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Seed Tech News

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Blue Corn

Blue corn also known as Hopi maize/Rio Grande Blue is a traditional maize commonly grown in Mexico and Southwestren United States. It is a non GM maize with ear colours ranging from slate blue to brilliant turquoise. It is said to be originated from the Hopi people (a Native American tribe). It is commonly used in traditional Southern and Central Mexican food known as tlacoyo. Ears are typically 6" to 12" long produced one per plant of 4-5 feet height. It has tolerance to wide temperature swings and cool soil and is an early maturing type with 90 days duration.

From President's Desk…

Dear Members,

Greetings from the Secretariat!

The year 2018 is fast reaching its last milestone. It is that time of the year, when we take a stock of happenings around us, learn from these events, ponder, plan and prepare for the year ahead. It is also the time to spare a few moments for introspection.

Overall, the year had been a mixed bag of events, and so was the agriculture scenario. Farmers' woes continued to remain a matter of concern. To address these, several policies and programs were launched by the central and state governments, while the NARES continued to work towards providing technological solutions. The Union Minister for Agriculture and Farmers' Welfare Sh. Radha Mohan Singh praised the contributions of scientists and acknowledged that technologies developed by the Indian Council of Agriculture Research have significantly contributed in increasing production of food grains, horticultural crops, milk, fish and eggs (Economic Times, 20 Dec., 2018). Availability of seeds continued to improve, with rising share of the private and informal sectors. However, the debate continued over the application of GM technology in agriculture. On one hand, improved crop varieties and hybrids continue to be adopted by more and more farmers for better productivity and tolerance against many biotic and abiotic stresses, a number of NGOs and farmers' groups are working towards conservation and promotion of traditional crops and varieties. There is also a growing interest about organic crop production. Therefore, the seed scientists have a responsibility to train farmers in proper methods of seed production, quality check and seed storage and also provide proper guidance in organic cultivation. In association with the concerned Ministries and Government Departments, seed scientists need to take proactive steps in developing Guidelines for Organic Seed Production and Certification.

India's poor performance in scientific research and innovation in general, and agricultural sciences in particular, remained a matter of concern. The Global Innovation Index (2018) put India at a poor 57th rank, whereas, China ranks in the top 20. Just as the Good Agriculture Practices (GAP) are needed for sustained growth in agriculture, good scientific research is essential for innovative agriculture. In the agricultural universities and research institutions of ICAR and others, a lot is needed to improve the quality of scientific research. For this, we may invest more in terms of adequate allocation and timely release of research grants; encourage original thinking and novel approaches to address the ground level problems, even if some of these fails to deliver; honour ethics in research, and shun plagiarism and malpractices in scientific publications an important indicator of scientific accomplishments.

As you are aware, the ISST is organising a National Seminar on "**Strengthening of Seed Systems in the North Eastern and Unreached Regions - Problems, Prospects and Policies"** from 3-5 February, 2019 at Imphal, Manipur. This had been a long unfulfilled goal of the Society to organise a seminar on draw the attention of all seed professionals to the issues concerning the seed supply system in the North Eastern and other difficult to reach regions and suggest a road map to address these. We look forward to your valuable participation in the Seminar.

Malavika Dadlani

AWARDS AND HONOURS

Dr. Sanjay Kumar, Scientist, Division of Seed Technology, Indian Grassland and Fodder Research Institute (IGFRI), Jhansi received the "Best Scientist" award under director nominee category from Dr U.S. Gautam, Vice Chancellor, BUAT, Banda (UP) during 57th foundation day of IGFRI on 01-11-2018. At present he is doing research on forage crops especially on berseem seed quality aspects and on role of honey bees in enhancing the berseem seed productivity. He is looking after breeder and truthfully labelled seed production as co-Nodal officer. Additionally, he is acting as the in-charge of the seed testing laboratory at ICAR-IGFRI, Jhansi.

Dr. Ashok S. Sajjan, Professor and Head, Dept. of Seed Science and Technology, College of Agriculture, UAS, Vijayapur received the Best IATian award from the Institute of Agricultural Technologist, Bengaluru for his contribution to the Institute during their golden jubilee year function at Bengaluru. Dr. Sajjan has obtained his masters and doctoral degrees from UAS Dharwad, Karnataka. He worked in various capacities viz., Professor, Warden, External Examination Coordinator, Deputy project Director ATMA, External Examiner, Head seed unit apart from teaching for Diploma, Graduate and Post graduate programmes and guiding MSc(Agri), PhD Students. Dr. Sajjan played a key role through trainings for the establishment of Lime board in Vijayapur. He has published more than 80 research articles in various national and international journals.

