



ICAR - NRCB NEWSLETTER

ICAR - National Research Centre for Banana

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From Director's Desk

ICAR – NRCB, established in 1993, is proudly celebrating its Silver Jubilee year. The Centre has grown and established its name for its state of art infrastructure, quality research, outreach programmes and extension activities. The Centre launched its Silver Jubilee celebration on 17th Feb., 2018 inaugurated by Hon'ble Dy. Director General (Hort. Science), ICAR, New Delhi - Dr. A.K.Singh, in the presence of Mr. S.N.A. Jinnah, Chief General Manager, NABARD, Chennai; Dr. B.M.C.Reddy, Former Vice Chancellor, YSRRHU, Andhra Pradesh and Dr. Prakash Patil, Project Coordinator - AICRP on Fruits, ICAR-IIHR, Bengaluru. The 5th group discussion of All India Coordinated Research Programme on Fruits was held at ICAR-NRCB and 180 scientists from different parts of the country participated in this meet. Series of Silver Jubilee programmes were planned and conducted like National Banana Festival - 2018 in collaboration with CISSA and Govt. of Kerala; QRT Meeting of ICAR-AICRP (Fruits), consultative meetings like 'Quarantine and Biosafety issues relating to *Fusarium* wilt - TR-4'; 'Application of Nanotechnology for enhancing production and productivity of banana'; series of Silver Jubilee lectures by eminent scientists from India and abroad. First consignment of banana was flagged-off to Dubai via sea using sea-port technology of ICAR-NRCB, which would be extended for the export of other traditional banana varieties of India. This year is recognized as 'Banana Export Year' where new ventures have been initiated and taking them forward with the help of banana federations, FPO's, State government and other agencies like APEDA.



As a part of Silver Jubilee Celebrations, tree guards, dust bins, waste collection boxes were distributed to adopted village

school. Toilet and drinking water facilities were created, sitting mats were supplied and best performing students were honoured.

This issue has focused on banana crop physiology. Banana cultivation demands assured irrigation throughout the season and it grows minimum of one year to give yield. Due to vagaries of weather, banana farmers facing irrigation water shortage during non-rainy season. To alleviate the negative effects of drought stress in banana, ICAR-NRCB has developed technologies. Also banana genotypes have been identified to grow in water limited environment and also in salt affected soil. Pre-flowering stored photosynthate and post-flowering current photosynthesis plays major role in bunch development in banana. Application of potassium sulphate as bunch spray has improved fruit development in major banana cultivars.

The drought stress alleviation technologies like, popularizing drought and salt tolerant variety – Saba; use of stress ameliorating chemicals, bunch sprays are being tested on large scale and some under AICRP-Fruits across the country. Krishi Vigyan Kendras (KVK) are being used as our technology conveyors and results are encouraging. Other research highlights are briefed in this Newsletter.

Amal

IN FOCUS

Physiology of flowering and fruit development

Deleafing of disease affected leaves at flowering in banana

Excising leaves with more than 50% necrotic area can reduce the spread of the leaf spot disease. Secondly, one or two young healthy leaves which are rubbing and scarring fingers on the developing bunch may be sacrificed to improve the fruit quality, if bunch covers are not used. Thirdly, keeping optimum number of leaves promotes light penetration to the lower leaves,

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reduces water loss through transpiration. Keeping 8-10 young leaves are sufficient at flowering for normal fruit development in Robusta, Karpuravalli, Ney Poovan, Saba, Poovan, Nendran, without affecting fruit quality. Deleafing of older leaves and keeping optimum number of younger leaves at flowering did not affect the starch content and post-harvest quality characters.

Pre-flowering stored starch mobilization

Pre-anthesis storage of starch in corm plays important role in sink development (fruit filling). In banana, sizable amount of starch is stored in corm and it is mobilized towards fruit filling. This mechanism is very important when plants are facing current photosynthesis reduction due to biotic and abiotic stresses. Genotypic difference in contribution of pre-anthesis storage of corm starch towards developing fruit was established. Banana cvs. Karpuravalli, Ney Poovan and Robusta could mobilize pre-anthesis stored starch better from corm to developing banana fruits.

Banana Cultivars	Percentage of starch mobilization from corm to fruit development
Rasthali (AAB)	73.81
Pachanadan	79.14
Robusta	82.05
Ney Poovan	82.64
Karpuravalli	83.52

Post-flowering contribution towards bunch development

Post-flowering contribution towards bunch (sink) development by different sources was established among popular banana cultivars. The current photosynthesis (leaf photosynthesis) contributes around 52 % for cvs. Rasthali and Ney Poovan. Whereas in cvs. Karpuravalli and Saba, pre-flowering storage contributes around 66%. The contribution of photosynthesis to finger development ranged from 3.14 - 7.07%.

