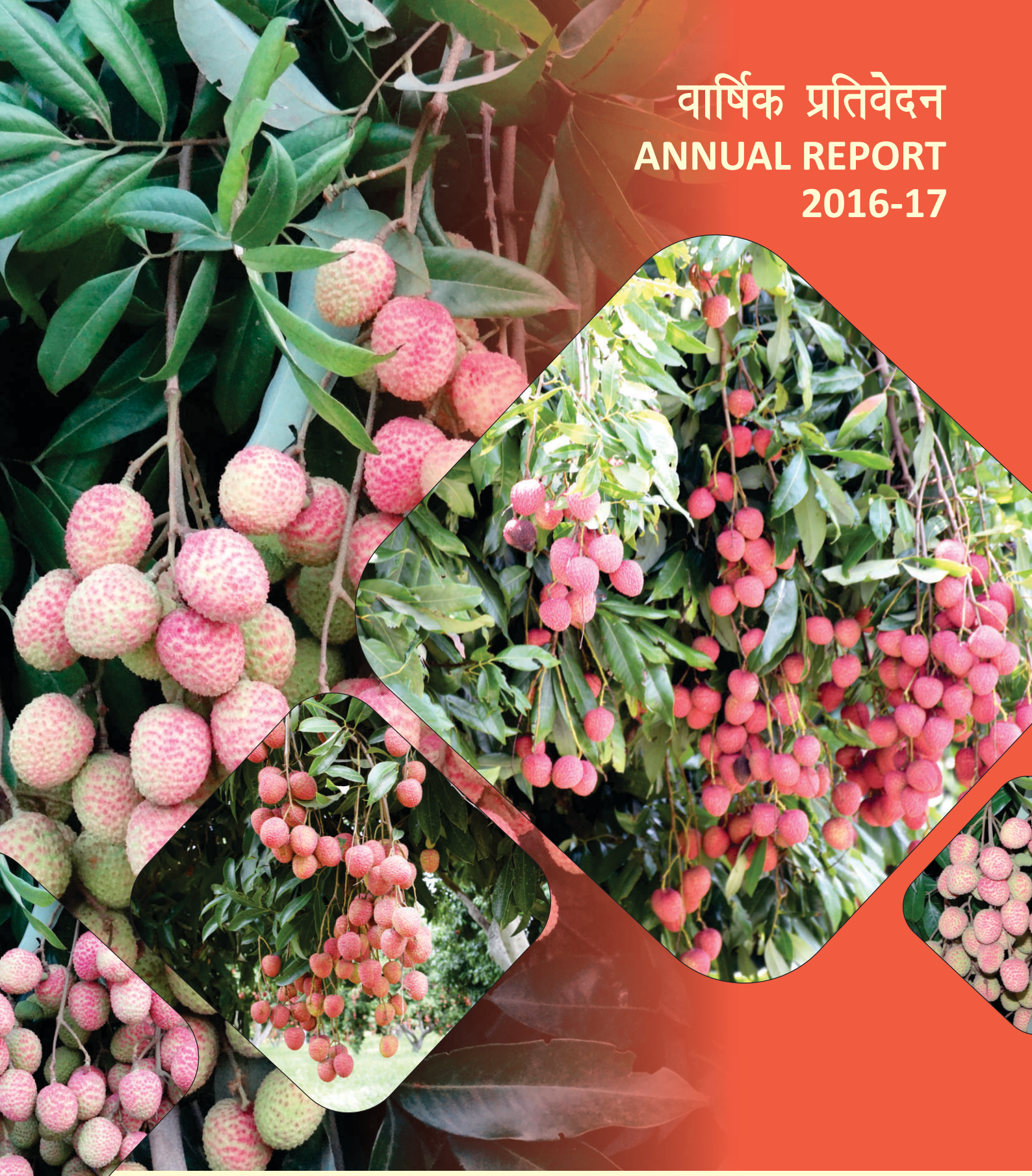
वार्षिक प्रतिवेदन
ANNUAL REPORT
2016-17



भाकृअनुप–राष्ट्रीय लीची अनुसंधान केन्द्र

ICAR-National Research Centre on Litchi

मुशहरी प्रक्षेत्र, मुशहरी, मुजफ्फरपुर–842 002 (बिहार), भारत

Mushahari Farm, Mushahari, Muzaffarpur–842 002 (Bihar), India

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ICAR-National Research Centre on Litchi

Mushahari, Muzaffarpur – 842 002, Bihar, India

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Correct Citation
ICAR-NRCL Annual Report 2016-2017. ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India. 77p.

Published
June, 2017

Printed at
APP Printing Press, 33 Nehru Road, Sadar Cantt., Lucknow- 226 002. Tel: 0622-2481164

Preface

Into its 16th year, ICAR-NRC on Litchi has made its presence felt in different litchi-growing regions of the country. During the year, we were also able to locate new potential areas for litchi such as Thane in Maharashtra, Kushinagar and Deoria in Uttar Pradesh, Shahdol in Madhya Pradesh, Mount Abu in Rajasthan, Mokokchung in Nagaland, and many more. This goes on to confirm the growing popularity of the fruit in the country.

ICAR-NRC on Litchi has made tremendous progress in R & D activities, with focussed research in genetic resource management and crop improvement, sustainable crop production, crop protection and post-harvest handling and value addition. The centre has also been mandated to carry out extension activities and propagate skills and improved technologies for the benefit of all stakeholders in the litchi industry.

I am proud to share that we have released three new varieties of litchi - Gandaki Yogita, Gandaki Lalima, and Gandaki Sampada, and the first variety of longan, Gandaki Longan-I which will provide litchi growers with more options for choice of variety during orchard planning. During the year we have attained deeper understanding into nutrient deficiency symptoms in litchi, role of mycorrhiza, and canopy architecture management. The Centre has released *NRCL Trichoderma,* a biopesticide. We have been able to induce flowering and fruiting in otherwise off-year in China variety of litchi. The Centre has also achieved leads into organic litchi production and litchi-based cropping systems. Our scientists have been actively involved in development of integrated pest management schedule for control of litchi borer and mite, as well as pre-and postharvest diseases of litchi. We have been able to strengthen and address postharvest issues through collaborative ventures with APEDA, BARC, and USDA.

During the period, the centre hosted a summer school on 'Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic condition', a short course on 'Bioassay, Production protocol, and quality control for Trichoderma based biopesticides.', and a model training course on GAPs in Litchi. With the aim to increase export of litchi, the centre conducted a capacity building programme in collaboration with APEDA and USDA. Training programme on preservation of litchi was also conducted in collaboration with BARC, Mumbai. ICAR-NRCL has actively participated in *Kisan Mela/Kisan Gosthis,* exhibition and training to farmers all over the country. During the period, the centre has organised various litchi-related programmes and trainings in the litchi-growing states of the country and extended its technical expertise to various stakeholders.

I would like to place on the record the guidance, support and encouragement received from Secretary, DARE and DG, ICAR, DDG (Horticultural Science), ICAR, Chairman, RAC and members of IMC from time to time.

With this background I present to you the Annual Report for the period 2016-2017. It is a gist of our efforts to understand and promote litchi in the country. I am hopeful that you will find it informative and your valuable feedback would further encourage our team to work towards achieving more and attaining greater heights.

Muzaffarpur
June, 2017

Vishal Nath
Director

Contents

Executive Summary

ICAR-National Research Centre on Litchi (NRCL), established in the year 2001 has continued its momentum in conducting basic and applied research under multi-disciplinary programme covering various aspects of litchi including genetic resource management and crop improvement, crop production, crop protection and postharvest management. Besides, the centre also conducts training, outreach programmes, and transfer of technology to improve knowledge and develop skills of different stakeholders. A concise summary of salient achievements the centre has made during 2016-17 is presented below.

Research Accomplishments

Genetic Resource Management and Crop Improvement

- Six germplasm of litchi were collected from Assam, Tripura and Uttarakhand during 2016-17. Besides, five genotypes of litchi were identified in Chattishgarh and Bihar.
- Seventeen genotypes of litchi have been characterized based on physico-chemical characters of fruit. IC-0615593 recorded highest fruit weight (36.85 g), pulp content (29.67 g), and ascorbic acid, while maximum TSS was recorded in IC-0615610 (21.79%).
- Standardization of tissue culture techniques in litchi has been initiated.
- Three new varieties of litchi namely Gandaki Yogita, Gandaki Sampada, and Gandaki Lalima, and one variety of longan (Gandaki Longan 1), have been identified and released at institute level.
- Shahi×GandakiYogita recorded maximum fruit set (13.60%) followed by China×Shahi (6.28%) and Shahi×China (4.25%) in conventional hybridization programme.
- Pollen grains stored at 4°C remained viable up to one year.

Crop Production

- Nutrient dose of 100:50:100 g NPK/plant/year to be the best dose for maximizing yield (72.33 kg/plant) in litchi cv. Shahi. The beneficial role of N and K application in improving fruit quality has been established, in cv. China, where application of 75 g each of N and K per plant/year resulted in highest pulp recovery.
- In a study on use of organic inputs in litchi, application of 20 kg FYM + 2 kg vermi-compost + 1 kg *neem* cake + bio-fertilizers was found to enhancegrowth performance and flowering. Efficient management of insect-pests was also achieved through application of neem oil, vermi-wash, panchgavya and bio-pesticides.
- Litchi plants provided with 32m^2 area per plant gave highest yield (7.7 t/ha) as well as fruit weight (22.18 g).
- Nutrient deficiency symptoms w.r.t. primary nurtients (N,P, and K) and four micro-nutrients (Fe, Cu, Zn, and B)have been established in litchi.
- Application of KNO_3 and PBZ in alternate years with keeping balance (by manual thinning) of fruit load per tree has been found to be effective for regular bearing in 'China' litchi. These chemicals also enhanced fruit weight, pulp weight, total fruit sugar, total phenol and reduced seed weight in Shahi.
- Girdling size of 4mm in 75% primary branches resulted in highest fruit yield (15.83 kg/plant) in 9-year old plants. While no or very poor flowering and fruiting was recorded in ungirdled branches.
- Application of biofertilizers resulted in significantly higher moisture content at different soil depths as well as leaf relative moisture content, which

indicates the beneficial role of microbes in mitigating water stress in litchi. Application of AMF and other microbial inoculants also significantly reduced incidence of sunburn, cracking, and disease incidence.

- Performance of different fruits and seasonal crops grown with litchi on pond bunds showed that Shahi cultivar had more vigorous growth than cv. China in the entire pond bunds model after two years of planting. Economic analysis of different models showed that cropping sequence of banana + cowpea-cabbage gave highest total net return/year, average net return and B:C ratio (Rs 28.77, 9.59/ m^2 & 2.33, respectively) followed by papaya + cowpea-cabbage (Rs 28.73, 9.57/m^2 & 2.41).
- Under the litchi-based cropping in low lying area, Shahi and China grown on ridges recorded more vigorous growth than in mound system of planting.
- Seasonal crops grown in ridge and mound furrows during summer (moong and cucurbits) and winter seasons (pea, mustard, faba bean) showed that yield performance of all the crops under ridge furrows was better than mound furrows due to high moisture retention in ridge furrows.
- Moisture content in ridges (14.62%) and their furrows (26.29%) recorded almost 2-4% higher than mound (12.01%) and its furrow (22.32%).
- Study to identify potential litchi areas in India using edaphic factors-based mapping and interpolation of daily temperature and precipitation data of existing litchi belts revealed that mean temperature below 20°C for 50-60 days and minimum temperature below 12°C for 50-60 days are ideal climatic conditions to induce flowering in litchi.

Crop protection

- The disease incidence of blight caused by *Alternaria alternata* in various nurseries ranged from 2.3-36.0%, with the highest incidence in February-March. The mean percent disease severity index (PDI) ranged from 34.8 to 78.1. Disease incidence of panicle blight was 5.3-27.8% in cv. 'Shahi' while in cv. 'China' it was 17.0-58.9%.
- Out of 12 fungicides tested, thiophanate methyl, difenoconazole and mancozeb were found effective against both anthracnose and fruit blight disease.
- NRCL bioformulation (NRCL T-01) was found superior to other *Trichoderma* strains and RDF in reducing the incidence of sunburn, anthracnose, cracking, and fruit blight.
- A comprehensive survey of insect-pests complex in different litchi growing areas of India was conducted during the period. Some insects common to all litchi growing areas include *Conopomorpha sinensis* Bradley, *Platypeplus aprobola* Meyer, *Indarbela quardinotata* Walker, *Myllocerus undecimpustulatus*, and litchi mite, *Aceria litchi*.
- Lambda cyhalothrin 5 EC (0.003%), thiacloprid 21.7 EC (0.013%), beta-cyfluthrin 8.49% + imidacloprid 19.81% were found to be effective against looper, leaf folder, and red and ash weevil.

Postharvest management and value addition

- Early morning (6 AM) harvesting resulted in better postharvest fruit quality and quantum of marketable fruits (74%) during 5-day storage in ambient condition, compared to late harvesting (later than 10 AM); thereby confirming the importance of harvesting time on postharvest performance of litchi fruit.
- Moisture loss from litchi fruit during storage shares a very strong correlation (r=0.92) with time. Peel thickness shares a strong positive correlation (r=0.87) with peel moisture content, and a strong negative correlation (r=-0.79) with per cent loss in weight (PLW). Moisture content in peel is strongly negatively correlated (r=-0.96) to PLW.
- Visual detection of pericarp browning in litchi becomes pronounced once the produce loses more than 4.65% of harvest weight.

- Litchi fruit treated with *Bacillus subtilis* NRCL-BS 01 recorded lowest activity of PPO and POD enzymes, and slower rate of anthocyanins degradation, thereby confirming the role of antagonists in reducing pericarp browning in litchi.
- Blanching litchi aril in combination with KMS (1500 ppm), 0.2% $CaCl_2$ and 0.2% ascorbic acid was found promising for minimal processing of fresh litchi aril under cling film packaging.
- Exogenous application of polyamines, ie putrescine (0.5mM) and spermine (0.5mM), significantly lowered fruit-drop thereby increasing fruit retention in litchi cv. Shahi and China.
- Postharvest application of polyamines (putrescine @ 0.5 and 1.0mM and spermine @ 0.5 and 1.0mM) significantly reduced pericarp browning during storage period over control, due to reduction in enzymatic activities of PPO and POD, and positive effect of polyamines in retention of anthocyanins pigments.
- Analytical method has been developed for estimation and quantification of methylenecyclopropylglycine (MCPG) in litchi fruit tissue.
- Studies on pre-cooling revealed that litchi can be hydro-cooled at 10°C for 10 minutes to remove field heat after harvest
- About 20% increase in fruit weight was recorded in the last five days before harvest (Between 17 May and 22 May). This reconfirms the quantum benefit growers can obtain by harvesting at optimum fruit maturity over the common practice of early harvesting.

Improving knowledge and skill of stakeholders

- During the year more than 2000 stakeholders were benefitted through various training and extension activities.
- Under TSP, rejuvenation technology has been demonstrated to litchi growers in Deogarh area of Odisha, and growth performance of mango and litchi was monitored in Rayagada district of Odisha. In addition, Shahdol in Madhya Pradesh has been identified as a potential litchi growing area.
- In a bid to popularize litchi-based cropping system, 12000 plants of litchi have been provided to farmers in Peren and Dimapur districts of Nagaland. Also, under NEH component litchi air layers were provided to farmers in Mokokchung, Nagaland and technical input was given for successful establishment of plants.
- Poultry chicks of backyard poultry 'Vanaraja' and 'Kuroiler' were provided to tribal women in Mokokchung, Nagaland for improving livelihood and nutritional status.

Externally Funded Projects

- Under the Farmers FIRST Programme, eight villages were selected in East Champaran, Bihar. Technology-led interventions in agricultural production system were executed under four major modules, viz. crop, horticulture, livestock, and microenterprise-based modules.
- Under the DBT mango project, 22 custodian farmers maintaining more than 15 varieties of mango have been identified. *Mithua* (from Patna), *Sewaiaya, Bhont, Jalbanda, Dayal* (Saran), *Gaurjeet* (West Champaran) and *Baramasi* (Jamui) were some unique mango varieties identified during the period.
- Utilization of interspaces in litchi orchard was studied and seasonal crops were grown in both *Kharif* and *Rabi* season. Turmeric, potato, and Maize showed promise for increasing income and improving soil health in young litchi orchards.
- Under CRP on Borers, infestation of litchi fruit borer ranged from 3.68 -33.67% based on survey of farmers' field. Several IPM modules were tested against the pest of which neem formulation (0.15%) + chlorantranilprole 18.5 SC (0.007%) proved to be the most effective in minimizing fruit infestation with litchi fruit borer.

- Approximately 35000 air-layers were prepared during the period under the ICAR-sponsored Mega Seed project. Additionally, 625 mother plants of nine promising litchi cultivars are being maintained in the mother block.

Linkages and Collaborations

The centre is working on different aspects in close collaboration with other organizations such as Agricultural Universities (DRPCAU, IGKV, JNKVV, SHIATS, SKAUST, BAU etc), NHB, APEDA, BARC, State Agriculture/Horticulture Departments, and other ICAR Institutes. Three PG scholars are conducting research at the centre in collaborative mode under the guidance of NRCL scientists. As a study centre of IGNOU, New Delhi for postgraduate diploma in plantation management and certificate course in organic farming, several students have registered for the courses.

Transfer of Technology

An MoU was signed between ICAR-NRCL and M/s. Clarion Casein Pvt. Ltd, Kadi, Gujarat, for 'Technology Transfer and Commercialization of products from litchi fruits (dehydrated and beverages)' on 22nd June 2016. Initiatives for effective transfer of litchi based technologies, through off-campus and on-campus training to farmers, field visits, and timely advice through print and electronic media were taken. The centre also participated in various Farmers` Fair to showcase and disseminate litchi technologies among stakeholders.

Other Activities

'Agricultural Education Day' was organized by the centre for school students at Khushinagar, UP. Swachhta Abhiyan was commemorated at the centre and efforts were made to keep the centre and the farms clean and hygienic. Hindi Chetna Maas was organised and the use of official language in all communication is being attempted. Van Mahotsav was organised at the centre where personnel from the district administration also took part. Other activities where the centre joined the rest of the nation in commemorating included National Science Day, Vigilance Awareness Week, National Productivity Week, etc

Infrastructural development

A farm store cum security room was developed at the northern end of the farm. In addition, a vermin-composting unit, farm toilet and vehicle parking shed were additions to the centres infrastructure. A tissue culture lab with facilities for molecular and biotechnological works and a soil science laboratory have been developed. A litchi treatment plant has come up in collaboration with BARC, Mumbai. The construction of residential quarters is also in progress.

INTRODUCTION

The ICAR-NRCL is the premier national institute for conducting research and development in litchi and provides leadership at national level. It also acts as a national repository for information on litchi production, processing, value addition, and provides consultancy services to end users.

Genesis and Growth

The ICAR-National Research Centre on Litchi (ICAR-NRCL) was established on 6th June, 2001 under the aegis of the Indian Council of Agricultural Research. With the lease deed having signed on 25th June, 2002 between the ICAR and Government of Bihar to transfer 100 acres of land to the Centre at Mushahari, Muzaffarpur, ICAR-NRCL began its journey. The centre grew in strength and number in subsequent years as more scientists and staff were allotted from the council. The centre can boast today of having almost it full sanctioned scientific strength, modern laboratories with core equipment, a sprawling farm and experimental area, and a buzzing campus. The Centre is located at Mushahari, on Muzaffarpur-Pusa Road at 26°5'87" N latitude, 85°26'64" E longitude at an elevation of 210 m. It is about eight km from Muzaffarpur railway station. The research farm of the centre is spread over an area of 35 ha.

Mission, Mandate and Functions

Mission

Harnessing science and technology by interfacing research and extension activities for enhanced quality production, productivity, processing and use diversification for sustained litchi production, industry and trade

Mandate

- Applied and strategic research on genetic resources and production technologies for enhanced, sustained, and safe production of litchi.
- Transfer of technology and capacity building for stakeholders for enhancing and sustaining productivity of litchi.

Infrastructure Facilities

The research farm of the centre has modern propagation structures, screen houses, glasshouses, irrigation networking and water sources. Modern analytical and diagnostic equipmentlike GCMS, AAS, UV-VIS spectrophotometer, HPLC, leaf area meter, portable photosynthesis system, horizontal electrophoresis unit, nitrogen analyzer, flame photometer, trinocular phase-contrast upright microscope, trinocular compound microscope, inverted phase contrast microscope, stereo binocular microscope, lyophilizer, ultracentrifuge, modified atmospheric packaging unit, hydro-cooling system, forced-air cooling system, litchi grading machine, plastic strip sealing and packaging machine, litchi peeling machine, cool storage chamber, bottle washing machine, litchi harvester cum pruner, power sprayer and mist chamber have been installed for different research and supportive activities.

Library

NRCL library has about 1800 books including recent editions of 400 reference books and hindi

literature in horticulture and allied fields. It has 16 encyclopedias and 30 vol. of Britannica. Currently, 14 Indian and 6 international journals are being subscribed. The centre has published 11 technical bulletins and 23 extension bulletins that are available in the library for researchers, extension workers and farmers.

Agricultural Knowledge Management Unit (AKMU)

The centre has an Agricultural Knowledge Management Unit to manage the knowledge database with software of international repute such as SAS, CAB abstracts, horticultural abstract, and other computing softwares. The centre has now installed server and LAN system for shared resources. Access to high speed internet is made available through the National Knowledge Network (NKN). The centre's website (www.nrclitchi.org) is regularly updated with the latest information and is visited by thousands of visitors from all over the world.

Significant Achievements

Genetic Resource Management and Crop Improvement

- The centre has introduced a number of promising germplasms of litchi and longan through indigenous and exotic collections. This has enriched the genetic pool for crop improvement programme at the centre.
- Three new varieties of litchi, namely Gandaki Yogita, Gandaki Lalima, and Gandaki Sampada, and a variety of longan (Gandaki Longan-1), have been released by the centre.

Crop Production

- ICAR-NRCL has developed, demonstrated, and fine-tuned the technology for rejuvenation of old, senile, unproductive litchi trees. Rejuvenation allows for bringing back old litchi trees into fruit production within three years, thus providing solution to growers for foregoing fresh plantation and for sustained income generation.
- The centre has achieved vital leads into understanding optimum canopy architecture in litchi. This includes apportionment of space for vegetative growth, fruiting and gallery as per plant spacing.
- ICAR-NRCL has developed and perfected technology for round the year production of quality planting material of litchi. Through the use of improved techniques like post-cut dip solution, root-trainers, and potting media, the centre has achieved improved survival of air-layers in nursery and initial plant establishment.
- Litchi-based cropping systems under low-lying conditions have been synthesized at the centre.
- Assured flowering and fruiting in litchi every year has been achieved through the technique of girdling of primary branches.
- Bunch bagging with non-woven PP bag 40 days after anthesisreduces infestation with fruit borer, sunburn and cracking, and improves overall fruit quality in litchi.
- ICAR-NRCL has developed bio-pesticide NRCL Trichoderma.

