with varying degrees of damage of varying types ranging from a mere scratch –abrasion - bruise on the seed coat [testa] to seed completely turning into powder; and or the larvae forming seed web clusters.

g) combination of two or more of [a] to [f] above.

The foregoing adequately explains the highly complex nature of the issue 'Insect Damage'. ISTA Rules, even the 2020 edition, does not have any exclusive testing procedure for insect damage; except for applying the 'Half Seed Rule' during Physical Purity Analysis, to classify the seed as Inert Matter [along with any other Inert Matter], if half or more of the seed is damaged, irrespective of the cause of damage. The limitation with applying 'half seed rule' is that it does not reflect the presence of insect damage. However, the Hand Book of Seed Testing [1993] has dealt with this aspect in some detail in Chapter 10. Critical review of the same will bring out the gaps needing attention, clarification, elaboration and guidance. Assessment method and precise Unit of expression [i.e. No. per unit weight of seed or percentage by No. or weight] are needed.

10. Standardized Methods/ Techniques for Pollen Collection, Storage and Use:

Stored pollen comes to the rescue in seed production especially F1s, in the event of 'pollen wash /drift 'due to drizzle, rains, heavy winds etc. Seed producers in typical hybrid seed production locations will find scientifically maintained 'Pollen Banks 'a welcome support for timely availability of the needed pollen for hand pollination. Technology is needed for Pollen Collection, Storage and Use in various crops to be adopted at the seed growers' level.

11. Seed Technology Studies:

Information is needed on : [i] Farmers' varieties protected under PPV&FRA; [ii] Rare, endangered, threatened species; [iii] Varieties bred for difficult situations viz., sea water intrusion in the coastal regions, floods, droughts, salinity, alkalinity etc.; [iv] Crops listed as 'Under- exploited'; [v] Small Millets; [vi] Agro-forestry; [vii] Mangrove – marsh lands species; [viii] Medicinal and aromatic plants; [ix] Crops / varieties listed as protected under Bio diversity regulations; [x] Unique and rarest species (eg. Bhoot Jalokia chilli of Assam); [xi] Objectionable/noxious weeds; [xii] Geographical Indicators- GIs; [xiii] Patented varieties/ species;

[xiv] Aquatic species; [xv] Age old and naturally evolved local germplasm / varieties in the tribal farming areas. This exercise would give a good insight into the merits /demerits among the genotypes from 'Seed' point of view.

12. Scope of using germination inhibiting factors in fleshy juicy fruits for inducing dormancy:

Research is needed to find the factors that inhibit the germination of seed inside the apparently 'juicy fleshy fruits / vegetables' inside which the seed does not get an opportunity to dry in spite of attaining physiological maturity. Can such germination inhibiting factors be identified and used to induce dormancy in seeds especially when mature seed ready for harvest is open to wet weather/rains? Similarly, what factor induces 'vivipary' allowing seed to germinate while still green or inside the fruit on the mother plant? Any scope for using such factor for 'breaking dormancy' or 'reducing the dormancy period'? Research in this direction is suggested.

13. Alternate fumigant / seed dressers:

Bulk of the 'seed fumigation' in the seed sector for almost the past 4-5 decades is by 'Aluminium Phosphide' with 'Phosphine' as the 'active ingredient'. So is the case with Thiram as seed dresser. Risks of excessive dependence on a single fumigant-product / seed dresser are known. Therefore, work on identification of alternatives is worth.

14. Effect of 'pin holes' made routinely during packing in vapour –proof seed packets:

During packing in vapour proof containers such as poly pouches etc, a few pin holes are made on the pouches in order to avoid bulging and to facilitate final packing. Obviously, the real purpose of vapour proofing is, in a way defeated. Yet, practical considerations prevail. Therefore, the effect of such a 'field level practice' on seed germination, vigour and storability is worth investigating through research designed for the purpose.