Importance of amylose content in un ripened banana fruits

Banana and plantains mainly differ based on their utility, as former has been used for table purpose and latter utilized mostly for cooking purposes. In un-ripe banana fruit (80-90% maturity), starch content recorded in the range of 80.53 - 86.76 % and amylose content ranged from 24.41 to 36.87 %. The un-ripe fruits of plantain and cooking bananas have around 34 % of amylose and Robusta, Rasthali and Ney Poovan recorded amylose < 30%. The amylose content differentiates the dessert bananas from plantain and cooking bananas.

Application of bunch growth regulator

In post flowering, bunch spraying with plant growth regulator substantially increases finger growth, weight and improves appearance. Application of potassium sulphate (1.5%) as bunch spray after full opening of bunch and 15 days after first spray has increased finger length (15.12%), girth (7.26%) and bunch weight (ca. 1.5 kg) over unsprayed normal matured bunch.

Drought stress tolerance in banana

Plant water deficits may occur as a consequence of seasonal decline in soil water availability, developing in the long term, or may result from drought spells. Water deficit occurs when water potentials in the rhizosphere are sufficiently negative to reduce water availability to sub-optimal levels for plant growth and development.

The timing, intensity and duration of stress episodes are pivotal to determine the effects produced by drought. The water deficits reduce the productivity of banana by 30-50%.

Banana flowering phase is more sensitive to soil moisture deficit

Maintenance of optimum soil moisture (80-90% in field capacity) at floral primordial initiation stage and flowering to first one month is most critical for normal bunch development. Soil moisture stress at these stages could reduce the bunch weight to the tune of 42.07% in susceptible banana cultivars (eg. Robusta, Grand Naine, Nendran, Rasthali). When a farmer maintains to banana plantation at different stages, the lifesaving irrigation must be provided to those plants which are in floral primordial initiation and shooting stage, to avoid major yield loss.

Alleviation of drought stress

Foliar priming of banana plants with 0.1mM acetyl salicylic acid prior to drought stress acclimatizes the plants to face drought, through better cell membrane stability index, antioxidative enzymes like, ascorbate peroxidase, catalase and SOD. These foliar primed plants have better recovery during post drought stress recovery period than non-primed plants.

Farmer's trial

A trial was conducted at farmer's field at Thottiyam, Namakkal Dt., Tamil Nadu on soil moisture stress relieving chemicals. The moistures deficit stress relieving chemicals was given as foliar spray in banana cv. Rasthali a month before flowering. The results revealed that application of ASA (0.1mM) + BHT (100 ppm) + KNO₃ (0.75%) recorded no leaf crinkling, less leaf drying, better bunch throw with sufficient spacing between hands. Whereas in untreated plants, the leaf crinkling, extensive leaf drying and poor bunch throw was recorded.

Evaluation of bananas with drought tolerant traits in the field

At ICAR-NRCB, we have field evaluated eighteen banana genotypes of different genomic groups (AAA, AAB, ABB) to identify drought stress tolerant banana genotypes. These genotypes were studied for stomatal conductance, cell membrane stability index, leaf emergence rate, rate of leaf senescence, RWC, and bunch yield under soil moisture deficit stress. The banana genotypes with ABB genome, viz., Saba, Monthan and Vennutu Mannan recorded higher bunch yield under drought stress. Among all, Saba, an exotic introduction through ITC, is the most drought tolerant banana genotype.

The *DREB* gene was amplified from the genomic DNA of cvs. Saba, Pachanadan and Ney Poovan. The size of the product was ca.400bp. A dehydrin gene was amplified from genomic DNA of banana cv. Saba. This gene was amplified by primer designed from ESTs of *Sk3 dehydrin* available from NCBI site. The amplicon size was 750 kb.



Fully matured bunch of Saba

Salt tolerance in banana

In saline-sodic soils (EC_{1:2.5} = 3.34 dSm⁻¹, pH 8.1), banana suffers from salt injury with external

symptoms of marginal chlorosis of leaves, less photosynthetic activities and less finger weight leading to yield loss.

Saba, also the salt tolerant banana genotype, accumulates higher nitrogen content in 2nd and 3rd leaf petioles and N, P and K in the inner core of corm at flowering compared to susceptible cultivars (Robusta and Nendran). The K^+/Na^+ ratio (> 200) of 3rd leaf and leaf petiole was recorded 50-60 fold higher in salt tolerant varieties (Saba and Karpuravalli) than susceptible cultivars (Nendran and Robusta). The salt tolerant traits of banana appeared to maintain higher K^+/Na^+ ratio in leaf tissues, higher NPK content in the corm and significant mobilization of Mg and Ca from the corm during fruit development. In salt susceptible banana cultivars (Robusta and Nendran), salt toxicity affects fruit filling. The salt tolerant banana cultivars have normal fruit development.



