

# वार्षिक प्रतिवेदन Annual Report 2016-17



भा.कृ.अनु.प.- केन्द्रीय नींबूवर्गीय फल अनुसंधान संस्थान  
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# PREFACE



*The year 2016-17 has been extraordinary because ICAR-CCRI, Nagpur has opened its first Regional Research Centre for Citrus (RRC) at Biswanath Chariali, District Biswanath, Assam. The Centre has been operationalised in the campus of Biswanath College of Agriculture, Biswanath with posting of one scientist and taking over 42.50 acres of land. The ICAR-CCRI has released 5 varieties of citrus during the year viz. Cutter Valencia, 'Flame' grapefruit, Pummelo 'US-145', NRCC grapefruit-6 and NRCC pummelo-5 and started distribution of their planting material. The institute has also registered with Agriculture Skill Council of India (ASCI) with receipt of NSDC Registration No. 15733 for training of Citrus growers. The institute has launched mobile App "CCRI- Citrus" which can be downloaded from the CCRI website on the smart phone having version Android 4.0 and above.*

*During 2016-17, ICAR-CCRI has completed many major works like Intake well for augmented water supply from Ambazari Lake. The 3.0 km long six inch pipe line work from Ambazari Lake to the institute has also been completed alongwith trial pumping of water. One more new tank of 1.5 lakh litre water holding capacity has been constructed to store water for nursery. The other works which were completed include farm roads, labour shed, new main gate of the institute, security guard room and a portion of compound wall. The institute has digitized its land records, implemented ERP (MIS and FMS), installed swipe machines for cashless transactions.*

*The institute has also installed advanced micro-irrigation and fertigation system for plantation on raised-bed system. For the first time lemon varieties viz. Kagzi Kalan, Pant lemon, Baramasi lemon, Assam lemon and Eureka lemon have been planted for evaluation. Brazilian sweet orange cultivars mainly Pera, Natal and Westin on various rootstocks have started flowering in third year after planting on raised bed system with fertigation indicating adaptability under agro-climatic conditions of central India. Valencia orange also recorded profuse flowering and fruit set. These varieties and the Cutter Valencia released by ICAR-CCRI hold very good promise as processing varieties for juice and other products.*

*The ICAR-CCRI Director continued to co-ordinate research on citrus under AICRP (Fruits) at 10 Centres across India.*

*This year, institute started 3 new externally funded projects and 2 new institute projects. The major research achievements include standardization of nutrition dose and potting media for nursery plants of Nagpur mandarin and acid lime, identification of a seedless mutant from seeded Citron-2. This seedless mutant is like lemon in most characters of fruits, profuse bearing, thorny and bushy in growing habit. The triploids and tetraploids of mandarin and Mosambi have been generated in-vitro and further studies are in progress. Very encouraging results were obtained in high density planting system of acid lime and Nagpur mandarin. The agronomic practices of HDPS are being standardized and hopefully these will be available for citrus growers in next 2-3 years.*

*Second consecutive year crop of Nagpur mandarin under organic farming practices (both crop nutrition and plant protection) have produced reasonably high yields of quality fruits indicating efficacy of module of organic practices that was developed at the institute. Several endophytic microbes have been isolated from citrus plants and cultures are being maintained for their efficacy as bio-fertilizers and bio-pesticides.*

*Crop regulation studies in Nagpur mandarin have indicated that Paclobutrazole is effective in inducing flowering and reasonably good Mrig bahar (monsoon flowering) crop can be taken even if water deficit stress is broken by intermittent irrigation in summer. The weather parameters for Nagpur mandarin have been identified and standardized as a rider for compensation in crop insurance schemes implemented by the Govt of Maharashtra through agricultural insurance companies.*



Phorate and acephate have been observed to be quite effective as repellants for fruit piercing moths in Nagpur mandarin orchards. Pheromone lure developed for management of citrus leaf miner in collaboration with IICT, Hyderabad, has been consistently effective in nurseries and orchards. CTV Reverse Transcription Loop Mediated isothermal amplification (RT-LAMP) have been designed. Similarly LAMP technique has been developed for sensitive detection of *Ca. L. asiaticus* and its vector psyllids. Integrated management practices developed by CCRI for Phytophthora root rot and Gummosis management in Nagpur mandarin have been very effective. Ready-to-Serve beverage from Nagpur mandarin and Candy from whole sweet orange slices have been very promising and being further improved as a technologies for transfer. Analysis of anti-oxidants and functional components from citrus fruits have indicated high nutritional value of these fruits.

In human resource development, total 4 on-campus training programmes have been organized in which more than 84 citrus growers and officers were trained. Institute participated in 12 exhibitions and reached out to thousands of citrus growers. Total 4 training programmes were organized under Tribal Sub Plan for farmers of Meghalaya, Madhya Pradesh and Rajasthan. Under Mera Gaon Mera Gaurav programme, demonstrations and trainings were organized in two villages that have been adopted. Total 19 employees of the institute including all categories (scientific to supporting) were sent for capacity building/skill development. Dr. D. K. Ghosh, Plant Pathologist was invited for oral paper presentation in International Citrus Congress organized in Brazil during 18-23 September, 2016.

Institute sold total 3,09,785 disease-free planting material and generated revenue of Rs. 97,29,805/- during the year including TMC and revolving fund scheme. Under Technology Mission on Citrus for Vidarbha, Marathwada and Chhindwara, 2656 citrus growers, 256 officers were trained. For the first time residential programme of 200 hrs (one month) was organized for citrus growers under ASCI and 13 participants were benefitted with in-depth training on citrus cultivation. Demonstrations were organized at 48 places across Vidarbha, Marathwada and Chhindwara.

In 2016-17, three new agreements were signed for consultancy/transfer of technology.

In all 29 research papers were published in National and International peer reviewed journals with high rating that shows constant efforts of the scientists towards achieving academic excellence and at the same time its a matter of encouragement to them and pride for the institute.

I am thankful to Research Advisory Committee (RAC) for its valuable guidance in reaserach programmes.

I express sincere gratitude to Dr. Trilochan Mohapatra, Secretary DARE and DG, ICAR for his unflinching support and encouragement. I am very thankful to Dr. A. K. Singh DDG (Agric. Extension) and in-charge (Hort Sci.) for his valuable guidance and support. I am grateful to Dr. Wasakha Singh Dhillon, ADG -I (Hort Sci) and Dr. T. Janakiram, ADG-II, (Hort Sci) for their timely help, guidance and support.

I am thankful to scientists and staff of the Institute for their sincere and dedicated efforts for the progress of the organization. I acknowledge very hard work of Dr. A.K. Das, Dr. C. N. Rao and Dr. A. A. Murkute in editing this report. I put on record sincere thanks to Miss Lily Varghese, ACTO (PME Cell) for compiling this report.

I am satisfied in placing this Annual Report (2016-17) before public and welcome suggestions and feedback to improve it further.

