



2. EXECUTIVE SUMMARY

Research Accomplishments

Crop Improvement

Thirty accessions of mango from Bhubneswar and Ranchi were collected and sixty accession were planted in the field gene bank during the period.

Five hundred and fifty eight accessions and over 600 hybrid seedlings of mango were evaluated for various traits. DUS parameters for mango were worked out by using characterization data of 150 accessions. Second volume of catalogue was developed on the basis of leaf and panicle characters of 100 mango accessions. An improvement was affected in the database structure and modules. Search module was also developed with option for IC number or name based search.

Out of 20 STMS markers used for characterization of one hundred and fifty mango cultivars, 18 microsatellites detected polymorphism in 144 cultivars. The dendrogram realized from microsatellites data grouped the 150 genotypes into 3 broad groups. Highest level of polymorphism was detected by HMID 016 and lowest by HMID 2041.

Twelve accessions of guava from different parts of Uttar Pradesh and two from Shirdi (Maharashtra) were collected. One hundred and twenty three accessions including six *Psidium* species were maintained in field gene bank. Eighty accessions were characterised for leaf, while 40 for fruit characteristics. Information on characterization of germplasm (120 accessions) were coded and updated for cataloguing.

Two cross- combinations ('Lalit' x 'Purple Guava' and 'Purple Guava' x 'Lalit') were attempted to incorporate genes responsible for anthocyanins synthesis in pulp. A population of 60 genotypes was developed for exploiting half-sib segregating population with desirable characters.

Nineteen cultivars of guava were studied for diversity and heterozygosity. Eight primers yielded 66 alleles at an average of 8.25 alleles per primer. Discrimination of cultivars was feasible through unique fingerprints of ISSR.

Papaya cultivars 'A 3', 'Pusa Delicious', 'Pusa Dwarf' and 'Red Lady' performed well in terms of yield

(63.33, 54.28 48.66 and 48.33 kg fruits⁻¹, respectively) and quality. The cultivar 'A 3' recorded the highest average fruit weight (2.20 kg) followed by 'A-7' (2.00 kg). The quality in terms of TSS (12.0° B) was better in 'Pusa Delicious' and 'CO-7'.

Six cross combinations of papaya parents having desirable characters were used and 70 crosses were made. Forty four fruits were obtained from successful crosses whose seed weight varied from 1.01 to 7.40 g fruit⁻¹. Highest germination(92%) was recorded in 'CO-7' x 'Pusa Delicious' as compared to the lowest (58%) in 'CO-7' x 'Lady Red'.

Somatic embryos of papaya 'Pusa Delicious' were targeted for *Agrobacterium tumefaciens* carrying dual gene. The antibiotic Cefotaxime (500 mg l⁻¹) was most effective in controlling *Agrobacterium* from tissue surface, while the additions of acetosyringone (100 µm) and spermidine (1.0 mM during co-culturing enhanced the survival of Kenamycine resistant plant (11.20%) increased the transformation efficiency), respectively. *Npt II* and *cp* genes were detected in transformed plantlets by PCR with primers specific to *Npt II* (480 bp) and *cp* (410 bp).

Three sets of oligonucleotide primers were used for predicting the sex of papaya. Primers F1 and F 2 (provided by University of Hawaii produced no bands in male, whereas H 1 and H 2 produced bands in hermaphrodites only on PCR based sex diagnostics.

Seven varieties of litchi, which came into bearing, were evaluated. Highest fruit yield (37.78 kg tree⁻¹) was recorded in 'Large Red' followed by 'Pickling' (35.36 kg⁻¹). The least fruit cracking (7.50%) was observed in 'Kasailiya'. Cultivar rose scented recorded highest (20.6° B) TSS followed by 'Ajhauli' (20.2 °B).