Salt injury symptoms

Post-harvest physiology

Chilling Injury (CI) is a physiological disorder. It develops in fruits while storing at non-freezing temperature below 12°C. In cv. Robusta, un-ripe banana fruits stored at 10°C recorded physical injury symptoms like pitting, browning on the peel unlike at 13.5°C. The un-ripe banana fruits stored at 13.5°C recorded significantly higher β -amylase activity than those stored at 10°C. The amylase gene (*Bmy 8*) is cold inducible and this product is involved in starch breakdown. The *Bmy8* was amplified from banana fruits and size of the amplicon was 900.

OTHER RESEARCH HIGHLIGHTS

Crop Improvement

- ◆ Survey in the North Eastern region of India led to the collection of 15 *Musa* accessions including *M. nagensium*. 29 accessions were collected from secondary sources and added to the genebank.
- ◆ Performance of NRCB selection 11 (Manoranjitham variant) was found better at higher elevations. Front line demonstration of NRCB selection 8 (Bangrier) and NRCB selection 9 (Saba) indicated that they could sustain cyclonic winds due to robust stem girth.
- ◆ Among the eight dwarf mutants received from BARC, Mumbai for evaluation, TBM 9 performed better in the farmers' field.
- ◆ Production of large scale plantlets from embryogenic cell suspension culture using bioreactor has been standardized for different cultivars of banana namely Grand Naine, Rasthali and Sabri.
- ◆ Progeny No 685 (Saba x Pisang Lilin) and Progeny No 690 (Saba x Pisang Lilin) were identified for their high yield and good cooking quality.



Progeny No 685

Progeny No 690

Crop Production

- ◆ Under organic banana farming, highest leaf nutrient concentrations (%) were recorded with application of poultry manure + groundnut cake + rural compost + wood ash + VAM + PSB + KSB at 20 leaf stage and shooting stage.
- ◆ The flavonoids content was high in Nendran peel extract attributing to its antioxidant activity and they showed highest tumor inhibition of the breast cell lines.
- ◆ Application of potassium sulphate (1.5%), as bunch spray in soil moisture stressed banana plants increased the fruit weight by 17.35 % more than drought stressed plants in cv. Grand Naine.
- ◆ 1-MCP treated Grand Naine bananas at 1 μ L (500 ppm) for 12 hr with ethylene spray ripened within three days.
- ◆ Among the cultivars, Ney Poovan exhibited highest Glycemic index followed by Karpuravalli and Grand Naine. Starchy cv. Monthan had the least Glycemic index.
- ◆ Anthocyanin pigment contents in six bracts of male flower bud varied between 57.8 mg in Ney Poovan and 22.2 mg in Grand Naine per 100 g of pigment yielding bracts. Other higher yielding cultivars were Hill banana (57 mg), Poovan (55), Rasthali (54.7), Pachanadan (53) and Nendran (52.5).
- ◆ Anthocyanin pigments at the rate of 52mg/100g fresh weight could be successfully extracted from flower bracts of Nendran, spray dried and encapsulated at 400mg per capsule for further evaluation as biomolecule.
- ◆ Under active packaging, improved post-harvest handling treatments, followed by packing in polybag and kept at cold storage at 13.5°C extended the shelf-life of banana cv. Grand Naine for 108, 94 and 60 days with respect to 75, 85 and 95% maturity, when compared to control, respectively.



Macro-encapsulated anthocyanin pigments from banana flower bracts

Crop Protection

- ◆ GC-MS analysis of volatiles from the wilt infected banana (cv. Ney Poovan) leaf sheath revealed the presence of functional groups viz., Aldehyde (1), Dicarboximide (1) and fatty acid ester (FAE:9).
- ◆ Survey conducted in banana cv. Grand Naine in Uttar Pradesh (Faizabad), Madhya Pradesh (Burhanpur), Gujarat (Surat), West Bengal (Nadia) and Karnataka (Chikkeballapura and Bengaluru) revealed that except in Karnataka all other states recorded an incidence of 10-50%. Characterization of *Fusarium* wilt indicated the presence of Tropical race 4 in UP while it was race 1 in the other states.
- ◆ Entomopathogenic nematode isolates viz., *Rhabditis rainai*, *Steinernema siamkayai* and *Heterorhabditis indica* were isolated



Banana field (cv. Grand Naine) devastated by Tropical Race 4 of *Fusarium* wilt in Faizabad district, U.P.

and tested against banana stem weevil under *in vitro* conditions.

