



ICAR - NRCB NEWSLETTER

ICAR - National Research Centre for Banana

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DIRECTOR'S DESK

Banana encounters qualitative and quantitative losses at all stages of post-harvest handling system of the distribution chain. Hence, post-harvest management and processing are important thrust areas in banana research. ICAR-NRCB has made significant achievements in fresh fruits handling including bunch care management and long distance transport of packed bananas, value addition using raw and ripe bananas and waste utilization using peel, central stem, flower, rhizome and pseudostem. The achievements are summarized in this newsletter under 'IN FOCUS'.



During October, 2018 to March, 2019, commendable achievements have been made by the centre both in research as well as in service. Three banana selections *viz.*, Kaveri Saba, Kaveri Kalki and Kaveri Sugantham, which were identified by ICAR-NRCB has been successfully notified and released by State Varietal Release Committee, Tamil Nadu. For the first time in history of council, ICAR-NRCB has successfully developed transgenic banana of cv. Grand Naine enriched with vitamin A and iron. The centre has identified more than 30 lines of banana germplasm accessions showing resistance to tropical race 4 (TR-4) of *Fusarium* wilt, an emerging threat to banana cultivation in India.

Quinquennial review team (QRT) of ICAR-NRCB had visited the centre during 25–26 February, 2019 under the chairmanship of Dr. K. V. Peter, Former Vice-Chancellor, KAU. The centre has conducted 22nd Institute Research Council meeting (IRC) and 24th Institute Management Committee meeting (IMC) during October, 2018.

The centre, in association with Tamil Nadu Banana Grower Federation, Thottiyam has successfully shipped fruits of banana cv. Grand Naine to Italy which was flagged off by DDG (Hort. Science), Agriculture Minister (Tamil Nadu), APC (Tamil Nadu) and others. The centre has signed an MoU with Tripura Biotechnology Council for supplying tissue culture 'Sabri' banana plantlets.

ICAR-NRCB, in association with Indian Phytopathological Society have successfully organized a National symposium on 'Cutting edge approaches for sustainable plant disease management and ensuring farmers' profit' during 21-23 December, 2018 at the centre. Three workshops *viz.*, Sensitization of *Fusarium* wilt, tropical race 4 (TR-4); Workshop on Arabi to Banana and ICAR-KRISHI Portal were successfully organized by the centre.

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In Focus

POST-HARVEST MANAGEMENT IN BANANA

Banana, being a climacteric fruit is highly perishable and has got a short shelf-life after harvesting. The post-harvest losses are high to the tune of about 25% due to faulty handling adopted by farmers, traders and retailers valued for more than Rs.2500 crores annually. Besides these losses, there is an invisible loss due to the physiological loss in weight during ripening phase. The institute has been focusing on handling fresh bananas and developing scientific postharvest operations for export and domestic markets by reducing post-harvest losses. ICAR-NRCB has also developed improved technologies for better utilization of various banana parts *viz.*, fruit, flower, central core stem etc. by converting them into value added products.

Post-harvest management of banana fruits

Post-harvest management technologies with modified atmosphere package (MAP) were developed for banana cvs. Grand Naine, Udhayam, Ney Poovan, Nendran, Red Banana and Mortaman. Improved post-harvest handling practices, packing in polybags, and cold storage at 13.5°C has enhanced the shelf of banana cv. Grand Naine to 94 days with 85% maturity.

Traditional banana Nendran when harvested at 80-85% maturity with scientific postharvest handling practiced extended the shelf life upto 32 days.

A successful joint venture by the ICAR-NRCB, Tiruchirappalli, APEDA (Ministry of Commerce & Industries, GoI, New Delhi) and Fair Exports (India) Pvt. Ltd., Kochi under the Public Private Partnership (PPP) mode set an Indian export to Dubai Sea Port with its 'Made in India' Farm Fresh Nendran Bananas. The transport cost has been brought down by one-seventh, compared to air lifted bananas.

Effect of bunch orientation on quality of fruits of banana cv. Udhayam

In banana cv. Udhayam, the hands located in the east direction of the bunch had maximum starch content (31.86%), TSS (9° Brix) and minimum acidity (0.076%) at harvest with ripe fruits containing maximum pulp : peel ratio (3.60), total sugar (26%) with minimum acidity (1.33%).