Twenty one accessions of aonla were collected from different parts of Madhya Pradesh and planted in the field for evaluation of their growth parameters. Five accessions of jamun including two seedless were collected from Gujarat and Uttar Pradesh. Physiochemical parameters of fruits of eight elite genotypes were assessed on the basis of fruit weight, seed weight, pulp content, TSS, titrable acidity, ascorbic acid, anthocyanins, tannis, etc. Maximum antioxidant value (53.29 mg AE AC g⁻¹) was observed in accession CISH-J-34.



A number of elite genotypes in jamun (5), khirnee (26), mahua (20), wood apple (17), tamarind (17) and cape gooseberry (3) were established in the field gene bank.

Crop Production

Among various combinations tried for mass multiplication of mango in polyethylene bags, addition of cocopeat (10%) to the media comprising soil, sand and FYM (1:1:1) resulted in better plant growth.

Higher fruit yield (15.12 t ha⁻¹) of mango 'Dashehari' was recorded in medium density planting (400 plants ha⁻¹) as compared to 4.15 ha⁻¹ in conventional planting (100 plants ha⁻¹).

The crown thinning treatment in 'Mallika' mango resulted in maximum yield (75.5 kg tree⁻¹) and number (41%) of A grade fruits as compared to untreated ones (56.5 kg tree⁻¹ and 22.5%).

The addition of organic manure or mulching improved the organic carbon and available N, P and K contents in soil. Moisture retention in soil was more where irrigation with 50 per cent reduction in water followed by organic mulching (leaf litter or paddy straw) was done. Higher fruit yield (4.6 t ha⁻¹) was recorded in mango trees mulched with leaf litter and irrigated at fruit growth and fruit maturity stages as compared to untreated one (2.1 t ha⁻¹). Drip irrigation either alone (6.57 t ha⁻¹) or in conjunction with NPK enhanced the fruit yield (7.21 t ha⁻¹) in 'Langra' as compared to basin irrigation (5.32 t ha⁻¹).

Maximum flowering (86%) was recorded in 'Dashehari' trees treated with 0.8 ml m⁻¹ canopy diameter of paclobutrazol which received 1.6 ml of paclobutrazol during the last two years as compared to untreated trees (47%). Mulching along with application of 1.6 ml paclobutrazol resulted in higher number of fruits and yield. The rate of photo synthesis and stomatal conductance were increased when methionine (100 ppm) and *Trichoderma harzianum* (10⁸ spores g⁻¹) were applied in the rhizosphere of 'Dashehari' mango. The application of paclobutrazol to 'Langra' and 'Amrapali' mangoes resulted in decreased rate of photo synthesis at (flowering and fruit set) stages as its concentration increased.

The effect of different levels of CO₂ on gas exchange parameters was observed under controlled conditions in regular ('Amrapali') and biennial (Chausa) cultivars at full bloom stage. The rate of photosynthesis increased with increasing

concentration of CO₂ (up to 450 μmol mol⁻¹) in both the cultivars. However, lower rate of photosynthesis was noticed in Chausa.

Thirty five and twelve plants of 'Allahabad Safeda' guava are required for prediction of yield at 95 per cent confidence probability with 5 and 10 per cent error with Tippet's methodology, when the yield of 100 plants was taken as 63.7 kg with a variance of 137.77.

The propagation techniques standardized in mulberry, custard apple, carambola and lasora were mainly found to be governed by prevailing temperature.

Crop Protection

Forecasting model developed on the basis of weather index and artificial Neural Network Technique enabled the prediction for infestation of mango fruit fly and hopper population 15 days in advance. Fruit fly and hopper population attained a peak population build up on mango during April- May and October- April, respectively. An unusually high incidence of thrips infestation was recorded in mango orchards which was found to coincide with the onset of new flesh. Acephate (1 g l⁻¹), spinosade (1 ml⁻¹), thiamethoxam (0.2 g l⁻¹) and imidacloprid (0.3 ml l⁻¹) were found effective in suppressing the hopper population even up to 100 per cent. Imidacloprid, owing to high degree of toxicity, could be replaced with acephate due to its lower degree of toxicity against honey bee.