15. Methods to determine sex in papaya based on seed- seedling features:

Papaya being dioecious, during commercial crop production as well as seed production, female plants are distinguished only after the reproductive phase sets in; and the excess males are uprooted implying waste of efforts on raising them. Hence, any method to identify the females in the seed / seedling stages will help. Research in this direction is worth.

16. Techniques to reduce 'seed discoloration':

Seed discoloration due to inclement weather at seed crop maturity stage is not uncommon, especially in field crops such as paddy, wheat, sorghum, bajra, small millets, oats, sunflower, safflower, etc in which the seeds are directly exposed to nature. Even if lustre affected seed meets the germination requirements, the mere look is a deterrent. Research information / recommendation is needed for any spray application on the standing crop ear heads at maturity, if and when bad weather is anticipated.

17. Anti -hygroscopic material[s] for coating on dried seed:

In order to keep the seed moisture of dried seed under control, it is worth identifying such non-toxic materials which on coating on seed would prevent moisture absorption from the environment without affecting seed quality.

18. Remedy for testa peeling off in soybean:

Over the years, with climate change phenomenon, in the typical soybean seed production areas especially in Madhya Pradesh, Maharashtra and Rajasthan, the seed dries down fast to even 8-10% even before full physiological maturity. At such moisture ranges, the testa peels off and the cotyledons split, during post-harvest handling. Any field level spray on the standing crop at maturity to prevent testa peeling will help. Research information in this regard is needed.

19. Quality of organically produced seed:

Organic farming is catching up fast and Organic Seed Certification is practiced in Karnataka, Orissa,

Rajasthan and Telangana by the respective State Seed & Organic Certification Agencies. Will organic seed production make any difference in seed quality - especially physiological quality? Though not expected, research to verify /confirm the same is required.

20. Fresh Ungerminated Seeds [FUS]- expected performance- scope to include with Normal Seedlings as is done for Hard Seeds:

Additional issues: What is the hope with FUS? Will they turn out to be Normal Seedlings? Classified as FUS only based on visual examination. Not tested for even viability? Are they merely dormant? Are they viable? In species with Hard Seeds, the minimum standard is for *"Germination including HS'* [i.e., Normal Seedlings + Hard Seeds], assuming that 'Hard Seeds' will produce normal seedlings in the field. If that assumption is valid for FUS also, then including FUS with normal seedlings for total germination is justified. For taking a view on this, relevant research data is needed. This is thus an area for work.

RECOLLECTIONS

My Experiences with Loose Smut of Wheat: Success and Failure

V.K. Agarwal
Former Professor & Head, Department of Plant Pathology, GBPUA&T, Pantnagar
email:- vkagarwal20@yahoo.co.in, Mob. 6397974959

Seed is the basic input in agriculture, hence the use of healthy good quality seed is essential in crop production. Treating seeds with chemical fungicides is one of the common approaches to manage seed borne diseases. However, establishing the level of infection is mostly based on the field standards for a disease, as in the case of loose smut, a seed borne disease of wheat, which emerged as a major problem during the post-Green Revolution era.

An approach of seed treatment, based on detection of seed infection, was first advocated by V.K. Agrawal for the control of loose smut of wheat during the 'Third All India Seed Seminar' organized by the Indian Society of Seed Technology at Indian Agricultural Research Institute, New Delhi on Feb. 17-18, 1976. On this basis, the routine testing of wheat seed for loose smut infection by embryo count method was standardized. This was adopted by the then U.P Seeds and Tarai Development Corporation (USTDC, now Uttarakhand Seeds and TDC), which not only restricted the increase in the incidence of loose smut infection but also saved unnecessary treatment of seeds having less than 0.5% infection. This resulted in net savings of Rs. 19.99 lakhs during the three years 1976 to 1978, besides reducing the environmental pollution. This approach is still being followed by the Uttarakhand Seeds and TDC as a measure to control the disease. However, it could not be incorporated in the national seed certification programme. Even the certification standards for loose smut could not be revised.