Post-harvest management of banana flower

The shelf-life of banana flowers (male buds) was extended up to ten days when the flowers were kept in 200 gauge polybag at 20°C, followed by vacuum packing.

Post-harvest management of banana central core stem

The shelf-life of banana central core can be extended up to 32 days when the central core was cut in to cubes (7.5 cm thickness with 1.5 cm dia.) / slices (5mm thickness with 30mm dia.) and stored at 5-6°C after treating them with 0.1% each of potassium meta-bisulphite (KMS) and citric acid for 30min. and sealed in 200 gauge HDPE polybag. Variety wise difference in use of preservative was identified.

Citric acid (0.5%) was found better in preventing browning of central core stem for banana cvs. Pachanadan and Poovan, whereas, KMS (0.5%) was found better for cvs. Karpooravalli, Ney Poovan and Saba. KMS (0.5%) along with sodium chloride (0.5%) was found suitable for cv. Mortman.

Juice content from central core stem and corm of different banana cultivars

Central stem of cv. Udhayam (94.6%), followed by Red Banana (94%) and Saba (91.50%) recorded more juice content. Similarly, corm juice recovery was also more with cv. Udhayam (94.8%), followed by cv. Nendran (91%) and Saba (88.55%).

VALUE ADDITION AND WASTE UTILIZATION

Value added products from ripe banana

More than 25 different value added products have been developed from banana and the process has been standardized. Cloudiness is the main problem on banana juice industry. Technologies were standardized for clarification of juice and preserve it for more than six months. 'Sip-up', a banana pulp based product was developed and storage conditions was standardized. A ready to-eat product, 'Pazhampori' and a ready to-drink, 'Banana pulp based beverage' were also developed. Banana jam was refined by mixing other fruit pulp (*esp.* apple).

Banana fig, a dehydrated ripe banana is the most popular product from ripe banana could be a packed nutri-snack for defense personnel and could be a supplement for school going kids to meet out their nutrients and to prevent hidden hunger like vitamins and minerals. Banana fig was refined by adding honey (85%), lemon and ginger juices. Institute also refined the technology to suspend the basil seed in the ripe banana clarified juice to enhance the functional values. Cookies and biscuits were made using the pomace, a left over in the Banana juice industry. Banana pickle was prepared from immature and fallen fruits.

Value addition in raw banana

Efforts were made to make banana slices which can retain its freshness atleast for two weeks after slicing. Employing pre-treatments and packing in suitable packages retained the lustre and turgidity of the slice for two weeks under refrigerated condition.

As banana flour made from unripe banana has a good amount of resistant starch (17.5%) and non-starch polysaccharides (14.5%), it could be used for the modulation of glycemic index, diabetes and weight management. Extruded snacks like pasta were prepared with the varying concentration of banana flour and modified starches. Noodles were enriched with carrot and beet root juices to increase the antioxidants in the finished product. Technologies for the preparation of various kinds of biscuits, baby food, health drinks, multi-flour mix, diabetic-flour were standardized by the institute. Process for the extraction of starch and modification of starches was also standardized by the institute.

Value added products from banana waste

Around 13 different technologies were developed for the utilization of banana wastes like banana flower, peel, rhizome and central stem. Ginger (4%) flavoured central core stem juice and

Nannari (4 & 6%) flavoured RTS central core stem juices were developed which can be stored for six months. Banana central core stem juice based jelly, squash and syrup were developed by blending stem juice with sugar and citric acid at various proportions. Banana central core based soup mix and ice cream mix were also developed. Banana flower thokku, stem pickle are being commercialized and has a great market impact on export markets. Technology for making banana peel into pickle and powders has been developed. The use of banana peel as the potent substrate to fight cancer was also established by the institute. Nutraceutical importance of the various banana parts was documented by the institute. With its higher functional nutrients central stem and peel was explored to make various confectionary products like cookies, bread, pizza and muffins.