Crop protection

- *Alternaria alternata* was found to be a major pathogen causing disease in litchi at multiple phenophases (nursery, reproductive, and postharvest stage).
- Regular monitoring of pre-and post-harvest diseases is being done and control has been achieved in litchi.
- Integrated management spray schedule for control of litchi fruit and shoot borer has been developed.
- Integrated management schedule for control of litchi mite has been developed.

Postharvest management and value addition

- Maturity indices for litchi has been established – TSS >18%, Acidity < 0.5% and TSS/acid ratio of > 40 are reliable indices for judging harvest maturity in litchi.
- *Bacillus subtilis* @ 1×10^8 cell/ml, Potassium silicate @0.5%, Chitosan @ 1%, Carbendazim @ 0.2%

as postharvest dip treatment have been found promising in controlling fruit rots. *B. subtilis* isolates, NRCL BS-1 was found most effective to control fruit rot incidence up to six days after dipping of litchi fruit.

- Pre-harvest spray of GA_3 (100 ppm) + Potassium sulphate (1%) significantly reduced fruit cracking and increased fruit weight in cv. Shahi. Fruits dipped in Chitosan (1%) + *B. subtilis*@1×10^8 cfu or Carbendazim (0.1%) was found effective in maintaining the quality and shelf life of the fruits up to five days under ambient condition and 18 days at refrigerated condition.
- In collaboration with BARC, Mumbai, the centre has established litchi treatment facility for increasing shelf life of litchi up to 60 days.
- The centre has developed various processed products of litchi namely litchi squash, litchi RTS, dehydrated litchi pulp, canned litchi, litchi nut, litchi honey, litchi wine etc.

Improving knowledge and skill of stakeholders

- The centre conducts regular training and outreach programmes for improving knowledge and skills of stakeholders
- The centre has made its pan-India presence felt in recent years with popularization of litchi in many pockets of the country.
- ICAR-NRCL provided 12000 plants of litchi cv. Shahi to beneficiaries in Peren and Dimapur districts of Nagaland.

Externally Funded Projects

In addition to the in-house research projects, the following externally funded projects are also on going at the centre.

- Improved livelihood through good practices in agricultural production system (Farmers First Programme)
- ATMA sponsored project: Studies on effective utilization of interspaces in young bearing litchi orchards for income and soil health improvement
- Consortia research platform (CRP) on borers
- ICAR Seed Project-Mega Seed project on Seed production in Agricultural crops and Fisheries (RFS)
- Developing National repository and facilities for DUS testing in guava and litchi
- National Agriculture Innovation Fund and Transfer/ Commercialization of Agricultural technology
- AICRP Honeybee and Pollinators
- AICRP Fruits

Staff Strength of the Centre

Staff	Sanctioned	Filled	Vacant
Scientific	15+1	14+1	1
Technical	14	2	12
Administrative	12	10	2
Skilled supporting staff	10	3	7

Financial Statement 2016-17

NON-PLAN (in Rs. lakh)

Sl. No	Head-wise break up	RE 2016-17	BE 2016-17	Release	Expenditure
(A)	**Recurring:**				
a.	Establishment (including pension)	339.00	310.00	341.00	332.27
b.	T.A.	3.00	3.00	3.00	2.92
c.	Contingency	108.90	64.00	108.90	108.72
d.	Loans and advances	2.00	1.00	-	1.21
	Total (A)	**452.90**	**378.00**	**452.90**	**445.10**
(B)	**Non-Recurring:**				
a.	Equipment	5.00	2.00	5.00	5.00
b.	Works (Minor)	-	-	-	-
c.	Furniture & Fixture	2.00	1.00	2.00	1.99
d.	Library	-	2.00	-	-
e.	Vehicle	-	-	-	-
f.	Live Stock	-	-	-	-
g.	Land	-	-	-	-
	Total (B)	**7.00**	**5.00**	**7.00**	**6.98**
	Grand Total (A +B)	**459.90**	**383.00**	**459.90**	**452.09**

PLAN (in Rs. lakh)

Sl. No	Head-wise break up	RE 2016-17	BE 2016-17	Release	Expenditure
(A)	**Recurring:**				
a.	Establishment	-	-	-	-
b.	T.A.	5.00	10.00	5.00	5.00
c.	Contingency	134.00	130.00	125.15	125.14
d.	HRD	1.00	1.00	1.00	1.01
	Total (A)	**452.90**	**378.00**	**452.90**	**445.10**
(B)	**Non-Recurring:**				
a.	Equipment	56.63	65.00	56.63	56.63
b.	Works (Minor)	266.68	130.00	266.68	266.68
c.	Furniture & Fixture	2.56	20.00	2.56	2.56
d.	Library	4.13	15.00	4.13	4.13
e.	Vehicle	-	-	-	-
f.	Live Stock	-	-	-	-
g.	Land	-	-	-	-
	Total (B)	**330.00**	**230.00**	**330.00**	**330.00**
	Grand Total (A +B)	**470.00**	**371.00**	**461.15**	**461.15**

Resource Generation

(Rs. in lakh)

Sale of farm produce	8.73
Interest earned on short term deposits	7.42
Income generated from internal resources (including recovery of loans and advances)	4.41
Miscellaneous receipts	2.31
Total	22.87

Receipts and Expenditure Statement of Externally Funded Projects

(Rs. in lakh)

Externally funded projects	Opening balance	Receipt during 2013-14	Expenditure
Total	12.86	91.46	107.51

RESEARCH ACHIEVEMENTS

1. Conservation, Characterization and Utilization of Genetic Diversity for Improvement of Litchi

1.1. Collection of indigenous and exotic germplasm, their characterization, evaluation, documentation and utilization

Collection of litchi germplasm from indigenous and exotic sources

Six germplasm of litchi were collected from Assam, Tripura and Uttarakhand during 2016-17 and planted in the nursery. Besides, explorations were undertaken to Chattishgarh and Bihar from where five genotypes were identified.

Out of the nine exotic germplasm introduced from Spain under FAO Project, four genotypes were regenerated during 2016-17.

Characterization of litchi germplasm based on morphological, biochemical and molecular markers

Seventeen genotypes of litchi have been characterized based on physico-chemical characters of fruit. Data revealed that maximum fruit length and fruit width was recorded in IC-0615593 which also registered the heaviest fruit weight (36.85 g) followed by IC-0615585 (28.99 g). IC-0615593, IC-0615587 and IC-0615593 recorded the lowest seed weight. Highest pulp weight was noted in IC-0615593 (29.67 g) accounting for 80% of fruit weight followed by IC-0615587 (19.91 g). IC-0615610, IC-0615597, and IC-0615602 have pulp weight ranging from 17.08 - 18.28 g with 70% pulp content. The maximum TSS was recorded in IC-0615610 (21.79%) followed by IC-0615587, IC-0615602 and IC-0615593. IC-0615600, IC-0615597, IC-0615606, IC-0615601, IC-0615594 and IC-0615593 recorded significantly higher ascorbic acid content.

Standardization of tissue culture techniques for propagation and multiplication of litchi germplasm

For standardization of tissue culture techniques in litchi, nodal explants (2.0 cm) were collected from 10-12 year old Shahi plants and treated as per standardized protocol. The explants were cultured on MS basal medium supplemented with 3% (w/v) sucrose and 0.8 % (w/v) agar. The pH of MS medium was adjusted at 5.80 prior and was incubated at 25±1°C with 16 h light/ 8 h dark photoperiod under the PAR fluorescent tubes. Subculture was done every three weeks interval with respective media.

1.2. Development of improved cultivars in litchi

Three genotypes from the existing gene pool with superior yield and quality attributes have been identified by Institute Technology Management Unit for release during 2016-17. The striking features of these varieties are presented below.

Gandaki Sampada

- A late maturing strain that ripens during mid June.
- Fruits are large in size (36.85 g), conical in shape, vermilion to carmine colour, and cracking resistant (Fig. 1.1).
- Fruit consists of creamy-white, soft and juicy pulp with 80 to 85 per cent pulp recovery.
- It has very high percentage of shrivelled and small seeded fruits.
- Yield ranges from 120-140 kg/tree.

Fig.1.1. Gandaki Sampada, a large fruited variety

Gandaki Yogita

- Dwarf plant stature, tolerant to hot waves and fluctuations in soil moisture.
- Tolerant to fruit borer and fruit cracking.
- Late maturing variety (5-15th June).
- Fruits are round in shape, tyrant rose in colour with creamy-white and juicy pulp (Fig. 1.2).
- Good yield potential (70-80 kg/tree).
- Suitable for high density planting.

Fig. 1.2. Gandaki Yogita, a late maturing variety

Gandaki Lalima

- A highly nutrient efficient strain possessing dark green leaves and the capability to withstand climatic aberrations (Fig. 1.3).
- Late maturing cultivar that ripens during second week of June.
- Fruits are conical, bright marigold-orange red in colour.
- Fruit weighs between 28-32 g with creamy white pulp.
- High yielder with average yield of 130-140 kg/tree.

Fig.1.3. Gandaki Lalima, a nutrient efficient variety

Development of improved hybrids of litchi

Out of the 52 hybrid population planted in the hybrid block, 12 hybrids are surviving. Nineteen hybrids were established during 2016 and populations raised in polyhouse. All together 11240 flowers were crossed out of which 167 crosses resulted in to fruit set. Among the crossed parents, maximum fruit set was observed in cross combination of Shahi×Gandaki Yogita (13.60%) followed by China×Shahi (6.28%) and Shahi×China (4.25%), while least fruit set was recorded in Shahi×Gandaki Sampada (0.8%) followed by Bedana×Shahi (1.80%). In pollination study of litchi, pollen grains remained viable up to one year during storage at 4°C. Morphological characterization of pollen grains of litchi using scanning electron microscopy (SEM) showed that the sculpturing of exine surface of all cultivars is striate with an irregular pattern (Fig. 1.4).

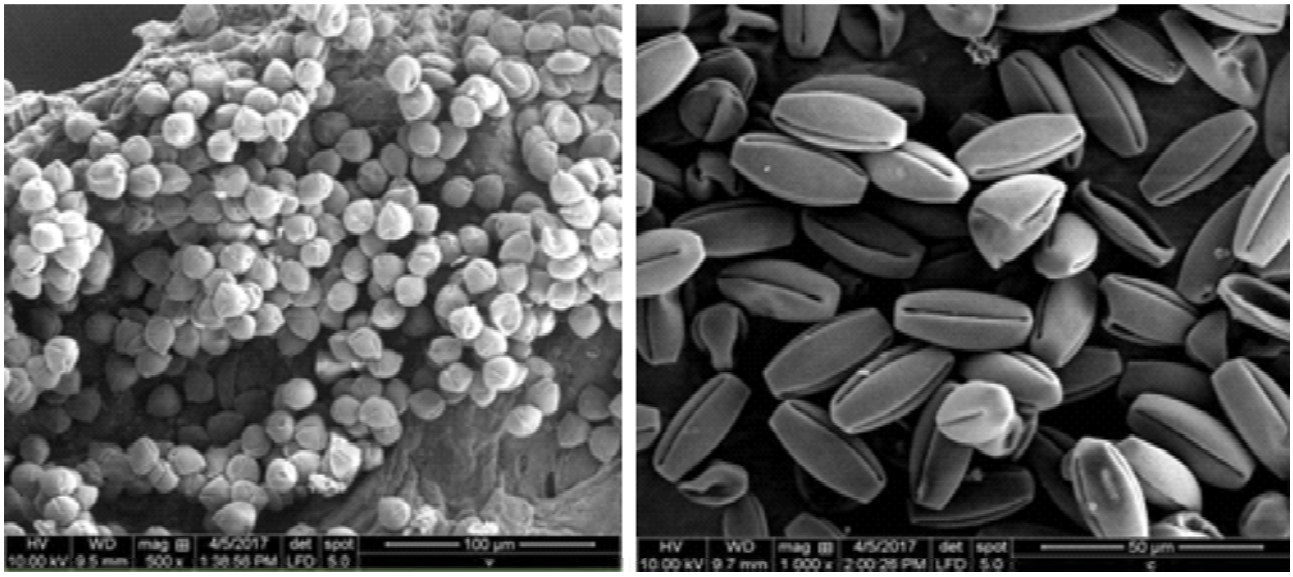


Fig. 1.4. Scanning electron microscopy of litchi pollen grains

Clonal selection for improvement in commercial cultivars of litchi

Nineteen clones were evaluated for morphological and fruiting characters out of which 4 clones came into flowering. Assessment of flowering parameters revealed significant variation among clones with respect to panicle size, sex ratio and fruit set. IC-0614728 recorded the highest panicle size (26.24 cm length and 14.37 cm width) and sex ratio (0.78).

Establishment and evaluation of segregating population of litchi

A total of 490 seedling plants were evaluated on the basis of vegetative growth characters like plant height and girth. Out of these,100 plants were selected for assessing the bark:wood ratio. Correlation results revealed that plant height, girth and internodal length shared strong positive correlation but were negatively correlated with bark:wood ratio. The dwarf-statured plants exhibitedhigher bark:wood ratio (1.09-1.14) than vigorous seedling plants (1.04-1.05).

1.3 Collection, characterization, evaluation, documentation and utilization of longan

Leaf and inflorescence characterization of 15 longan genotypeswas done. A population of 160 longan variants is being maintained in the longan block out of which 47 plants flowered during 2016-17.A superior genotype was identified as Gandaki Longan 1 by Institute Technology Management Unit (Fig. 1.5) and released at institute level during 2016-17. Salient features of this variety are given below.

Gandaki Longan 1

Fig. 1.5. Gandaki Longan 1

- Regular bearing and high yielding (20 kg/ tree).
- Fruit weighs between 11-13 g.
- Pulp recovery ranges from 58-60%.
- Free from fruit drop, majorpests and diseases.
- Good shelf life.

2. Development and Refinement of Integrated Production Technologies for Improved Productivity of Litchi

2.1. Development and refinement of integrated technologies for improved productivity of litchi

Effect of graded level NPK on vegetative and reproductive character of Shahi litchi

Application of different doses of N and K had significant effect in yield attributing characters. Highest improvement in all yield attributes were observed with application of 100:50:100 g N P K/plant/year, which was similar with all combination of 100 and 75 g of N and K. Maximum yield 72.33 kg/plant/year recorded in combination of 100 g N and K/plant/year. Available soil nitrogen (209.75 kg/ha) and leaf N (1.71 %) was found higher in 100 g N and K combination. Fruit colour and ascorbic acid content were better through lower application of N and K. Fruit quality was found better with application of higher level of N and K application.

Effect of graded level NPK on vegetative and reproductive character of China litchi

In case of China variety similar trend was observed and 68.32 kg/plant yield was recorded with application of 100:100 g N and K per plant per year. Pulp recovery was found more in 75:75 g N and K combination with 64.33 kg fruit yield/plant which was at par with combination with 100 g N and K.

Standardization of organic inputs for litchi production

To determine the nutritional needs of litchi through organic sources and to evaluate the potential of organic resources, a trial was initiated. Application of 20 kg FYM + 2 kg vermi-compost + 1 kg *neem* cake + bio-fertilizers showed better growth performance and flowering in the experimental trees with fruit yield of 27.27 kg yield/plant at 8-9 year of planting. Slightly higher leaf nitrogen content (1.52%) was recorded through application of in 20 kg FYM + 2 kg vermi-compost + 1 kg neem cake + bio-fertilizers, whereas, in other treatments it ranged from 1.41–1.44%. Insect-pests were efficiently managed with application of neem oil, vermi-wash, panchgavya and bio-pesticides.

Development of package of practices for organic litchi production

One block of Shahi, China, Mandraji and Trikolia cultivars has been established in 1.6 ha area with 6x6 m spacing under organic management practices to study the response of different organic resources *viz.*, FYM, vermi-compost, bio-fertilizers, bio-enhancers, green manures on growth performance of litchi. Maximum plant mortality was observed in middle block of the orchards while least mortality in lower side of the orchard which is might be due to more moisture retention in lower block and less in middle block.

Faba bean was grown as intercrop in between two rows of organic litchi block during *Rabi* season. The average yield of 14.56 q/ha was recorded in faba bean. Soil samples were collected from organic block after green manuring with dhaincha in 2016 for analysis. Whole orchard was divided into 3 blocks as upper, middle and lower block as per the slope gradient. The data revealed that the pH, EC and nitrogen content varied due to slope gradient. The pH and EC content gradually decreased while nitrogen increased from upper to lower side of the orchard and ranged from 7.95 to 8.18 and 0.19 to 0.21 dsm^{-1} from lower to upper side. The available nitrogen ranged from 240.41 kg/ha in top side to 262.75 kg/ha in lower side.

High density planting in litchi cv. Shahi

Maximum fruit yield was recorded under plant spacing of 8 × 4 m (76.17 q/ha) followed by 6 × 4 m (73.33 q/ha). However, highest fruit yield per plant was recorded under 10 × 10 m (28.53 kg) which was at par with 8 × 8 m planting density. Highest fruit weight was

recorded under 8 × 4 m and 10 × 10 m (22.18g and 22.14g, respectively). There was no significant difference among planting densities for fruit quality parameters.

Nutrient deficiency symptoms in litchi plants

A pot experiment was conducted with three macro (N, P, K) and four micro (Fe, Cu, Zn, B) nutrients to study the deficiency symptoms of these nutrients (Fig. 2.1). Under N deficient plants the older leaves turned yellowish in colour and newly emerged leaves became light green. Plant growth was stunted with reduced leaf size.In P deficient plant,foliage turned dark green with erect leaves.Zn-deficient plants showed inter-veinal chlorosis in leaves. Cu-deficient plants expressed symptoms of narrowing of younger leaves, which become hard. Fe deficient plants expressed chlorosis without spot on new leaves initially, and later on brown coloured spotting was observed.

Fig. 2.1. Nutrient deficiency symptoms in litchi,A: Nitrogen; B: Phosphorus; C: Potassium; D: Iron; E: Zinc

2.2. Investigation and establishing the physiological and biochemical relations for improved litchi production

Applications of paclobutrazol and potassium nitrate in influencing shoot physiology, flowering and leaf flushing of litchi cv. China

During 2016, paclobutrazol (PBZ) and potassium nitrate (KNO_3) was applied during September. Non-floral shoots had much higher net photosynthesis rate and transpiration rate than floral shoot in litchi cv. Shahi irrespective of application or non-application of PBZ. Photosynthesis rate, transpiration rate and stomatal conductance in 'Shahi' litchi reduced after 30 days of PBZ application while 4.0 g PBZ enhanced stomatal conductance in 'China' litchi. Increase in dose of PBZ increased stomatal conductance in litchi (Table 2.1). Application of $KNO_3$and PBZ in alternate years with keeping balance (by manual thinning) of fruit load per tree has been found to be effective for regular bearing in 'China' litchi. Manual de-flushing during December brought flowering in next season. In contrast, no flowering was induced even if tree sprayed with ethephon (1000 to 2000 ppm) during the same period.

Application of 2.0 g PBZ per m canopy diameter, and girdling in September was found to be best in 'China' litchi to inhibit emergence of new [winter] flushes. There was significant effect of application of PBZ and KNO_3 on leaf gaseous exchange parameters of litchi cv. China. The data presented in Table 2.1 reflected that net photosynthetic rate (*Pn*) reduced during flowering over vegetative phase but during flowering phase 1.0 KNO_3 recorded maximum *Pn* followed by 2.0 g PBZ. Except control trees, transpiration rate (*E*) reduced during flowering phase over October and maximum reduction due to application of 4.0 g PBZ. The stomatal conductance (*gs*) was found to be increase during vegetative phase but reduced during flowering. In contrast, control trees had 3 times higher *gs* during floral phase over vegetative. Internal CO_2 concentration (*Ci*) reduced during flowering period over vegetative phase and maximum recorded during both the phases due to 2.0 % KNO_3. Tree applied with 4.0 g PBZ has been able to have higher photosynthesic rate even at low *Ci* as reflected in Table 2.2. Water use efficiency (WUE) increased by 50-100 percent in tree applied with 2.0 % KNO_3 and 2.0 g PBZ over control trees during vegetative phase but during flowering, various treatment favoured high WUE over control. The leaf carboxylation efficiency (CE) also increased by 10-100 % by various doses of PBZ and KNO_3. It was also observed that higher the dose of KNO_3 and PBZ lesser the leaf temperature (LT) during flowering period (Table 2.2).

Application of PBZ and KNO_3 enhanced fruit weight, pulp weight, total fruit sugar, total phenol and reduced seed weight in 'Shahi' litchi but in 'China' litchi, fruit weight, pulp weight, seed weight and TSS although reduced but total fruit sugar and anthocyanin content was augmented. In litchi cv. China, 3.0 g PBZ increased up to highest level in terms of ascorbic acid, phenol and anthocyanin content than other treatments. PBZ application increased fruit ascorbic acid, total sugar, total

Table 2.1. Effect of PBZ and KNO_3 on leaf gaseous exchange parameters of 'China' litchi

Treatments	Photosynthetic rate (μ mol CO2) $m^{-2} s^{-1}$)		Transpiration rate (m mol $H_2O \cdot m^{-2} \cdot s^{-1}$)		Stomatal Conductance (m mol(H_2O) $m^{-2}s^{-1}$)		Internal CO_2 Concentration (μ mol CO_2 mol^{-1} air)		Water use efficiency (μmol mol^{-1})		Carboxylation efficiency [(μmol CO_2 m^{-2} s^{-1}) (μmol mol^{-1} $^{-1}$)]		Leaf temperature (°C)	
	October	March	October	March	October	March	October	March	October	March	October	March	October	March
1.0 g PBZ	4.63	1.98	1.30	1.01	34.00	24.70	341.22	207.33	3.56	1.96	0.013	0.009	34.27	35.73
2.0 g PBZ	8.00	2.79	1.53	1.05	22.66	45.62	331.22	257.33	15.09	1.59	0.024	0.010	34.11	35.50
3.0 g PBZ	5.63	2.01	1.73	0.88	19.66	23.55	358.66	225.33	7.71	2.28	0.015	0.009	35.90	34.00
4.0 g PBZ	5.60	2.13	2.16	0.85	65.66	18.84	322.66	173.66	2.59	2.50	0.017	0.012	37.21	33.73
1 % KNO_3	5.33	3.12	1.96	1.18	74.00	34.64	336.33	193.33	2.71	2.64	0.014	0.016	33.73	34.57
2 % KNO_3	8.96	2.29	1.76	0.99	76.33	41.33	359.66	279.66	11.78	2.31	0.025	0.008	34.87	31.38
Un-treated	7.16	2.05	0.96	1.93	14.33	43.53	359.22	253.00	7.45	1.06	0.012	0.008	34.44	35.52
$CD_{0.05}$	NS	0.08	0.84	0.086	25.35	0.62	4.54	7.40	NS	0.34	0.003	0.002	1.79	1.20

Table 2.2. Physico-chemical attributes of fruits affected by soil application of PBZ and foliar spray of KNO_3 in litchi

Cultivar	Treatment	Fruit weight (g)	Pulp weight (g)	Seed weight (g)	Peel weight (g)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugar (%)	Phenol (mg/100 g GAE)	Total sugars (%)	Anthocyanin content (mg/100g)
China	1.0 g PBZ	21.67	14.58	3.14	3.52	17.20	0.46	32.12	9.31	19.92	13.84	22.38
	2.0 g PBZ	21.31	14.52	2.96	3.57	18.00	0.44	30.64	9.26	20.36	12.78	23.64
	3.0 g PBZ	21.04	14.42	3.16	2.90	16.40	0.50	34.16	9.72	23.51	13.10	24.18
	4.0 g PBZ	22.16	14.15	3.43	3.41	17.20	0.48	32.18	8.32	22.36	12.46	22.64
	1 % KNO_3	21.88	13.58	3.76	3.63	18.00	0.47	31.16	8.52	22.18	12.60	23.04
	2 % KNO_3	21.58	12.30	4.08	3.89	18.40	0.47	30.84	8.70	21.96	12.84	23.28
	Un-treated	24.09	15.77	4.65	4.65	19.00	0.45	32.12	7.62	20.38	11.74	22.12
Shahi	3.0 g PBZ	19.78	13.71	3.18	2.30	17.40	0.42	32.78	8.73	22.87	12.89	17.38
	2.0 g PBZ	19.10	13.04	3.24	2.36	19.40	0.39	29.34	9.42	23.53	13.37	16.84
	1.0 g PBZ	18.97	12.68	3.42	2.40	16.50	0.41	30.29	9.68	22.68	13.26	18.46
	Un-treated	17.51	10.74	3.33	2.70	18.20	0.42	28.14	8.96	21.94	12.38	19.42

phenol in 'Shahi' litchi irrespective of doses. Application of 2.0 g PBZ led to least peel weight and highest TSS (Table 2.2).