27<sup>th</sup> June, 2017

Nagpur



**(M. S. Ladaniya)**  
Director





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# 1. EXECUTIVE SUMMARY

ICAR- Central Citrus Research Institute, Nagpur is presenting the 28<sup>th</sup> edition of its Annual Report for the year 2016-17. During this year, a Regional Research Centre for Citrus (RRCC) has been started at Biswanath Chariali in the campus of Biswanath College of Agriculture, Assam Agricultural University, Assam. This was the most significant achievement since the establishment of the Institute in 1985. Institute also launched a mobile app “ICAR-Citrus”. Institute received FSSAI registration No. 2151725-9000455 for sale of beverages prepared from citrus fruits and continued to coordinate citrus research at 10 centres under ICAR-AICRP (Fruits). The ICAR-CCRI, Nagpur is now affiliated with Agriculture Skill Council of India (ASCI) and received SDMS registration No. NSDC-Reg. No. 15733 on 24 January, 2017. The Institute executed its research programmes through different multidisciplinary projects (in-house and externally funded), transferred technologies through trainings, visits and demonstrations and made an all round progress. The salient achievements are as follows :

## Research Achievements

A total of 18 accessions of citrus from different groups were characterized based on IPGRI descriptors. Acid lime accessions IC-285414, IC-285421, IC-285422, IC-342347, IC- 342336 for yield (>3000 fruits/plant/year) and juice content (> 49.5%); IC- 322087 for fruit weight (50.40g) and juice content (51.0%); IC-342350 and IC-322098 for bigger size and attractive colour and Galgal accession IC-285430 for fruit weight (520.0g), size (116.00×101.5mm) and peel thickness (5.8mm); IC-311340 for maximum juice (35.7%); IC-285434 for minimum seeds (5.9) were promising. Among 54 clones of Nagpur mandarin N<sub>28</sub>, N<sub>34</sub>, N<sub>38</sub>, N<sub>43</sub> and N<sub>51</sub> were identified superior w.r.t. yield, fruit size and colour. CCRI Pummelo-7 was observed promising for table purpose w.r.t. fruit size, colour and tender segments with attractive pink colour. Sikkim mandarin SM-1, SM-11 and SM- 6 recorded highest fruit weight, juice content and lowest acidity, respectively. Of the 5 clones of Darjeeling mandarin, DM-13 and DM-16 recorded maximum fruit weight and lowest acidity, respectively. Seven rootstocks (foreign and indigenous) screened for *Phytophthora* root rot were found susceptible to highly

susceptible except Kachai lemon and *C. latipes* which showed moderately tolerant reaction. All the 37 acid lime clones screened for bacterial pathogens were found to be susceptible to citrus canker under open field conditions.

Induction of tetraploidy by *in vivo* colchicine treatment via microbudding gave stable tetraploid and triploids in Nagpur mandarin and Sweet orange from direct sprouts of the micro budded plants. Response of Nagpur mandarin endosperm for callus and/embryogenesis was significantly highest in Murashige and Tucker (MT) + Casein Hydrolysate (CH) (500mg/l) + 2,4-D (2mg/l) and MT + Malt Extract (ME) (500mg/l). In case of sweet orange, percentage of embryogenesis and callus induction was higher in MT +ME followed by MT + CH + 2,4-D + BA. Maximum cotyledenary embryoid production was obtained in 2MT + CH (500mg/l) + BA (0.25mg/l) + Gibberellic Acid (GA<sub>3</sub>) (1mg/l) and shoot bud differentiation was significantly maximum in MT + GA<sub>3</sub> + Adenine Sulphate and Murashige and Skoog (MS) + Indole-3-Butyric Acid (IBA) in Nagpur mandarin and Sweet orange.

In conventional hybridization, successful crossings were observed in US Pummelo 145 × Sweet orange (TM 33), Rough lemon × Rangpur lime and Rough lemon × Trifoliate orange.

High density planting of Nagpur mandarin on raised bed recorded maximum plant height, stock girth, soil K, leaf N and K in 5×4m spacing, while maximum canopy volume, organic carbon, soil N & P and leaf P were recorded in 4.5×4.5m spacing. The incidence of citrus psylla, citrus leaf miner, mites, aphids and thrips was minimum in Nagpur mandarin at 6×6m spacing.

Among exotic sweet orange and grapefruit cultivars on Rough lemon rootstock under raised bed system, Marsh Seedless recorded maximum plant height and canopy volume, while, Star Ruby recorded maximum stock and scion girth. Maximum flowering percent was recorded in Jaffa. Red Blush recorded maximum soil N & P and leaf N & K. Among 16 Brazilian sweet orange scion and rootstock combinations under raised bed system during August-September 2014, maximum plant height, stock girth, canopy volume, plant spread in NS and soil organic carbon were recorded in plants of Hamlin on



Volkameriana rootstock. Highest soil N in Pera budded on Volkameriana, P in Valencia on Volkameriana and K in Lane late budded on Rough lemon rootstock were recorded. Hamlin, Pera, Valencia and Natal recorded profuse flowering, fruit set during January - February, 2017. Acid lime cv. PKM-1 (Jaidevi) and lemon cv. Baramasi planted on raised bed system recorded maximum growth. Among lemon cultivars, maximum soil N in 'KagziKalan', P in 'Baramsi lemon' and K in 'Assam lemon' were recorded. All lemon cultivars except Eureka recorded flowering and fruit set in first year. Among exotic mandarin cultivars under raised bed system, maximum growth and soil K were recorded in 'Daisy'. Maximum soil N & P and leaf K in Clementine, leaf N in 'Michal' and P in N-4 seedless were recorded.

Nagpur mandarin budded on hybrid NRCC rootstock-4 was observed superior regarding vigour, leaf N and P. Maximum canopy spread ( $81.73\text{m}^3$ ), fruit TSS (9.55%) and soil N was recorded in NRCC rootstock-5, whereas, high yield (24.72 t/ha) and soil K were recorded in NRCC rootstock-3. Evaluation of Rough lemon and Rangpur lime rootstocks on performance of Nagpur mandarin under different spacings continued for fourth year. Highest soil N was observed in  $6\times 4\text{m}$  (Rough lemon) while leaf N was highest in  $6\times 3\text{m}$  (Rangpur lime). Soil K and P was highest in  $6\times 3\text{m}$  (Rough lemon and Rangpur lime).

Drought tolerance capacity of different citrus rootstocks showed that Alemow, CRH-12 and Shekhawasa Rough lemon recorded less reduction in stem girth and less susceptibility to drought. Volkmarina, NRCC-2 and Rough lemon recorded increase in proline content and observed to be susceptible to drought. Study of water logging tolerance capacity of different rootstocks revealed that membrane stability index decreased with the increase in duration of water logging in Alemow, NRCC-2 and Rangpur lime rootstocks.

Alemow rootstock at  $6\times 3\text{m}$  spacing planted under raised bed system recorded maximum growth. Minimum incidence of citrus leaf miner in July, thrips and aphids in August and mites in September were recorded at  $6\times 6\text{m}$  spacing.