Banana fibre: Golden yarn

More than two-thirds of the total biomass produced during banana cultivation consisted of pseudostem, leaves, mid rib, peduncle and corm. Banana pseudostem is a waste material after the harvest. 9-10 layers of sheath of pseudostem could be used to extract fibre. The fresh pseudostem yields about 1-1.5% of fiber. It is estimated that annually 30 million tons of biomass is produced through banana cultivation, from which there is scope to produce 1.5 million tons of banana fiber as byproduct, which otherwise recycled into soil for enrichment or goes as a waste. Banana fibre softening procedure was standardized.

Several handicrafts like file cover, floor mat, yoga mat, fruit basket, flower basket, *etc.*, can be made from coarse fiber extracted from outer sheath of banana pseudostem.

RESEARCH HIGHLIGHTS

Crop Improvement

- Three ICAR – NRCB selections *viz.*, Kaveri Sugantham, Kaveri Kalki and Kaveri Saba were released by State Varietal Release Committee, Tamil Nadu.



Kaveri Kalki



Kaveri Saba



Kaveri Sugantham

- ICAR – NRCB has developed Nendran based banana hybrids, NCR 17 (yielding 26 kg bunch) and NPL 33 (desert banana).
- Embryogenic cell suspension (ECS) derived plants were developed from banana cvs. Ney Poovan, Red Banana and Sabri.
- Six indigenous and three wild banana accessions were collected. Morphotaxonomic characterization was done for 21 accessions and molecular characterization was done for 14 North Eastern wild germplasm lines using SSR and ISSR markers.
- Screening for Fusarium wilt (race 1 at Tamil Nadu and tropical race 4 at Bihar) resistance in banana core collection accessions was done and identified five resistant accessions. 153 accessions were genotyped using 26 SSR primers and 32 accessions were phenotyped for Fusarium wilt by association mapping. 11 putative mutants showing resistance to Fusarium wilt race 1 (3 nos.) and race 4 (8 nos.) were identified.

- Full length Leucine-rich repeat receptor-like protein (LRR-RLPs-39nos.) and Leucine-rich repeat receptor-like protein kinase (LRR-RLKs-16nos.) genes were amplified, cloned and sequenced from roots of both Fusarium wilt race 1 resistant and susceptible cultivars.
- Three explorations were made in different parts of Tamil Nadu and Karnataka states and collected 16 elite clones of banana cultivars Grand Naine, Ney Poovan and Nendran for traits such as high yielding, dwarf stature and shy suckering (without side suckers).
- Induction of callus and embryogenic callus and their germination were achieved from anthers. Putative gynogenic haploids were produced through wide crossing involving inter family and inter specific crosses. About 2000 F1 ornamental banana hybrids were produced from 19 different crosses.
- Mineral content analysis was completed for 205 banana genotypes using ICP-OES. LD50 for oryzalin and EMS for induction of euploids / aneuploids were determined in ornamental bananas.

Crop Production and Post-Harvest Technology

- Flower bracts of banana cvs. Red Banana (95mg/100g) and Nendran (83mg/100g) contain highest amount of anthocyanins among the 12 commercial cultivars tested. Flower bracts of Monthan-II (345mg/100g) and Bhat Manohar (268mg/100g) contain highest anthocyanins among the 52 germplasm accessions evaluated.
- Treatment of pedicel region of finger drop susceptible cv. Rasthali with 500 ppm gibberellic acid and 6% calcium chloride prevented finger drop by 40% and 50% respectively.
- The gas exchange properties of ABB banana genotypes and North Eastern banana genotypes were characterized and cultivars, Kothia, Kachkel, Pacha Bontha Batheesa were recorded Pn, gs and E which was on par with that of cv. Saba (drought tolerant), whereas, cvs. Sabari and Borjhaji were with lower gas exchange parameter values.
- The high temperature tolerant traits of PSII activity in terms of Y(II) recorded significantly lower in cvs. Rasthali and Nendran compared to cv. Saba.
- Under nutrient dynamics study, dry matter production by various parts of banana plant was calculated for cvs. Nendran and Grand Naine. Similarly, composition of various macro and micronutrients were estimated for banana cvs. Nendran and Grand Naine.
- Under clump management study, highest plant growth parameters were recorded in treatment Mother plant + 4 suckers in cv. Ney Poovan. Similarly, all these parameters were found higher in plants applied with the highest nutrient dose (175% recommended dose of fertilizer per clump).
- ICAR-NRCB in collaboration with ICAR-CIAE (Regional station), Coimbatore developed two models of modified banana sucker paring equipment and evaluated.
- Storing banana leaves at 13.5°C increased shelf-life of banana cvs. Poovan, Naadu and Karpooravalli by 9, 7 and 6 days respectively.
- Under the technical support of ICAR-NRCB expert team, fruits of banana cv. Grand Naine were harvested, processed, packed and successfully exported to Italy via sea route.
- Among the banana cultivars tested, cv. Saba recorded maximum peel recovery (44.68%), followed by cv. Monthan (41.92%) and cv. Nendran (36.65%). However, maximum peel powder recovery was recorded with cv. Pachanadan (9.15%), followed by cv. Monthan (9.07%), cv. Nendran (9.04%), cv. Saba (7.45) and cv. Karpooravalli (4.10%).
- Light transmittance was reduced in the flour and starch of cvs. Monthan and Nendran when it was stored at 4°C. All the banana starch granules were solubilized at 90°C except cv. Monthan.
- Flour of Monthan, Grand Naine and Saba were recorded higher swelling and water holding power at 70-90°C while Popoulu recorded higher solubility.