Improving bearing potential though use of girdling cv. China

A field experiment was conducted to study the effect of girdling on flowering and fruiting in litchi cv. China. The treatments comprised of 3 levels of girdling size (2, 3 and 4 mm) on 3 levels of primary branches (25, 50 and 75%) along with control. The girdling operation was performed during September. No new vegetative flush was recorded in girdled branches. However, in ungirdled branches flushing was recorded in December. All the girdled branches exhibited flowering panicles but, no flowering or very poor flowering was noticed in ungirdled branches of the tree (Fig. 2.2). Under 4 mm girdling, flower panicle emergence was delayed by 6-7 days in comparison to control. Maximum shoot flowered (90%) in 3 and 4 mm with 75% PB girdling treatments. Trunk girdled plants expressed very good flowering with mixed inflorescence. The 4mm 75% PB girdling treatment recorded highest fruit yield (15.83 kg/plant and 22.80q/ha) in 9-year old plants. However, maximum fruit weight of 24.14g was recorded in 3mm 50% PB girdling which was at par with 4mm girdling size. The reduction in fruit weight might be due to more number of fruit per plant in 4 mm 75% PB.

Fig. 2.2. Flowering in girdled branches

2.3. Investigation on mycorrhizal association and role of bio-fertilizers for sustainable production of litchi

Effect of AMF and other microbial inoculants on soil moisture depletion and leaf relative water content under stress

Soil moisture depletion: Moisture content in soil at different depth could be one of the criteria to judge effect of microbes on water availability to plants. Hence, the gravimetric moisture content (%) was estimated in different depth (0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm) of soil. The results indicated that there was significantly higher moisture content at different soil depths with application of various biofertilizers (Table 2.3).

Leaf relative water content: The experiment was conducted to know the effect of AMF and other microbial inoculants on leaf relative water content (LRWC) under stress condition in young non-bearing trees. Irrigation to trees was withheld for two months so as to induce water stress. The LRWC was determined

Table 2.3. Effect of microbial treatments on moisture content in different soil depths

Treatment details	Moisture in different soil depth (%)			
	0-15 cm	15-30 cm	30-45 cm	45-60 cm
AMF@200 g/plant	7.2	10.9	15.4	13.3
AZ@100 g/plant	6.4	8.4	13.5	11.9
TR@100 g/plant	8.9	13.5	14.3	13.9
BM	7.7	10.4	12.9	10.3
AMF+ RDF	5.8	7.9	15.7	12.0
AZ + RDF	8.7	10.8	15.8	14.1
TR + RDF	7.8	13.5	14.9	14.0
BM + RDF	9.7	14.3	15.8	11.2
AMF + AZ	9.5	14.2	15.1	13.5
AMF + TR	8.9	12.7	12.4	11.0
AMF + BM	7.6	11.6	9.7	11.8
AZ+TR	10.3	12.8	12.6	11.8
AZ + BM	6.9	10.2	9.0	11.6
TRI + BM	8.7	10.2	15.2	11.3
AMF + AZ + TR	6.8	8.5	12.6	11.3
AMF +TR +BM	9.0	11.8	16.4	16.8
AZ + TR + BM	8.1	12.9	16.6	16.9
AMF +AZ +TR+BM	11.6	14.7	16.0	17.4
RDF	7.3	10.5	13.2	14.7
Control	7.6	10.6	10.2	9.6
C.D. (p=0.05)	0.76	1.22	0.94	0.87
SE(m) ±	0.37	0.43	0.33	0.30

RDF= Recommended dose of fertilizers (Urea =150 g, SSP=150 g, and MOP =100 g per tree); AMF= Arbuscular mycorrhizal fungi @200 g/plant, AZ= *Azotobacter chrococcum* @100 g/ plant, TR= *Trichioderma viride* @100 g/ plant, BM= *Bacillus megatarium* @100 g/plant

in about 2-month old leaves. The results showed that the application of biofertilizers resulted in significantly higher LRWC than in control (80.1%), highest being in AZ+TR (110.2%) treatment (Fig. 2.3). LRWC provides a measurement of the water deficitof the leaf, and may indicate a degree of stress expressed under drought and heat stress. Thus, it is inferred that microbes were helpful in mitigating water stress.

Effect of application of AMF and other microbial inoculants on fruit diseases and quality parameters (bearing trees)

The result showed that all the microbial inoculants had significant effect on reducing incidence of sunburn, cracking, and disease like anthracnose and fruit blight (Fig. 2.4). Not only they positively influenced the fruit size but also the percentage of good quality fruits was enhanced (75.8-85.6%) by these treatments as compared

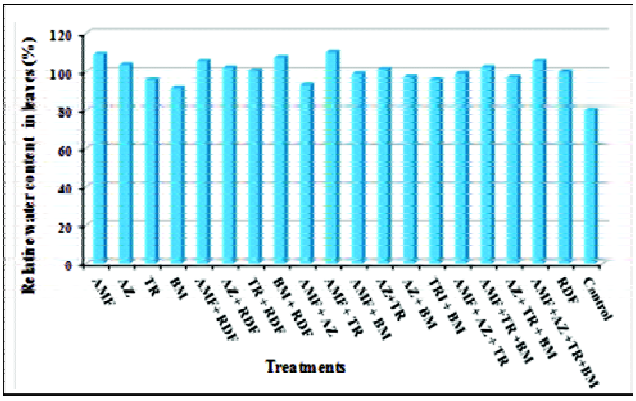


Fig. 2.3. Relative water content in the leaf samples under different microbial treatments

to control (55.3%) and RDF (66.8%). Application of these microbes also showed positive effect on content of anthocyanin, and total phenolics in fruits.

2.4. Litchi based cropping system for low lying conditions

Litchi based cropping system for pond/low land

Performance of different fruits and seasonal crops grown with litchi based cropping system on pond bunds: Experiment on litchi based cropping system in low land has been executed with construction of ponds and planting of litchi, banana, papaya, vegetables and other seasonal crops on pond embankment. The

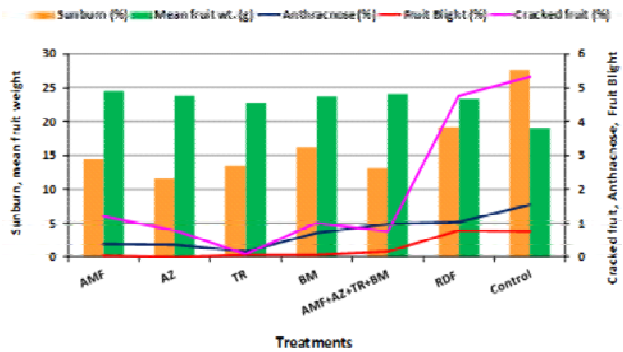


Fig. 2.4. Effect of AMF and other microbial inoculants on fruit diseases and quality parameters

cropping system on bunds includes three tier model (Fig. 2.5 & 2.6) of litchi cum banana/papaya and seasonal crops based system comprised with 5 models (model I: two row of litchi& banana + vegetables/seasonal crops, model II: two row of litchi & papaya + seasonal crops, model III: two row of litchi + banana in between two litchi plants + seasonal crops, model IV: two row of litchi + papaya in between two litchi plants + seasonal crops and model V: two rows of litchi). Vegetative growth parameters of litchi plants at 2 years after planting revealed that cultivar Shahi showed more vigorous growth than China cultivar in the entire pond bunds model. The highest plant height (136.16 cm), stem girth (11.61cm) and plant spread (123.16x120.5 cm, East-West x North-South direction) was noticed in Shahi cultivar under model I.

Banana cv. Grand Naine grown as first ratoon crop with litchi under model I produced bunch weight ranged from 16-25kg/plant with average yield 519.75 q/ha, no of fingers/bunch 112-154 and no of hands/bunch 7-10. However in model III, bunch weight ranged from 12-28.8kg/plant with average yield 486.5 q/ha, no of fingers/bunch 95-154 and no of hands/bunch 6-9. Similarly, papaya cv. Pune Selection-3 planted under model II recorded fruit yield of 10-26.8 kg/plant with average yield of 18.2-27.2 t/ha and 0.80-1.48 kg fruit weight.

Cow pea cv. Kashi Nidhi, maize cv. Star Gold and soybean were grown during Kharif season 2016 in all the system. The highest yield in cowpea and maize has been recorded under model I (110.45 & 136.67q/ha) followed by model IV (105.31&132q/ha), model II (98.3&127.37q/ha) and model III (90.7&122.24q/ha), respectively. Soybean crop did not performed well.

Fig. 2.5. Growing of litchi with banana & other seasonal crops on pond bunds: A. Litchi+banana+cowpea (*Kharif* season), B. Litchi+banana+maize (*Kharif* season), C& D. Litchi+banana+seasonal crops in *Rabi* season

During Rabi season 2016, cole crops, pea, faba bean and mustard were taken on pond bunds under different models. Among the crops grown in model I, the highest yield was recorded in cabbage 318.6 q/ha followed by cauliflower (259.8q/ha), broccoli (160q/ha), faba bean (20.24q/ha) and mustard (13.6q/ha). In model II also, cabbage recorded highest yield (428.6 q/ha) followed by cauliflower (314.8q/ha), pea (37.56 q/ha), faba bean (22.54 q/ha) and mustard (19.0 q/ha). Faba bean (25.32q/ha) and mustard (26.2q/ha) were grown in model III while, only mustard (23.8q/ha) in model IV.

On the basis of overall economic analysis of different models, the highest total net return/year, average net return and B:C ratio were obtained with banana+cowpea-cabbage (Rs 28.77, 9.59/m^2& 2.33, respectively) which is closely followed by banana+cowpea-cauliflower (Rs 28.52, 9.51/m^2& 2.30,

Fig. 2.6.Litchi with papaya & other seasonal crops grown on pond bund during *Kharif* (A) &*Rabi*(B) season

respectively) in model I. Similarly in model II also, cropping sequence of papaya+cowpea-cabbage (Rs 28.73, 9.57/m^2& 2.41, respectively) recorded highest return followed by papaya+maize-cabbages (Rs 27.34, 9.11/m^2& 2.37, respectively). In model III, banana grown with cowpea (Kharif) and faba bean (*Rabi*) cropping sequence gave highest return (Rs 23.69, 7.89/m^2& 2.17, respectively) than other crops. Arhar was also grown on sloppy area of ponds bund gave good yield.

pH, EC and nitrogen content in soil of pond bunds: Soil analysis for pH, EC and nitrogen content was done after maize and cowpea crops taken during Kharif season on different pond bunds. Data showed that nitrogen content was bit higher while pH and EC was lesser in cow pea grown plots than maize grown plots (Table 2.). The pH, EC and nitrogen content in cowpea grown plots under different bunds varied from 7.47-7.85, 0.13-0.17 dsm^{-1}and 99.5171.6 kg/ha, respectively however in maize grown plots pH ranged from 8.09-8.32, EC 0.17-0.32 dsm^{-1}and nitrogen 92.32-145.66kg/ha.

Vermicompost and vermiwash production through farm waste utilization: Vermicompost production by utilizing crop residue like banana pseudostem, maize straw, litchi leaves, peels and other farm grasses, which are considered to be farm waste, has been initiated at organic products production unit. It was observed that banana pseudostem were easily decomposed and converted into vermicompost by the earth worm (*Eisenia fetida*) followed by farm grasses and litchi leaves. Vermiwash was also produced during vermicompost making.

Fish culture in ponds: Fish cultivation was done in the ponds of litchi-based cropping system models. Fish fingerlings of *Pangasius* sp. of about 100-150 g weight were released in ponds during Aug.-Sept. 2016. The fishes were fed twice daily continuously for four months. After 4-5 months of release in pond, fish attainedaverage body weight of 550-850 g.

Litchi-based cropping system for low land/ wet land

Litchi-based cropping for low lying area was carried out under three planting situations (PS I: raised bed 3 m width, PS II: raised bed 2.5 m width & PS III: mound). Planting of litchi was done during September 2014 at 8.25x4m spacing on ridges and mounds (Fig. 2.7 & 2.8). Banana and papaya were also planted in between litchi plants on ridges during August 2016.

Growth performance of litchi grown on ridges and mound system at two year after planting revealed that cultivar Shahi showed more vigorous growth than China cultivar irrespective of the entire planting situation (Fig. 2.9). Whereas, litchi cultivars grown on ridges recorded more vigorous growth than the mound system. The highest plant height (145.3 cm), stem girth (13.0cm) and plant spread (140.33x1141.0 cm, East-West x North-South direction) was observed in Shahi cultivar in PS I.

Soil pH, EC and nitrogen content in different planting system of low lying area: Soil analysis for pH, EC and nitrogen content was done after moong and cowpea crops taken in furrows system during summer season. Data showed that nitrogen content was higher and pH was lesser in cowpea grown plots than moong grown plots. The pH, EC and nitrogen content in cowpea grown plots of ridge and mound furrow ranged between 8.21-8.22, 0.15-0.22 dsm^{-1}and 106.77-156.96 kg/ha, respectively whereas in moong grown plots pH varied from 8.31-8.51, EC from 0.18-0.20 dsm^{-1}and nitrogen content from 95.97-98.10 kg/ha.Similarly, soil pH, EC and nitrogen content of ridges, mounds and furrows of low lying area after receding

Fig. 2.7.View of litchi plantation on ridges & mound system with seasonal crops in furrows

Fig.2.8. Litchi plantation on ridges with fish culture in furrows under low lying condition

of rain water accumulated in furrows were also analyzed. The soil pH found little bit lesser in ridge soil than mound but higher in furrows whereas nitrogen content was found to be higher in ridges than mound as well as their furrows also. The nitrogen content ranged from 135.36-139.75 kg/ha in ridges to 94.86-109.97kg/ha in mound. Likewise, in furrows of ridges ranged from 93.95-114.70kg/ha and in furrows of mound ranged from 66.39-73.70kg/ha.

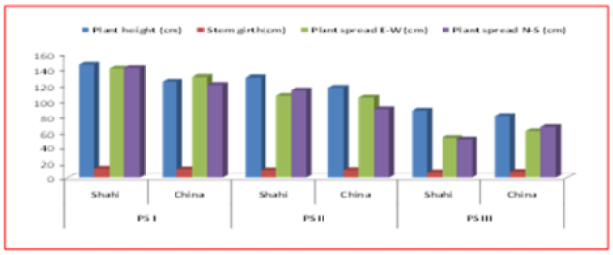


Fig. 2.9 Plant growth performance of litchi evs. Shahi & China planted on ridge & mound system

Performance of different seasonal crops grown in furrows system of low lying area: Moong and cucurbitaceous crops were grown in furrow system of low lying area during summer season. Yield performance of all the crops grown under ridge furrows was superior to mound furrows. Among the different growing situation, moong yield ranged from 17.8-21.9 q/ha, pumpkin from 87.68-91.56q/ha and bottle gourd from 80.5-85.5 q/ha cultivated in mound furrows to ridge furrow. Pea, mustard and faba bean have been cultivated in furrow system during *Rabi* season 2016. The highest green pod yield has been recorded in pea (52.5q/ha) sowed in ridge furrow. The yield performance of both mustard (17.52q/ha) and faba bean (19.80q/ha) grown in ridge furrows found better than the mound furrows (15.85 & 17.35q/ha).

Weather parameters (Temp & RH) and soil moisture study of low lying ridge & furrow system: Temperature and relative humidity of furrows in low lying area were recorded during April-May, 2016 and compared with open area. Data showed that temperature was little bit less and humidity was more in furrow system than open condition. Temperature difference between two conditions (furrows vs. open) varied from 0.2-1.37°C (less) and RH from 1-6.6% (high). Soil moisture content in different low lying conditions was recorded during November 2016. Moisture content of the furrows soil recorded more value than ridge/mound soil however ridges soil showed better moisture content than mound condition. Moisture content in ridges (14.62%) and their furrows (26.29%) recorded almost 2-4% higher than mound (12.01%) and its furrow (22.32%).

2.5. Identifying potential litchi growing areas

Edaphic factor based identification of potential litchi area in India

Edaphic factor-based identification of potential litchi area in India is prerequisite for expanding litchi area. Edaphic factors primarily including soils and climate are being mapped to delineate suitable area. In an attempt to develop suitability index, climate data of different places was mapped (Fig. 2.10) and key climatic feature were identified. Interpolated daily temperature and precipitation data of Malda, Motihari, Dehradun and Pathankot, Coorg in India and Guangzhou (China), Taichung (Taiwan) and Nambour (Australia) have been analysed and mapped in order to define key factors for flowering in litchi. Fruit maturity period in Coorg and Nambour is Nov-Jan where as in rest of the above places it is May to July. Mean temperature below 20°C for 50-60 days and minimum temperature below 12°C for 50-60 days are ideal climatic condition to induce flowering in litchi. Deviation from this climatic condition leads to irregular or no flowering and fruit set. Relatively dry period during flowering to fruit set is desired. Loamy soil with depth more than 1.5 m on a slope <3% and moderate organic carbon is considered good for Litchi. Higher slope, stoniness, high salinity and acidity are not good for Litchi even though it is successfully grown on

calcareous soil of Bihar (pH 8.5). Using daily interpolated data from monthly observed climatic data extracted from FAOs New_LocClime_1.2, soil extracted from 1: 250,000 scale soil map of ICAR-NBSSLUP and the suitability condition defined for the project, Litchi suitability map was developed. Prominent litchi districts of Bihar have been mapped using ArcGIS_10.1 (Fig 2.11) where as other potential district including Saharsa, Purnea, Lakhisarai, Munger, Khagaria, Katihar, West Champaran were identified. Considering climate of Muzaffarpur as one of the ideal, comparative climate data of potential area including, Amravati (Maharashtra), Agartala (Tripura), Tezpur (Assam) and Waynad (Kerela) indicates other than best condition of all these places. High wind speed and rainfall during flowering and fruit set are identified as major problems in off season litchi.

MarkSim generated simulated daily weather data specifically designed for use in the tropics, including rainfall, maximum and minimum temperatures of 30 year period starting from 2030, 2050 and 2070 under all four representative concentration pathways *i.e.* RCP 2.6, 4.5, 6.0 and 8.5 for Agartala, Darbhanga, Dehradun, Ranchi, Muzaffarpur, Bulandsahar, Sabour, Ooty, Pathankot were extracted from WorldClim. These daily weather data files of 30 arc-second derived from WorldClim were analysed for projected change which will be further incorporated with observed climatic data for defining potential litchi area.

Integrated soil health management for quality litchi production

For good quality high production of litchi on sustainable basis requires a management which ensures stability if not improvement in soil health. There is significant area of litchi grown on light soil near river bank which overlaid sand layer. These orchards are extremely vulnerable to heat and moisture stress, and needs special attention. A project was envisaged for integrated soil health management in which various treatments including organic manures, chemical fertilizer and bio-fertilizers are used in various combinations (Table. 2.4) in a 12 year old litchi cv. Shahi plantation. The experiment has been laid out in RBD in which block was decided mainly through present general vigour pattern and prior knowledge of soil status. The vigour pattern of trees was found closely related to soil organic carbon and nutrient status. Baseline data in terms of

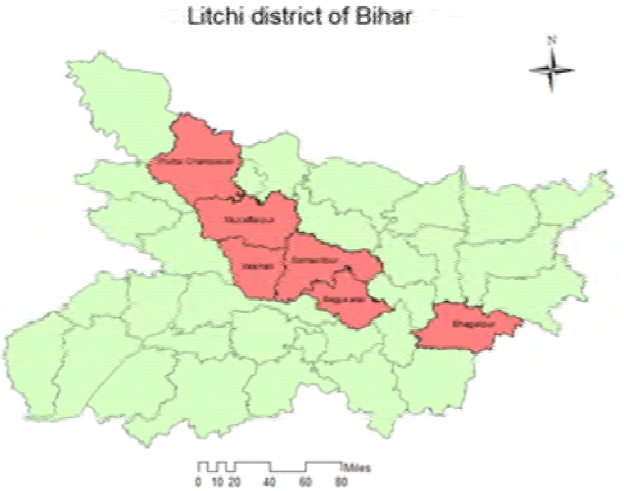


Fig 2.11. Prominent litchi districts of Bihar

girth and spread was taken before deciding blocks (Table 2.5). However, severe corrective pruning including centre opening was carried out in order to bring relative uniformity in canopy size.