Acid lime cv. 'Pramalini' (seedling) at  $2.5\times 2.5\text{m}$  recorded highest organic carbon content (1.20%), soil N, P, K, plant height, fruit weight, fruit yield/ha, bigger sized fruits, higher TSS and acidity as compared to  $5\times 2.5\text{m}$  and  $5\times 5\text{m}$  spacing. Incidence of leaf miner and canker and

percent disease index (PDI) was also high in  $2.5\times 2.5\text{m}$  spacing. Nagpur mandarin planted at  $3\times 1\text{m}$  spacing recorded higher availability of soil N, P and K while  $4\times 1\text{m}$  and  $6\times 3\text{m}$  spacing recorded maximum available leaf N and P & K, respectively. Maximum plant growth and canopy were observed in  $6\times 3\text{m}$  and  $6\times 6\text{m}$ . Higher leaf area index, maximum no. of fruits/plant and fruit yield was observed in  $4\times 1\text{m}$  spacing. Lowest incidence of citrus leaf miner, psylla and aphids in  $6\times 6\text{m}$  spacing was recorded. In Acid lime, higher availability of soil N, P and K, light interception and leaf area index were observed at  $3\times 1\text{m}$ . Maximum plant height, plant spread, canopy volume and stock girth were recorded in  $6\times 6\text{m}$  spacing. No. of fruits/plant and yield in terms of kg/plant was high in plants at  $6\times 6\text{m}$  spacing. Yield per area basis was highest in  $3\times 1\text{m}$  spacing (t/ha). Lowest incidence of citrus leaf miner and psylla was recorded in  $6\times 6\text{m}$  spacing. Architecture engineering for the canopy management in Nagpur mandarin under different densities of planting showed that  $2\times 2\text{m}$  spacing recorded highest content of soil N, P and K, leaf N, plant height, fruit yield, minimum peel thickness and maximum fruit juice content, while,  $6\times 3\text{m}$  spacing recorded highest content of leaf N, P and K, stock girth, leaf area index, no. of fruits/plant. At  $6\times 3\text{m}$  spacing, plants recorded maximum canopy growth with lowest insect-pest incidence.

Growth retardants viz. paclobutrazol and chlormequat chloride were evaluated for ensuring crop during intermittent irrigation while plants were on water deficit stress during summer. During *Mrig* crop season, flowering of Nagpur mandarin was maximum with maximum fruit set and final fruit retention and yield in treatment with paclobutrazol @ 6g/tree as soil application while, maximum fruit weight, bigger fruit, maximum TSS:acid ratio and vitamin C content was recorded in paclobutrazol @ 12g/tree as soil application.

Among the micronutrient mixtures, maximum canopy volume, soil macronutrients like N, P and K and leaf N and K were recorded in micronutrient mixture-2 (soil application) + macronutrient (soil application).

Under integrated nutrient management of Nagpur mandarin, treatment 30% RDF + 30% vermicompost + microbial consortium resulted in maximum plant height, no. of fruits/tree, yield, soil P, K, Fe and Zn, enzymes like dehydrogenase, invertase and polyphenol oxidase and leaf P, Fe, Mn. Studies on residual and cumulative effect

of nutrient on Nagpur mandarin revealed that application of 1/6 of RDF for 6 years and 60% RDF after 6 years was superior w.r.t. tree volume, fruit yield, TSS, juice %, leaf N & K, available soil N, K, Fe, Mn and Zn.

The microbial analysis of the consortium developed at ICAR-CCRI revealed the bacterial components population density as high as  $10^8$ - $10^4$ cfu/ml while the fungal component was between  $10^6$ - $10^4$ cfu/ml. In acid lime, soil microbial inoculation application resulted in high germination rate (79.8%), maximum growth. Highest population of component microbes and micronutrient composition were observed in the treatment with *Azotobacter chroococcum* + *Pseudomonas fluorescens* + *Bacillus mycoides* + *Paenibacillus polymyxa* + *Trichoderma harzianum* at 100 days of observation with seed viability index of 3.20.

Soil inoculation with plant endophytic microbe *Bacillus mycoides* @ 125 ml/seedling resulted in highest seed germination (80.5%), viability index, growth of acid lime seedling in nursery at 100 days of sowing.

Rough lemon seedlings grown in potting mixture + cocopeat (25%) + 4g N + 2g P + 2g K + *Trichoderma* strain 44 recorded maximum plant height and no. of leaves/plant while Rangpur lime seedlings recorded maximum growth in potting mixture + 6g N + 3g P + 3g K + *Trichoderma* strain 44. Acid lime seedlings grown in secondary nursery recorded maximum plant height and stem girth in potting mixture + 2g N + 1g P + 1g K + *Trichoderma* strain 44.

Foliar application of 0.50%  $\text{FeSO}_4$  + 0.50%  $\text{MnSO}_4$  + 0.50%  $\text{ZnSO}_4$  + 0.25% borax + ammonium molybdate + 10ppm 2,4-D + 1% urea at anthesis, pea size, marble size and initiation of fruit enlargement recorded maximum canopy volume, fruit weight, fruit yield with higher soil organic carbon and available soil and leaf micro and macro nutrients.

Organic practices such as soil application of *Jivamrut* as fertilizer and use of *Dashparni* concentrate, neem seed kernel powder, *Agniastra* and fermented *Jivamrut* against insect pests and *Trichoderma viride* against *Phytophthora* as plant protection measures were recorded as traditional practices being followed in organically claimed Nagpur mandarin orchards by local growers.

The organic cultivation package developed at CCRI, Nagpur viz. vermicompost loaded with microbial

consortium (100% N-equivalent basis) + IPM<sub>2</sub> (foliar application of Horticulture Mineral oil (2%) followed by *Beauveria bassiana* @ 5g/l and Azadirachtin (1%) @ 4 ml/l) + IDM<sub>1</sub> - Bordeaux paste ( $\text{CuSO}_4$ : Lime: Water = 1:1:10) as pre monsoon/post monsoon trunk application along with *Trichoderma harzianum* native antagonistic strain, NRCfBA29 (100g/plant) with carrier material of FYM (1kg) as soil application at root zone) recorded maximum soil and plant nutrients, plant height, canopy volume, fruit yield, number of fruits, fruit weight and lower incidence of insect pests and diseases as compared to other treatments.

Studies were conducted to record physiological parameters of citrus spp. Nagpur mandarin Seedless N-4 showed light saturation point (LSP) at 1200 PAR with maximum photosynthetic assimilation rate ( $5.98 \mu\text{mol m}^{-2} \text{s}^{-1}$ ). Galgal was less efficient to transpiration while, Seedless N-4 recorded higher transpiration rate at all the PAR levels. The photosynthetic yield was inversely proportional to the all levels of PAR and increase in PAR levels enhanced the electron transport rate (ETR) in all the tested cultivars. Rate of photosynthesis of Nagpur mandarin plants differ significantly with the fruit stages being maximum in marble stage and reduced simultaneously with the fruit maturity stages.

Application of mono potassium phosphate (1.5%) + 2,4-D (10 ppm) during Oct.- Nov. was superior w.r.t. fruit retention, no. of fruits/plant and yield in *Mrig* crop of Nagpur mandarin while, application of mono potassium phosphate 1.5% + GA<sub>3</sub> 10 ppm during Oct.- Nov. was superior w.r.t. fruit quality parameters.

Fruit oblongness was maximum in Nagpur mandarin budded on Galgal followed by Rangpur lime and Shekhawasa × Rough lemon. With higher canopy density of plants fruit oblongness was more. To reduce fruit oblongness during fruit growth stage, there was a need to minimise the soil moisture stress (excess or deficit moisture) for reduction of ABA concentration in fruits.