Crop Protection

- Three corm weevil resistant and 11 stem weevil tolerant genotypes were identified.
- GC-MS profiling was done for healthy and infected (banana bunchy top virus and Fusarium wilt) samples and identified specific metabolites due to infection.
- *Dysmicoccus brevipes* (Cockerell), *D. neobrevipes* Beardsley, *Scirtothrips dorsalis* Hood, *Anascirtothrips arorai* Bhatti and *Pseudodendrothrips mori* (Niwa) were recorded as pests of banana. Preliminary life table studies of banana aphid were done on cv. Grande Naine. Distribution maps prepared for pseudostem weevil and scarring beetle using geospatial data.
- Biocontrol agents, *Bacillus flexus* (Tvpr1) and *Trichoderma asperellum* (Prr-2) were found effective against root-lesion (*Pratylenchus coffeae*) and root-knot nematodes (*Meloidogyne incognita*) under *in vitro*. *T. asperellum* (Prr-2) was found more effective in reducing root-knot nematode population in banana cv. Grand Naine under pot conditions.
- Among the seven hybrids screened for resistance to root-knot nematode (*Meloidogyne incognita*) progeny 134 (Anai-komban x Matti) was found resistant.
- Sampling at Fusarium wilt (Foc) infected fields of Madhya Pradesh and Gujarat showed that they belong to sub tropical race 4 and Foc from West Bengal belong to race 1.
- Out of 232 banana germplasm accessions evaluated under sick plot, three accessions in genotype AAA, six each in AAB and AA; five accessions in BB were found resistant to Foc race 1. Out of 225 accessions screened, 35 accessions showed resistant to Foc tropical race 4. Out of nine progenies of Calcutta X Kadali evaluated against Foc race 1, progeny no. 106, 182 and 133 were found highly resistant. Three Grand Naine mutant lines and six lines were found resistant to race 1 and tropical race 4. Out of 67 accessions screened, 20 plants showed resistance to race 1.
- Survey was done in Andhra Pradesh, Bihar and Tamil Nadu and a total of 133 bacterial isolates were collected from different banana cultivars. Characterization of biocontrol agent (IBC1) infecting pseudostem weevil confirmed as *Beauveria bassiana*.
- Primers were designed for developing infectious clones of banana streak mysore virus (BSMYV). Dual expression clone for cucumber mosaic virus (CMV) and banana bract mosaic virus (BBrMV) was developed. Monoclonal antibodies were produced for expressed protein of CMV. Ready to use ELISA kit was developed for BBrMV and CMV. RCA products of six segments of BBTBV bombarded onto TC plants resulted in expression of BBTB symptoms in one plant. The long-term experiment of Poovan for natural expression has been revived by replanting in the same field.