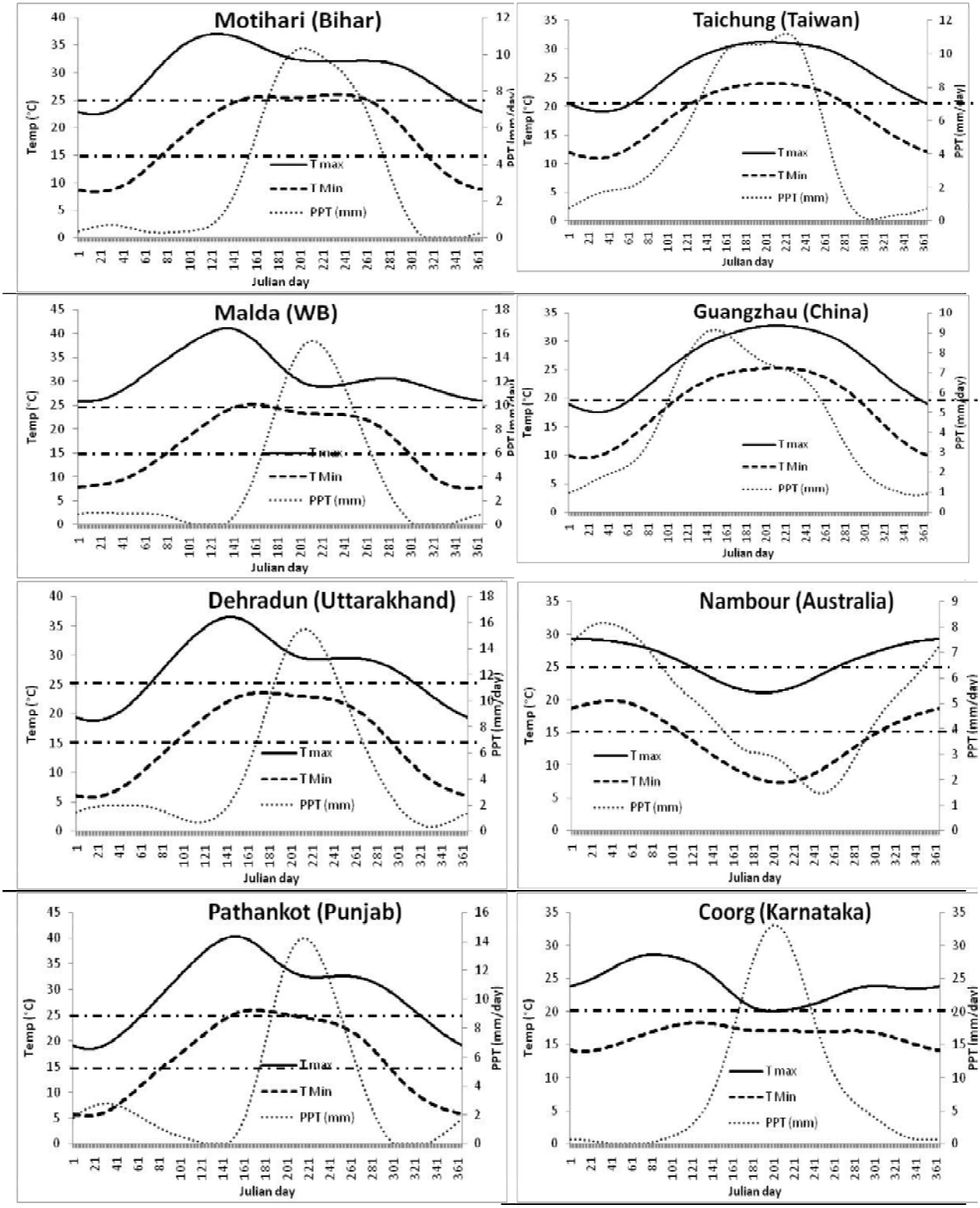


Fig.2.10 Temperature and precipitation of Motihari (India), Taichung (Taiwan), Malda (India), Guangzhau (China), Dehradun (India), Nambour (Australia), Pathankot (India) and Coorg (India)

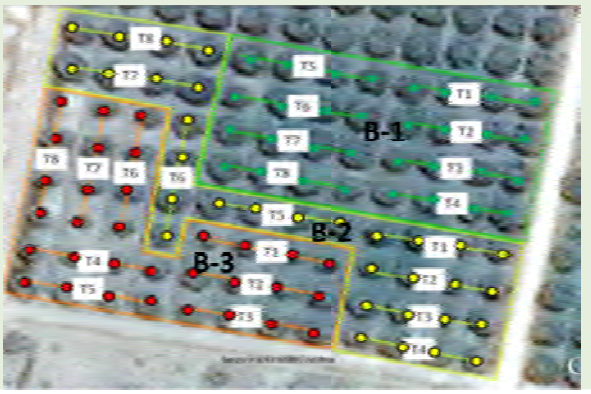
Table 2.4. Treatment details as per technical programme

Treatments	N (g)	P(g)	K (g)	FYM (kg)	Oil cake	Biofertilizers		
T 1	1000	550	1000	35	3	A	T	**PSB**
T 2	500	275	500	70	3	A	T	**PSB**
T 3	1000	550	1000	0	0	0	0	0
T 4	500	550	1000	70	3	A	T	**PSB**
T 5	500	550	1000	35	3	A	T	**PSB**
T 6	0	0	0	70	3	A	T	**PSB**
T 7	0	0	0	35	3	A	T	**PSB**
T 8	0	0	0	0	0	0	0	0

Bio fertilizers (A: *Azotobactor*, T: *Trichoderma,* and PSB: Phosphate solublizing bacteria)

Table 2.5. Baseline data in terms of girth and spread of litchi cv. Shahi and layout details

Treatment	Girth (Cm)			Layout of the field
	B1 (4)	B2 (4)	B3 (4)	
T 1	76.3	71.1	69.9	
T 2	78.9	68.5	66.3	
T 3	79.3	72.2	65.8	
T 4	76.5	73.7	70.2	
T 5	74.1	69.3	65.9	
T 6	72.8	72.6	68.4	
T 7	74.4	70.5	71.2	
T 8	77.1	72.3	67.3	
Mean	73.8	70.2	68.1	
CV	3.3	3.7	5.2	



3. Development and Refinement of Integrated Crop Protection Technologies for Improved Productivity of Litchi

3.1. Investigation and management of pre-harvest diseases of litchi

Disease incidence and severity of leaf, panicle and fruit blight

Since last four years *Alternaria alternata* has been an important pathogen of litchi causing blights of leaf, panicle, and fruits. During 2016 season, we conducted pathogenicity test at each phenophases. Spraying leaves of 5 healthy nursery plants, 4 bunches of panicles, and 10 developing fruits on orchard trees with a 10^6 spores/mL conidial suspension reproduced leaf, panicle, and fruit blight symptoms in 10-15 days. Control plants sprayed with sterile distilled water remained symptomless. Re-isolation of the pathogen with the same morphological characters was achieved from symptomatic tissue fulfilling Koch's postulates.

Incidence and severity of leaf blights in nursery plants during November 2016 to March 2017 is given in Table 3.1. The mean disease incidence among plants in various nurseries ranged between 2.3-36.0%, highest during February-March. The mean and range of disease incidence among leaves of infected plants were 12.3-59.7% and 5.0-100%, respectively. Further, the mean percent disease severity index (PDI) ranged from 34.8 to 78.1.

Disease incidence of panicle blight was 5.3-27.8% in cv. 'Shahi' while in cv. 'China' it was 17.0-58.9% (Fig. 3.1). The distribution of trees based on severity scale (% infected panicles on trees) is given in Fig. 3.2. Fruit blight incidence in cv. 'China' recorded at farmers field of five orchards during June 2016 ranged from 3.6 to 18.9%.

Table 3.1. Incidence and severity of *Alternaria* leaf blight on litchi in nursery

Nursery	Disease parameters		Months (November 2016 - March 2017)				
			November	December	January	February	March
I	Disease Incidence		8.8	7.4	9.0	4.5	36.0
	PDI		40.0	47.4	50.4	56.7	50.7
	Infected leaves (%)	Mean	24.9	15.5	19.9	30.3	59.7
		Range	9.1-47.4	5.0-22.2	9.1-33.3	16.7-40.0	32.3-100.0
II	Disease Incidence		13.4	9.2	2.3	1.9	5.5
	PDI		38.5	40.0	48.1	57.4	39.3
	Infected leaves (%)	Mean	22.2	24.5	20.9	27.1	36.0
		Range	11.1-45.0	5.2-54.5	11.1-33.3	16.7-41.7	25.0-57.2
III	Disease Incidence		9.0	12.5	5.5	5.3	6.7
	PDI		78.1	60.0	48.9	59.6	34.8
	Infected leaves (%)	Mean	29.1	15.3	19.3	31.8	33.1
		Range	16.7-47.0	5.5-23.5	6.3-40.0	23.1-41.7	12.5-54.5
IV	Disease Incidence		4.8	14.8	8.4	8.1	10.9
	PDI		54.8	51.1	54.8	50.0	46.7
	Infected leaves (%)	Mean	28.9	33.0	23.3	21.9	24.4
		Range	9.5-47.1	15.4-50.0	6.3-27.3	14.9-33.3	15.8-33.4
V	Disease Incidence		14.6	8.3	10.0	15.8	7.1
	PDI		58.5	47.4	49.3	53.7	41.5
	Infected leaves (%)	Mean	34.1	27.6	21.5	32.3	38.1
		Range	11.1-71.4	11.1-57.2	9.5-3.3	18.2-50.0	11.1-66.7
VI	Disease Incidence		8.41	7.21	7.30	12.00	11.65
	PDI		38.9	43.7	37.8	58.5	54.5
	Infected leaves (%)	Mean	15.6	16.0	12.3	25.1	19.6
		Range	6.7-29.4	5.5-21.4	9.5-16.6	12.5-50.0	9.1-27.8

PDI= Percent disease severity index

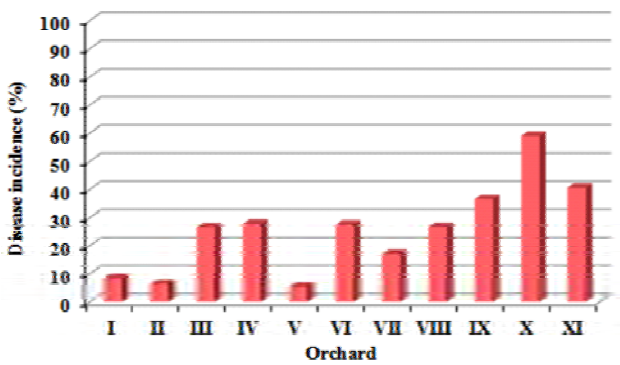


Fig.3. 1. Incidence of panicle blight in different orchards

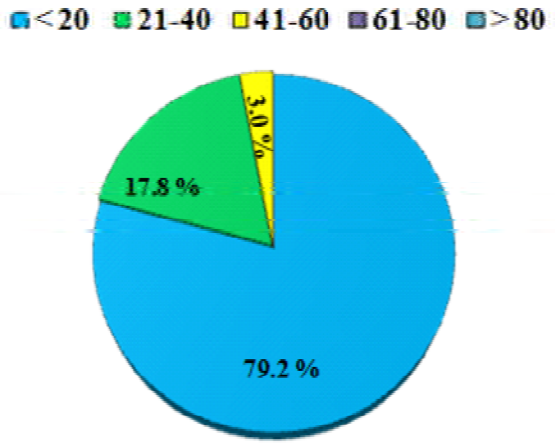


Fig. 3.2. Percent distribution of trees in different severity category of panicle blight (data presented is average value of 11 orchard)

Evaluation of fungicides and antagonists for management of *Alternaria* disease of litchi

Twelve different fungicides (copper oxychloride, mancozeb, thiophanate methyl, carbendazim, difenoconazole, hexaconazole, propiconazole, propioneb, chlorothalonil, azoxystrobin, metiram + pyraclostrobin, and mancozeb + carbendazim), two antagonists (*Trichoderma viride* isolate NRCL T01 and *Bacillus subtilis*) and one defense activator (chitosan) were evaluated against anthracnose (*Colletotrichum gloeosporioides*) and fruit blight (*Alternaria alternata*) disease under natural infection field conditions. Results showed that the disease incidence of anthracnose and fruit blight were 0.5-3.0% in the effective fungicidal treatments as against 10.7-14.7% in control trees of orchard at NRCL experimental farm. Thiophanate methyl, difenoconazole and mancozeb were found effective against both anthracnose and fruit blight disease (Table 3.2).

Table 3.2. Effect of application of different fungicide on incidence of anthracnose and fruit blight disease at harvest

Treatments	Dose		Anthracnose	Fruit blight
	Active ingredient (%)	Formulation (ml or g/L)		
Chlorothalonil (75%WP)	0.15	2.0	2.8	2.5
Thiophanate methyl (70 %WP)	0.14	2.0	3.0	0.7
Carbendazim (50%WP)	0.10	2.0	3.8	1.9
Copper oxychloride (50%WP)	0.10	2.0	1.9	2.5
Difenoconazole (25%EC)	0.05	2.0	6.1	0.9
Hexaconazole (5% EC)	0.01	2.0	5.3	5.5
Mancozeb (75%WP)	0.187	2.5	0.5	1.9
Propiconazole (25%EC)	0.05	2.0	1.3	9.8
Propineb (70%WP)	0.175	2.5	5.1	1.6
Azoxystrobin (23%SC)	0.023	1.0	7.3	5.2
Metiram+Pyraclostrobin (55%+5% WG)	0.055 + 0.005	1.0	6.3	3.0
Mancozeb +Carbendazim (63% +12% WP)	0.126 + 0.024	2.0	9.0	10.1
Trichoderma viride	2.0	*	4.4	3.6
Bacillus subtilis BS-01	2.0	**	5.5	5.9
Chitosan	1.0	-	5.7	5.1
Control (DW)	-	-	10.7	14.7
C.D. (p=0.05)			0.72	0.41
SE(m) ±			0.25	0.14

**Trichoderma viride* NRCL T-01@1x10^6 conidia/mL, ** *Bacillus subtilis* NRCL BS-1 @1x10^6 cfu/mL

Comparative field efficacies of NRCL *Trichoderma viride* isolate T-01

The comparative field efficacy of NRCL bioformulation based of *Trichoderma viride* (=*T. asperellum*) strain NRCL T-01 was tested in junior-adult bearing trees of litchi for fruit quality parameters with reference to recommended dose of fertilizers (RDF; Urea =1.0 kg, DAP= 1.5 kg and MOP= 0.5 kg/tree), another *T. viride* strain (NRCG T -09) and control (without any application). The results showed that NRCL strain was superior to other *Trichoderma* strain and RDF with respect to its positive influence on fruit quality parameters (Table 3.3). *Trichoderma* is well known for inducing systemic resistance (ISR) in plants besides plant growth promotion acting as biofertilizers. Our experimental results reinforced this hypothesis.

3.2. Investigation and management of insect-pests complex in litchi

Survey of insect-pests complex in different litchi growing areas

Results showed that most of the major insect-pests of litchi occurred in all litchi growing areas (Table 3.4). Litchi fruit & shoot borer, *Conopomorpha sinensis* Bradley has been noticed as most severe pest of litchi during survey of litchi growing area namely, Bihar, West Bengal, NEH, U. P., Uttarakhand, Punjab and J&K. An unidentified nut borer infesting litchi fruits was also observed at Muzaffarpur and Punjab. Among lepidopteran defoliators, leaf folder, *Platypeplus aprobola* Meyer was observed as major defoliators of litchi in all the places while, litchi looper, *Perixera illepidaria* was recorded at Muzaffarpur, Sabour and Kushinagar. Bark eating caterpillar, *Indarbela quardinotata* Walker is also infesting litchi everywhere while, semilooper, *Trichoplusia* spp. was observed only at Pantnagar. Litchi mite, *Aceria litchi* (Keifer), another very serious pest of litchi, was also noticed in all areas (Fig. 3.3) while, litchi bug, *Tessaratoma javanica* (Thun.) was observed at Pantnagar and Pathankot. Among weevil complex, both ash weevil,

Fig. 3.3. Mite infestation on litchi panicle and foliage

Table 3.3. Comparative field efficacy of NRCL Trichoderma strain in reduction of sunburn, cracking and diseases

Treatments	Sun burn	Anthracnose (%)	Fruit blight (%)	Cracked fruits (%)	Mean fruit weight*
NRCG T-09	24.8	1.9	0.9	1.4	25.3
NRCL T-01	13.4	1.3	0.5	1.1	26.1
RDF	19.2	5.2	4.0	4.8	23.4
Control	27.6	7.8	3.9	5.3	18.9
C.D. (p=0.05)	4.0	2.1	NS	1.1	1.3
SE(m) ±	2.0	0.6	0.9	0.3	1.8

*Data is based on observation of 10 fruits

Table 3.4. Survey of insect-pests in different litchi growing areas

Insect	Muzaffarpur	Mohanpur	Sabour	Pantnagar	Kushinagar	NE region	Jammu	Pathankot
Litchi fruit & shoot borer, *Conopomorpha sinensis* Bradley	+++	+++	+++	+++	+++	+++	+++	++
Semilooper, *Trichoplusia spp.*	-	-	-	+	-	-	-	-
Litchi looper, *Perixera illepidaria*	+++	-	+++	-	+++	-	-	-
Leaf folder, *Platypeplus aprobola* Meyer	+++	+++	+++	+++	+++		+++	+++
Mango mealy bug, *Drosicha mangiferae* (Green)	+	-	+	+	-	-	-	-
Litchi bug, *Tessaratoma javanica* (Thun.)	-	-	-	++	-	-	-	+
Bark eating caterpillar, *Indarbela quardinotata* Walker	+	+	+	+	+	-	++	++
Ash Weevil, *Myllocerus undecimpustulatus*	+++	+++	+++	+++	+++	-	+++	+++
Red weevil, *Apoderus blandus*	+++	++	++	++	++	-	-	-
Litchi mite, *Aceria litchi* (Keifer)	+++	++	+++	++	+++	-	+++	++++
Nut borer (Unidentified spp)	+	-	-	-	-	-	-	+++

+++: major, ++: minor, +: sporadic

Myllocerus undecimpustulatus and red weevil, *Apoderus blandus* were observed at all the places except red weevil in NE region.

Performance of some newer molecules against litchi defoliators

Among defoliators complex in litchi lepidopteran (leaf folder, *Platypeplus aprobola* and litchi looper, *Perixera illepidaria*) and weevils (ash weevil, *Myllocerus undecimpustulatus* and red weevil, *Apoderus blandus*) are causing serious damage to newly emerged litchi leaves, especially in growing orchards. Lepidopteran defoliators of litchi causing severe damage to the new flush resulting poor growth of newly established orchard in particular and established orchard in general. Ash weevil preferred older leaves while red weevil preferred newly emerged leaf which is therefore more severe than ash weevil. Hence, field trial was conducted to evaluate some newer molecules against these defoliators. Horticultural practices were performed as per recommended package of practices for litchi cv. Shahi under the trials. Seven treatments were undertaken including control viz., T_1- lambda cyhalothrin 5 EC (0.003%); T_2- thiacloprid 21.7 EC (0.013%); T_3- beta-cyfluthrin 8.49% +imidacloprid 19.81% (0.011%); T_4- propargite 57 EC (0.17%); T_5- deltamethrin 2.8 EC (0.0028%); T_6- imidacloprid 17.8 SL (0.0089%); T_7- control, without spray and replicated thrice in RBD. Treatments were imposed as twice during September and October months.

In case of looper, lambda cyhalothrin 5 EC (0.003%) was highly effective with 1.67 population against 17.00 in control followed by thiacloprid 21.7 EC (0.013%) and beta-cyfluthrin 8.49% + imidacloprid 19.81% (0.011%) as registered 2.00 and 2.33 looper population, respectively after three days of spraying. In case of leaf folder, lambda cyhalothrin, thiacloprid and beta-cyfluthrin 8.49% + imidacloprid 19.81% were highly effective as registered 0.00 populations against 8.33 in control at three days after spraying. Similarly, all above mentioned insecticides were highly effective against red weevil as recorded 0.00 populations against 4.67 in control while, in case of ash weevil lambda cyhalothrin 5 EC (0.003%) was most effective with 0.00 populations against 4.33 in control followed by thiacloprid 21.7 EC (0.013%) and beta-cyfluthrin 8.49% +imidacloprid 19.81% (0.011%) as registered 0.33 and 1.33 weevil population, respectively after three days of spraying.

4. Integrated Postharvest Management to Reduce Losses, Improve Marketing and Product Diversification

4.1. Standardization of maturity standards, harvesting and postharvest handling techniques for litchi fruits

Effect of time of harvest and packaging on quality and shelf life of litchi fruit

Fruit harvested early in the morning (6 AM), kept in perforated mono-polymer bag and packed in 2 kg CFB box recorded least physiological loss in weight (6.8%), browning index, respiration rate (116.2 mL CO_2 $kg^{-1}h^{-1}$) and maximum anthocyanin content 28.36 $mg100g^{-1}$ peel) as well as marketable fruits (74%) after 5 days of storage at ambient condition. Fruit harvested in sunny hours (10 AM onwards) kept in perforated polymer bags and packed in CFB box resulted in only 58% marketable fruits, after 5 days of storage.

4.2. Investigation and management of postharvest losses in litchi

Postharvest storage behavior of litchi cv. Shahi under ambient condition

Litchi is a highly perishable fruit, and the rate of deterioration in quality is rapid during postharvest storage. Under ambient conditions, peel contribution to litchi fruit weight drastically reduces from 11.68% to 6.29% within 48 hours of harvest, during which time the aril also starts losing weight. Moisture loss during storage shares a very strong correlation (r=0.92) with time; about 13.47% PLW was recorded after 96 hours. Peel thickness reduced from 0.63 mm to 0.24 mm within 96 hours of harvest. The peel thickness shared a strong positive correlation (r=0.87) with peel moisture content, and strong negative correlation (r=-0.79) with PLW. Moisture content in peel is strongly negatively correlated (r=-0.96) to PLW. No significant change in hunter 'a' was recorded up to 8 hours after harvest and visible discolouration was observed and recorded by 11 hours. This corresponded to about 4.65% PLW; it can, therefore, be inferred that pericarp browning can be visible if produce loses more than 4.65% weight. There was no significant change in TSS and acidity of harvested fruit up to 96 hours.

Effect of *Bacillus subtilis* and other fruitplane antagonists on quality and biochemical parameters of litchi

Browning of fruit results from the oxidation and polymerization of phenolic compounds and also involves the activities of phenylalanine ammonia-lyase (PAL), polyphenol oxidase (PPO) and peroxidase (POD). An investigation was conducted to compare the effects of various postharvest treatments including fruit plane antagonists, when fruits are stored at ambient conditions (36±2 °C temperature and 76±6% R.H.) after treatments. The antagonists were *Bacillus subtilis* (isolate NRCL BS-01, BS-02, BS-03, BS-04, and BS-05), yeast (isolate Y1) and *Trichoderma* (NRCLT-01) and their combinations. The concentration of postharvest dip solution with *B. subtilis* and yeast isolates were $1x10^8$ cell/mL. Various postharvest dip with chemicals included potassium silicate (0.5%), chitosan (1.0%), and carbendazim (0.1%). Thirty fruits in three replicates were taken for each treatment. Duration of dip treatments was 5 min followed by air drying. For control treatment, fruits were dipped in distilled water. Observations were recorded at 3 days interval.