Type of occupation and annual income of the citrus grower showed significant relationship with the perceived acceptability of contract farming. Inadequate water for irrigation followed by price uncertainty was observed to be the main risk factors in acid lime farming as perceived by growers. The guaranteed and fixed pricing structures were believed to be the main advantage of contract farming. Pricing arrangement and payment procedures received maximum preference for signing an



agreement by the respondents. Studies on constraints of citrus nursery owners of Vidarbha showed the significant negative relation of type of occupation and significant positive relation of communication behaviour with the acceptability towards containerized nursery system. The guaranteed and fixed price structure, minimum support price and need for providing appropriate technology, necessity of issuing permits for nursery growers, availability of genuine rootstocks are the issues/actions to be taken by Government agencies for sustenance of citrus nursery business.

In the management of citrus leaf miner, 20mg lure/0.3 ha + foliar application of thiamethoxam @ 0.008% followed by acephate @ 0.008% and fenvalerate @ 0.02% at 10 days interval recorded significantly low leaf miner infestation (pooled mean: 10.87%) in pre-bearing Nagpur mandarin orchards. In the management of fruit sucking moth, % fallen fruits was significantly low (pooled mean: 11.95%) in foliar application of Horticultural Mineral Oil @ 1.0% at 7, 14, 21, 28 and 35 days after treatment. Repellents were evaluated against fruit sucking moths and percent fallen fruits were significantly low in acephate and phorate (10g) alone or in combination with soap stone powder/sand 5g @ 2 sachets/tree (pooled mean: 6.96-8.64%).

Studies on vector-pathogen interaction in relation to transmission of citrus greening disease revealed that acquisition period of 12 hrs and inoculation period of 5 days are optimum in symptom expression of *Liberibacter asiaticus* infection 6 months after inoculation period in Nagpur mandarin seedlings.

Highest incidence and intensity of bark eating caterpillar was recorded in >10 years old Nagpur mandarin orchards in Nagpur, Amravati and Wardha districts. Spraying the tree trunk with cypermethrin 10EC @ 0.02% and neem oil @ 5% before the onset of monsoon resulted in significantly low mean no. of webs/tree (pooled mean: 1.29 webs/tree)). A new insecticide molecule Cyantraniliprole 10% OD @ 60 g.a.i./ha was quite effective against citrus psylla, thrips, citrus leaf miner and @ 70 g.a.i./ha against lemon butterfly.

Twenty-three *Phytophthora* sp. isolates (12 isolates of *Phytophthora nicotianae*, 6 isolates of *P. palmivora*, 3 isolates of *P. insolita*, 1 isolate of *P. virginiana*-like and 1 isolate of *Phytophthora vexans*) were isolated and purified. Among these one *P. virginiana*-like isolate was isolated from a pond (water reservoir). A total of 260

isolates of *Phytophthora* sp. have been isolated, purified and being maintained in sterile distilled water at 25°C in the 'Phytophthora Repository of ICAR-CCRI'. Total 22 isolates of bacteria were isolated and purified from stem, root and leaf samples. The pure isolates generated were then used for performing confrontation assay against *Phytophthora nicotianae*. In a field trial, integrated application of Bordeaux paste + *Trichoderma harzianum* Str. 44 + Fosetyl Al (0.25%) reduced maximum number of *Phytophthora* propagules/cc soil, fruit yield and also increased the feeder root density as compared with control in Nagpur mandarin.

Survey of citrus orchards for Phytoplasma induced disease symptoms revealed that 4-5% Nagpur mandarin and 7% acid lime trees were infected. Detection of Phytoplasma by nested PCR was standardised. NCBI-BLAST analysis revealed that the 16S rRNA gene sequences shared 99.9% similarity with that of the earlier reported 'Candidatus Phytoplasma cynodontis' strains (LT558777, KF234570, AB741630). Phylogenetic analysis of obtained sequences showed that the WBDL phytoplasma formed a distinct clade with *Ca. Phytoplasma cynodontis* strain BGWLC1. One CTV RT-LAMP (Loop mediated isothermal amplification) technique has been developed for detection of CTV. New primer pair set targeting on RNA binding protein gene (P23-RBP-F/P23-RBP-R) has been designed and standardized to detect the Citrus tristeza virus.

Lac-based fruit coating formulation, SH10B with fungicide Azoxystrobin recorded maximum freshness of fruit, juice recovery with better firmness, lower weight loss and higher retention of TSS and Vit'C' content in Nagpur mandarin fruits after 21 days of storage at ambient condition. Spoilage % was lower in SH10B + Azoxystrobin and stayfresh + Azoxystrobin treated fruits after 21 days. Disinfection treatment with sorbic acid (2%) and sodium bicarbonate (3%) recorded maximum juice recovery, lower weight loss with better firmness, TSS and Vit. C content with zero spoilage % in Nagpur mandarin of *Ambia* and *Mrig* crop. Borax (6%) treatment of Nagpur mandarin (*Mrig* crop) with polyethylene liner in the box recorded maximum juice recovery, lower weight loss with better fruit firmness, TSS, Vit. C content and lowest spoilage percent.

Foam mat drying of Nagpur mandarin and Mosambi juice using methyl cellulose and maltodextrin resulted in orange coloured juice powder. Peel oil was extracted



using hydro distillation from Khasi mandarin and Assam lemon. Studies on super critical fluid extraction of peel oil showed that vessel pressure of 100 bar, vessel temperature (Vt.) 45°C and valve temperature (Vlt.) 55°C resulted in 1.87% peel oil recovery in 30 minutes and vessel pressure of 400 bar, vessel temperature (Vt.) 35°C and valve temperature (Vlt.) 40°C resulted in 2.27% aroma recovery in 350 minutes in Kachai lemon.

Highest amount of hesperidin (1.36mg/lit), naringin (41.69 mg/lit) and limonin(11.75ppm) was recorded in Wilking mandarin and in Chinotto (1.43 mg/lit) rootstock. Phenol content was higher in juice of Wilking(11.56 mg/lit) and rootstock Cleopatra (16.13mg/lit). However, Pectinifera (235.40mg/lit) and Butwal (14.91mg/lit) contained more flavonoids in peel and in juice, respectively.

### Regional Research Centre for Citrus (RRCC)

A Regional Research Centre for Citrus has been started at Biswanath Chariali in the campus of Biswanath College of Agriculture, Assam Agricultural University, Dist. Biswanth, Assam during the year 2016-17.

### Infrastructure Developed

New infrastructure work completed during 2016-17 were 1) Internal farm roads, 2) Rain water harvesting pond, 3) Intake well on Ambazari Lake, 4) Pipeline (6 inch diameter) from Ambazari Lake to Institute (3 km), 5) Water tank with 1.5 lakh litre capacity, 6) Labour shed and 7) Main gate of the Institute.

Foundation stone of Farmers' Hostel was laid by Hon'ble Secretary, DARE and DG, ICAR Dr. Trilochan Mohapatra on 27<sup>th</sup> October, 2016 and the work has been started.