Two sprays of Ethopphenprox (0.05%) at 15 days interval were highly (100%) effective in controlling borer infestation on guava cv. 'Allahabad Safeda' followed by cartap hydrochloride (0.05%) (1.26% infestation), neem excel (0.2%) (2.66% infestation) and carbaryl (0.2%) (4.66 % infestation) as compared to untreated check (20.40% infestation). Similarly, bark eating caterpillar, *Inderbela* sp., could be effectively managed in guava 'Allahabad Safeda' by mechanical methods (cleaning of webs and collection and killing of the larvae) and swabbing (during the last week of February) with pine oil (1%), castor oil (2%), Excel Plus (1%), chloropyriphos (0.05%) and neem oil (0.15%). Pine oil (1%) and Excel Plus (1%) caused 100 per cent reduction in larval galleries followed by castor oil (75.5%), neem oil (75%) and chloropyriphos (60.25%).

The attack of gall maker (*Betousa stylophora*) in aonla was noticed in nursery as well as in old bearing trees of aonla. Its incidence was considerably low (0.5



galls plant⁻¹) in nursery. However, shoot galls were observed in mature trees of all the cultivars. Its maximum incidence could be noticed (6.8 galls tree⁻¹) from 1st fortnight of October to 1st fortnight of March. Similarly, fruit borer, *Deudorix (Virachola) isocrates*, incidence in aonla started from 1st fortnight of August and continued up to first fortnight of November causing 2.65 per cent fruit loss. Two sprays of cartap hydrochloride (0.05%), carbaryl (0.15%) and neem oil (0.15%) at fortnightly interval during July were highly effective in the management of shoot galls in aonla.

Four bacterial isolates of *Bacillus subtilis*, isolated from certain biodynamic preparations, could not exhibit a perceptibly significant degree of nematotoxicity as the juvenile mortality was found to be only 0.12 per cent. Lower degree of temperature regimen (20-22°C) could be ascribed for lower degree of nematotoxic potential of the isolates.

Mustard cake in combination with FYM (75:25 ratio) was found to support the maximum (19 CFU g⁻¹) population of *Trichoderma harzianum*.

Floral powdery mildew in mango could not attain apiphytotic proportion on account of relatively low temperature (below 35°C) and high humidity (72-98%) prevalent during March. Similarly, congenial temperature and humidity could significantly impact the occurrence and incidence of anthracnose, blossom blight, sooty mould and die back diseases in mango.

Twig die back and gummosis symptoms were observed in seedlings *Aegle marmelos* cultivars 'NB-5' and NB-9.

Hot water supplemented with carbendazim (0.05%) was found effective in controlling post-harvest diseases of mango up to 8 days of storage under ambient conditions while carbendazim (0.1%) could control post harvest diseases up to 10 days. Prochloraz in cold water was found ineffective at ambient temperature.

Postharvest Management

A lopper type bael harvester was designed and fabricated on the principal of holding and cutting of fruit. The blades of mango slicer and cube cutting machines were refined and mango feeding opening were adjusted for better efficiency of machines.

Tray type CFB boxes were developed for packaging and export of mangoes. The grading for export of mango cvs 'Langra' and 'Chausa' and guava

cvs 'Allahabad Safeda' and 'Sardar' were standardized.

Nine mango varieties/hybrids for pickle in oil and twelve for pulp/beverage were evaluated for their acceptability. Sensory evaluation of pickles indicated that 'Bathui' was the most acceptable variety followed by 'Pau', 'Katakee Bihar' and 'H-1886', while best beverage was obtained from cvs 'Afeem' and 'Black Andrew', followed by 'Sohrab Pasand' after six months of storage. Calcium chloride (0.0375M) improved the organoleptic quality of osmo-air dried slices of ripe mango cv. 'Totapuri' when stored up to six months in PET jars.