OTHER INFORMATION

Institute Management Committee meet

The 24th IMC meet was held at ICAR-NRCB on 6 October, 2018. Salient research achievements made by the centre during 2018-19 were presented which were appreciated by the members of the IMC. Director, ICAR-NRCB briefed about the infrastructural developments taken place during the last year. Various issues pertaining to IMC were deliberated and discussed.

Institute Research Council meet

22nd IRC meet was held during 5, 12 and 23 October, 2018. Scientists of the centre presented salient research achievements made during 2018 and technical program for the forthcoming year. Scientific discussions were held and recommendations were made.



QRT members with Scientists of ICAR-NRCB

Quinquennial Review Team meet

QRT meet of ICAR-NRCB was held at the centre during 25–26 February, 2019 under the chairmanship of Dr. K. V. Peter, Former Vice - Chancellor, KAU. Salient research findings were presented and the review team visited all the laboratories and the farm and had discussions with the scientists on various aspects of the on-going research projects.

National workshop on 'Sensitization of Fusarium wilt (Tropical Race 4)'

ICAR-NRCB hosted a high-level workshop on "Sensitization of tissue culture industries in preventing the spread of newly emerging disease - Fusarium wilt (Tropical Race 4) of banana" on 26 November, 2018. The meeting was attended by delegates representing major tissue culture companies from different parts of India. Dr. N. Kumar, Vice Chancellor, TNAU, was the guest of honour. Dr. B.N.S. Murthy, Horticulture Commissioner, was the



Dr. S. Uma, Director, ICAR-NRCB addressing stakeholders at National workshop on 'Sensitization of Fusarium wilt - Tropical Race 4'

Chief Guest. Dr. R.R. Hanchinal, Consultant, Bioversity International, attended the meet as a special invitee. Dr. B. Padmanaban, Principal Scientist, welcomed the gathering. Dr. S. Uma, Director, in her inaugural address gave a brief overview of the Workshop.

National Symposium on 'Cutting edge approaches for sustainable plant disease management and ensuring farmers' profit'

Indian Phytopathological Society (Southern Zone Chapter) and the ICAR-NRCB have jointly organized a three days National Symposium on 'Cutting edge approaches for sustainable plant disease management and ensuring farmers' profit' during 21-23 December, 2018 at ICAR-NRCB. The symposium was inaugurated by Dr. N. Kumar, Vice-Chancellor, Tamil Nadu Agricultural University, Coimbatore, with Dr. W. S. Dhillon, ADG (Horticultural Science), Indian Council of Agricultural Research, New Delhi as the Guest of Honour. Dr. S. Uma, Director, ICAR-NRCB; Dr. Dinesh Singh, Secretary, IPS, New Delhi; Dr M Anandaraj, Former Director, ICAR-IISR and former President, IPS; Dr A.S.Krishnamoorthy, Director, CPPS, TNAU and Dr R.Selvarajan, President of Indian Phytopathology Society - South zone / Organizing Secretary of the National Symposium were the dignitaries in the function. Scientists across the country, farmers, industrial firms, students and research scholars from SAUs of southern India have participated and benefitted. Around 179 students participated in the one day special interactive workshop conducted on 22 December, 2018.



Release of souvenir by scientific delegates at IPS - National symposium held at ICAR-NRCB

Workshop on Arabi to Banana

One day workshop on "Arabi to Banana: Potential & Fruitful Research Project" was held at ICAR-NRCB on 13 March, 2019. Student from various colleges located in and around Tiruchirappalli were participated in the workshop. Dr Albert Premkumar, Visiting guest scientist from Istanbul University, Turkey gave special lecture and practical demonstrations to students. of *Arabidopsis* genes from the TAIR database, design T-DNA primers of T-DNA inserted mutant lines and checking the mutant availability from the *Arabidopsis* Seed Stock Centres

Workshop on "ICAR-KRISHI Portal

One day workshop on "ICAR-KRISHI Portal - A Central Research Data Repository" was held at ICAR-NRCB on 25 March, 2019. Dr. K. Alagusundaram, DDG (Agril. Eng.), ICAR, New Delhi was the Chief Guest of the workshop. Nodal Officers of KRISHI Portal and scientists of various ICAR-AICRP (Fruits) centres were participated and got benefitted.

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