Dr. K. Keshavulu, Director, Telangana State Seed and Organic Certification Authority (TSSOCA) has received the Global CEO Award-2018 from Indian Council of Food and Agriculture during a function at New Delhi. The award was presented by the Hon'ble Ex-Prime Minister of Bhutan Mr. Lyonpo Kinzang Dorji and H.E. Mr. P. Sathasivam, Hon'ble Governor of Kerala on 25-Oct, 2018. He was selected for this award for his contributions at the National and International level in several seed production and certification programs. He played a key role in the export of 720 tonnes of seed under OECD seed certification from India. He is the first Indian to get elected as ISTA, Zurich governing body member and played a crucial role in bringing the upcoming 32nd ISTA seed congress to India. He is also looking after the Telangana State Seed Corporation as Managing Director and was instrumental in enhancing its seed production from 3.27 to 7.48 lakh quintals. He served as Head and Professor of Division of Seed Science and Technology at ANGRAU and PJTSAU before joining as Director TSSOCA.

Note: All the ISST members are requested to contribute to various columns of the Seed Tech News by providing information on Awards and honours received; News items; Upcoming trainings, workshops, seminar and symposia; Job vacancies; Recommendations of scientific gatherings with one or two photographs; One page note on latest novel research findings of students and scientists with good photographs etc. for wider dissemination of the information and knowledge among the seed community including both public and private sectors.

NEWS ITEMS

More than 7000 Seed Testing Labs in INDIA!!!

The Ministry of Agriculture and Farmers Welfare of Government of India is planning to establish more than 7000 seed testing labs across the country in consultation with state governments. Out of 7183 STLs proposed, 583 in major towns and 6600 at block level in rural areas to cater the seed quality assurance to the farming community. This will help in availability of quality seed to the farmers and also provides a great employment opportunity to the graduates of Seed Science and Technology. At present only 130 seed testing laboratories across the country are providing the quality assurance service in India. The newly established labs will boost the quality assurance system in the country and farmers can get analysed their seed quality before sowing the seeds on paying nominal fee. It also helps in eradication of spurious seeds from the market.

Source: https://economictimes.indiatimes.com

Plant Variety Protection: Date range for submission of seeds

The Protection of Plant Varieties and Farmers Rights Authority of Government of India has issued a public notice, effective from 15 Oct 2018, about the date range for submission of seeds along with application for DUS testing. As per section 14 of PPV&FR Act, 2001 the applications for the registration of plant varieties will be received throughout the year. However, for DUS testing to be taken up in the same year, the seed shall be submitted in the date range as mentioned below.

Season	Date Range
Kharif Crops	1st March to 15th April
Rabi Crops	1st August to 15th September
Summer/Spring	1st November to 15th December

Source: https://plantauthority.gov.in

India emerges as major seed hub in South and South East Asia region

Access to Seeds Foundation, an independent, non-profit organization based in The Netherlands, which is an ally of the World Benchmarking Alliance has in its report, Access to Seeds Index (ASI), stated that six countries viz., India, Thailand, Indonesia, Vietnam, the Philippines and Bangladesh can be considered as seed hubs in South and South East Asia, based on the concentration of production, breeding and processing activities by 24 index seed companies in these countries. Among these countries, in India out of 24 companies, 21 sell seeds, 18 have invested in breeding and production activities and 17 have processing facilities established in the country. These kind of investments can have a positive effect on the advancement of the national seed industry. The age of variety, which is an indicator of investment in crop breeding program, on an average is 3 years for 66% of global companies and 53% of regional companies working in this region. Public research is the breeding source for 12% of these regional companies whereas, it accounts only 5% in case of global companies operating in this region. For two thirds of these companies, vegetable seed is the major driving force and among food crops they deal mainly with rice and maize. Based on estimates of farmers reached by the 24 companies in the index, together they reach no more than 20% of all active smallholder farmers in the South and South East Asia region.