### Resource Generation

Disease free plants worth Rupees Seventeen lakh seventy three thousand six hundred seventy three (Rs.17,73,673) were sold under the Revolving fund project of the institute. Under Technology Mission on Citrus for Vidarbha, disease-free plants of citrus worth Rupees Seventy eight lakh forty one thousand five hundred ninety four (Rs. 78,41,594) were sold during the year 2016-17. Besides this, revenue worth Rupees Six lakh seventy three thousand two hundred thirty one (Rs.6,73,231) from sale of farm produce and Rupees One lakh thirty four thousand one hundred sixty six (Rs. 1,34,166) from sale of CCRI publications was generated.

This way, total revenue generated was One crore four lakh twenty two thousand six hundred sixty-four (Rs. 1,04,22,664/-)

### Planting material produced

A total of 71,095 disease-free plants of Nagpur mandarin, Acid lime, Mosambi and rootstock mother plants besides fruits of Acid lime, Rangpur lime, Rough lemon (for seed purpose) were distributed to various stakeholders under Revolving fund project. In Technology Mission on Citrus, 2,38,690 disease-free planting material was sold to various stakeholders.

### Training/ Capacity building and Extension

The Institute has consistently attempted to transfer the improved technologies to the ultimate users through varied activities such as trainings (On-campus-4, Off-campus-4) of farmers/Officers, visits of scientists to orchards, farmers visit to the Centre and participation in Krishi Exhibition (12). A 200 hrs Skill Development Training Programme on 'Citrus Fruit Grower' as per Agriculture Skill Council of India guidelines was conducted during 1-31<sup>st</sup> March, 2017, in which 13 trainees were participated. On-line insect pest and disease management has been regularly followed through information uploaded on ICAR-NCIPM website and field visits. Training on insect pest identification and data recording was given to scouts and masters trainees related to HORTSAP project in four training programmes during the period.

For the skill development of CCRI Staff, 19 personnel of various categories were sent for trainings.

### Important events organized by the Institute

'Soil Health Day' was celebrated by institute on 5<sup>th</sup> December, 2016 in collaboration with TMC and Department of Agriculture, Government of Maharashtra at Hetikundi, Tahsil Karanja, District Wardha. The institute celebrated ICAR foundation day on 28<sup>th</sup> July, 2016. A one-day training programme on 'Indian Patenting Procedures: Commercialization of Patents' in collaboration with Rajiv Gandhi National Institute of Intellectual Property Management (RGNIPM), Nagpur was held on 11<sup>th</sup> August, 2016. Institute Celebrated 'Hindi Pakhwada' from 14-28<sup>th</sup> September, 2016. Celebrated International Yoga Day on 21<sup>st</sup> June, 2016. The Institute observed *Parthenium* Awareness week from 16-22 August, 2016. Institute also observed Productivity Week-

2017 wherein special campaign for waste to wealth through recycle/reuse was done by decomposting of agri-waste. A cleanliness campaign was organized at premises of ICAR- CCRI on 2<sup>nd</sup> October, 2016 as part of '*Swachh Bharat Abhiyan*'. SwachhtaPakhwada was observed at the Institute from 16-31<sup>st</sup> October, 2016. ICAR-CCRI, Nagpur adopted two villages viz. Panchgaon and Hetikundi of Maharashtra under "*Mera Gaon Mera Gaurav*". The events like 125<sup>th</sup> Birth Anniversary of Dr. Bhimrao Ambedkar (15<sup>th</sup> April, 2016), Anti-Terrorism Day (23 May, 2016), Independence Day (15<sup>th</sup> Aug., 2016), Sadbhavana Diwas (20<sup>th</sup> Aug., 2016), Quami Ekta Week (29 Oct. to 3 Nov., 2016), Rashtriya Ekta Diwas (31 Oct., 2016), Preamble on Constitution Day (26 Nov. 2016), Republic Day (26<sup>th</sup> Jan., 2017) and Martyrs' Day (30<sup>th</sup> Jan., 2017) were organized.

ICAR-CCRI, Nagpur has implemented ERP system (MIS and FMS). Institute also installed swipe machine (POS) facilities for cashless public digital transaction.

### **Technologies commercialized and Varieties released**

Consultancy on analysis of flavonoids and other compounds by HPLC to M/s. Orem Enterprises, Gurgaon, Haryana; Establishment of processing unit and cold storage of 100 tonne capacity for Khasi mandarin fruits to Eleutheros Christian Society (ECS), Tuensang, Nagaland; Nursery establishment to M/s. Karunamaya Agrotech, Nagpur was given during 2016-17. Diagnosis of citrus greening using real time qPCR was done on payment basis to Sequoia Bio Sciences, Pvt. Ltd, Pune.

New varieties viz. 'Pummelo US-145', Sweet orange 'Cutter Valencia' and grapefruit 'Flame' from exotic material and two varieties developed through indigenous material viz. NRCC Pummelo- 5 and NRCC Grapefruit-6 have been released by Institute technology and variety release committee. These varieties will fulfill long standing demand of citrus growers of Central India for diversification and citrus processing.

### **Awards and Recognition**

'Santra Samwad' received the Second Best Hindi Patrika Award from Nagar Rajbhasha Karyanvayan Samiti (NARAKAS), Nagpur. Dr. M. S. Ladaniya, Director received "Vasantrao Naik Krishi Award - 2016" for contribution in Agriculture especially development of citrus industry in the country and Maharashtra in particular on 1<sup>st</sup> July, 2016. Dr. A.K. Srivastava, Pr. Scientist (Soil Science) received Dr. B.H. Jain Award-2016 for excellence in creation and dissemination of Knowledge among the students and farmers from Confederation of Horticulture Association of India (CHAI), New Delhi; World Aqua Foundation Award (2016) from Aqua Foundation at New Delhi and he was also awarded fellowship of the Horticultural Society of India, New Delhi on 15<sup>th</sup> November, 2016. Dr. A.D. Huchche and his team received best poster paper award on "Climate change and citrus: A phonological Perspective in 7<sup>th</sup> Indian Horticulture Congress- 2016 during 15-18 November, 2016. ICAR-CCRI has received FSSAI registration No. 2151725 - 9000455 for sale of beverages for a period of 5 years (17.3.2017 to 16.3.2022).



## 2. ICAR-CCRI : A Profile

### Genesis

Initially Citrus Research Station was established at Nagpur under IIHR, Bengaluru to address dieback and decline of citrus plantations in Central India. The status of citrus crops as one of the most important fruit crops in nutritional and livelihood security of the people of the country was also a deciding factor. Various bodies / agencies such as Quinquennial Review Team of IIHR, Bengaluru; Govt. of Maharashtra; UNDP Consultant and task force of Ministry of Agriculture, Govt. of India recommended establishment of the Regional Station under IIHR, Bengaluru. The foundation stone of the station was laid by Shri. P. V. Narasimha Rao, then Hon'ble Minister of Defense, Govt. of India on 28<sup>th</sup> July, 1985 and work started to develop the station from scratch. Later this station was upgraded and started functioning as independent National Research Centre for Citrus, Nagpur from 1<sup>st</sup> April, 1986. The Centre which is located in the heart of Nagpur mandarin growing area of the country has completed 32 years of its service to the nation. The 'NRC for Citrus' has been upgraded in October 2014 to the status of 'Institute' in the XII Plan approval and has been renamed as 'Central Citrus Research Institute' (CCRI) with a regional centre in Assam. Regional Research Centre for Citrus started functioning from March, 2017 in the campus of Biswanath College of Agriculture, AAU, BiswanathChariali, Assam. Regional Research Centre on Citrus would cater the research and development needs of citrus industry of entire northeast India. The institute is the country's only premier national organization exclusively mandated for citrus research, education and extension. Over the years it has emerged as the torch bearer for citrus research at national level and recognized at international level. ICAR-CCRI, Nagpur has been awarded ISO-9001:2008 Certification for adoption of standard operating procedures.