Prologue

The introduction of high yielding varieties (HYVs) of wheat and rice in the 60s and 70s resulted in green revolution in India. However, within few years, these HYVs of wheat such as Sonalika became susceptible to loose smut *(Ustilago tritici)*. Recognizing the seed borne nature of the disease, the Central Seed Certification Board, prescribed a maximum of 0.1% and 0.5% loose smut infected plants in the foundation and certified seed plots, respectively, in the Indian Minimum Seed Certification Standards in 1971 to manage the disease. However, this approach failed to restrict the increase in the incidence of loose smut in wheat, following the practice of treating the entire seed lots with carboxin, increasing the expenditure in seed production of wheat. Hence, to manage the disease a new approach was suggested based on percent seed infection.

The present article is an attempt to recapitulate this significant contribution of Seed Technology in the mainstream agriculture almost 50 years back.

Different degree of disease manifestation in the ear heads

Heavily infected embryo of wheat with the mycelium of Ustilago segetum var. tritici

Courtesy: Ashok Gaur

Standardization of Loose Smut Testing Technique and its Utility

Loose smut of wheat caused by *Ustilago tritici* is an exclusively seed borne disease. The pathogen was detected in 1886 in wheat seed embryo and in 1937, a technique was used for routine analysis of wheat seeds.

Dr W.J. Rennie and Dr. Mary Noble demonstrated the method of embryo count for the routine analysis of wheat seed as a major approach in the control of loose smut of wheat during my brief visit to the Official Seed Testing Station (OSTS) for Scotland, Eastcraigs, Edinburgh in the month of Feb.1970.I have had a rare opportunity to meet Dr. Noble during this period, who had coined the word 'Seed Pathology' in 1940. Visualizing the application of embryo count method in managing the loose smut, an attempt was made during 1974-1976 to standardize the technique and apply in routine testing of wheat seeds. Samples of artificially infected wheat seeds was obtained from the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi in 1974. The comparative tests were done by Dr. Rennie and us to decide feasibility of this technique and its application in routine analysis of wheat seed samples. Based on the comparative tests, this technique was standardized and applied in routine testing of wheat seed produced by USTDC. In addition, a large number of field trials were conducted at the Crop Research Centre to study seed transmission of infection in different varieties, range of transmission in different seed lots of cv. Sonalika, transmission in different dates of planting, influence of seed size in transmission, effect of infection on plant morphology, effect of different doses of carboxin in the control of loose smut and economics of seed treatment.

Dr. Rennie visited GBPUA&T, Pantnagar, specially the seed pathology laboratory in the Department of Plant Pathology, and USTDC in February, 1982 to discuss and assess the application of embryo count method in the management of loose smut of wheat on a large scale by the collective efforts of the university and the seed corporation. The entire project was a team work involving V.K. Agarwal (incharge) H.S. Verma, R.K Khetarpal, Mridula Agarwal and R.K. Gupta during 1975 to 1982.

The routine testing of wheat seeds specially cultivar Sonalika produced by USTDC in 1976 was done in the Seed Pathology lab of the department of Plant Pathology. This testing was done with the help of about 15 technical staff appointed on adhoc basis with a background of agriculture/ biology. They were initially trained for about a week in

the technique of embryo count method. Only on the basis of results of the test the seeds were either treated, not treated or not used for further multiplication at all. This is just to put on record that we were never approached for the results of the analysis or even faced any embarrassing situation between the results of the test, seed treatment or appearance of disease in the field. The economics of this technique was calculated for three years i.e., 1976-78. The data on loose smut infection in certified seed lots of wheat produced during 1975-78 revealed a higher incident of loose smut in 1976 as compared to 1977and 1978. The maximum natural infection was 8.14%, 5.41% and 5.73% in the year 1976, 1977 and 1978, respectively. Seed lots below 0.5% infection were 6.4%, 69.5% and 43.5% in the years 1976, 1977, 1978, respectively. This quantity of seed was not treated with carboxin. It resulted in net saving of Rs. 1.42, Rs. 9.97 and Rs. 8.6 Lac in year 1976, 1977, 1978, respectively likewise 69.2%, 29.1% and 49.22% seed lots were treated with carboxin and 24.4%, 1.4% and 7.3% seed lots having more than 2.0% loose smut infection were not used for distribution in the year 1976, 1977 and 1978, respectively.