- ◆ Rapid and cheaper method of isolation of crude DNA from *Eumusae* leaf spot infected tissues was developed and it took only 2 hours as against 18hrs in the normal method of isolating DNA for PCR analysis.
- ◆ Seed transmission of banana bract mosaic virus was confirmed besides lace wing bug as additional vector.
- ◆ Occurrence of CMV in *Musa ornata* was recorded for the first time.

OTHER INFORMATION

Silver Jubilee interactive meeting

An interactive meeting on “Application of Nanotechnology for enhancing production and productivity of banana” was held at ICAR-NRCB on 25 November, 2017 where lectures were delivered by eminent faculty members from TNAU, Coimbatore; NIT, Tiruchirappalli and Anna University, Tiruchirappalli.

QRT meet of ICAR - AICRP (Fruits)

Quinquennial Review Team Meet of ICAR-AICRP (Fruits) was held on 19-20 December, 2017. The meeting was presided over by Padmashri Dr. K. L. Chadha, Chairman, and Drs. H. K. Senapathi, Satyabrata Maiti, V. S. Thakur and B. M. C. Reddy, members of QRT team. Scientific delegates from various ICAR institutes and state agricultural universities (SAU) participated in the meet. Banana stakeholders' meet was also organized as part of the QRT and the meeting was attended by farmers, innovators, entrepreneurs and delegates from SAUs, ICAR-KVKs etc.

Consultative meet on Fusarium wilt, Tropical race - 4

A consultative meet on 'Quarantine and biosafety issues relating to Fusarium wilt Tropical race - 4: An emerging threat to banana cultivation in India' was held at ICAR-NRCB on 21 December, 2017 where Scientists from different centers *viz.*, Dr. N. K. Krishna Kumar, Regional Coordinator - Bioversity International, New Delhi; Dr. Rajan Sharma, Head (Quarantine Unit), ICRISAT, Hyderabad; Dr. N. Sathyanarayana, Joint Director (PP, DPPQS), Faridabad; Dr. M. Anand Raj, Former Director, ICAR-IISR, Calicut; Dr. S. C. Dubey, Head, Plant Quarantine Division, ICAR-NBPGR, New Delhi; Dr. B. K. Pandey, Principal Scientist, ICAR, SMD(Hort. Sci.), New Delhi; Dr. A. S. Krishnamurthy, Head, Plant Pathology, TNAU, Coimbatore and Dr. K. Soorianathasundaram, Professor, Horticulture, TNAU, Coimbatore participated and issues related to research, biosafety and quarantine of tropical race 4 of Fusarium wilt disease were discussed.

National Banana Festival - 2018

ICAR-NRCB participated and exhibited more than 60 different banana varieties in 'National Banana Festival' held at Thiruvananthapuram, Kerala from 17-21 February 2018. The event was organized by Centre for Innovation in Science and Social Action (CISSA), Kerala.

Fifth annual group discussion of ICAR-AICRP (Fruits)

Fifth annual group discussion of ICAR-AICRP (Fruits) was hosted by ICAR-NRCB, Tiruchirappalli from 15-18 February, 2018. Delegates from different SAUs and ICAR institutes participated. On this occasion, silver jubilee celebration of ICAR-NRCB was formally inaugurated by Dr. Anand Kumar Singh, DDG (Hort. Sci. & Crop Sci.), ICAR on 17 February, 2018. Dr. S. Nagoor Ali Jinnah, CGM, NABARD, Chennai and Dr. B. M. C. Reddy, ICAR, Special Invitee & Ex-Vice Chancellor, YSRHU attended the inaugural function as guests of honour. Directors of ICAR institutes namely, ICAR-IIHR, Bengaluru; ICAR-CISH, Lucknow; ICAR-CCRI, Nagpur; ICAR-NRCG, Pune and ICAR-NRCL, Muzzafarpur were also present in this meeting.



Dr. Anand Kumar Singh, DDG (Hort. Sci. & Crop Sci.), ICAR addressing the gathering at Silver Jubilee Celebrations of ICAR-NRCB

Krishi Unnati Mela 2018

ICAR-NRCB organized Krishi Unnati Mela - 2018 on 17 March, 2018. The farmers meet was attended by over 300 banana farmers from nearby districts such as Tiruchirappalli, Karur, Namakkal, Pudukottai, Perambalur and Ariyalur. Address by the Prime Minister of India was live telecasted at the venue and the gist of his speech was translated to the farmers and other participants. Mr. N. Ravichandran, Commissioner, Tiruchirappalli City Corporation was the Chief Guest of the event. Mr. Manikantan Nair, Deputy General Manager, State Bank of India, Tiruchirappalli and Mr. K. Natarajan, Programme Director, All India Radio, Tiruchirappalli also addressed the meet.

Published by

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