Source: www.accesstoseeds.org

Seed piracy threatening Spain's R&D sector

Spain is considered to be the world leader in the research and development of fruit and vegetable varieties after the Netherlands. Virtually all the major companies in the world have research centres, mainly in Murcia and Almeria regions, making Spain a technological powerhouse in Europe. The vegetable varieties developed here will be exported for their later use in all climates, including the US, the Mediterranean and Asia. The seeds of these varieties are reproduced illegally and end up back in Spain in an illegal form competing with the companies that actually made this research possible. It is estimated that 50% of the cereal seeds in use in Spain are pirated and 53% of the nurseries inspected by the police in 2016 lacked the proper authorization to reproduce protected varieties. The seeds annually generate 600 million Euro, but the royalties barely exceed 4 million. Seed piracy results in loss of about one hundred million Euro per year from the Spanish agricultural sector. The powerful R&D sector in Spain is under threat and the systematic seed piracy could lead many of the seed companies to abandon research in Spain if they don't later receive the corresponding royalties.

Source: www.abc.es

Cotton seed protein for human nutrition a reality!!!

Researchers from Texas A&M University are one step closer in achieving the usage of cotton seed protein for human nutrition. Their petition for determination of non-regulated status for Ultra-Low Gossypol Cottonseed (ULGCS) TAM66274" has been approved by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, or APHIS in October 2018. The lead researcher Dr. Kirthi Singh Rathore has spent half of his professional career in creating this breakthrough which will have tremendous effect in the field of nutrition and will be a boon to the cotton farmers throughout the world. Gossypol, while toxic to humans and monogastric animals such as pigs, birds, fish and rodents, is useful to cotton plants for defence against insects and pathogens. Its presence in the leaves and stalks of the cotton plant serve as a pest deterrent, but its presence in the seed serves no purpose. Through Cotton incorporated funding they developed a transgenic cotton plant TAM66274 with ultra-low gossypol levels in the seed that maintains normal plant-protecting gossypol levels in the rest of the plant.Thus, paving the way to use the cottonseed for animal and human food. The kernel can be ground into a flour like powder after oil extraction and used as a protein additive in food preparations.

Source: https://today.agrilife.org

SCIENTIFIC BREAKTHROUGH

Synthetic Apomixis for asexual propagation through seeds

A team of scientists led by Prof. Venkatesan Sundaresan from UC Davis have figured out a way to make rice reproduce asexually and thus made an agricultural dream come true. Apomixis is a boon to agriculture dominated by hybrids. It will not only ease the process of hybrid seed production, but also opens a gateway for use of farm saved hybrid seed by farmers. The work describes a ground-breaking way to allow a rice plant to produce seeds that grow into a clone of the parent plant. To mimic the apomixis there is a need to circumvent two key processes *viz*. meiosis and fertilization. The expression of a single wild-type transcription factor, BABY BOOM1 (BBM1), can overcome the requirement of fertilization for embryo initiation by an egg cell. However, seed viability depends upon a functional *BBM1* allele from the male parent, consistent with male-specific expression of *BBM1* in zygotes. A genetic approach called *MiMe*, which eliminates recombination and substitutes mitosis for meiosis, was earlier reported in *Arabidopsis* and rice. In *MiMe*, a triple knockout of the meiotic genes *REC8*, *PAIR1* and *OSD1* produces unrecombined diploid male and female gametes. By combining these two techniques they were able to produce synthetic apomictic plants. Seed formation in this system still requires fertilization to make endosperm, which is a common phenomenon in naturally occurring pseudogamous apomictic grass species. Even though the efficiency of clonal propagation in this system is limited by the frequency of parthenogenesis, that can be improved using different promoters. Since the homologous *BBM*-like and *MiMe* genes are found in other cereal crops also, the methods described by the authors for asexual propagation through synthetic apomixis should be generally extendible to most cereal crops. For more details on this breakthrough research refer the article published in Nature journal December 2018 issue at https://doi.org/10.1038/s41586-018-0785-8.