The results of the trials to elucidate the relationship between loose smut infection in seeds as determined by embryo count method and subsequent field trials clearly demonstrated a close relationship between loose smut infection in seeds and its transmission to the field. The results of embryo count method were first presented during the 'Third All India Seed Seminar' organized by the Indian Society of Seed Technology, Indian Agricultural Research Institute on February, 17-18, 1976 and was published as a research note by Agarwal in Seed Tech News in 1978 [Agarwal, VK, 1978; STN 8(3):1].

Subsequently, the results of this technique were presented in several national symposia, Seminars, Conference at national and international levels, including the International Symposium on Seed Pathology, DGISP, Denmark 1982, Fourth International Congress of Plant Pathology, Australia 1983, and China Agricultural University Beijing, China 2000 and International Workshop on Biological Control of Plant Diseases, Yunnan, China, 2000.

Summing Up

The loose smut caused by *Ustilago tritici* is one of the most important seed borne diseases of wheat. Increase of the disease in the cultivar Sonalika during the years 1967-72 required treating seeds with expensive fungicide, resulting in the increase in the cost of seed production. Globally an embryo count method is being used in the routine testing of wheat seeds. The demonstration of embryo count method for the detection of loose smut of barley during a visit in the month of February, 1970 of the Official Seed Testing Station for Scotland, East Craigs, Edinburgh initiated in the standardization of a routine technique through comparative testing of wheat seeds involving Pantnagar (Agarwal) and East Craigs (Rennie).

The Central Seed Certification Board, Govt. of India prescribed the standard based on the percent infected plants in the seed certification plots. Accordingly, the maximum permissible infected plants are to the extent of 0.1% and 0.5% for foundation and certified seed plots, respectively. These standards are being followed even after 50 years. This approach resulted in unnecessary treatment of healthy or seeds with low infection. Therefore, an approach of selective treatment based on seed testing of wheat seeds for assessment of loose smut infection, advocated in 1978 was most appropriate.

This approach applied for the first time in India as an internal quality control measure by the USTDC in 1976, proved highly satisfactory in the management of loose smut of wheat. USTDC visualizing the utility of this technique established a separate seed health laboratory at their headquarters in 1982. The above practice proved to be a success story and is still being followed by the corporation in their seed production programme. However, application of embryo count testing could not be adopted at national level. Even as a member of the Technical Committee of Central Seed Certification Board, I

failed to convince the Board the simplicity of the technique and its manifold advantages. It is not that the Central Seed Certification Board is not receptive to new recommendations on the revision of standards. The sodium hydroxide seed soak method which we developed was recommended by it for the detection of Karnal bunt of wheat and bunt of rice. But on this count, I failed!

I participated in a discussion on the advantages of the embryo count method for assessment of loose smut infection in 2000 at China Agricultural University. To my surprise they were following the standardized method advocated by us mentioned in the Bulletin of 'Seed borne Fungi and Viruses of Some Important Crops, 1981'. They were using the Bulletin, as a reference book.

Epilogue

I retired long back but even now my attachment with the fascinating seed as an ideal research material does not allow me to come out of it. The pandemic Covid-19 period given me an opportunity to put my experiences.

I express my sincere gratitude to Dr. W.J. Rennie and Dr. Mary Noble of Official Seed Testing Station for Scotland, Edinburgh for their crucial role in demonstration and standardization of this technique. Now it is for the reader to decide whether it was a success story or a failure.