Effect on PPO and POD enzyme activity: The data indicated that activity of both the enzymes increased significantly over time but less increase was observed with antagonists' treatment compared to control. Significantly lowest activity of PPO and POD enzymes in fruits treated with *Bacillus subtilis* NRCL-BS 01 indicated its efficacy in having better shelf life of fruits (Fig. 4.1 & 4.2).

Effect on anthocyanin and phenol content: Anthocyanin content just after treatment was significantly lower than other treatments including control fruits. It was observed that fruits treated with carbendazim have

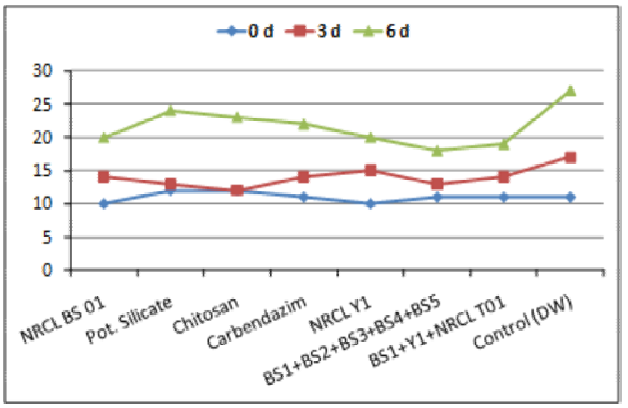


Fig. 4.1. Effect of various post harvest treatments on PPO activity (unit/min/g FW)

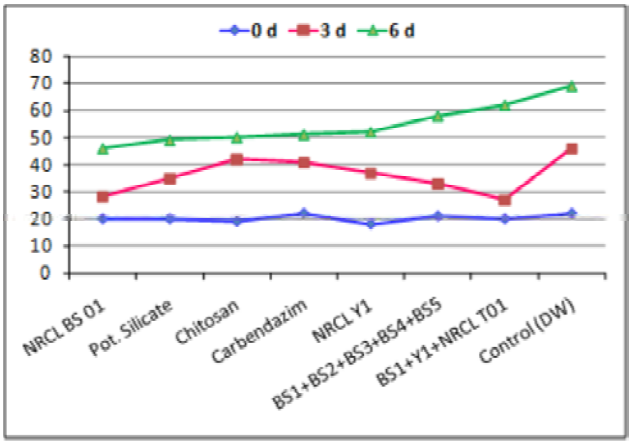


Fig. 4.2. Effect of various postharvest treatments on POD activity (unit/min/g FW)

a sort of bleach effect on colour of fruits. The anthocyanin contents in all the treatments declined with progress of time but significantly less reduction was observed with antagonists' treatment (Table 4.1).The result of studies showed that the concentrations of phenols measured as gallic acid equivalent was significantly higher in fruits treated with antagonists as compared to control. The slow degradation of phenols during storage is an indication of positive effect on quality of fruits. The treatments also resulted in better organoleptic quality of the fruits during storage at ambient conditions.

Table 4.1. Effect of antagonists and other postharvest treatments on anthocyanin and phenol content

Treatment	Anthocyanin (mg/100 g FW)			Phenol (mg GAE/100 g FW)		
	0 d	3 d	6 d	0 d	3 d	6 d
Bacillus subtilis (NRCL BS 01)	35	24	18	35	20	19
Pot silicate	37	22	13	41	18	21
Chitosan	37	16	15	38	29	23
Carbendazim	26	22	13	37	27	22
NRCL Y1	39	20	20	39	32	26
BS1+BS2+BS3+BS4+BS5	32	25	15	42	31	18
BS_1+Y_1+NRCL T-01	37	32	24	40	30	19
Control	36	28	17	39	32	26
C.D. (p=0.05)	3.2	2.3	2.8	3.0	3.2	2.7
SE(m) ±	1.0	0.7	0.9	1.0	1.1	0.9

NS=Non-significant, d = Days, FW= Fresh weight

Effect on changes in contents of total soluble solids and titratable acidity: The contents of total soluble solids (TSS) of litchi fruits increased marginally up to 3 days of storage with treatment of antagonists while it decreased significantly in chemicals dip and control treatments. However, from 3rd day to 6th day a decline in TSS of fruits was observed in all the treatments but between treatments, the differences were statistically non-significant. The titratable acidity (TA) also marginally declined over time but differences between treatments were statistically non-significant (Table 4.2).

Table 4.2. Effect of antagonists and other treatments on TSS and titratable acidity

Treatment	TSS (°B)			Acidity (%)		
	0 d	3 d	6 d	0 d	3 d	6 d
Bacillus subtilis (NRCL BS 01)	22.1	23.0	19.8	0.6	0.4	0.4
Pot silicate	22.7	21.7	22.4	0.6	0.5	0.4
Chitosan	22.6	19.9	21.1	0.6	0.6	0.4
Carbendazim	22.0	19.5	21.0	0.5	0.4	0.4
NRCL Y1	21.4	22.0	21.0	0.5	0.5	0.3
BS1+BS2+BS3+BS4+BS5	20.7	21.6	20.0	0.5	0.5	0.4
BS_1+Y_1+NRCL T-01	20.0	18.8	20.0	0.6	0.5	0.4
Control	20.0	19.7	19.3	0.5	0.4	0.3
C.D. (p=0.05)	1.54	1.51	NS	NS	NS	NS
SE(m) ±	0.50	0.49	0.67	0.07	0.07	0.06

NS=Non-significant, d = Days, FW= Fresh weight

4.3. Processing and value addition in litchi (*Litchi chinensis* Sonn) studies on preservation of litchi pulp

Development of minimally processed RTE litchi pulp

A study on minimal processing of litchi aril was conducted develop ready-to-eat (RTE) pulp (Fig. 4.3). Different treatment combinations involving blanching (3-5 min), $CaCl_2$ (0.2%), ascorbic acid (0.2%), and potassium metabisulfite (1500 ppm) were tested. The treated litchi aril was packed in plastic punnet and wrapped with cling film. Treated and packed aril was

then stored under refrigerated condition (5±1°C). Blanching litchi aril in combination with KMS (1500 ppm), 0.2% $CaCl_2$ and 0.2% ascorbic acid was found promising for minimal processing of fresh litchi aril under cling film packaging. Such treated fruit could keep up to 4 months under refrigerated conditions and 25 days under ambient conditions. This treatment combination resulted in minimal leakage and loss of firmness while also retaining colour and quality.

Fig. 4.3. Minimally processed litchi pulp

Optimization of osmo-mechanical dehydration techniques for litchi pulp

Effects of osmotic dehydration on mass transfer properties such as water loss (W), solute gain (S) and weight reduction (G) during osmotic dehydration were investigated in order to determine the usefulness of this technique as pre-treatment for further drying of litchi pulp. The effect of variation in sucrose (40%, 50% and 60 % w/w) and preservative/salt concentrations (5-10% w/w), solution temperature, and duration of immersion on moisture removal of the product and its organoleptic characteristics were analyzed (Fig. 4.4). About 45% of the water loss occurred between 4-6 h. After osmotic treatment, the pulp was dried in a tray dryer at 50ºC for 10-15 h. Osmotic treatment increased drying rate in subsequent convective tray drying. It was found that consumer preferences with regard to dried litchi include characters such as golden-yellow color (*L** ranging around 50; *H* ranging around 75°), soft texture (SMF ranging between 13 and 14 kN/100 g or 1000g) and sweet taste (TSS:TA ranging between 25 - 28and acidity 0.3%).

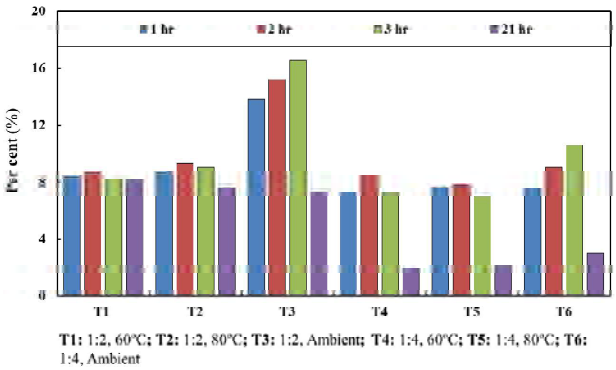


Fig. 4.4. Effect of treatment combinations on solute gain during osmo-mechanical dehydration

4.4. Influence of polyamines on pheno-physiological attributes and fruit quality of litchi

Response of pre-harvest polyamines treatments and time of application on fruit set and fruit drop patterns of litchi

Effect of polyamines on fruit set and fruit drop patterns in litchi was studied. Polyamines (putrescine and spermine @ 0.5 mM) treatment was found to be effective in enhancing the initial fruit set over the control trees in China (Fig. 4.5). However, initial fruit set was not significantly different in Shahi cultivar among the treatments. Fruit drop was significantly reduced by the putrescine @ 0.5 mM and spermine @ 0.5mM exogenous pre-harvest treatments at three stages in both Shahi and China (Fig. 4.6). It was recorded that ~1.65 times more fruit drop occurred in control in comparison to the treated trees after 6 days of fruit set in Shahi. It was observed that the fruit drop percentage was high during the first week after fruit set. After this period, the rates of fruit drop declined very sharply and the fruit were retained. Fruit drop was significantly reduced by polyamines treatment in China. Fruit drop rate was higher during the initial 10 days after fruit set in China which stabilized thereafter. However, overall during the pre-harvest stages the fruit drop rates was significantly lowered and fruit retention increased by the putrescine (0.5mM) and spermine (0.5mM) sprays in both Shahi and China.

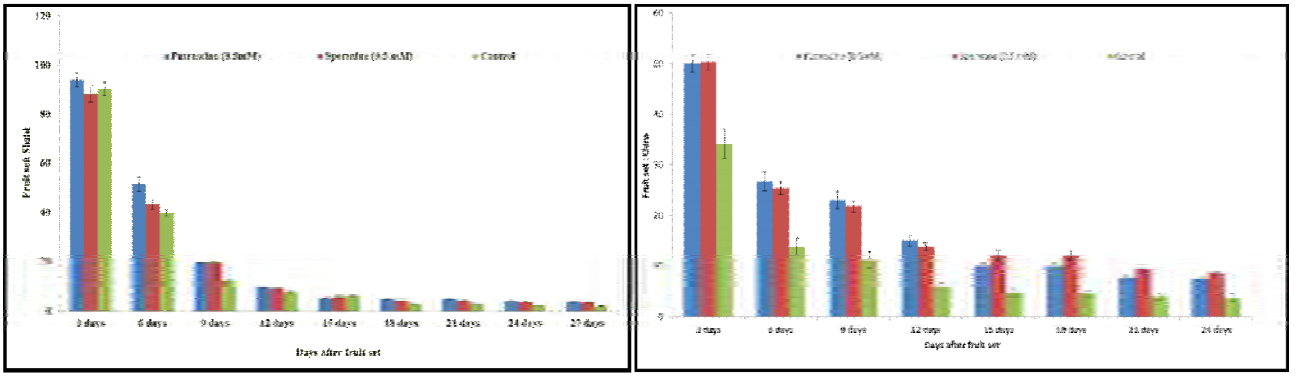


Fig 4.5. Initial fruit set and retained fruitlets during fruit growth and development stages in Shahi and China litchi

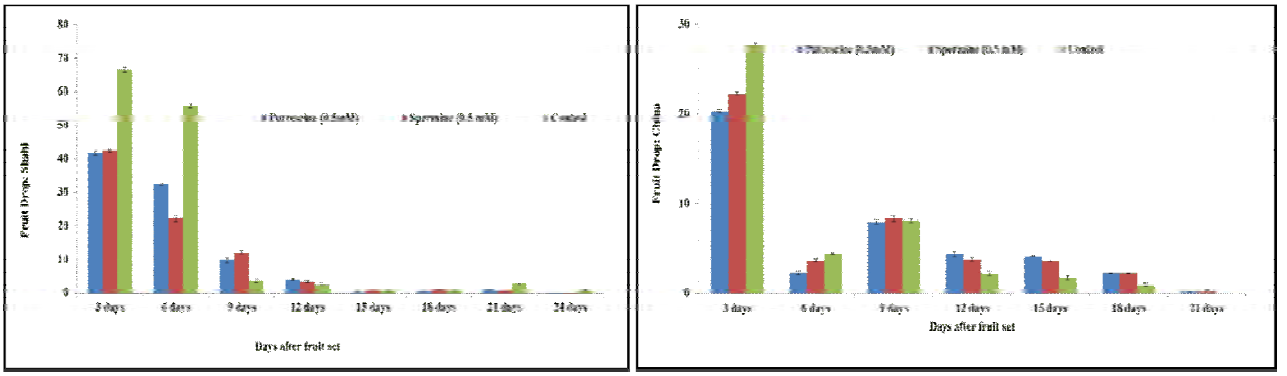


Fig. 4.6. Fruit drop pattern in Shahi and China litchi during fruit growth and development

Response of postharvest polyamines treatments on pericarp browning and enzymatic activity

This study was designed to ascertain the effects of polyamines dip treatment (putrescine @ 0.5 and 1.0mM and spermine @ 0.5 and 1.0mM) on quality of Shahi and China fruit during postharvest storage. The treated fruit exhibited an extension of about 4 days of postharvest life over untreated fruits. No significant difference among the various concentrations or treatments of putrescine or spermine was recorded overall in the major parameters during the postharvest storage period. It is evident from the figures that all the polyamines treatment and doses reduced pericarp browning significantly during the storage period over control (Fig. 4.7).

The polyphenol oxidase (PPO) and peroxidase (POD) enzyme activity in both Shahi and China fruit displayed negative correlation with L* values, which indicates their important role in the browning of litchi

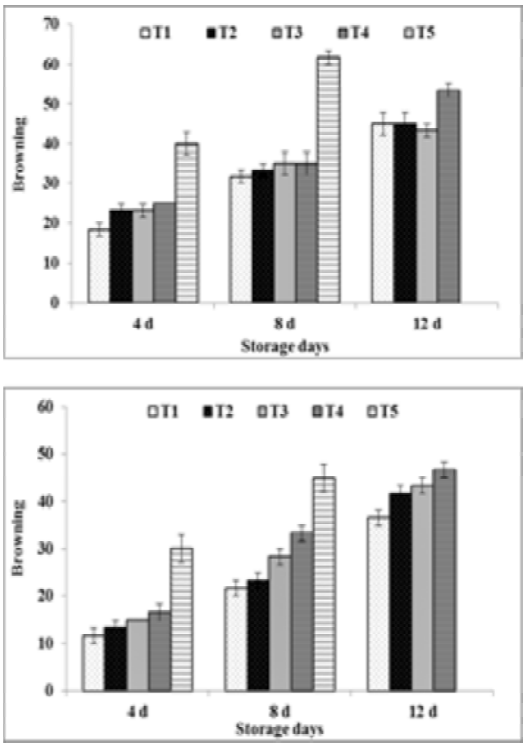


Fig. 4.7. Pericarp browning in Shahi (A) and China (B) fruit during storage

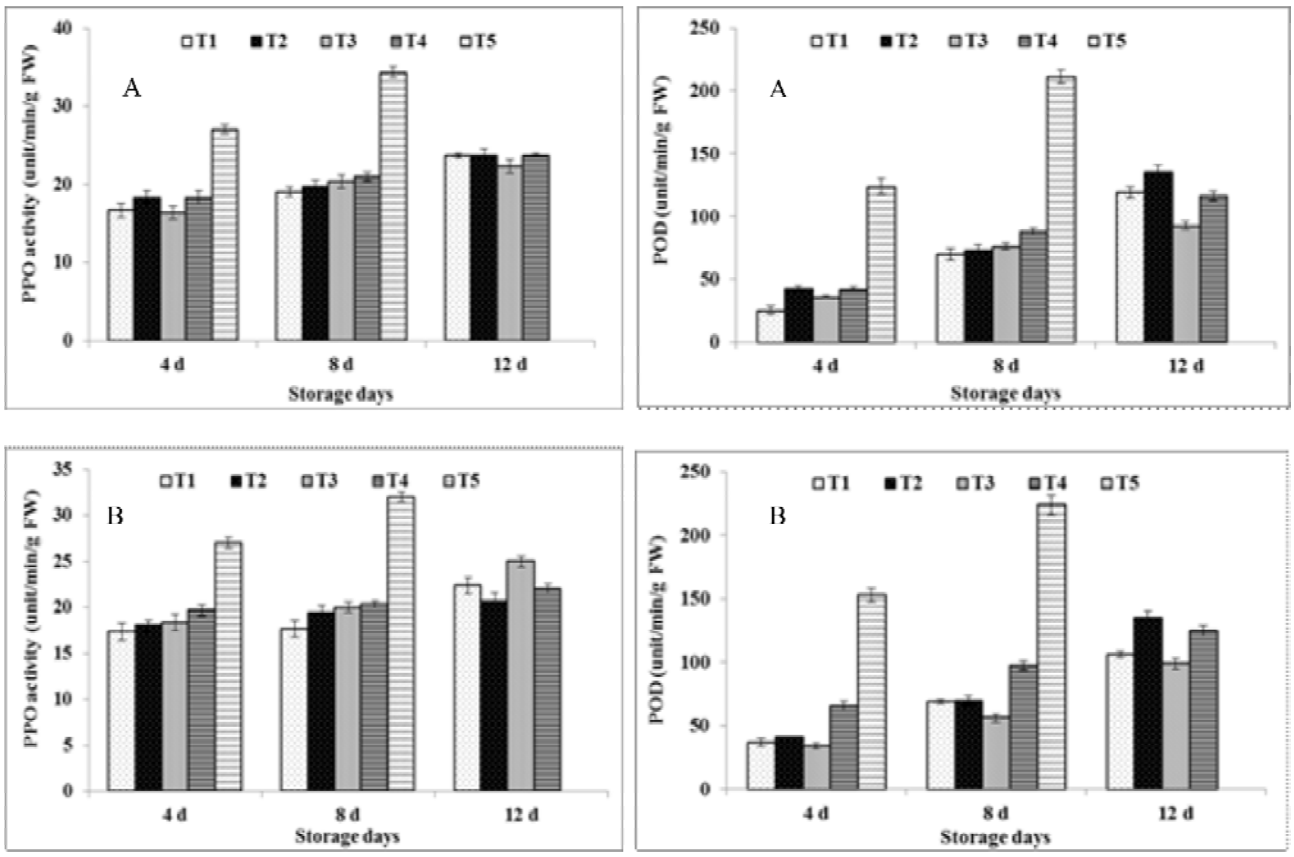


Fig.4.8. PPO activity in Shahi and China litchi pericarp (A and B, respectively), POD activity in Shahi and China litchi pericarp

fruits (Fig. 4.8). The PPO enzyme activity was ~1.3 times more in untreated fruits on 8th day of storage than in treated fruits on 12th day of storage. It was observed that the POD enzyme activity increased by about 5 times over the base value on 4th day of storage in treated fruits over the activity value in control fruits on 8th day of storage. No significant difference in PPO activity was recorded among the different doses of putrescine (0.5 and 1.0 mM) and spermine (0.5 and 1.0 mM) treatment in both Shahi and China litchi cultivars. On the last day of storage, the peroxidase activity was about half in comparison to the activity in control fruits on the 8th day of storage.

Response of postharvest polyamines treatments in combination with pre-harvest polyamine treatments on biochemical parameters and fruit quality of litchi

The application of polyamines, putrescine and spermine @ 0.5 mM, as pre-harvest sprays synergistic

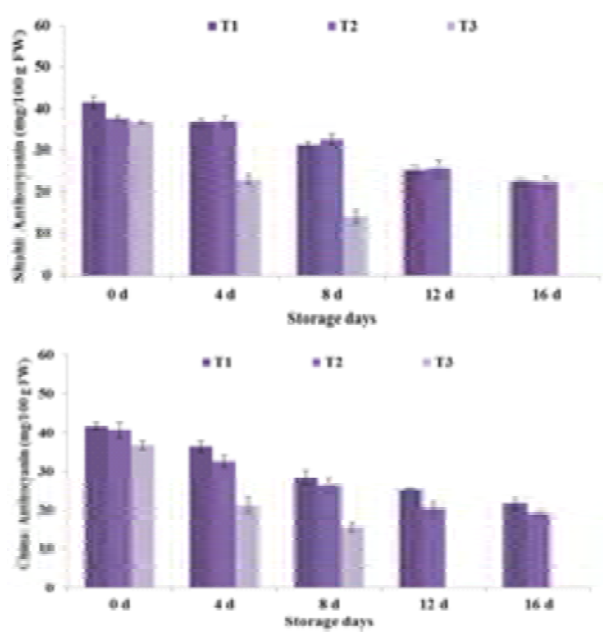


Fig. 4.9. Anthocyanins content in Shahi and China fruit during storage

with postharvest dips maintained anthocyanin pigments in the fruit over control (Fig. 4.9). There was no significant difference in the retention of anthocyanin pigments with putrescine @ 0.5mM and spermine @0.5 mM treatments at different intervals during storage. It was observed that both the polyamines treatment maintained significantly higher anthocyanin pigment in comparison to control fruit in both Shahi and China. The total anthocyanin content was found to decline with the increase in postharvest storage period. Increase in pericarp browning, polyphenol oxidase and peroxidase enzymatic activity and decrease in L values were also recorded.

Soluble solids content and titratable acidity in litchi fruit declined during storage irrespective of treatments (Fig. 4.10). Soluble solids content declined slightly during the storage period. Titratable acidity was recorded to be significantly higher in polyamines (putrescine and spermine in both pre-harvest and postharvest stages @ 0.5mM) treated fruits compared to control. No significant difference was recorded among the different polyamines treatments and doses. The slow decline in titratable acidity in treated fruit over control during storage may be because of delay in senescence and deterioration rates by the polyamines treatment.