Germination arrest triggered by presence of harmful bacteria

The seed in real life is continuously confronted with soil microbes that may harm or benefit, apart from environmental factors like light and temperature. Plants are known to block seed germination under unfavourable situations particularly under abiotic stresses but little is known about their response to harmful microorganism in the soil. The scientists from University of Geneva studied the response of seeds for the presence of harmful bacteria, *Pseudomonas aeruginosa*, in the rhizosphere. They observed a toxin produced by this bacterium, called L-2-amino-4-methoxy-trans-3-butenoic acid (AMB) which causes the seeds to block germination without killing the plant. Genetic evidence was provided that in AMB-treated seeds DELLA factors promote the accumulation of the germination repressor ABI5 in a GA-independent manner. Through in vitro experiments they showed that the AMB-dependent germination arrest protects seedlings from damage induced by AMB. The genes that control the production of AMB are also known to control the behaviour of bacterial populations when they accumulate to high densities. It is therefore likely that *Pseudomonas aeruginosa* would make AMB if it reached a high density in the soil. Thus, it was hypothesized that plants have specifically evolved to stop germination if there are enough microbes nearby to pose a risk of disease. For further details refer the full-length article at https://elifesciences.org/articles/37082.

Role of light in seed germination:understanding the molecular basis

Germination of many species is triggered by sunlight which is rich in red wavelength. The germination is regulated by the crosstalk between two key hormones ABA and GA whose levels in turn are controlled by the phytochromes after sensing the red and far red-light ratio. While understanding the mechanism by which these hormones control germination in response to light quality, the researchers have discovered that MOTHER-OF-FT-AND-TFL1 (MFT) is the key component that integrates and interprets signals coming from both ABA and GA. The MFT gene is regulated by light quality and receives signals from both ABA and GA. In dark or shady conditions, it then directs the production of the MFT protein, which regulates germination by switching on a block of genes that prevent growth and switching off another block of genes that promote growth. This prevents a plant from germinating under the wrong conditions such as when there is not enough light to grow. Understanding the molecular basis of seed germination and its control will offer new tools to improve seed quality and seedling vigour in the crops in future. For further information on this topic refer the article published in PNAS at https://doi.org/10.1073/pnas.1806460115.

Salinity and Heat stress tolerant transgenic rice

The researchers from Jawaharlal Nehru University (JNU), International Centre for Genetic Engineering and Biotechnology (ICGEB) and University of Illinois (USA) in collaboration developed a transgenic rice that promises to generate high yields even under conditions of high salinity, high temperature and drought. The scientists hit upon the idea while studying a rice variety, Pokkali, grown in coastal regions of Kerala. This study provided a clear evidence about the unique involvement of intermediate filaments (Ifs) of cytoskeleton in cellular protection against abiotic stress in rice. Overexpression of *Oryza Sativa* intermediate filament (OsIF) in transgenic rice enhanced the tolerance to salinity and heat stress. Seeds of OsIF overexpression rice germinated normally in the presence of high salt, showed better growth, maintained chloroplast ultra structure and favourable K+/Na+ ratio than the wild type and knock down plants.For more information on the experiment refer the article at https://www.nature.com/articles/s41598-018-22131-0.

UPCOMING EVENTS

National Seminar

The Indian Society of Seed Technology in collaboration with ICAR-RCNEH and CAU, Imphal is organizing a National Seminar on "Strengthening of Seed System in the North Eastern and Unreached Regions Problem, Prospectus and Policies" at Imphal from 3-5 Feb, 2019. This is the first Seed seminar in the North Eastern region of the country highlighting the seed aspects of the region. The seminar comprises six thematic areas covering various aspects of seed research, seed production and supply chain management. The society is conferring various awards and prestigious fellow as per the guidelines. For more information about the seminar, visit the website http://www.isst-india.com

XIV Agricultural Science Congress

The National Academy of Agricultural Sciences and ICAR-Indian Agricultural Research Institute, New Delhi jointly organizing the 14th Agricultural Science Congress (XIV ASC) on the theme "Innovations for Agricultural Transformation" from February 20-23, 2019 at IARI, New Delhi. The congress with ten major themes on agriculture viz., Plant Sciences (Field crops), Plant Sciences (Horticulture crops), Natural Resource Management, Plant Protection, Food Science and Value addition, Animal Sciences, Fisheries, Engineering and IT, Social Sciences and Agricultural Education. Apart from these ten thematic areas, sessions on student elocution, Panel Discussion, Farmers session and Postersession are also there. The last date for submission of abstracts is extended to 15 January 2019. For more information about the congress, visit their website http://14agricongress2019.in

Indian Seed Congress

The National Seed Association of India (NSAI) is going to organize the Indian Seed Congress from 11-12 March, 2019 at Hyderabad, Telangana. The Indian Seed Congress provides a platform for the Seed Industry to interact closely with technology developers, sector development officials and policy makers. The last date for the registration is 15-Feb, 2019. Interested persons may visit the website of NSAI, http://www.nsai.co.in/isc2019 for more information.