ANNOUNCEMENT

Announcement of Padma Bhushan Dr. R. S. Paroda Award for the Best Research in Seed Science and Technology

A new award has been instituted by the ISST during the year 2019-20, as a result of a generous contribution of Rs. 200,000 from Padma Bhushan Dr. R. S. Paroda, Chairman, TAAS and Former DG, ICAR & Secretary DARE, a renowned scientist and legendary figure in Indian agriculture. The purpose of this award is to encourage research scholars in pursuing outstanding research in Seed Science and Technology during their Ph.D. degree programmes and to provide incentive for enhancing the quality of doctoral research in the field of seed science and technology. The award is meant exclusively for the doctoral thesis in Seed Science and Technology from any Indian University. This award, consisting of a cash grant of Rs. 10,000/-, a scroll of honour, a memento and a certificate, will be presented once in two years during National/International event organized by the Society. For details, please see the ISST website/ write to Secretary, ISST.

OBITUARY

Dr. Ashok Gaur, Former Principal Scientist, Division of Seed Science & Technology, ICAR-IARI, New Delhi, passed away on 14th December, 2020. A condolence meeting was organized through video conference mode on 26.12.2020 by ISST with the participation of several members of ISST and his family members and paid tributes to him. Dr. Ashok Gaur born on 3rd July, 1945 in Allahabad in a family of teachers. He completed his M.Sc. in 1967 from Agra University. He joined the post of Research Assistant in the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi in 1969. In 1972, he was selected for the post of Sr. Research Assistant in the Division of Seed Science and Technology. He got his Ph.D degree in 1979 from Agra University. When Agricultural Research Services were created in 1976, he was inducted into the service as Scientist S-1. From 1972 till his retirement in 2007, he worked on various aspects of seed pathology. He guided 8 Ph.D and 4 MSc. Students. His main area of research was storage of treated seeds, revision of certification standard for loose smut of wheat and chemical

control of seed borne diseases. He has published more than 50 research papers in various national and international journals and contributed at least twelve review articles in different edited volumes. He also provided the Hindi equivalents of the name of various plant diseases, which has been compiled as 'Compendium of Plant Diseases' published by United States Department of Agriculture, USA. He was fellow of Indian Society of Seed Technology and Indian Phyto pathological Society. He served the Indian Society of Seed Technology (ISST) in various capacities.

KNOWLEDGE UPDATES

Climate smart varieties of paddy and wheat and their status in seed chain

Boraiah, K.M[1]., Vijay, D[2]., Vijayakumar, H.P[2]., Umesh R. Kamble[3], Chandu Singh[2]

1 - NIASM, Baramati; 2- ICAR-IARI, New Delhi; 3-ICAR-IIWBR, Karnal

Water is the most limited natural resource of late, due to failure of rains and over-exploitation of groundwater. The dwindling water resources reveal a grim situation. Rice is the staple food crop of India. Rice crop, on average, needs 10 mm of water per day. To produce one kg of rice, nearly 5000 litres of water is required. Several cultivation packages are developed to reduce the water use in rice crop. One such method is rice cultivation under an aerobic situation which is characterized by an aerated soil environment during the entire period of crop growth. Aerobic rice requires approximately 30-50% less water than flooded low land rice. Aerobic rice does not require nursery, transplanting, puddling or standing water. In this type of cultivation, rice is grown like maize or sorghum by giving surface irrigation. Irrigation is given once in 5-7 days in direct-seeded aerobic rice crop. Varieties suitable for this type of cultivation possess the ability to withstand drought periods. Varieties are bred for the aerobic situation with root introgressed from upland genotype base that yield on an average of 5 ton/ha of grain and 5.5 t/ha of fodder. The list of suitable rice cultivars for the aerobic situation and their adoption area is presented below (Table 1). After rice, wheat is the most important staple food crop of India. Drought is one of the most wide spread abiotic stress particularly under rainfed condition. The drought tolerant varieties are the need of the hour. In wheat, stay green character provides tolerance against drought-induced post-flowering senescence. A list of wheat varieties which can be cultivated with restricted irrigation (1 or 2 irrigations at critical stages) suitable for drought conditions is presented below (Table 1). Such comprehensive and compiled information will be useful for different stakeholders and researchers involved in abiotic stress management. The research insights into the stress tolerance mechanisms and the identified promising lines should be translated into climate-smart and resilient varieties tolerant to various abiotic stresses.