4.5. Estimation and quantification of methylenecyclopropylglycine content in fruits of litchi genotypes

Development of analytical method for estimation of methylenecyclopropylglycine content in litchi

The analytical method for estimation of methylenecyclopropylglycine content in litchi fruit was developed at NRL, Pune using HPLC-QqQ MS, Column: Atlantis Silica HILIC Column, 5 µm, 4.6 mm X 150 mm, Mobile phase: A - water + 0.1 % formic acid and B – Acetonitrile. The extraction solvent used was 80% methanol with 1% (v/v) Formic acid. 10 g

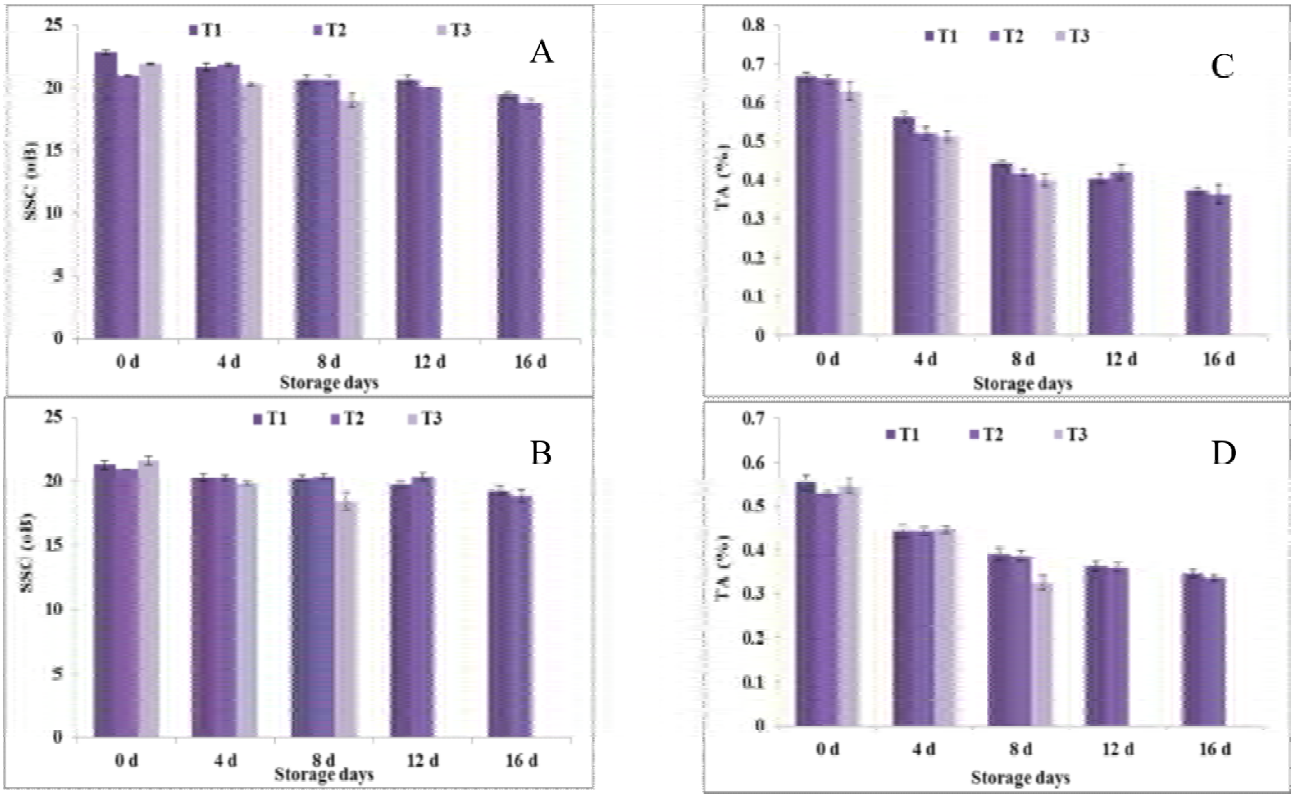


Fig. 4.10. Soluble solids content in Shahi (A) and China (B) litchi pulp and titratable acidity in Shahi (C) and China litchi pulp (D)

homogenized sample was taken and 10 ml extraction solvent was added. It was then kept on shaker for 1 h at 150 rpm at 30°C. All samples were then centrifuged at 5000 rpm for 10 min and supernatant was collected and used for analysis. Recovery % was calculated by spiking 5 ppm MCPG in China pulp as no MCPG was detected in it. The mass transitions in MRM mode were 128/110 and 128/82. The run time was 18 min, gradient program: 0-7 min 100%B, 7-10 min 40%B, 10-11 min 100%, 11-18 min 100%, Retention time: 4.55 min, Estimated - % recovery range was 80-105%. Four point calibration curve was established from matrix match standards at concentration range of 0.5-10 ppm (Fig. 4.11).

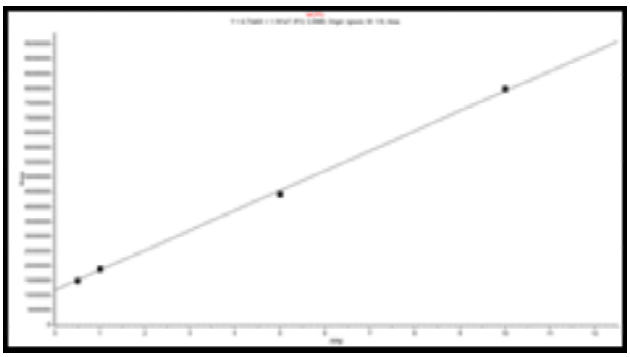


Fig. 4.11. Calibration curve of methylenecyclopropylglycine

Estimation of methylenecyclopropylglycine content in peel, pulp and seed of litchi

Fruit of litchi cv. Shahi and China in three different growth stages (Stage 1: 30 days before harvesting, Stage 2: 15 days before harvesting, and Stage 3: fresh ripe fruits) were collected and partitioned into different parts viz. pericarp, seed and pulp. The peel, pulp and seed samples were then analyzed for MCPG content at NRC for Grapes by the developed analytical method. The results showed that fruit pulp and peel of China litchi were completely free from MCPG content. However, the seeds of China litchi showed presence of MCPG (Stage-1: 61.2 ppm, Stage-2: 118.5 ppm, Stage-3: 330.2 ppm). The content of MCPG in seeds of China and Shahi was found to increase during growth and development. This is in line with the earlier reports of litchi seeds having MCPG. Shahi seeds also showed presence of MCPG which increased with the growth of the fruit. MCPG was found to be absent during the stage 1 and stage 2 of Shahi litchis studied in this experiment.

5. Improving Knowledge and Skill of Stakeholders for Increasing Production of Litchi

5.1. Tribal Sub Plan Project

Kashipur block of Rayagada district of Odisha where 86% of the population is rural out of which 55.71% belong to Scheduled Tribes and 13.95% Scheduled Caste had been selected under this scheme. More than 60% lands in the target area are high lands. The agro-climate of target area is very favourable for long (mango, litchi, cashew) and short duration (papaya and pineapple) fruit crops. Mango and litchi plants that were planted in the area two years back are regularly monitored for their growth performance. In addition, the centre has also demonstrated rejuvenation of old litchi plants in Deogarh area of Odisha.

In the tribal dominated district of Shahdol in Madhya Pradesh, potential for litchi growing has been identified by the centre. Beneficiaries have already been identified under the programme.

5.2. North Eastern Hill (NEH) region: R&D project on litchi

The centre undertook an exploratory visit to Mokokchung and Medziphema in Nagaland. Aliba village, located in Mokokchung district was identified as a potential litchi-growing area where an interaction meeting was held with the litchi growers. For a beginning, about 100 air-layers of litchi cv. Shahi were provided to farmers (Fig. 5.1). The farmers were given technical assistance in preparation of potting media and care for successful establishment of air-layers.

Another intervention that the centre undertook during the period was backyard poultry rearing. About 28 needy tribal women were identified in Mokokchung village of Nagaland. Chicks of Vanaraja breed were procured from the poultry farm of ICAR RC NEH Region, Nagaland Centre, Jharnapani, and of Kuroiler

Fig. 5.1. Raising nursery plants of litchi in farmer's field

Fig. 5.2. Distribution of poultry chicks among tribal women in Mokokchung, Nagaland

breed from the State Poultry farm at Dimapur. The poultry chicks along with initial feed were provided to the select beneficiaries (Fig. 5.2).

Realizing the potential of litchi cultivation and its expansion in Nagaland, ICAR-NRCL in collaboration with ICAR RC NEH Region, Nagaland Centre, Jharnapani, identified several villages along the foothills in Peren and Dimapur districts of Nagaland. Subsequently, 12000 disease-free planting material of litchi cv. Shahi have been provided by the centre to growers in these villages (Fig. 5.3).

Fig. 5.3. Director and staff of ICAR-NRCL flagging off vehicles carrying litchi planting material to Nagaland

6. Flagship Projects

6.1. Postharvest management with respect to pericarp browning and fruit decay

Studies on hydro-cooling in litchi

Freshly harvest litchi fruit was hydro-cooled by immersing in water maintained at a temperature of 10°C. Change in pulp temperature Vs time was recorded. Results confirmed that rapid drop in pulp temperature from 31°C to 13°C occurs up to 10 minutes. Thereafter, the pulp temperature stabilizes at around 13°C as long as the temperature of cooling medium is maintained. It can be concluded that litchi can be hydro-cooled at 10°C for 10 minutes to remove field heat after harvest.

Studies on physical, anatomical, physiological, and biochemical basis of pericarp browning in litchi

Significant change in Hunter a value during fruit development occurred between 5th and 10th May, which indicates the stage of visible colour break in litchi (Fig. 6.1). There was no change in fruit weight and size from 22 to 29 May. On the contrary, there was significant reduction in hunter L and a values. This suggests that fruit maturity in litchi cv. Shahi is complete by 22nd May and further delay in harvesting might result in reduced visual appeal. It is a matter of common practice among litchi growers to begin harvest operation even before fruits have attained proper maturity. It was found that about 20% increase in fruit weight occurred between 17 May and 22 May 2017. This indicates that growers would gain about 200 kg for every tonne of harvest done after proper fruit maturity as compared to early harvesting (around 15-17 May).

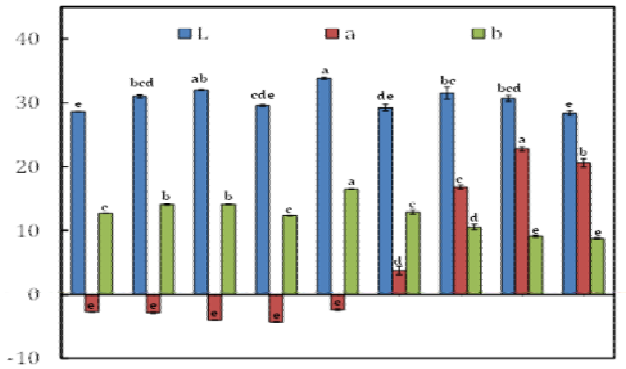


Fig. 6.1. Changes in Hunter colour values of pericarp during litchi fruit growth and development in cv. Shahi

6.2. Shoot physiology in relation to flowering and fruiting of litchi

During 2016-17, most of the tress flowered in year 2016 ('on' year) but in 2017, litchi tree receiving 2.0 ml PBZ per m canopy diameter shown partial flowering. Control tree did not flower at all. Litchi cv. Shahi was treated with 1.0, 2.0 and 3.0 ml paclobutrazol (PBZ) through ring basin method of application, and it was observed that floral shoots had shown reduction in net photosynthetic rate (*Pn*) due to application of PBZ, and also overall floral shoots had reduced *Pn* over non floral shoots. PBZ also reduced transpiration rate (*E*) in non-floral shoots over control and 1.0 ml PBZ was found to be significant in recording highest *E*. Internal CO_2

Table 6.1. Gaseous exchange parameters in leaf affected by paclobutrazol (PBZ) during flowering in litchi cv. Shahi

Treatment	Type of shoots	Photosynthetic rate (*A*) (m mol CO_2) m^{-2} s^{-1})	Transpiration rate (*E*) (m mol H_2O $\cdot m^{-2} s^{-1}$)	Internal CO_2 Concentration (*Ci*) (m mol CO_2 mol^{-1} air)	Stomatal Conductance (*gs*) (m mol(H_2O) $m^{-2}s^{-1}$)
PBZ@ 3.0 per m canopy diameter	Floral	3.03	0.93	278	37.33
	Non floral	1.93	2.06	289	36.60
PBZ@2.0 ml per m canopy diameter	Floral	1.45	0.95	343	32.00
	Non floral	2.80	0.65	110	17.66
PBZ@1.0 ml per m canopy diameter	Floral	2.10	1.50	267	42.33
	Non floral	2.56	1.03	216	33.00
Control	Floral	3.60	1.20	204	40.33
	Non floral	2.03	1.50	261	52.66

concentration (*Ci*) observed to highest in floral shoots of tree receiving 2.0 ml PBZ and reduced in non-floral shoot of same tree which bears the fruits during this season (2017) i.e. application of PBZ enhanced *Ci* in floral shots of the litchi tree might be attributed to less *Pn*. Control trees had highest stomatal conductance (*gs*) in non-floral shoots but application of PBZ @2.0 ml was able to drastically reduce in non-floral shoots, other trees also show reduction in *gs* in non-floral over floral shoots (Table 6.1).

After harvest in June, the biochemical analysis of litchi leaves was done after post-harvest flush emergence and it was observed that total CHO (carbohydrate), proline content was found to increase from July to September in China and Shahi litchi except reduction in proline content during September in Shahi. Reducing sugar (RS) and total phenol (TP) content increased from July to September in Shahi. TP content showed decreasing trend in China. Preliminary results depict reduced concentration of proline and TP in litchi leaves during September is desirable for assure flowering in coming season.

Only manual de-flushing during December month has brought flowering in next season, no flowering was induced even if tree sprayed with ethephon (1000 to 2000 ppm) during the same period. During flowering period, the non-floral shoots had much higher net photosynthesis rate, transpiration rate than floral shoot across PBZ applied or not in litchi cv. Shahi.

The leaf chlorophyll a content was higher in Shahi than China litchi across July to September but chlorophyll b was at par or lesser during the same period (Fig. 6.2). Higher chlorophyll a, chlorophyll b and total chlorophyll content was recorded in leaves of litchi cv. Shahi over China might be the reason for low net photosynthetic rate (*Pn*) in China and that is why China is irregular bearing and Shahi as regular bearer.

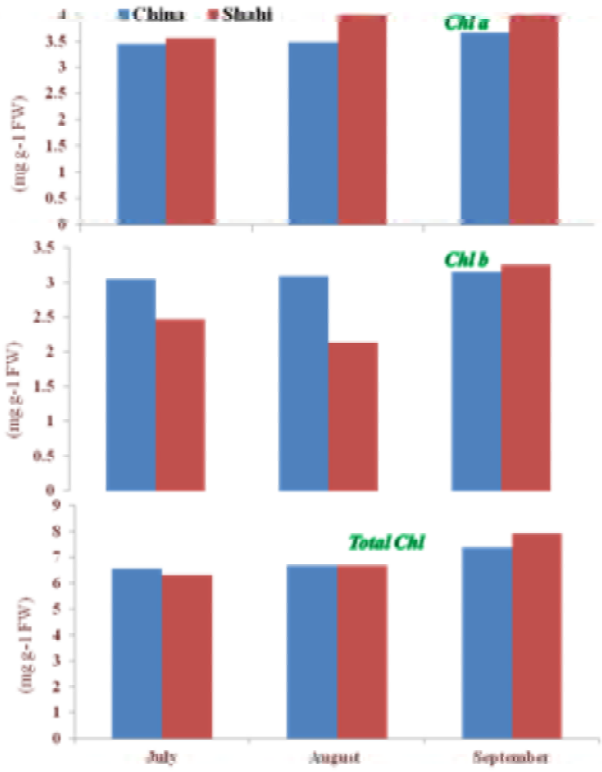


Fig. 6.2. Variation in leaf chlorophyll content in litchi during postharvest flush emergence

7. Externally Funded Projects

7.1. Improved livelihood through good practices in agricultural production system (Farmers FIRST programme)

The project was formulated and initiated under the ambitious Farmers FIRST Programme (FFP) of ICAR. The project was initiated with objectives to enhance farmer-scientist interface for analysing management gap in agricultural production system. Eight villages were selected (Table 7.1) for implementation of the project with four major modules, *viz.* crop, horticulture, livestock, and microenterprises-based modules.

Under crop-based module, experimentation on improved varieties of wheat was conducted by 930 farmers in an area of 160 ha. Experimentation on summer moong was also done by 715 farmers on 125 ha area with a seed quantity of 22 quintals. The summer mung of varieties Pusa Vishal and SML668 was primarily aimed to increase cropping intensity and farm income.

Under livestock based module a winter care experimentation kit (De-wormer, mineral mix, multi-vitamins, anti-stress, and energy booster) for milch animal was prepared and provided to 400 farmers (Fig. 7.1). Significant increase in milk production from both cow and buffalo was recorded under the programme.

Experimentation on backyard poultry was also conducted. Two group comprising 50 participants including 41 women were provides 3 days training on back yard poultry management. Set of 25 (30) chicks of Vanraja (5 weeks old), initial feed (10 kg), additives, initial medicine were provided(Fig. 7.2).

Table 7.1. Demographic information about selected villages

Village	No. of farm family	Small farmer	Marginal farmer	Big farmer	Land holding (ha)	Family member	No of live stock	Wheat (area)
Ujhilpur (Mehsi)	210	3	207	-	0.17	7.9	1.3	0.41
Bakhari Nazir (Mehsi)	100	6	94	-	0.14	6.66	2.2	0.31
Damodarpur (Mehsi)	100	53	47	-	0.27	6.56	1.8	-
Vaisaha (Chakia)	100	52	48	2	0.32	5.88	-	-
Ramgarhava (Chakia)	120	46	74	-	0.21	7.8	1.4	0.14
Vishunpura (Chakia)	50	13	37	-	0.17	5.8	1.1	0.14
Chintamanpur-Malahi tola (Chakia)	200	24	176	-	0.12	7.34	1.4	0.23
Khairva (Chakia)	120	33	87	-	0.21	7.21	1.4	0.20

S: small farmer (< 2 ha), M: marginal farmers , B: Big farmers (>10 ha), FM: Family memberLS: Live stock

Fig. 7.1. Distribution cum training on winter care experimentation kit for milch animals

Fig. 7.2. Distribution of chicks and initial medicine and feed to women

Under horticulture-based module improved techniques for establishment of new litchi/mango orchards and plant health management for quality litchi productionhas been demonstrated. A kit comprising vermicompost, biofertilizers, Trichoderma and biopesticides has been made available to litchi growers of the selected village. Another intervention on use of bagging to protect litchi fruit bunches and production of quality fruits was done. Besides, experiment was also done to enhance and popularize improved production technologies in vegetables among the beneficiaries. Farmers were introduced to improved varieties and trained in modern production methods of summer vegetables (cowpea, okra, and other cucurbitaceous crops) cultivation. Seeds of improved variety of cowpea, okra, bottle gourd, bitter gourd, cucumber, and sponge gourd were provided to more than 750 farm families covering an area around 20 ha.

Under microenterprises-based moduletraining and initial kit distribution on mushroom production and pickle making was conducted among women (Fig. 7.3).

Fig. 7.4. Hon'ble Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh interacting with farmers and scientistsof Farmers FIRST project at Chakia, East Champaran on 11th March, 2017

Fig. 7.3. Training on mushroom cultivation and pickle-making

A one day field training on Oyster mushroom cultivation was conducted at Chintamanpur village. Two visits cum training on cultivation of Rajendra Dudhia mushroom was held at Dr. Rajendra Prasad Central Agricultural University, Pusa, where 100 women participated. Two training programmes on pickle-making were conducted at Chintamanpur-Malahi tola and Ujhilpur villages where about 60 women participated.

7.2. DBT-sponsored Mango Project: Development of National Database on Mango

During 2016-17, data was collected from different districts of Bihar and Jharkhand for district level information, farmers who grow and maintains more than ten mango varieties in their orchard, information on fruit usage, methods of value addition, medicinal uses and cultural practices followed in the orchard. The database on medicinal practices and ITKs, major diseases and pests of mango and prevalent protection measures, harvesting season and prevalent harvesting and packaging methods were also collected. Twenty two orchardists maintaining more than 15 varieties in their orchard were identified (Table 7.2). Some unique mango varieties identified during the period were *Mithua* (from Patna), *Sewaiaya, Bhont, Jalbanda, Dayal* (Saran), *Gaurjeet* (West Champaran) and *Baramasi* (Jamui) (Table 7.3 & 7.4).

Sri. Harendra Kumar Singh of Makhdumpur, Bihta, Patna has been identified as torch bearer for farmers who need information on e-marketing, weather forecast, skilled grafter/budder and encourage farmers to grow non-commercial but important fruit crops like Jamun and Date palm. Sh. Anuj Rai, Malikaur, Pusa, Samastipur growing more than 25 number of fruit trees species in their orchard including temperate and arid fruits.

The major problems of orchards of Bihar was found as young plant mortality, grazing of small plants by goat, thefts of fruits, poor irrigating facility due to deep water table, drying of '*Sipia*' mango, dieback, fruit drop, burl disorder, monkey, blue bull, termites, mealy

Table 7.2. List of custodian farmers of mango growing >15 varieties in their orchard

Name of farmer	No. of trees	No. of variety grown
Sh. Kaushal Motani, West Champaran	2000	17
Sh. Pankaj Kumar Singh,East Champaran	250	26
Sh. Shailesh Pandey, Saran	150	16
Sh. Abdul Rahim,West Champaran	360	28
Sh. Vinod Kumar Rai, Samastipur	300	36
Sh. Vijay Kumar Sharma, Samastipur	350	20
Sh. Sanjay Sharma, Samastipur	130	19
Sri. Washi Akhtar, Gopalganj	400	19
Sh. Rajeev Nayan Tiwari, Gopalganj	600	16
Sh. Harsh Ranjan, Muzaffarpur	300	19
Sh. Sudhir Kr. Pandey, Muzaffarpur	100	16
Sh. Amresh Kumar, Katihar	1500	17
Sh. Kalidas Banerjee, Katihar	450	25
Sh. Sameer Kumar Jha, Katihar	400	16
Sh. Sanjeet Kumar, Purnea	25	15
Sh. Kumar Tarun, Purnea	140	22
Sh. Ashok Kr. Singh,Siwan	200	15

Table 7.3. List of unique mango varieties conserved by custodian farmer of Bihar

Unique variety (s)	District	Unique variety (s)	District
Jalbanda	Saran	*Kerwa*	Siwan
Jalmarai	Purnea	*Tairia*	
Baramasi	Samastipur	*Latkampu (Syn. Bahadura)*	East Champaran, Gopalganj
Lamba Bahadur	Katihar	*Hajipur Mithui'*	Samastipur
Hilsa Peti		*Madhukupia*	
Bhastara (syn. Baramasi	Siwan	*Paharpur Sinduria*	
Sabja (syn. Bombaiya	East Champaran	*Rari mango*	
Dalma (syn. Kalkatia Malda	Goplaganj	*Kapuria*	
Malda seedling	Samastipur	*Hajipur Mithui*	
Bhont	Saran	*Ajgavi Sipia*	
Suraypuri	Purnea	*Belwa*	
Raja	Gopalganj	*Chauaria*	Katihar
Kaveri, Balajee		*Navras*	
Esna	Katihar	*Jethua*	Purnea
Baelkhash	*Gopalganj,*	*Kala Pahad*	
Chitranjan	Katihar, Purnea	*Jing Jing*	
Gaurjeet	West Champaran		

Table. 7.4. Custodian farmers identified during the period from various districts of Bihar and Jharkhand with unique local variety

Sl. No.	District	Block	Village	Farmer	No. of trees	No. of varieties	Unique mango variety
Bihar							
1.	Patna	Bihta	Bela	Sh. Mahesh Singh	750	13	*Digha Malda*
2.			Painal	Sh. Sanjay Kr Sharma	50	10	-
3.				Sh. Rajesh Kumar	100	10	Malbhog
4.			Makhdumpur	Sh. Harendra Kumar Singh	90	11	*Mithua* (Early and cracking resistant)
5.	Jamui	Chakai	Urva	Sh. Susheel Kumar Sinha	200	12	*Sinduria* (Earliest to ripen)
6.	Saran	Isuapur	Agawthar	Sh. Sachidanand Pandey	40	10	*Sabja* (Bombaiya)
7.		Lahladpur	Dhamsar	Sh. Shailesh Pandey	120	15	*Sukul* (yield up to 9 quintal per tree)
8.		Nagra	Afaur	Sh. Umesh Kr. Singh	200	10	-
9.		Manjhi	Majhanpura	Sh. Udai Shankar Singh	40	13	*Jalbanda* (sweet at mature green stage)
10.				Sh. Krishna Singh	100	14	*Bhont* (Thin Stone, high pulp content), Dayal (suitable for pickle making)
11.	Siwan	Goriakothi	Ageyan	Sh. Sudhanshu Shekhar	60	10	-
12.	West Champaran	Mainatand	Gamharia	Sh. Kaushal Motani	3000	17	*Gaurjeet* (excellent marketable and highly flavoured)
13.	Samastipur	Pusa	Malikaur	Sh. Anuj Kumar Rai	145	25	Arka Aruna, Ambika
Jharkhand							
14.	Hazaribagh	Sadar	Babhnave	Sh. (Col.) Vinay Kumar	60	10	-
15.	Lohardaga	Sadar	Hirhi Jobla Toli	Sh. Mahrang Lohra	108	10	-
16.			Ita	Sh. Jairam Uraon	300	-	
17.	Ranchi	Silly	Lagan	Sh. Suresh Mahto	45	10	-
18.		Jonha	Angarha	Sh. P K Sinha	800	11	-

bugs, stem borers, irregular bearing and marketing of rare varieties while in Jharkhand, it was black tip, hailstorm, mango malformation and fruit drop. Mango malformation was found to be severe in *Jamui* and *Lohardaga*, Jharkhand and labour scarcity for various agricultural operation in both states.