ISTA Seed Symposium 2019

The seed symposium of the 32n International Seed Testing Association Congress under the theme "Seed Technology and Quality in a changing world" is going to be held in Hyderabad, Telangana from 26-28 June 2019. The symposium provides opportunity for the seed analysts, technologists, researchers and managers from universities, research institutes, government and the seed trade to discuss various aspects of seed quality and its technological application in seed testing. For more details, visit the website https://www.seedtest.org/en/seed-symposium-_content---1--3400.html

NSRTC trainings

The National Seed Research and Training Centre, Varanasi is conducting the following training programs on seed testing and seed certification for improving the skill of manpower engaged in seed sector. Officers involved in seed testing, certification, processing, quality regulation and marketing can apply for the trainings. Each training course is limited to 30 participants on first come first serve basis. Training on "Quality seed production technology of oilseeds and pulses" from January 7-11, 2019 at Karaikal, Puducherry (contact: Dr. T. Ramanadane, 09443875443); Training on "Recent Innovations in Seed Quality Enhancement for Production in Quality Seed Production" from January 28 to 1st February, 2019 at College of Agriculture, Raichur, Karnataka (Contact: Dr. N. M. Shakuntala, 09448973630); Training on "Pre & Post Harvest Management Techniques for Seed Quality Assurance" from February 5-9, 2019 at NSRTC, Varanasi (Contact: Dr Aravind N Singh, 0542 2370222, 0542 2370298). For more details visit the NSRTC website http://www.nsrtc.nic.in/ hrd_activities.html

9th National Seed Congress

The 9th National Seed Congress on "Quality Seed: A key component for doubling the farmers income is being organized by National Seed Research and Training Centre, Ministry of Agriculture and Farmers welfare, Government of India in collaboration with Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi from 19-21 Feb 2019. The congress was originally planned from 29 Sept to 1 Oct 2018. But due to some unavoidable exigency it was rescheduled. Those who have already registered can attend the same by providing the details of their travel plan to the organizing secretary through email 9nationalseedcongress@gmail.com. This seed congress will provide a forum to review the progress made in seed science and technology issues related to production of high quality seeds, processing, testing, certification and seed policies and regulations.

Pre-Congress ISTA Workshop

The Pre-Congress ISTA Workshop on Seed Morphology and Seed Identification for Purity and OSD Test is being organized on the side-lines of ISTA seed seminar from 22-24 June 2019 at Novotel Hyderabad Convention Centre, Hitech city, Hyderabad, India. It is being jointly organized by Indo American Hybrid Seeds (India) Pvt. Ltd. and Telangana State Seed & Organic Certification Authority. The aim of the workshop is to provide knowledge about seed identification at both theoretical and practical level. The work shop will deal with seed morphology in general and the meaning of seed characteristics for systematic classification so that the identification of family, genus, species step by step can be done. Maximum number of participants is 22 on first cum first serve basis. The registration fee is 500 EUR for ISTA members and 750 EUR for non-members. The last date for registration is April 22, 2019. For more details visit ISTA website at https://www.seedtest.org/en/event-detail---0--0--0--106.html

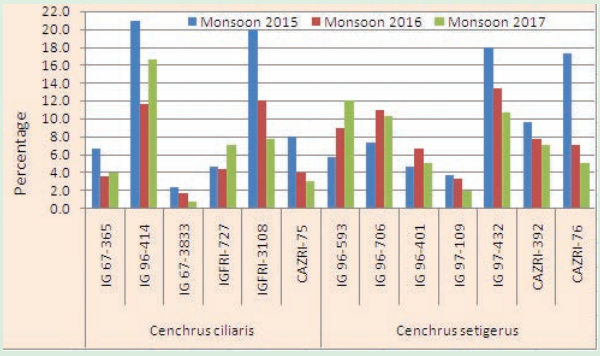
SIGNIFICANT RESEARCH FINDINGS

Quality seed production in *Cenchrus* sps

Cenchrus grasses are predominant perennial grass component of the *Dichanthium-Cenchrus-Lasiurus* pasture cover of semi-arid and arid regions western India. Seed production of *Cenchrus* grasses is traditionally taken during