The success of newly developed varieties depends on the availability of their quality seed to the end-users. Thus, inclusion of such varieties in the seed chain only ensures their availability, popularization and cultivation. The details of breeder seed indent for the latest two years at the national level for the climate smart varieties is given in the table 2. The data shows that, in case of rice, out of the total seed indented, only 0.25 to 0.5% is of aerobic varieties and in wheat, 1.6-3.8% of the total seed is of drought tolerant varieties listed below. The miniscule level of breeder seed indent of climate smart varieties in both the crops flags the lacunae in their spread. Thus, there is an urgent need to popularize the varieties so that the state seed corporations will take up their multiplication in large scale. The research institutes shall also concentrate on the spread of varieties by allocating sufficient funds for minikit trials, farmer participatory trials, field days and large-scale demonstrations. The data also depicts that there is a need for developing pan India climate smart varieties or more varieties for different locations. The collaborative action of identification of drought endemic regions and popularization of suitable climate smart varieties in those regions is one of the most plausible solutions for the success of these varieties.

Table 1: List of latest climate smart varieties in rice and wheat (released during the past 16 years)

Sl. No.	Variety	Year of release	Developed by	Area of adoption/ state	Other useful features
Rice varieties suitable for aerobic conditions					
1.	CR Dhan 200	2014	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, BS, SB and LF
2.	CR Dhan 201	2014	ICAR-NRRI, Cuttack	CG and BH	Moderately resistant to LB, SR, SB, LF
3.	CR Dhan 203	2014	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, BS SR, SB,
4.	CR Dhan 204	2019	ICAR-NRRI, Cuttack	JH, TN	Tolerant to BL, BS, SB, LF
5.	CR Dhan 205	2019	ICAR-NRRI, Cuttack	TN, OD, WB	Resistant to LB, BS, SR, SB and LF
6.	CR Dhan 206	2019	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, BS, SB, and LF
7.	CR Dhan 207	2019	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, NB, BS, SR, SB, LF, GLH, GM
8.	CR Dhan 209	2019	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, BS, RTV, SB, LF, GLH, WBPH
9.	CR Dhan 210	2020	ICAR-NRRI, Cuttack	OD	Moderately resistant to BL, NB, BS, SB, SR, LF, GLH
Wheat varieties tolerant to drought					
1.	JW 3020	2004	JNKVV, Jabalpur	MP	Resistant to all the rusts
2.	HI 1531	2006	IARI RS, Indore	CZ	Resistant to BR & BWR
3.	HI 8627 (MALAV KIRTI)	2007	IARI, RS-Indore	CZ	Resistant to BR & BWR
4.	PBW 596	2008	PAU, Ludhiana	PZ	-
5.	MP (JW) 3173	2009	JNKVV, Jabalpur	CZ	Resistant to lodging and rusts
6.	Ratan	2009	IGKV, Raipur	CG	Resistant to BR
7.	MP 3211 (JW 3211)	2009	JNKVV, Jabalpur	MP	Resistant to rusts
8.	Netravati	2011	MPKV, Rahuri	MS, KA	Resistant to lodging
9.	HD 2987	2011	IARI, New Delhi	MS, KA, AP, TN	-
10.	KRL-213	2012	ICAR-CSSRI, Karnal	AS, BH, DL, HR, UP, RJ, PB, WB, UK	Resistant to salinity, alkalinity and Karnal bunt
11.	HD 3043	2012	IARI, New Delhi	HR, RJ, UP, DL, RJ, UK, MP	Resistant to BR and YR
12.	PBW 644	2012	PAU, Ludhiana	DL, HR, HP, J&K, PB, RJ, UP, UK	-
13.	HW 5216 (PUSA THENMALAI)	2013	IARI, RS-Wellington	SHZ	high degree of resistance to BR and BWR
14.	WH 1142	2015	CCSHAU, Hissar	NWPZ	Tolerant to lodging
15.	Sabour Nirjal	2017	BAU, Sabour	BH	-
16.	HUW 669	2018	BHU, Varanasi	UP	-
17.	HD 3237	2019	ICAR-IARI, New Delhi	NWPZ	Resistance to YR and BWR
18.	HI 1620	2019	IARI RS, Indore	NWPZ	Tolerant to lodging, Resistant to YR & BWR
19.	HI 1612	2019	IARI RS, Indore	NEPZ	Resistant to YR & BWR
20.	DBW 252	2020	ICAR-IIBWR, Karnal	UP, BH, JH, OD, WB, AS	Resistant to wheat Blast