7.3. ATMA Sponsored Project: Studies on effective utilization of interspaces in young bearing litchi orchards for income and soil health improvement

Studies on the feasibility of intercropping under partial shade of litchi

Seasonal crops were grown in interspaces of litchi orchard during both *Kharif* and *Rabi* seasons. Excellent performance of turmeric, potato and maize has been recorded. Good flowering and fruit set was recorded in the litchi trees. Yield in turmeric and potato recorded 116.16q/ha of and 140.62q/ha, respectively.

7.4. Consortia Research platform (CRP) on borers

Seasonal abundance of litchi fruit & shoot borer

During survey litchi fruit borer infestation ranged from 3.68-33.67% at farmers' field from initial to harvest stage during 2016 (Fig. 7.5). However in 2015, due to favourable weather conditions borer incidence had increased up to 73% and in some areas it was observed around 80%.

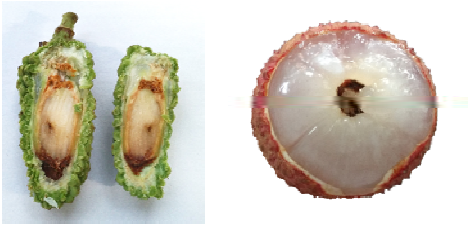


Fig. 7.5. Litchi fruit borer infestation in both immature and ripe fruit

Management of litchi fruit borer using synthetic pyrethroids and diamides based IPM modules

A field trial was conducted to evaluate different synthetic pyrethroids and diamides based IPM modules against litchi fruit borer *viz*., Module 1: neem formulation 0.15% (0.009%)+ lambda cyhalothrin 5 EC (0.003%), Module 2: neem formulation 0.15% (0.009%) + deltamethrin 2.8 EC (0.0028%), Module 3: neem formulation 0.15% (0.009%) + thiacloprid 21.7 EC (0.013%), Module 4: neem formulation 0.15% (0.009%) + chlorantranilprole 18.5 SC (0.006%), Module 5: neem formulation 0.15% (0.009%) + chlorantranilprole 18.5 SC (0.007%). First spray was given with neem oil before flower opening stage in all modules while second, third and fourth spray of different chemicals were applied as per modules at clove size fruit, cardamom size and after 10 days of third spray (about 15 days before harvest), respectively. Minimum fruit infestation (7.00%) was recorded with spray of chlorantranilprole 18.5 SC (0.007%) followed by lambda cyhalothrin 5 EC (7.22%) as against 33.67% fruit damage in control.

7.5. ICAR Seed Project-Mega seed project on seed production in agricultural crops and fisheries (RFS)

Maintenance of the mother block

Mother block comprising 625 plants of nine promising litchi cultivars *viz*. Shahi, Rose Scented, Longia, China, Mandraji, Purbi, Swarnroopa, Yogda Selection, and Bedana is being maintained in 1.2 ha area for large scale propagation of quality planting materials. Fifty (50) plants of guava cv. Lalit are also being maintained, out of which 200 plants produced during the period.

Propagation of quality planting material

Approximately 35000 air-layers were made in litchi using soil-less rooting media containing vermicompost, coco-peat, and vermiculite (1:1:1 ratio) during June to August out of which, about 34000 well-rooted air-layers were detached and planted in the nursery. Of these, 32000 air-layers were maintained and kept for sale to farmers and stake holders. Grafting was done in 300 litchi plants in cultivars Shahi and China out of which 100 grafted plants survived.

7.6 Livelihood and nutritional improvement of tribal farm women through horticulture

Tribal women farmers from Bakwa Chandraul and Parsauni village of West Champaran district of Bihar were selected to demonstrate the improved production technology of horticultural crops including training program. Eighteen women farmers were selected and demonstrated the vermi-compost production technology. Planting materials of mango (Malda), litchi (Shahi & China), guava (Lalit) and lime (Kagzi lime) were also distributed among 75 farm families and trained on establishment of new orchard. Seeds of cowpea (Kashi Kanchan & Kashi Nidhi) were distributed and cultivation technique was also demonstrated during Kharif season in both the village among tribal women's. Seeds of winter vegetables like cabbage (hybrid), cauliflower (hybrid), pea (Azad Pea 3) and radish (Shweta) have also been distributed and demonstrated the production technology among 44 families of the villages. Very good crop yield in cabbage and cauliflower was observed among the on farm demonstration. Cabbage yield ranged from 230-400q/ha and cauliflower from 240-400q/ha. The highest average yield of pea was obtained 48q/ha in the plot of Niroopa Devi Bakawa Chandraul whereas minimum yield was obtained 25q/ha. The average yield of radish was found 90-120q/ha and 100-135q/ ha in Parsauni and Bakawa Chandraul, respectively.

Institutional Activities
Human Resource Development

Participation of scientists/staff in conference/seminar/symposia/workshop/training/meeting during 2016-2017

Sl. No.	Title	Venue and Date	Participant (s)
1.	ISMPP 37th Annual Conference and National Symposium on "Food Security through Plant Health Protection	RAU, Pusa, Bihar, 4-6thApril, 2016	Dr.Vinod Kumar
2.	District Stakeholders workshop	District Agriculture office, Muzaffarpur, Bihar, 26th April 2016	Dr. Vishal Nath
3.	National Conference on Fruit Breeding in Tropics and Subtropics - An Indian Perspective	ICAR-IIHR, Bengaluru, 27-29th April, 2016	Dr. Sanjay Kr. Singh
4.	Reservation and Roster preparation	ICAR-NAARM, Hyderabad, 27-29th April 2016	Sh. AbhishekYadav
5.	Capacity building programme on cold treated litchi export to USA	ICAR-NRCL, from 19-21st May 2016	Dr. S.K. Purbey Dr. Kuldeep Srivastava Dr. Alemwati Pongener Dr. Vinod Kumar
6.	Global Conference on perspective of future challenges and options in agriculture	Jalgaon, 28-31st May, 2016	Dr. Amrendra Kumar Dr. Kuldeep Srivastava Dr. R.K. Patel
7.	V International Symposium on Lychee, Longan and other Sapindaceae Fruits	BAU, Sabour, Bhagalpur, from 31st May to 3rd June 2016	Dr. Vishal Nath Dr. S.K. Purbey Dr. Amrendra Kumar Dr. Kuldeep Srivastava Dr. R.K. Patel Dr. Vinod Kumar Dr. Alemwati Pongener Sh. Alok Kumar Gupta Dr. E.S. Marboh
8.	IJTA 3rd International Conference on Agriculture Horticulture and Plant Sciences	New Delhi, 25-26th June, 2016	Dr.Vinod Kumar
9.	National worskshop cum PMC meeting for project formulation under Farmer's FIRST Programme of ICAR	Agricultural Extension division, New Delhi:, KAB-2, on 27th June 2016	Dr. Gopal Kumar
10.	Steering committee meeting on 2nd Green Revolution in NE Region	ICAR-RC ER, Patna, 27th June 2016	Dr. Vishal Nath
11.	Academia-Industry Meet for need of Mechanization in Agriculture	CIAE, Bhopal and ICAR-RC ER, Patna, 28th June 2016	Dr. S.K. Purbey
12.	Agriculture and Farmer's welfare on Statistics day	NSSO (FOD), Muzaffarpur, 29th June, 2016	Dr. S D Pandey Dr. S K Purbey
13.	Training on Income tax	ISTM, New Delhi, 4-5th July, 2016	Sh. Sawan Kumar
14.	Inter State Horti Fair Sangam 2016	Hajipur, Bihar 9-10th July, 2016	Dr Vishal Nath Dr. S.K. Purbey Dr.Amrendra Kumar Dr.Gopal Kumar Dr Evening Stone Dr Alok Kumar Gupta
15.	24th National Children Science Congress	NCSC, Muzaffarpur, 12th July 2016	Dr. S.K. Purbey
16.	Summer School on "Canopy Architecture Management in Fruit Trees for Conservation and Utilization of Natural Resources in Changing Climatic Condition"	ICAR-NRCL, from 11-31st July 2016	Dr. E.S. Marboh Dr. Alemwati Pongener Dr. Swati Sharma Sh. Alok Kumar Gupta
17.	International conference on Agriculture, Food Science, Natural Resource Management and Environmental Dynamics: The technology, people and sustainable development	BCKV, West Bengal, 13-14th August 2016	Dr. E.S. Marboh
18.	Training programme on 'Statistical Data Analysis'	ICAR-NAARM, Hyderabad from 18-23rd August, 2016	Dr. Sanjay Kr. Singh
19.	Competency enhancement programme on motivation and positive thinking for technical officers of ICAR	ICAR-NAARM, Hyderabad, 17-26th August 2016	Sh. Rajiv Ranjan Rai

20.	World Peace prayer & Kishan Sangosthi	ASM Foundation, Mahamada, Bihar, 3rd September 2016	Dr. Vishal Nath
21.	Workshop on pension and other retirement benefits	ISTM, Hyderabad, 5-8th September 2016	Sh. Dileep Kumar
22.	Short course on "Advances in Soil Testing and Soil Test Crop Response (STCR) based Fertilizer Management."	ICAR-IISS, Bhopal from 23rd August to 1st Sept 2016.	Sh. Prabhat Kumar
23.	Short Course on "Bioassay, Production Protocol and Quality control for Trichoderma based Bio-pesticides"	ICAR-NRCL, from 5-14th September 2016	Sh. Prabhat Kumar
24.	Review meeting under CRP on borers in network mode	Bengaluru, 6th October, 2016	Dr. Kuldeep Srivastava
25.	3rd National meet of Entomologists 2016	Bengaluru, 7-8th October, 2016	Dr. Kuldeep Srivastava
26.	Biennial group meeting of ICAR-AICRP on honey bees and pollinators	Dr. YSPUHF, Solan, 16-18th October 2016	Dr. Kuldeep Srivastava
27.	Workshop on 'Dynamics of Challenges and options in Integrated Aquaculture'	Patna, Bihar 2nd November, 2016	Dr. Vishal Nath Dr. R.K. Patel
28.	1st International Agrobiodiversity Congress	New Delhi, from 6 -9th Nov, 2016)	Sh. A.K. Gupta
29.	Zonal Group meeting of Zone II and Zone III, for operationalization of the implementation strategy of FFP Approach and Guidelines	ATARI Kolkata, on 9th Nov. 2016	Dr. Gopal Kumar
30.	International Congress on "Post-Harvest Technologies of Agricultural Produce for Sustainable Food and Nutritional Security"	Integral University, Lucknow, 10-12th November 2016	Dr. Vishal Nath
31.	7th Indian Horticulture Congress	ICAR-IARI, New Delhi, from 15-18th November 2016	Dr. Vishal Nath Dr. S.D. Pandey Dr. Amrendra Kumar Dr. Sanjay Kr. Singh
32.	Brain storming session on the germplasm introduction and exchange related issues in horticultural crops	ICAR-NBPGR, New Delhi, 19th November 2016	Dr.Amrendra Kumar Dr. Sanjay Kr. Singh
33.	MTC on GAP in Litchi	ICAR-NRCL, Muzaffarpur, 21-28th November 2016	Dr.Ramashish Kumar Dr. J.P. Verma
34.	Identification of insect pests and vectors – their damaging symptoms and management	ICAR-IARI, New Delhi, 1-14th December 2016	Dr. J.P. Verma
35.	International Seminar on "Recent Trends and Experimental Approaches in Science, Technology and Nature"	ICAR-IISR, Lucknow on 23rd December, 2016	Dr. Vishal Nath Dr. Sanjay Kr. Singh
36.	National Conference on "Management of Microbial Resources for Food Security under Climate Smart Agriculture"	Dr. RPCAU, Pusa, Bihar, 22-24th December, 2016	Dr.Vinod Kumar
37.	Recent Advancement in Bio-fertilizer & Vermicomposting Technology for sustaining Agricultural Development"	Dept. of Soil Science, Dr. RPCAU, Pusa, Samastipur, Bihar, 29th December 2016	Dr. S.K. Purbey
38.	4th Group Workers Meet, AICRP on Fruits	ICAR-IIHR, Bangaluru, from 4-7th January, 2017,	Dr. Vishal Nath Dr. S.D. Pandey Dr. Amrendra Kumar Dr. E.S. Marboh
39.	Global Seminar on Enhancing Productivity of fruit crops – mitigating major challenges	Bangaluru, 8th January 2017	Dr. Vishal Nath Dr. Amrendra Kumar
40.	National Symposium on "Diagnosis and Management of Plant Diseases: Integrated Approaches and Recent Trends"	ICAR Research Complex for NEH Region, Umiam, Meghalaya, 9-11th January, 2017	Dr.Vinod Kumar
41.	International conference on sustainable natural resource management: from Science to practice	Varanasi, Uttar Pradesh, 12-13th Jan, 2017	Dr. Swati Sharma
42.	International Seminar on 'Agriculture and Food for inclusive growth and development'	Lucknow, 14-15 January 2017	Dr. Vishal Nath
43.	JPIC meeting at BARC and visit of Fruit export unit at Mumbai, Nasik and Pune	BARC, Mumbai, ICAR-NRCG, Pune, 15-21 January 2017	Dr. S.K. Purbey Dr. Alemwati Pongener
44.	Pro-Tech Kisan	ICAR-CISH, Lucknow, 21 January 2017	Dr. Vishal Nath
45.	Brain Storming workshop on Potential Collaboration in the area of Food Science and Technology	DFRL, Mysore, 27th January 2017	Dr. Vishal Nath
46.	The Second Workshop of Officer Incharge, Data Management of ICAR Knowledge Based Resources Information Systems Hub for Innovations in Agriculture (KRISHI)	NASC, New Delhi, 24-25thJanuary, 2017	Dr. Vinod Kumar
47.	Competency enhancement programme for effective implementation of training functions by HRD nodal officers of ICAR	Hyderabad,16-18 February, 2017	Dr. Kuldeep Srivastava
48.	MDP on Public Procurement	NIFM, Faridabad, 20-25 February 2017	Sh. Abhishek Yadav

49.	Training on Public Financial Management System	INGAF, Patna, 22-23rd February, 2017	Sh. Subhankar Dey
50.	NICS e-Procurement solution through CPP portal	IASRI, Pusa, New Delhi, 22-23rd February, 2017	Sh. Ritesh Kumar
51.	National Conference on Perspective, Challenges and Options in Maize Production and Utilization	DRPCAU, Pusa, Samastipur, Bihar, 3-4th March 2017	Dr. Vishal Nath
52.	Training programmeand state level seminar on 'Canopy management and flower regulation in Mango'	CHES, Bhubaneswar, 16-18thMarch 2017	Dr. Vishal Nath
53.	National Conference on "Farmers Centric Agri Innovation for Sustainable Development"	CSAUAT, Kanpur, UP, 24-25th March 2017	Dr. Vishal Nath
54.	2ndZonal project evaluation meeting of Zone II, Farmer's FIRST Programme	ICAR-RCER Patna, on 22nd March 2017	Dr. Gopal Kumar Dr. Alemwati Pongener Dr. Kuldeep Srivastava
55.	National Sensitization cum Evaluation workshop of Farmer's FIRST Programme	NAARM, Hyderabad on 18-19th March, 2017	Dr. Gopal Kumar

Meetings, workshops and events

National Science Day

ICAR-NRCL joined the rest of the nation in commemorating National Science Day on 28th February 2017. The function, chaired by the Director of the centre, comprised of deliberations on the role of science and technology for specially-abled persons. On the occasion, students who had enrolled for IGNOU's Certificate in organic farming were also initiated to the course. National Science Day was observed on 28th Feb., 2017 at ICAR-NRCL. All the staff of the centre and IGNOU learners of certificate in organic farming course actively participated in the programme. The programme was celebrated on the theme'Science and Technology for specially-abled persons'. Prof. Vishal Nath, Director ICAR-NRCL chaired the programme and shared his views on role of science and technology for common people in general and specially-abled person in particular in their day to day life. In addition, scientists and staff expressed their views on importance of science and technology for welfare of the society.

National Science Day being commemorated at ICAR-NRCL

16th Foundation Day

ICAR-NRCL celebrated its 16th Foundation day on 24th May 2016. Dr. S.D. Shikhamany, was the chief guest on the occasion. Other dignatories present on the occasion included Dr. D.S. Khurdiya, Dr. S.K. Mitra, Dr.Jitendra Kumar, Dr. Ramamurthy.

Dr. Vishal Nath highlighted the progress made by the centre during the 15-year journey and exhorted the staff to continue the hard work and dedication to take the centre to greater heights. Dr. S.D. Shikhamany congratulated the Director and staff of the centre on the occasion, and released the centre's first issue of Newsletter as well as the NRCL Trichoderma.

राजभाषा कार्यान्वयन समिति की बैठक

इस अवधि के दौरान राजभाषा कार्यान्वयन समिति की 4 बैठके और 3 कार्यशालाओं का आयोजन किया गया। राजभाषा हिंदी के प्रचार प्रसार हेतु 1–30 सेपटेम्बेर, 2016 के

मध्य हिंदी चेतना मास का आयोजन किया गया। इस दरम्यान कुल 5 प्रतियोगिताओं का आयोजन किया गया एवम् उत्कृष्ठ प्रदर्शन करने वाले प्रतिभागियों को पुरस्कृत भी किया गया। हिंदी कार्यशाला सह पुरस्कार वितरण समारोह 20.10.2016 को किया गया। डॉ. एस. के. घोष, हेड, एफ. टी.डी., भा.प. अनु. केन्द्र, मुम्बई, समारोह के मुख्य अतिथि थे। डॉ. एस. गौतम, भा.प.अनु.केन्द्र, मुम्बई एवम् श्री सुदपी सैनी, सचिव, नराकासा, मुज़फ्फर्पुर, समारोह के विशिष्ट अतिथि थे। समारोह की अध्यक्षता डॉ. विशाल नाथ, निदेशक रा. ली. अनु. केन्द्र ने की, सचिव, नराकासा, मुज़फ्फर्पुर ने हिंदी के प्रचार प्रसार में कम्प्यूटर के योगदान पर प्रशिक्षण दिया, मुख्य अतिथि ने सभरी विजेताओं को पुरस्कृत किया। अपने सम्बोधन में उन्होंने हिंदी को विश्व की सबसे सरल एवम् सहज भाषा कहा। विशिष्ट अतिथि ने कहा कि भारत जैसी विभिन्न भाषाई वाले देश में हिंदी सबकों सरल एवम् सहज भाषा कहा। विशिष्ट अतिथि ने कहा कि भारत जैसी विभिन्न भाषाई वाले देश में हिंदी सबको एक सूत्र में बांधने का काम करती है। अध्यक्ष महोदय ने हिंदी की महता पर प्रकाश डाला एवम् हिंदी भाषा के प्रचलन को बढ़ाने हेतु हर सम्भव प्रयास करने को कहा, इस साल राजभाषा हिंदी की पत्रिका लीचिमा का प्रकाशन भी किया गया।

Swachh Bharat Abhiyan

ICAR-NRC on litchi celebrated 2nd Oct 2016 *Gandhi Jayanti* - by way of a voluntary cleanliness drive. *"SwachhtaPakhwada"* was organized from 16 to 31 October 2016 at Mushahari, Muzaffarpurby spreading the message of cleanliness and hygiene *"Swachha Bharat Swasth Bharat"*. Director of the centre Dr. Vishal Nathadministered *"Swachhta Pledge"* to the scientists and staff to bring the Mahatma`s dream into reality. During this *"Pakhwada"*Cleanliness drive was organized on 21 & 31 October 2016 in which all employees participated. In addition, several initiatives were taken for overall cleanliness of office building and premises, residential campus and research farm.

Summer school on 'Canopy architecture management in fruit trees'

The centre organized a Summer School on "Canopy Architecture Management in Fruit Trees for conservation and utilization of Natural Resources in Changing Climatic Conditions" during 11-31st July, 2016.

Short course on 'Bioassay, production protocols'

A Short Course on "Bioassay, Production Protocol and Quality Control for *Trichoderma* based Bio pesticides" was organised from5-14th September, 2016.

APEDA-sponsored Capacity building programme on cold treated litchi export to USA

'Capacity Development Programme on Cold Treated Litchi Exports to USA' was held at ICAR-NRCL from 19-21st May, 2016. The programme was sponsored by APEDA, New Delhi with technical knowhow from USDA experts. Personnel from scientific field, academia, industry, NPPO, APEDA, and exporters participated in the programme.

BARC-sponsored awareness programme on preservation of litchi

An awareness programme on preservation of litchi was organised at the centre from 25-26th May 2016 in collaboration with BARC, Mumbai. Several litchi growers, entrepreneurs and stakeholders took part in the training.

Model Training Course on GAPs in Litchi

A model training course on Good Agricultural Practices in Litchi was organised at ICAR-NRCL from 21-28th November 2016.