Healthy seed (Left) and ergot sclerotia (Right) of *C. ciliaris*

monsoon season as rainfed crop. An experiment was conducted during 2014-17 in three seasons i.e. monsoon (July-September), autumn (September-November) and spring seasons (February-April) for evaluating fodder and seed yield and quality in *C. Ciliaris* and *C. setigerus*. It was observed, that irrespective of species, highest fodder yield was recorded during monsoon season while higher seed yield with better quality was recorded during autumn and spring seasons. Ergot infestation caused by *Cleviceps fusiformis* in both species was observed during monsoonseason resulting in loss of seed quality. However, no ergot infestation was observed during autumn and spring seasons. The proportion of infested spikelet increased with increase in the intensity of rains and number of rainy days during flowering/seed developmental stage. The ergot infestation was observed by manual de-husking of spikelet and the proportion of spikelet filled with seed and ergot was calculated. Significant differences were recorded among the genotypes in both the species for ergot infestation. In *C. ciliaris* ergot infestation was ranging from 1.6% (IG 67-3833) to 16.4% (IG 96-414) with mean value of 7.7 per cent. Similarly, in *C. setigerus* ergot infestation was ranging from



Per cent spikelet infested with ergot sclerotia in *C. Ciliaris* and *C. setigerus*

3% (IG 97-109) to 14% (IG 97-432) with mean value of 8.4% during monsoon. Significantly less ergot formation was recorded in late flowering genotypes like IG 67-365 and IGFRI-727 compare to early flowering genotypes IG 96-414 and IGFRI-3108 of *C. ciliaris*. Therefore, this study recommends autumn and spring seasons where minimum irrigation is available and late flowering genotypes in dry areas which are completely dependent on monsoon rains for quality seed production.

S. S. Meena and R. P. Nagar
ICAR-IGFRI, WRRS, Avikanagar

Hybrid seed production of wheat (*Triticum aestivum* L.)

Wheat is the second most vital crop that contributes significantly to the global food security. Almost 60% of country's net cultivated area is rainfed and exposed to several biotic and abiotic stresses, especially temperature and water stress. High temperature spell towards the end of the crop season i.e. terminal stage is a major determinant factor for wheat productivity, especially under Indian conditions. The present study was conducted under both field and growth chamber (controlled environment) to understand the impact of changing climate, particularly increase in temperature on growth, yield and seed quality attributes in promising parental lines (CMS, maintainer and restorer) of hybrid wheat. Field experiments were conducted during *rabi* season of 2015-16 and 2016-17 at the research farm of the Division of Seed Science and Technology (DSST); whereas growth chamber study was conducted at the National Phytotron Facility, ICAR-IARI, New Delhi. The experimental material comprised of four CMS lines *viz.* CMS 2019, CMS 2041, CMS 2046 and CMS 3083 along with their respective maintainer lines; and four restorers *viz.* T 2003 R, R 902, R 958 and R 965 under field conditions. The crop was raised under two contrasting sets of environments *viz* normal sown (first fortnight of November), and late sown (first fortnight of January) to expose the crop to high temperature stress at terminal stage. For controlled condition studies, optimum temperature was maintained throughout growing period (OPT) in one growth chamber (C_1), whereas the second growth chamber (C_2) maintained 5°C higher (HT) than that of C_1. The phenological, growth, yield and seed quality parameter were recorded in parental lines and their F_1's under normal and late sown conditions. All the crop phenological stages *viz*. days to booting, anthesis and maturity were reduced under late sown conditions. Further, significant reduction in various yield and quality parameters was recorded under heat stress conditions. Canopy temperature depression (CTD) was higher on 16 DFA and decreased thereafter under normal sown condition, whereas it was higher on 0 DFA and decreased continuously in late sown condition. Chlorophyll content, carotenoid content, growth parameters *viz*. plant height, flag leaf area, tiller number and pollen viability; yield attributing traits *viz*. spike length, spikelet number, spike density, seeds per spike, one thousand seed weight and grain yield per plot; physical and physiological quality of seed recorded a significant