Abbreviations: OD-Odisha; CG-Chhattisgarh; BH-Bihar; JH-Jharkhand; TN-Tamilnadu; WB-West Bengal; CZ-Central Zone; MS-Maharashtra; KA-Karataka; AP-Andra Pradesh; AS-Assam; DL-Delhi; HR-Haryana; UP-Uttar Pradesh; RJ-Rajasthan; PB-Punjab; UK-Uttarkhand; MP-Madhya Pradesh; HP- Himachal Pradesh; J&K-Jammu & Kashmir; NWPZ-North West Plain Zone; TG-Telangana; GR-Gujarath; NEPW-North eastern plain zone; SHZ- Southern Hill Zone; PZ- Peninsular Zone.

BL-Leaf blast; BS- Brown Spot; SHR- Sheath Rot; BLB-Bacterial leaf blight; BS- Brown spot; GR- Glume discolouration; SR-Stem rust; SB-Stem borer; LF-Leaf Folder; LB-leaf Blight; NB-Neck Blast; GLH-Green Leaf hopper; GM-Gall Midge; RTV-Rice *Tungro* virus; WBPH-White Backed Plant Hopper; BR-Black rust; YR-Yellow rust, BWR-Brown Rust

Table 2: Breeder seed indent of the climate smart varieties for recent two years

(in Qtl.)

Variety	Kharif 2020/ Rabi 2020-21	Kharif 2021/ Rabi 2021-22	Indented by
Rice Varieties			
CR Dhan 200	0	0	-
CR Dhan 201	1.0	1.15	West Bengal, SAI
CR Dhan 203	9.50	11.75	Odisha, West Bengal, SAI
CR Dhan 204	0	3.00	Odisha
CR Dhan 205	0	0	-
CR Dhan 206	0	3.00	Odisha
CR Dhan 207	0	0.30	SAI
CR Dhan 209	1.0	1.00	West Bengal
CR Dhan 210	0	0	-
Wheat Varieties			
HI 1531	17.40	2.00	Chhattisgarh, MP, NSAI
MP (JW) 3173	0	0	-
Ratan	135.00	63.40	Chattisgarh
Netravati	12.00	6.00	Maharashtra
Pusa Bahar (HD 2987)	20.80	0	MP, NSAI
KRL-213	0	0	-
HD 3043	61.20	0	Jammu & Kashmir, NSAI
PBW 644	1.00	0	Punjab
WH 1142	104.40	1.20	UP, NSC, NSAI
Sabour Nirjal	50.00	50.00	Bihar
HUW 669	4.20	17.20	NSC, NSAI, UP
DBW 252	0.00	12.50	NASI, NAFED, NSC, WB
HD 3237	76.4	93.0	KCO, NSC, NSAI, UP, JK, NAFED, UP
HI 1620	12.60	31.2	NSC, NSAI, JK,
HI 1612	0	0	-
HI 8627 (MALAV KIRTI)	0	0	-
HW 5216 (PUSA THENMALAI)	0	0	-
JW 3020	10	0	MP
MP 3211 (JW 3211)	100	0	MP
PBW 596	0	0	-

NOTE:

All the ISST members are requested to contribute to various columns of Seed Tech News by providing information on a) Awards and Honours received; b) Upcoming trainings/ events; c) Recommendations of scientific gatherings; d) Latest research findings etc. In addition, brief technical notes may also be submitted for fast dissemination.

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