

# 1. EXECUTIVE SUMMARY

ICAR-Directorate of Cashew Research (ICAR-DCR), Puttur has been in the forefront in carrying out research and extension activities to enhance the production, processing and value addition of the cashew crop. The significant achievements of ICAR-DCR in the five major research programmes i.e. management of genetic resources, crop improvement, crop management, crop protection and post harvest technology and also the achievements made in transfer technologies to the farmers and other stakeholders during the year 2019 are summarized here.

## CROP IMPROVEMENT

CNSL is an important by-product of cashew industry having a great industrial and medicinal value. In the current year, twenty germplasm accessions were evaluated for CNSL content. The cashew germplasm database was enriched with 842 images belonging to 76 germplasm accessions and the database has been visited 2919 times during the year 2019.

To create novel genetic variations through mutations, 113 seedlings and grafts (from gamma-ray treated seeds and scion sticks) of two popular varieties i.e. Bhaskara and Ullal-3 have been raised and being evaluated for traits such as dwarfness, excessive branching etc. As part of DUS characterization of cashew genotypes, a total of 30 reference varieties have been established during 2019 and maintained.

The efforts to develop dwarf and compact cashew hybrids have yielded in the selection of a promising semi-tall genotype, Tree No. 8 derived from Dhana x NRC-492 (Dwarf genotype) during the reporting year. Besides, two hybrids viz., Tree No.102 of the cross Madakkathara-2 x NRC-492 and

Tree No.5 of the cross Vengurla-4 x Thaliparamba-1 recorded higher 4-years cumulative nut yield of 11.10 kg and 10.86 kg, respectively, compared to that of local check Bhaskara (10.74 kg).

A study on generation mean analysis involving six generations viz.,  $P_1$ ,  $P_2$ ,  $F_1$ ,  $F_2$ ,  $B_1$  and  $B_2$  was initiated to estimate the nature of gene action on important traits in cashew. Screening of 17 selected cashew germplasm accessions for cashew apple and nut characters showed that the fat content varied from 22% in NRC-18 to 29% in NRC-384 accessions. Further, NRC-301 had the longest (9.33 cm) and heaviest apples (188.80 g), and the broadest apple was recorded in NRC-389 (7.09 cm). The Organoleptic evaluation of fresh apples of these accessions according to the 9-point Hedonic scale showed that the cashew apple of NRC-301 was appealing based on colour and fragrance and the overall acceptability of this accession was better among the tested accessions, while the check Vengurla-8 scored the highest points with respect to the overall acceptability.

A draft genome sequence of the popular Indian cashew cv. Bhaskara was generated for the first time using the hybrid genome assembly approach. The total genome assembled is 385 Mb (92%) of the cashew genome arranged in 4,981 scaffolds, with a scaffold N50 of 2.55 Mb. The gene annotation and gene prediction of the assembled genome showed a total of 40,264 protein coding genes, of which 32,194 were annotated proteins and 8,070 were unannotated proteins. Further, a total of 47,646 SSRs were detected comprising of 59% of di-repeats followed by 24.4% tri-nucleotide, 3.6% of tetra-nucleotide, 1% of penta-nucleotide, and 0.8% of hexa-nucleotide repeats and 11.1% complex SSR motifs. The decoding of cashew genome forms the

basis for genomics assisted breeding in cashew to improve yield, biotic and abiotic stress tolerance, altered plant stature, quality traits and other useful traits in cashew.

The two mapping populations viz. Bhaskara x NRC-188 and Vengurla-7 x NRC-116 developed for mapping of QTLs governing the nut yield and CNSL was raised. The comparison of seedling growth characteristics of these populations with the five crossings viz. Bhaskara x H-130 (UV), NRC-492 (Dwarf) x H-130, NRC-492 (Dwarf) x Thaliparamba-1, NRC-492 (Dwarf) x Vengurla-7, and Vengurla-7 x NRC-492 (Dwarf) revealed significant differences for the traits like seedling height and leaf size.

### **CROP MANAGEMENT**

The evaluation of the influence of time of fertilizer application on the phenology of cashew cultivar Ullal-3 showed that application of fertilizer in September month stimulated early onset of reproductive phenological growth stages compared to the control. Nutritional management of cashew under Ultra Density Plants (UDP) is the need of the hour to popularize the technology. An experiment was setup under UDP in cashew to optimize the mineral nutrition and to develop a fertilizer nutrient management package for UDP in cashew. The results of the initial soil analysis showed that soil pH ranged from 5.5 to 5.92, electrical conductivity from 0.053 to 0.056 dSm<sup>-1</sup>, organic carbon from 0.59 to 0.69% in the surface 0 to 30 cm layer. The available nitrogen content in the surface layer varied from 275 to 325 kg ha<sup>-1</sup>.