### Location

The CCRI, Nagpur is located on Amravati Road (Kolkata- Mumbai National Highway 6). It has in its close vicinity the ICAR-Affiliated National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Ginning Training Centre (GTC), a Regional Centre of

Central Institute for Research on Cotton Technology (CIRCOT) and Regional Remote Sensing Centre (RRSC) of ISRO. The campus of the Institute is also quite close to Nagpur University. Hence, CCRI, Nagpur has locational advantage which facilitates multidisciplinary studies, inter-institutional interactions and research linkages etc. The Regional Research Centre for Citrus with an area of 42.5 acres is located in the campus of Biswanath College of Agriculture, AAU, BiswanathChariali, Assam.

### Mandate

- Basic, strategic and applied research on crop improvement, sustaining productivity, crop protection and utilization of citrus.
- Repository for genetic resources and scientific information on citrus.
- Nodal centre for training, quarantine, certification and supply of disease-free planting material of citrus.

The role of Central Citrus Research Institute (CCRI), becomes all the more important in view of serious challenges viz., unavailability of certified disease free planting material, threats of insect-pests and diseases, nutrient deficiencies, scarcity of irrigation water, climate change, lack of post-harvest fruit handling and processing infrastructure across India.

### Major Research Themes

- Genetic Resources management and Crop Improvement
- Crop and Resource Management and Environment
- Integrated Pest and Disease Management
- Post Harvest Technology, Processing and Value addition
- Social sciences (Extension, Economics, Computer Applications)

### Training And Transfer Of Technology

- Imparting training to students and researchers on advanced research methodologies



- Capacity building of staff of state Agri./Horticulture departments, KVKs, private entrepreneurs
- Commercialization of technology

## Management

A high powered Research Advisory Committee (RAC) comprising of eminent professionals and scientists guides the institute on formulating its research policies and in planning research thrusts and strategies. The Institute Management Committee (IMC), constituted and mandated by the ICAR, supervises the functioning of the Institute. Internal Committees such as, Institute Research Council, Purchase Committee, Library and Publication Committee, Official Language Committee and a Grievance Committee, to name a few, are operating for decentralization of management. The Institute Joint Staff Council promotes healthy interaction and congenial work environment.

## Infrastructural Facilities

Central Citrus Research Institute, Nagpur is established on 250 acres of land out of which 180 acres is under plantation on which experiments are being conducted. Rest of the land is utilized under seven different farm ponds for rain water harvesting, administrative-cum-laboratory building, staff quarters, screen and glass houses, shed nets, meteorological observatory, farm house, drip system, water storage tanks etc. Over the years the institute has created modern laboratories in different disciplines (see organogram). Research is being carried out in frontier areas of tissue culture, crop regulation and agro-techniques, plant nutrition, viral, fungal and bacterial diseases, insect-pest management, water management, extension, post-harvest technology etc. Some of the modern equipments available at the institute include Real time PCR, Advanced Photosynthesis System, Atomic Absorption Spectrophotometer, Multiplate Reader, GC, HPLC, wide range of fruit and juice processing equipments etc.

An excellent library, especially on citrus, with a collection of 2024 Books and 1054 back volumes of research Journals has been established to support research, teaching and extension. Institute subscribes 30 Indian, 7 foreign journals, 2 online foreign journal and provide internet services to all its scientist in their laboratories. Online literature search facility is also being provided under consortium of e-resources in Agriculture

(CeRA) to the Institute scientists. The library has been fully computerized by using the Koha software, a web-based integrated management system. Documentation unit was further strengthened electronically by subscribing G-Gate e-Journal for the year 2016-17.

The institute has the best nursery in the country which is accredited as 5-Star nursery by National Horticulture Board. This nursery has provided around 3 million disease-free certified plants of good pedigree to growers across India so far.

## Major Achievements

CCRI has 614 citrus germplasm accessions out of which 62 are from exotic sources and 522 from indigenous sources. Institute has also collected 7 endangered/ rare/ wild citrus species. Institute has released nine citrus varieties so far namely Nagpur mandarin seedless - 4, acid lime - 7 and acid lime - 8 with three exotic varieties viz. 'US Pummelo-145', 'Cutter Valencia' and 'Flame grapefruit'. Varieties NRCC Pummelo- 5 and NRCC Grapefruit-6 have been developed through indigenous material. *Citrus macrophylla* (Alemow) has been released as promising rootstock for Nagpur mandarin and acid lime for tolerance to *Phytophthora* diseases. Micro-budding technique has reduced cost and time in propagation and is being followed for commercial scale multiplication. With shoot-tip grafting (STG) technology it has become possible to clean elite high yielding material and propagate under insect-proof screen houses to provide disease-free planting material. Leaf nutrient standards and crop regulation techniques helped growers to get bumper yields of quality fruits.

During last thirty two years, CCRI has made significant contributions towards developing farmer-friendly technologies for the benefit of citrus growers. Successful demonstration of rejuvenation technology in the farmers' field resulted in increasing average yields from 6-7 tonnes/ha to 10-11 tonnes/ha. During last five years technologies of fertigation (saving 20-30% of fertilizers at 80% evaporation replenishment) have been developed for application of inputs at critical growth stages for saving of inputs. Mass talcum powder based production of *Trichoderma harzianum* native strain-44 control of *Phytophthora*. Biological and chemical control measures have been standardized for all important insect-pests. PCR based molecular diagnostic methods were

developed for rapid and sensitive detection of CTV, ICRSV, CMBV, exocortis and greening pathogens. Complete post-harvest handling protocol has been developed to minimize losses from present 25% to less than 5% and technology has been commercialized.

**Establishment of First Regional Research Centre for Citrus of ICAR–CCRI, Nagpur at Biswanath, Chariali, District Biswanath, Assam**

Regional Research Centre for Citrus was sanctioned for North-Eastern region in Assam state under ICAR-CCRI, Nagpur in XII Plan. This matter was persuaded since 2014 (approval of XII Plan EFC came in October 2014) to select the site out of 5 sites. As suggested by Dr. K. M. Bujarbaruah, Vice Chancellor of Assam Agriculture University, the survey was conducted and the site at Biswanath college of Agriculture of AAU was selected on the basis of road, rail and air connectivity, suitability of land for cultivation of citrus, climate, availability of sufficient land, water and availability of college rooms to start activities immediately. The land was given by AAU its 42.5 acres on lease basis for 99 years. Earlier, Biswanath was a Tehsil town in Sonitpur district of Assam. Now Biswanath has become separate district in Assam.