As the steeping preservation of aonla cv. 'Chakaiya' in water prolonged from 0 to 25 days, the ascorbic acid content decreased in the extracted juice. Blanching of aonla cv. 'Chakaiya' fruits in 0.5 or 1.0 per cent alum resulted into preparation of good quality of segments-in-syrup. Powder prepared from 0, 15, 30, 45 and 60 days stored aonla juice by spray drying showed a continuous decrease in ascorbic acid and polyphenol contents and increase in non-enzymatic browning.

The post-harvest treatment of mango cv. 'Dashehari' with putrescine (0.01%) resulted in better retention of quality when packed in ventilated LDPE bags and stored at low temperature (12±2°C; 90±5% RH). Similarly, 'Chausa' mango fruits treated with spermidine (0.01%) could be stored up to 30 days when packed in ventilated LDPE bags and stored at low temperature (10±2°C; 90-95% RH). Maximum FRAP value in fruits of aonla cv. 'Kanchan' treated with CaCl₂ .2H₂O (2%) + KMnO₄ (0.01%) was observed during 9 days of ambient storage.

Good quality of guava and aonla cider were obtained when tannins concentration in fermentation medium was kept at 0.2 and 0.4 per cent, respectively. Addition of lemon peel or cinnamon were found to enhance the quality of mahua wine. Mahua vermouthe could be prepared by fortification with spices. The protocols were developed for the production of pectinase and cellulase enzymes from mango kernel. The budding yeast, isolated from spoiled aonla juice, was found to survive at 100°C for 20 minutes.

The total quantity (71.6 thousand MT) of mango arrived in Lucknow market during 2008 was less than that of last year (85.7 thousand MT). The earliest mango variety, available in the market, was 'Banganpally', which arrived during April. A total of 51.58 thousand MT of mango fruit was sent to different markets of the



country. The total arrival of guava during the year was 1639.5 MT, while that of papaya was 5581.7 MT. The export of mangoes from India declined from 79.06 to 54.35 thousand MT during the year 2007-08, whereas export of mango pulp increased to 166.75 thousand MT.

Technology Transferred

Besides, carrying out research in the sphere regarding gamut of challenges being faced in the mandate crops, the Institute also concentrated on dissemination of technologies to the end users. In pursuance to the programme, the Institute organized one goathi wherein around 500 farmers were benefited. The Institute also participated in a number of state as well as national level events across the country and dealt with the problems faced by farmers through its technology modules. Technologies were also delivered through demonstrations, scientists-farmers interactions, exposure visits for the benefit of farmers, extension workers/students, counseling, postal queries, farmers helpline call, training programmes and TV/Radio talks.

Meetings

The 13th meeting of RAC of the Institute was held during June 18-19, 2008 under the Chairmanship of Dr. R. S. Rathore, Ex Vice-Chancellor, C.S.K. Himanchal Pradesh Krishi Vishwavidyalaya, Palampur.

Two IMC meetings (20th and 21st) were held on May 21, 2008 and March 4, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director.

Twenty fourth and twenty fifth Institute Research Committee meetings were held from July 14 to 16, 2008 and March 16-17, 2009 under the Chairmanship of Dr. B.M.C. Reddy, Director.

Education and Training

Twelve scientists and one technical office were deputed to different programmes organized by various national agencies for the development of human resource skills and knowledge in respective fields. One scientist was also deputed to USA for Agribusiness Programme.

Awards and Recognitions

Scientists of the Institute brought laurels and and

got recognition from various scientific/developmental agencies. One Principal Scientist was conferred with the prestigious Dr. J. C. Anand Gold Medal during the Third Indian Horticulture Congress 2008 held at OUA&T, Bhubaneswar, while the other one was bestowed with Amrood Pandit Award by Hon'ble Union Minister for Agriculture, Shri Sharad Pawar at the National Guava Symposium held at Shridi, Maharashtra. One scientist each were honoured with the Fellowship of Horticulture Society of India (HSI) and Indian Society of Plant Physiology (ISPP).