### **CROP PROTECTION**

TMB is a major pest of cashew in India which causes severe yield losses. The investigations on semio-chemicals for management of TMB showed that the maximum pheromone activity of TMB virgin females to attract males occurs between 4<sup>th</sup>

and 5<sup>th</sup> days after emergence (DAE).

Identification of new chemical molecules with better insecticidal properties is essential for effective management of insect pests. The evaluation of newer molecules for management of tea mosquito bug (TMB) showed that thiamethoxam (0.2g L<sup>-1</sup>) and  $\lambda$ -cyhalothrin (0.6ml L<sup>-1</sup>) could result in a damage score below 0.5 after 15 days after treatment (DAT). However, these promising insecticides could not lead to damage scores lower than 0.5 after 30 DAT and lower than 2.0 at 45 DAT under the laboratory evaluation.

The investigations on inflorescence pests of cashew showed that in the month of December, higher infestation by TMB (20-30%) and a complex of flower caterpillars (25-35%) was noticed in the ICAR-DCR plots. An investigation on nest occupancy by *Braunsapis picitarsus*, a major pollinator of cashew, in the artificial bee nests showed that for successful artificial nests for *B. picitarsus*, the nest hole of 3 mm diameter is ideal.

### **POST HARVEST TECHNOLOGY**

A mechanical slicer for cashew apples, and a capacitance based 3 in 1 non-destructive moisture meter for raw cashewnuts, and for peeled and unpeeled cashew kernels were developed by ICAR-CIAE, Bhopal and M/s EMCON, Kochi and was calibrated and evaluated at ICAR-DCR, Puttur. A comparative performance study of various categories of cashewnut processing units in India helped to delineate the underlying problems for enhancing the productivity of industries. Besides, dehydrated products from cashew apple such as vacuum fried cashew apple chips and cashew apple ponace powder-based extrudates, cashew apple chew, cashew apple fig and cashew apple crisp were developed. These value-added products of cashew are expected to enhance the economic utility of cashew apples, which mostly go waste due to their highly perishable nature.

## **TRANSFER OF TECHNOLOGY AND EDUCATION**

As part of technology transfer, in the project funded by RKVY-RAFTAAR, 59 demonstration plots were developed in cashew growing districts of Karnataka to showcase the usefulness of improved technologies to realize higher yield. These field demonstrations with farmer's participation is expected to benefit the growers to appreciate the impact of technologies in the field. In the year 2019, a total of 8 farmer's field visits/field days/ diagnostic field visits and 11 lectures/TV talks/Radio talks on cashew production and processing were given as part of the transfer of technology. Besides, two mobile apps were also developed for the transfer of know-how to the cashew farmers and stakeholders in the country. Mobile phone app viz. "Cashew India" app was developed in 11 different languages of India for transferring the cashew production-related knowledge to the farmers. Another mobile app for nutrient management in cashew was developed. The directorate also facilitated carrying out six M.Sc. students' research projects and thesis writing. The institute also coordinated the Annual Group Meeting (AGM) of Scientists of AICRP on Cashew which was organised at the University of Horticultural Sciences, Bagalkote from 13 to 14 December 2019. The Institute Technology Management Unit (ITMU), which shoulders the responsibility of commercialisation of technologies developed at the Directorate steered commercialization of 6 cashew processing machinery technologies to the private firms. ITMU unit is regularly following up the

status of the patent application filed at the patent office, Chennai. Further, the research associate of ITMU visited the Gujarat state to explore the potential licensees for the technologies developed at this Directorate.

The Quinquennial Review Team (QRT) reviewed the work done by the ICAR-Directorate of Cashew Research, Puttur and All India Coordinated Research Project (AICRP) on Cashew for the period 2013-2018 and submitted its report to ICAR on 12 February 2019. The Directorate organised various events such as Foundation day, International day of yoga, Swachhata Hi Sewa campaign, Vigilance awareness week, Annual cashew day, Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) and International women's day. The Hindi cell of the Directorate conducted Hindi week and also quarterly and half-yearly Hindi workshops. During the FY 2019-20, the Directorate generated Rs. 116.45 Lakhs revenue through the sale of grafts and other services. The directorate has supplied 1,85,314 cashew grafts to farmers from 2019-20. In the project funded by RKVY-RAFTAAR, a centre for excellence in nutrient management with the state of art laboratory facilities was created in the Soil Science Section of the Directorate with the installation of modern instruments such as Micro-wave Plasma Atomic Emission Spectrometer (MP-AES-Agilent 4210), UV-Visible Spectrophotometer (Shimadzu UV-1900) and eight minor equipments.