reduction due to higher temperature. Starch and total antioxidant potential decreased in seeds obtained from late sown condition, whereas protein content and hydrogen peroxide activity increased. Based on morpho-physiological and yield component traits under late sown condition, CMS 3083 was the best performer followed by CMS 2019, CMS 2046, R 965 and R 958. Based on mean performance of hybrids for yield traits, five hybrids *viz* CMS 3083 x T 2003 R, CMS 3083 x R 902, CMS 3083 x R 958, CMS 3083 x R 965 and CMS 2019 x R 965 were found better cross combinations under both normal as well as late sown Delhi climatic conditions. These could be used to obtain homozygosity by using pure line/pedigree method in wheat breeding for future hybrid seed production programme.

A. Sanyal and M. A. Joshi
ICAR-IARI, New Delhi

Studies on application of polymer, spermine and scape regulation on seed yield and quality in onion (*Allium cepa* L) and garlic (*Allium sativum* L)

The present investigation was conducted at Seed Production Unit, ICAR-IARI, New Delhi during *rabi* 2015-16 and 2016-17 with the objectives to study the effects of application of polymers, plant protectants, spermine and scape regulation on growth, disease intensity, thrips incidence, seed yield and seed quality. Onion mother bulb coating with polymer and 0.15% fipronil+0.25% (carbendazim+mancozeb) showed significantly higher values for seed yield attributes *viz* productive scapes plant^{-1} (5.56), umbel diameter (6.97 cm), 1000-seed weight (3.44 g), seed yield plant^{-1} (21.15 g), seed quality attributes-seedling length (10.18 cm), vigour index-I (923.42), vigour index-II (1752.10), lowest scape lodging (21.16%), EC (188.38 µmhos/cm/g), percent disease index (34.96) and thrips plant^{-1} (5.35). The residue of fipronil and carbendazim after 30 DFP in polymer coated bulbs were 2.04 ppm and 0.60 ppm, respectively, whereas pesticides applied as water soaking was 0.36 ppm and 0.05 ppm, respectively. In garlic seed crop the application of polymer along with 0.25% (carbendazim+mancozeb) resulted in higher clove sprouting. Polymer coating and 0.15% fipronil + 0.25% (carbendazim+mancozeb) showed significantly higher values for attributes *viz*. bulb diameter (4.43 cm), lower disease incidence (27.95%) and number of thrips plant^{-1} (1.17), whereas polymer coating along with 0.15 % fipronil had highest cloves bulb^{-1} (22.74) and yield plant^{-1} (17.48 g).

Pre-harvest spray of 1.00 mMspermine recorded higher seed quality when germinated under favorable conditions. Plants sprayed with (0.25mM) spermine recorded least deterioration due to accelerated ageing, highest germination (70.33%), seedling length (9.52 cm), seedling dry weight (16.03 mg), seed vigour index I (666.36), seed vigour index II (1114.77), SOD (0.032 unit/min/g of seed), POD (0.117 Δ/min/g of seed) were recorded in spermine sprayed plants. In plants raised from one-year ambient stored seeds, sprayed with 1.00 mM, pre-harvest recorded highest seed viability and vigour. Seed priming with 1.25 mMspermine recorded significantly higher seed quality attributes over non-primed seeds, but was on par with halo-priming. Seed priming with 1.25mM spermine had minimal deterioration with accelerated ageing and recorded the higher seed quality attributes *viz* germination (59.33 %), speed of germination (1.54), seedling length (9.10 cm), seedling dry weight (20.10 mg), seed vigour index I (541.03), seed vigour index II (1072.47), SOD (0.11 unit/min/g of seed) and POD (0.03 Δ/min/g of seed).

Scape regulation showed significant influence on seed quality. The scape length and umbel diameter were significantly higher in plants retained up to three scape plant^{-1}. Highest number of florets umbel^{-1} (727.75), seeds umbel^{-1} (1464.62) was recorded in plants with one scape plant^{-1}. Plants with single scape produced 88.78 % more seed yield umbel^{-1} in comparison to plants with six scapes plant^{-1}. Seed quality parameters like 1000-seed weight, speed of germination and seedling vigour were higher in plants having up to four scape plant^{-1}.