Biswanath headquarter is about 70 Km (1 hr. road travel) from Tezpur airport. Kolkata to Tezpur and back to Kolkata flights are available thrice in a week (Tuesday, Thursday & Saturday). Apart from this there is a Lilabari airport near Lakhimpur city. Distance from Lilabari to Biswanath is 140 Km (2.5 hr. travel time) and thrice a week air connectivity is available from Kolkata to Lilabari and back (Monday, Wednesday, Friday and Sunday).

Biswanath is also connected to Guwahati with highway at a distance of 250 Km with travel time 5 hrs. (National Highway No. 27). This highway further goes to Dhemaji district where new IARI like institution has been planned by ICAR.

The Memorandum of Understanding (MoU) was signed between Dr. M. S. Ladaniya, Director ICAR-Central Citrus Research Institute, Nagpur and Dr. Tapan Baruah, Associate Dean, Biswanath College of Agriculture in October, 2016. The Lease Deed was also signed between Dr. M. S. Ladaniya, Director, ICAR-Central Citrus Research Institute, Nagpur, Nagpur and Registrar, AAU,

Jorhat on 6<sup>th</sup> March, 2017 in presence of Dr. K. M. Bujarbaruah, Vice Chancellor of Assam Agriculture University at Jorhat, Assam. AAU, Assam has given old Agric. College building temporarily for setting up of office of Regional Centre.

**Immediately all round activities have been started at the site.**

**Renovation of old college building:** The Biswanath college of Agriculture, provided its old abandoned college building to start the Centre. Renovation of old college building started in March, 2017. Electricity and water connections were needed to be restored. Building was in bad shape and repairs and painting work was needed urgently to start/ operationalize the Centre. Equipments like, printers (3), desk top computer, Inverter (for electricity supply), office furniture, internet connection were procured. The land line connection and broad band connection through BSNL were also obtained and made functional at office of RRCC.

**Land operations at Biswanath:** Considerable vegetation was growing on the site (42.5 acres) which was provided by AAU for establishment of new Regional Centre. Most of the land was not under cultivation for quite some time and thick vegetation was growing. All the vegetation needed to be removed and clearing operations started with the help of labourers (manual operations) tractor drawn implements (on hired basis) and the JCB.

The layout of land has been started for plantation in coming monsoon season. The biodiversity of citrus of NEH region will be planted apart from rootstock trials for Khasi mandarin orange and Assam lemon. New citrus cultivars will be planted to evaluate their performance.

**Operationalization of new RRCC:** Dr. A. A. Murkute, Sr. scientist was initially appointed as RRCC in-charge from 20<sup>th</sup> March, 2017. With purchase of computers and connectivity of net, the Centre started functioning. Later on charge was given to Dr. Kiran Kumar Kommu, Scientist from 25<sup>th</sup> March, 2017 and he was appointed as In-charge of the RRCC, Biswanath.

**Present status :** Office of RRCC, Biswanath is now functioning with all connectivity (e-mail: rrcc.biswanath@gmail.com); Telephone: 03715-230015, Telefax: 03715-230014).





Glimpses of the newly established MRCC at Biswanath Chariali, Assam

## Infrastructure and facilities developed during 2016-17

### Farm development

During 2016-17, following new works were completed to strengthen the infrastructure for improved efficiency at farm : 1) Construction of intake well at Ambazari lake, 2) Pipeline from Ambazari Lake to CCRI (3 Km), 3) Microirrigation system with fertigation unit, 4) A labour shed at the farm site, 5) Repairing of boundary wall, 6) WBM road at farm and 7) New entrance gate and security guard room, 8) Water tank (10 lakh litres) and 9) Water for better accessibility Rain water harvesting pond. A new farm pond was constructed during April-May 2016 at the end of the campus keeping in view farm slope so as to collect maximum rain water.

### New staff car

The ambassador car which was purchased in 2005 was quite old and needed replacement. Therefore, new Maruti Suzuki Ciaz as a staff car was purchased in July, 2016.

### Farmers' Hostel

The foundation stone of the new farmers' hostel was laid by Hon'ble Secretary DARE and DG, ICAR, Dr. Trilochan Mohapatra on 27<sup>th</sup> October, 2016. The work of the hostel has been started.

### Swachh Bharat Mission

- Swachhta Pakhwada was celebrated wherein

fortnight long cleanliness drive was taken up at the Institute from 16-31 May, 2016 and 16-31<sup>st</sup> October, 2016. A Swachhta pledge was taken by all the staff members on 16<sup>th</sup> May, 2016 and 2<sup>nd</sup> October.

- Big garbage pits have been created for plastic/ metal/ glass, etc. The composting of the waste generated on farm viz. Pruned wood, grasses, weeds, nursery plants etc. has been started.
- Recycling of Agro waste :** Huge quantity of agro waste gets generated at CCRI farm in the form grasses, pruned wood, leaves, nursery plant waste etc. The composting pits have been filled. This farm compost is being used for the crops at the institute.
- Mera Gaon Mera Gaurav :** Since last two years training, demonstrations and technology dissemination activities are continuing at two villages viz. Pachgaon, Tehsil Umred, District Nagpur and village Hetikundi, Tehsil Karanja District, Wardha.

### Mobile app on 'CCRI Citrus' launched

Institute launched a mobile app "CCRI Citrus" on 10<sup>th</sup> February, 2017. The Mobile app enables the growers for the effective and accurate citrus cultivations practices, monthly calendars of operation, etc. which provides online and offline information to the farmers. The mobile app in English, Marathi and Hindi can be downloaded from the CCRI website ([www.ccringp.org.in](http://www.ccringp.org.in)) on any android based cell phone with version 4.0 and above.





**Dr. C.D. Mayee, Ex. Chairman, ASRB, New Delhi launching the Mobile App "CCRI-Citrus"**

### Consultancy / Analytical services

The following consultancy services were undertaken during 2016-17. 1) Consultancy on analysis of Flavonoids and other compounds by HPLC was given to M/s. Orem Enterprises, Gurgaon, Haryana, 2) Establishment of processing unit and cold storage of 100 tonne capacity for Khasi mandarin fruits given to Eleutheros Christian Society (ECS), Tuensang, Nagaland, 3) Nursery establishment with M/s. Karunamaya Agrotech, Nagpur and 4) Analysis of 11 citrus samples for the presence of citrus greening disease using real time qPCR of Sequoia Bio Sciences, Pvt. Ltd, Pune.

**Laboratory facilities created :** In order to strengthen the laboratories, following major equipments were purchased : Automatic weather station with software, ultrawater purification system, sigma plot 13, scientific graphing and data analysis software.

**Furnishing of New laboratories :** Biotechnology, Soil Science, Entomology lab (Semiochemical) laboratories have been furnished in the new building.

### Administrative Reforms implemented during 2016-17

- Digitization of land records and entire 250 acres campus with GPS System and mapping.
- All Scientists and staff are making the entry of training details through the ERP System.
- The project on "Implementation of Management Information System (MIS) including Financial Management System (FMS)" is being implemented and personal information, leave, bill etc. are being entered.
- BSNL lease line 10mbps is operationalized and functioning to satisfaction.