Director/scientists of the Institute also acted as Chairman, Co-chairman, Coordinator, Rapporteur and Member in various seminars/symposia/conferences/meetings, task force, curriculum/monitoring committees and editorial boards, etc.

Udyan Rashmi, Rajbhasha Patrika of the Institute was awarded 2nd prize by the Nagar Rajbhasha Karyanvayan Samiti, Lucknow at its 60th half yearly meeting held at CDRI, Lucknow.

Linkages and Collaborations

Various research, developmental and educational programmes were run at the Institute in collaboration with various national scientific bodies including APEDA, DBT, DST, Indo-German Programme of Kali and Salz, Ministry of Agriculture, Networking Mode of ICAR, New Delhi, UPCST, Lucknow, UPCAR, Lucknow, IGNOU New Delhi, SAU's (Pantnagar, Faizabad, Kanpur), State Universities (Rewa, Lucknow, Jhansi) and Central University (BBAU, Lucknow).

AICRP/Coordination Unit

The Project Coordinator's Cell of All India Coordinated Research Project on Subtropical Fruits is situated at the Institute. The Cell's coordinated research on crop improvement, production and protection (mango, guava and litchi) were carried out at 18 centres located at SAUs and ICAR Institutes.

The Project Coordinator's Cell organized the 18th Group Worker's Meeting of AICRP (STF) at its Rehmankhara campus during June 29 to July 2, 2008. About 200 participants including scientists and professors from seven ICAR Institutes, eleven State Agricultural Universities, one Non-governmental Organization and Presidents/Vice Presidents of crop grower's associations (mango, guava, litchi and grape) participated in the meeting. During the meeting,



progress of research with respect to approved technical programmes of different centers was reviewed and the new programmes for the next biennium were finalized. Besides the achievements made in ad hoc scheme were also discussed. After comprehensive review of programmes in the plenary session, related recommendations were made for further refinement of recommendation/ improvement of the work carried out.

Consultancy, Patents and Commercialization of Technology

Consultancy services were provided to various governmental and non-governmental organizations and entrepreneurs on payment.

Other Activities

Institute organized the Rashtriya Krishak Mela Evam Pradarshini- 2008 on June 20. The newly developed hybrids, Ambika, Arunika, CISH-M-2, H-949, etc., along with other exotic varieties available in the Institute's Field Gene Bank were displayed on the occasion. About 500 farmers participated in the Rashriya Krishak Mela Evam Pradarshini.

A farmer-scientist interaction also took place in one of the sessions of the Pradarshini. During the session, farmers projected their problems which were addressed by the concerned expert related to suitability of varieties and management of irrigation, insect pest

and diseases. The farmers also displayed interest in the management schedule of thrips infestation in mango, a newly emerged phenomenon in the region. A mango exhibition was also organized during the period. Newly developed hybrids, viz. Ambika (Amrapali x Janardan Pasand), CISH-M-2 (Dashehari x Chausa) and H-39 (Amrapali x Vanraj) were the centre of attractions amongst the visitors.

Validation Workshop of the project Technology gap analysis study for food processing industry cluster of Malda', sponsored by TIFAC(DST), Govt. of India, New Delhi, was organized by the Institute at Golden Park Hotel, Malda (W.B.) on January 28, 2009. The workshop was aimed at positioning the fruits and vegetables from Malda and adjoining districts at a higher platform and invite industries/ entrepreneurs render these available to their advantage, thereby strengthening the farmers, industry and traders partnership.

The Institute also organized Hindi Chetna Mass from September 14 to October 12, 2008 wherein various programmes including competitions and cultural activities for the propagation of official language were held and prizes were distributed.

Revenue Generation

A total revenue of Rupees 41.38 lakhs was generated by the Institute during the financial year 2008-09.