V. R. Yalamalle and B. S. Tomar
ICAR-IARI, New Delhi

Seed development, maturation and characterization in Marigold (*Tagetes* spp)

Studies on seed development, maturation and characterization in selected marigold (*Tagetes* spp.) involving four genotypes (two each from African and French type) were carried out in Division of Seed Science and Technology, ICAR-Indian Agricultural Research Institute, New Delhi. The crop was raised on ridges at divisional experimental farm during *rabi* 2015-16 and 2016-17 following RBD and CRD designs. The flowers buds were tagged every day from start of anthesis. Seeds were harvested at periodic intervals and used. The on-set of germination started on 8-9 DFA and 4-6 DFA; physiological maturity was witnessed during 42-44 DFA and 36-39 DFA; and harvest maturity was identified and mature seeds can safely be harvested between 46-48 DFA and 38-40 DFA in African types and French types, respectively. Besides, ABA and GA (A_3 basis) were identified and quantified on different stages of seed development *ie* on seed set, on-set of germination, physiological and harvest maturity. The levels of ABA and GA at different stages of seed development varied. At the initial development of seed, higher levels of ABA, followed by decrease as seed advanced maturity; balanced with GA on physiological maturity; and slightly increased at harvest maturity; on the other hand, GA levels were low at initially stages of seed development; which increased with increased seed germination and register a slight decline on harvest maturity. Thus, it provided a physiological basis for seed development and maturation. Further, total oil content in seeds at seed physiological and harvest maturity showed varied levels of oil content in seeds; with a maximum (35%) in PNG and PA to a minimum of 12% in GO; which also provided a biochemical basis for seed maturity in marigold. Studies suggested that marigold may be considered as a new and potential oil seed crop.

Influence of capitulum position on flower characteristics, seed geometric properties and quality at full botanical maturity in the African type (cv Pusa Basanti Gainda) and French type (cv Pusa Arpita) from terminal and lateral positions; and seeds (within a capitulum) from outer (1-3 whorls), middle (4-6 whorls) to inner (7-9 whorls) showed variations. Besides, seed geometric properties from terminal capitulum showed changes even between whorls 1 and 2. Further, high quality seeds can be obtained from outer and middle whorls of terminal to lateral-I capitulum (up to whorl 6). Correlation analysis between seed geometric properties and quality showed that seed area and equivalent diameter were identified as better indices for seed quality. The studied genotypes can be distinguished using various morphological descriptors (*viz.* plant height, number of primary and secondary branches, number of leaflets/leaves, peduncle length, flower diameter, flower colour, seed yield and 1000-seed weight) either individually or in combination; and alternatively using leaf/leaflet traits like serrations on leaf margin, venation pattern, etc. The distinction of genotypes was also possible using isoenzymeguaiacol-peroxidase (GPx) expression, based on

Phenomics of marigold plants

the Rm value, number of bands and intensity. Seed geometric properties (*viz.* area, length, perimeter, equivalent diameter, axial length, axial width, median length and median width) were explored to distinguish the genotypes accurately and non-destructively; besides, physiological characteristics (*viz.* plant area and caliper length) using plant phenomics. Among the various seed priming treatments, GA_3 (50 ppm) and KNO_3 (3%) for 24 hr under laboratory temperature had shown higher responses to the seed quality; thus, it can be recommended to improve the poor quality (low vigour) seeds of marigold during planting.

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USEFUL TIDINGS

ISTA Vigour Tests

Seed vigour is one of the most complex phenomenon and a difficult trait to quantify. Seed vigour is not a single measurable property. It is the sum of those properties that determine the activity and performance of seed lots of acceptable germination in a wide range of environments. The long-time research on various vigour tests in different crops by numerous seed researchers has led to the finalization of certain vigour tests for a limited number of crops. Vigour test methods are species specific and require suitable equipment and control samples. The International Seed Testing Association has completed the validation of the following vigour tests for the given crops.

Vigour Test	Suitable for Species
Conductivity test	*Cicer arietinum, Glycine max, Phaseolus vulgaris, Pisum sativum* (garden peas only, excluding petit-pois varieties), *Raphanus sativus*
Accelerated ageing test	*Glycine max*
Controlled deterioration test	*Brassica* spp
Radicle emergence test	*Zea mays, Brassica napus* (oilseed rape, Argentine canola), *Raphanus sativus*
Tetrazolium vigour test	*Glycine max*

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