- Aadhar Enabled Bio-matrix attendance System is being followed.
- Implementation of unified communication facility a new domain created by ICAR for the institute and all the staff members.
- CCTV cameras installed initially at strategic locations.
- Installed two swipe machines (PoS) facility for cashless transaction.

### Transfer of Technology

- Technologies developed by CCRI, Nagpur have been transferred to citrus growers through demonstrations at farmers' fields, Kisan melas, field surveys/visits of Scientists, Agro-Exhibitions and Radio talks.
- Technical consultancy is being given through SMS services Technical consultancy was also given to the citrus growers in adopted villages in Warud, Taluka, Distt., Amravati through the mKrishi software developed by Tata Consultancy Services (TCS).
- Helpline Services to the Citrus Growers : The Helpline Service is very handy for citrus growers to get appropriate solutions to the problems at any time.

### Visit of Director General to ICAR- CCRI, Nagpur

Dr. T. Mohapatra, Secretary (DARE) & Director General (ICAR) visited ICAR-CCRI, Nagpur on 27<sup>th</sup> October, 2016 and laid foundation stone of Farmers' Hostel in the Institute's premises. He also visited new irrigation facilities of CCRI viz. intake well at Ambazari Lake (developed through Maharashtra Jeevan Pradhikaran), TMC nursery and laboratories. While interacting with



**Dr. T. Mohapatra, Secretary (DARE) & Director General (ICAR) visiting CCRI nursery**



**Dr. T. Mohapatra, Secretary (DARE) & Director General (ICAR) visiting Semochemical Lab**

scientists, Dr. Mohapatra appreciated the achievements on production of disease-free healthy planting material, the research work on improvement, production, protection, processing and value addition of citrus.

### Training / Skill Development

The Central Citrus Research Institute, Nagpur is now affiliated with Agriculture Skill Council of India (ASCI) with a registration No. NSDC Reg. No. 15733 received on 24<sup>th</sup> January, 2017. Institute has started providing one month long training to desirous stakeholders under qualification pack : Citrus fruit Growers.

### Linkages

CCRI maintains close linkages with National organizations like IISR, Mau, Uttar Pradesh; IIHR, Bengaluru; IISR, Calicut; IINRG, Ranchi; DBT, New Delhi; IICT, Hyderabad, NCIPM, New Delhi, Govt. of Maharashtra; FSSAI, New Delhi for conducting various research projects on citrus. CCRI also has linkage with NHB and various research projects on citrus at the institute were funded by NHB. Institute also provides expertise to NHB for accreditation of nurseries.

### AICRP

CCRI, has been entrusted to look after the responsibilities of coordinating the Citrus research in All India Co-ordinated Research Project (AICRP) on fruits from Nagpur and accordingly the technical programme of all the Centre's of AICRP on citrus is being monitored. The AICRP Citrus Co-ordination cell has been established at the CCRI, Nagpur and the Director of the institute has been co-ordinating citrus research across 10 centers in the country viz. Rahuri, Akola, Tirupati, Chethali,

Periyakulam, Tinsukia, Pasighat, Ludhiana, Abohar and Sri Ganganagar.

### New Initiatives

Increasing productivity per hectare is the major challenge in coming decades when resources are shrinking and climatic changes are posing threat to citrus production. The ICAR-CCRI has taken new initiative since 2014 with all new plantation at the farm on raised beds (1.5-2 feet height and 8-10 feet wide) with fertigation. Several new exotic cultivars of Sweet orange, mandarins, grapefruit have been planted apart from most of the acid lime and lemon cultivars available in the Country. High density plantations of mandarin and acid lime are being evaluated at the farmers' field and institute farm. Canopy architecture for higher photosynthetic efficiency of plants is being studied so as to get higher yields of good quality fruits. Development of package of practices for organic citrus production is the need of the hour and research has been initiated in this direction in a holistic manner covering plant protection and plant nutrition issues.

During 2016-17, following new externally funded research projects have been started.

- 1) Innovative strategies for climate resilient citriculture (NICRA funded).
- 2) Molecular diagnostics, transcriptomics and cisgenic approaches to combat greening (HLB) disease of citrus (DBT funded).
- 3) Functional components and antioxidants analysis of citrus fruit for its potential application in food industry (FSSAI funded).

### Thrust Areas for XII Plan

- Characterization of the collected citrus germplasm using phenotypic and molecular descriptors.
- Development of seedless varieties through ploidy manipulation and artificial mutation in Nagpur mandarin and mosambi orange.
- Development of fertigation protocol for increased water and nutrient use efficiency and higher yields.
- Development of tolerant rootstock to *Phytophthora* diseases through marker assisted selection (MAS).
- Production of Disease-free elite planting material in all citrus growing regions of the country.



- Standardization of cultivation practices in high density planting using raised beds, fertigation, IPM and IDM.
- Development of collaborative projects for cultivar-specific and region-based technologies for Sathgudi and Mosambi oranges; Coorg, Khasi, Kinnow and Nagpur mandarins and acid lime considering important regional problems.
- Development of value-added products from citrus grown in different parts of the country.

### Technology Mission on Citrus (TMC)

The Horticulture Mission (now Mission for Integrated Development of Horticulture, MIDH), Govt. of India funded programme of “Technology Mission on Citrus for Vidarbha, Marathwada and Chhindwara” is operational at the institute since 2007. The CCRI, Nagpur is co-ordinating all the activities at three locations viz. Nagpur (for Vidarbha), Parbhani, Jalna and Aurangabad (for Marathwada) and Chhindwara (for Madhya Pradesh).

Under this mission, 3.05 lakhs disease-free planting material of citrus has been produced during 2016-17. Planting material is distributed to citrus growers, nurserymen, SAUs, ICAR institutes, KVKs, and State departments/farms. Under this programme nearly 47 lakhs citrus planting material has been produced since 2007. Under skill development programme 19 trainings of 32 hrs. duration undertaken with 256 beneficiaries and 23 training of 8hrs. duration with 2656 beneficiaries were organized. During 2016-17, for the first time, ICAR-CCRI in collaboration with Technology Mission on Citrus for Vidarbha conducted a skill development programme of 200 hrs for citrus fruit growers (course master ID - 9836) for 13 participants during 1-30 March, 2017. Demonstrations for rejuvenation of declining orchards and showcasing technologies were organized at 48 places. Baseline survey was conducted in Nagpur, Amravati, Wardha and Akola districts of Vidarbha covering 630 citrus growers (Nagpur mandarin 365, Acid lime 148 and Sweet orange 117).

### Budget (2016-17)

Head	Fund received	Fund utilized
Plan	407.00 lakhs	402.17 lakhs
Non-Plan	964.00 lakhs	961.04 lakhs

### Staff Strength (as on 31/3/2017)

Category	Sanctioned posts	In position	Vacant
Director (RMP)	01	01	-
Scientific	20	17	03
Technical	20	20	-
Administrative	11	08	03
Supporting	17	11	06
<b>Total</b>	<b>69</b>	<b>57</b>	<b>12</b>



## ORGANOGRAM