Commemoration of Vigilance Awareness Week

Van Mahotsav 2016

National Productivity Week

Agricultural Education Day

The ICAR-National Research Centre on Litchi, Muzaffarpur celebrated Agriculture Education Day on 11 September 2016 at SJNP Ganna Krishak Inter College, Singha, Kushinagar, U.P., for promoting the spirit of agriculture and allied subjects among the students. The day was marked with the participation of more than 80students of Class XI and XII (Agriculture and Science) from the SJNPGK Inter College, along with their teachers and management representatives. Prof. (Dr.) Vishal Nath, Director, ICAR-NRCL, Muazffarpur, welcomed and told the students about the spirit behind celebrating Agricultural Education Day. He emphasized the importance of research, education and extension in various spheres of agricultural sciences and motivated the students to put their best efforts in shaping their career in the field of agriculture. Dr.KuldeepSrivastava, Senior Scientists, ICAR-NRCL appraised students about the importance of agriculture, organizational set up of ICAR and its role inresearch, education and development activities. Different institutes involved under ICAR in various subject areas were also highlighted to students. He stressed on the role of education in the development of the society and the role of KVKs in the demonstration of the new technology. Dr. ES Marboh highlighted about the mode of entrance and the pattern of preparation for ICAR exams, different scholarships and career opportunities in fields of agriculture. Dr. AK Gupta, Scientist emphasized on the mode of preparation at intermediate and UG levels for higher studies. He also conducted practical demonstration on propagation, insect management, and preparation of solution etc., to 80 students with 20 students per batch. Shri DK Shahi, Manager of School expressed happiness about the active role of the ICAR-NRCL for providing knowledge of current agriculture education system in the country through Agricultural Education Day and expressed his satisfaction for the keen interests of the council to shape the future of rural students particularly in the remote areas like Kusshinagar during the day long celebration of event at this school. Other activities like inspirational talks, career counseling and a quiz competition were organized. The program was followed by prizes and certificates distribution to

the successful students. In the closing function, Shri RN Gupta, Principle thanked the ICAR-NRCL for organizing such informative and inspirational event.

ICAR-NRCL participated in the East Zone ICAR Sports Meet 2016

A 9-member contingent, led by Chief-de-Mission Dr. S.D. Pandey and Team Manager Sh. AbhishekYadav, represented ICAR-NRCL at the ICAR Sports Tournament for Eastern Zone being held at ICAR-NRRI, Cuttack, Odisha from 6-9 March 2017.The team participated in various sports events, where Dr. Gopal Kumar obtained Gold medal and Bronze medal for Discus Throw and Shot put, respectively, while Dr. E. S. Marboh achieved bronze medal in 400 m race.

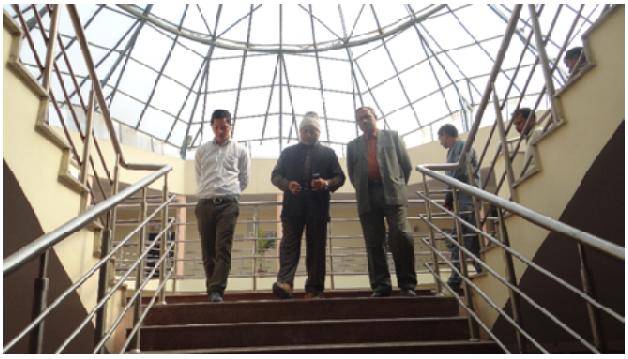
Participants of ICAR-NRCL in the East Zone ICAR Sports Meet 2016

Various meeting conducted at the centre

Sl. No.	Date of Visit	Name	Designation/affiliation
1.	5th April 2016	Interaction meeting with Reliance Polymer, M/s. Hari Om Polymers, Farmers and Scientists	7 persons participated
2.	13th April 2017	Pre-IRC meeting	All scientists
3.	22-23rd April 2016	14th Institute Research Council Meeting	All scientists
4.	24th May 2016	10th RAC meeting	Members
5.	7th June 2016	EFC Equipment Prioritization meeting	All officers
6.	21st June 2016	First Annual Surveillance Audit for ISO 9001:2008	
7.	3rd August 2016	Library advisory committee meeting	Members
8.	5th March 2017	ITMU meeting	
9.	6-7 December 2016	15th IRC meeting	All scientists

Distinguished Visitors

Dr. T. Janakiram, ADG (HS), ICAR, New Delhi, at the centre on 18th December 2016




Dr. P.S. Pandey, ADG (Education), ICAR, New Delhi, at the centre on 18th December 2016


Dr. Regina Cronje, ARC-ITSC, Nelspruit, South Africa visited the centre on 5th June 2016


Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasargod,at the centre on 13th January 2017


Dr. H. P. Singh, Former DDG (Hort), ICAR, visited the centre on 5th March 2017

Sh. D.K. Singh, IAS, Chairman, APEDA, visited the centre on 16th March 2017

The centre was also host to the following distinguished visitors during 2016-17.

Sl. No.	Date of Visit	Name	Designation/affiliation
1.	1st April 2016	Dr. S. Gautam	Head, Food Technology, BARC, Mumbai
2.	13th May 2016	Sh. S. Bilgrami	Comptroller, ICAR-IARI
3.	5th June, 2016	Edward Grantham, Nick Grantham	Iniwe Farm, Felixton, South Africa
4.	22nd July 2016	Sh. Dharmendra Singh, IAS	District Magistrate, Muzaffarpur
5.	22nd July 2016	Smt. Bebi Kumari	Hon'ble MLA, Bihar VidhanSabha
6.	2nd September 2016	Dr.Birpal Singh	Ex-Director, CPRI, Shimla
7.	28th September 2016	Sh. Sumedh Nagrare, ISS	Director, N.S.S.O. (FOD), Western Zone, Nagpur
8.	16th March 2017	Sh. D.K. Singh, IAS	Chairman, APEDA, New Delhi

Transfer of Technology

Dissemination of technologies was done through organizing training programmes and *Kisan Gosthi*, delivering lectures, showcasing NRCL technologies, and interaction with stakeholders. The details of formal training and other programmes pertaining to transfer of technology and human resource development activities are summarized below.

Outreach and extension activities

Programme	Venue and date	No. of beneficiaries
Field day cum Kisan Gosthi on girdling techniques for regular bearing in China litchi	Katarmala, Garoul, Vaishali, 30th April, 2016.	60
Training Programme on Bagging of litchi fruits	Katarmala, Garoul, Vaishali, 30th April - 2nd May 2016	45
16th Foundation Day	ICAR-NRCL, Muzaffarpur 24th May 2016	150
Awareness programme on litchi preservation with collaboration of BARC, Mumbai	ICAR-NRCL, Muzaffarpur, 25-26th May, 2016	35
Agri fair	ICAR RCER, Patna, 28-30th May 2016	93
Kisan Vikas Parv evam Sangosthi	Seva Samiti Banvari Lal Inter College, Deoria, UP, 11th June 2016	125
Kisan Gosthi	Kushinagar, UP, 12th June 2016	132
Kisan Gosthi in Inter State Horti Fair "Sangam 2016 organised by NHB, Gurgaon	Indoor Stadium, Hajipur, Bihar, 9-10th July, 2016	500
Demonstration of rejuvenation technology	Paharpur, Kanti, Muzaffarpur, (12 and 24 August 2016; 9th and 12th September, 2016)	15
GAPs in Litchi	Sigha, Kushinagar, UP, 14th August 2016	70
Front line demonstration on establishment of new litchi orchard	Khutahi, Ramkola, Kushinagar, UP, (13th August. 2016 and 10-11 September, 2016)	95
Farmer-Scientist interaction meet	Kankatti, Mehsi, E. Champaran, 28th September 2016	35
Training on GAP in Litchi	Khotahi, Ramkola, Kushinagar on 13th December 2016	52
बेहतर लीची बाग प्रबंधन एवं प्रोडूसर कंपनी आमुखीकरण प्रशिक्षण	Tengrari gaon, and Pakri Gaon, Muzaffarpur, 2nd - 3rd February 2017	85
Awareness programme on Organic Farming	Kankati (Kothia Hariram), East Champaran 17th February 2017	20
Kisan Gosthi	Bakhari Nazir and Damodarpur, Motihari, 21st February, 2016	
Management during fruit development stage for quality litchi production of litchi	Katarmala, Garaul, Vaishali on 6th and 24th March 2017	50
Agro. Fair (Bihar Divas-2017)	Gandhi Maidan, Patna, 22-24th March, 2017	25
शून्य बजट प्राकृतिक खेती विषय पर प्रशिक्षण एवं विधि प्रदर्शन	Kankatti (Kothiya Hariram), Motihari on 10th and 29th March 2017	73
Oisan Gosthi	Ujhilpur, Motihari, 26th March, 2016	
Role of pollinators in quality litchi production	Motihari, 26th March, 2016	

In addition to these, the scientists of the centre were involved in transfer of improved agricultural technology under the Farmers FIRST Programme, which are listed below:

1. Provided "Improved varieties of wheat" to 930 farmers in eight villages of Mehsi and Chakia, East Champaran, Bihar.
2. Technology for cultivation of summer mung - "Seed of improved varieties" to 715 farmers in eight villages of Mehsi and Chakia, East Champaran, Bihar
3. Technology for "Winter stress care in Milch animal" to 400 farm families in eight villages of Mehsi and Chakia, East Champaran, Bihar
4. Participatory experimentation for improving nutritional security and farm income through backyard poultry among 100 women beneficiaries eight villages of Mehsi and Chakia, East Champaran, Bihar
5. Technology for cultivation of Oyster mushroom and Rajendra Dudhia along with technology kit

and input to 100 women participants eight villages of Mehsi and Chakia, East Champaran, Bihar

6. Improved techniques for establishment of new litchi orchard - 200 farmers from Ujhilpur, Damodarpur, Khairva and Ramgarhava village, East Champaran, Bihar.

7. Improved production technology in vegetable cultivation - 750 farmers of eight villages of Mehsi and Chakia, East Champaran, Bihar

8. Enhancing income though pickle making: 60 women participants (Ujhilpur-30 and Chintamanpur Malahitola-30), East Champaran, Bihar.

9. Technology of soil health-based nutrient management in Litchi was transferred to litchi growers and soil health cards (50 Nos.) were prepared and distributed to the farmers from Khairva and Ramgarahava village of East Chmparan, Bihar.

- Delivered lecture on topic "Emerging Horticultural Technologies to Enhance and Sustain Farmer's Income" *In:* National Conference on Farmers' Centric Agri-innovation for Sustainable Development on 24-25th March, 2017
- Delivered lecture on topic "Financing opportunities in Litchi Value Chain" *In:* Focused Programme on Financing Agriculture in Bihar, for officers of various banks at Reserve Bank of India, Patna on 17.02.2017.
- Delivered lecture on topic "Recent development in litchi production-An overview" *In:* Model "Training Course on Good Agricultural Practices in Litchi" on 21.11.2016.
- Delivered lecture on topic "Ideal Canopy Architecture and their management in litchi" *In:* Model Training Course on 'Good Agricultural Practices in Litchi' on 24.11.2016.

Trainings organised at NRCL, Muzaffarpur

Name of Training/Workshop/Seminar	Date of programme	No. of participants
Bagging of litchi fruits	5th April, 2016	12
Capacity Building programme on Cold Treated Litchi export to USA	19-21st May, 2016	39
Awareness Programme on Litchi preservation	25-26th May, 2016	40
Exposure visit of farmers from Mayurbhanj, Odisha	27th May, 2016	24
Summer Training on Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic condition	11-31st July, 2016	19
Short Course on Bioassay, Production protocol and quality control for trichoderma based biopesticides	5-14th Sept., 2016	19
Model Training Courses on Good Agricultural Practices in Litchi	21-28th Nov., 2016	15
Interaction meet of BARC, Mumbai and NRCL Scientists with Litchi growers/ traders on "Litchi Preservation technology"	20th December 2016	34
Exposure Visit of Farmers from Deogarh, Odisha	10th January, 2017	10
Exposure Visit of Farmers from Khutahi, Ramkola, Kushinagar, U.P.	24th January, 2017	06
Farmers/traders/processors/entrepreneurs-Scientist interaction meeting along with BARC scientist, officials & APEDA officers on preservation of fresh litchi fruits	28th March, 2017	60

Lectures delivered as resource person/ participation in programme outside the organization in individual capacity

Dr. Vishal Nath

- Delivered lecture on topic "Tree Framing: a necessity in newly planted orchards" during Training progamme on Canopy Management and flower regulation in mango on 17.03.2017.
- Delivered lecture on topic "Rejuvenation of old senile litchi orchard" *In:* Model Training Course on Good Agricultural Practices in Litchi" on 25.11.2016.
- Delivered lecture on topic "Improved characteristics in litchi cultivars for yield and quality" *In:* Model Training Course on 'Good Agricultural Practices in Litchi' on 27.11.2016.

- Delivered lecture on "Packaging of Litchi for better storability" *In:* International Congress on "Post-Harvest Technologies of Agricultural Produce for Sustainable food and Nutritional Security" on 10-12th November, 2016.
- Delivered lecture on "Addressing the problems of unproductive mango orchard through rejuvenation and top working" *In:* State Level Seminar on Plant Architecture and Flower regulation in Mango on 18.03.2017.
- Delivered lecture on "Under-Utilized Fruit Production Technology" *In:* Annual Zonal Workshop of Krishi Vigyan Kendras of Uttar Pradesh and Uttarakhand on 27th June, 2016.
- Delivered lecture on "Scenario of litchi Research and Development in India" *In:* ICAR-Summer School on Canopy Architecture Management in Fruit Trees for conservation and utilization of Natural Resources in changing climate condition" on 11.07.2016.
- Delivered lecture on "Canopy Architecture Designing for different density planting" *In:* ICAR-Summer School on Canopy Architecture Management in Fruit Trees for conservation and utilization of Natural Resources in changing climate condition" on 16.07.2016.
- Delivered lecture on "Canopy Architecture Management for Doubling India's fruit production" *In:* 7th Indian Horticulture Congress-2016" on 15.09.2016.
- Delivered lecture on "Status, challenges and opportunities of litchi production in India" *In:* V International Symposium on Lychee, Longans other Sapindaceae Fruits on 01.06.2016.
- Delivered lecture on "Canopy Management in Litchi" *In:* V International Symposium on Lychee, Longans other Sapindaceae Fruits on 02.06.2016.

Dr. S. D. Pandey

- Delivered lecture on "Canopy development under high density planting" *In:* Summer School on "Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions" (11-31 July), ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "Nutrient management in litchi" *In:* Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions" (11-31 July), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th July, 2016
- Delivered lecture on "Organic cultivation of crops: Reality, myth and way forward" *In:* Short Course on Bioassay, production protocol and quality control for Trichoderma based bio pesticide (5-14 September, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "Nutrient management in litchi for quality production' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016 (21-28 November, 2016)
- Delivered a talk on GAP in litchi (bearing regulation and IPM) at Pathankot, Punjab organized by PAU, Ludhiana on 18th November, 2016
- Provided training Hands on canopy management of litchi at Chettali organized by ICAR-IIHR, CHES- Chettali, Karnataka on 4th January, 2017).

Dr. S.K. Purbey

- Delivered lecture on" Role of Horizontal canopy management in quality fruit production" *In:* Summer Training on Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic condition during 11-31 July, 2016, ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "Popularization of bio-pesticides: Challenges and way forward." *In:* Short course training on on Bioassay, Production protocol and quality control for trichoderma based biopesticides, (4-15 Sept., 2016), ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "Impact of Vermicopost and Bio-fertilizer on growth and yield of litchi". *In:*

21 days training programme on Recent advancement in Bio-fertilizer and Vermicomposting Technology for sustain agricultural development (12 Dec. to 1st Jan, 2017), DRPCAU, Pusa, Samastipur.

Dr. Amrendra Kumar

- Delivered lecture on "Role of Canopy Management to Improve Farm Operations" *In:* Summer School on "Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions" (11-31 July), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th July, 2016
- Delivered lecture on "Physical Alteration to Manage the Canopy of Fruit Plants" *In:* Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions" (11-31 July) ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th July, 2016
- Delivered lecture on "Efficient utilization of interspaces in litchi orchard to enhance income' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016
- Delivered lecture on "Orchard plantation, care and maintenance of young orchard for gap in litchi' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016
- Delivered lecture on "Nursery management in litchi' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016
- Delivered a talk on GAP in litchi (bearing regulation and IPM) at Pathankot, Punjab organized by PAU, Ludhiana on 18th November, 2016

Dr. Kuldeep Srivastava

- Delivered a lecture on "canopy management a way forward to reduce the pest infestation in fruits" *In:* Summer School on Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions, ICAR-NRCL, Muzaffarpur on 29th July, 2016.
- Delivered a lecture on "major insect-pests of litchi and their eco-friendly management" *In:* MTC on Good Agricultural Practices in litchi at ICAR-NRCL, Muzaffarpur on 26th November, 2016.
- Delivered a lecture on "Integrated management of litchi fruit borer" in Field Day-cum-Kisan Gosthi at KVK Saraiya, Muzaffrpur on 12th May, 2017.
- Delivered a lecture on "Insect-pest management in horticultural crops" in Kasan Vikash Parva aur Sangosthi at Deoria, UP on 11 June, 2016.
- Delivered a lecture on "IPM in fruit crops" in FLD programme at Kushinagar, UP on 13-14th August, 2016.
- Delivered a lecture on "Insect-pest management in horticultural and cereal crops" in Kisan Gosthi at Bakhari Nazir and Damodarpur, Motihari on 21 February, 2016 under FFP.
- Delivered a lecture on "Insect-pest management in horticultural and cereal crops" in Kisan Gosthi at Ujhilpur, Motihari on 26 March, 2016 under FFP.
- Delivered a lecture on "Pollination in litchi" in one day training programme on Role of pollinators in quality litchi production at Ujhilpur, Motihari on 26 March, 2016.

Dr. R. K. Patel

- Delivered lecture on "Role of bio fertilizers for improving the plant growth and performance with appropriate canopy management" *In:* Summer School on "Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions" (11-31 July),ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th July, 2016.
- Delivered lecture on "Organic cultivation of crops: Reality, myth and way forward" *In:* short course on Bioassay, production protocol and quality control for *Trichoderma* based bio pesticide (5-14 September, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar.

- Delivered lecture on "Litchi based integrated farming system for different topography and condition' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016.
- Delivered a lecture on "Cultivation of summer vegetables" in Kisan Gosthi at Bakhari Nazir and Damodarpur, Motihari on 21st February, 2016.

Dr. Vinod Kumar

- Delivered lecture on 'Utilization of biosphere microorganism for effective fruit production' *In:* ICAR Summer School on "Canopy management in Fruit trees for conservation and utilization of natural resources in changing climatic conditions' (11-31st July, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "*Trichoderma*: Biology, taxonomy and importance"; 'Identification of species of *Trichoderma';* Isolation and bioassay of *Trichoderma* for antagonistic potential against plant pathogens'; 'Evaluation of isolates of *Trichoderma* spp. for antagonistic fitness' and Delivery system and compatibility of *Trichoderma* for disease management *In:* short course on Bioassay, production protocol and quality control for *Trichoderma* based bio pesticide (5-14 September, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar
- Delivered lecture on "Efficacy and role of mycorrhiza for quality litchi production; Important diseases of litchi, symptoms extent of damage and their management including management by organic sources' *In:* Model training course on Good Agricultural Practices in litchi (21-28 November), ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th November, 2016.

Dr. Gopal Kumar

- Delivered lecture on "*Microbes in soil health" In: Short Course* on "Bioassay, Production Protocol and Quality Control for Trichoderma Based Biopesticides" (5th to 14th September, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "*Climate Change and sustainable horticulture production" In: Short Course,* ICAR-IARI Regional Station Pusa, Bihar on 31st March 2017.
- Delivered lecture on "Improving Climatic Resilience through Canopy Management in fruit trees" *In:* Summer School on Canopy architecture management in fruit trees for conservation and utilization of natural resources in changing climatic conditions, (11-31 July, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar
- Delivered lecture on '*Soil health management for quality Litchi Production' In:* Model Training Course *on Good Agricultural Practices in Litchi* (21-28 November, 2016), ICAR-NRC on Litchi, Muzaffarpur, Bihar

Dr. Sanjay Kumar Singh

- Delivered a talk on '*Improving Source-Sink relationship with tree canopy design'* during ICAR sponsored Summer School on *"Canopy Architecture Management in Fruit Trees for conservation and Utilization of Natural Resources in Changing Climatic Conditions"* at ICAR-NRCL, Muzaffarpurduring 11-31st July, 2016
- Delivered a talk on '*Current Scenario and Future Prospects of Biopesticides in India*' during ICAR sponsored Short Course on "Bioassay, Production Protocol and Quality Control for *Trichoderma*Based Biopesticides" at ICAR-NRCL, Muzaffarpur during 05-14 September, 2016.
- Deliver a talk on '*Application of micronutrient, reducing fruit drop and cracking in litchi'* under one day training programme on GAPs in litchi at Pathankot, Punjab on 18th, November, 2016
- Delivered a lecture on "*Plant Growth Regulators and chemicals for flowering and quality litchi production*' *In:* 'Model Training Courses on Good Agricultural Practices in litchi' held from 23rd- 30th November, 2015 at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, sponsored by Ministry of Agriculture and Farmer's Welfare, Govt. of India.
- Deliver a talk on a) *Integrated pest and Diseases Managment on mango and litchi, and b) how to cope with alternate bearing tendency of mango* to the farmers of mango and litchi of Siwan District at KrishiVigyan

Kendra, Bhagwanpur Hat, Siwan on 6th March, 2017

Sh. Prabhat Kumar

- Delivered talk and conducted practical session on topic "Leaf and soil sampling technique for nutrient analysis and production of organic inputs" *In:* 'Model Training Courses on Good Agricultural Practices in litchi' held from 23rd- 30th November, 2015 at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, sponsored by Ministry of Agriculture and Farmer's Welfare, Govt. of India.

Sh. Alok Kumar Gupta

- Delivered a lecture on 'Germplasm Management' *In:* 'Model Training Courses on Good Agricultural Practices in litchi' held from 23rd- 30th November, 2015 at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, sponsored by Ministry of Agriculture and Farmer's Welfare, Govt. of India.

Dr. Alemwati Pongener

- Delivered a lecture on "Physiological disorders in litchi and their effective management" *In:* 'Model Training Courses on Good Agricultural Practices in litchi' held from 23rd- 30th November, 2015 at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, sponsored by Ministry of Agriculture and Farmer's Welfare, Govt. of India.

Dr. E. S. Marboh

- Delivered a lecture on "Water management for improved litchi production" *In:* 'Model Training Courses

Research Programmes and Projects

Institutional Projects

Sl. No.	Programmes / Projects	PI	Co-PI (s)
1	***Conservation, characterization, and utilization of genetic diversity for improvement of litchi***		
1.1	Collection of indigeneous and exotic germplasm, their characterization, evaluation, documentation and utilization	Dr. Vishal Nath	Prof. Vishal Nath Dr. Amrendra Kumar Sh. A. K. Gupta Dr. Evening Stone Marboh
1.2	Developing improved cultivars in litchi	Dr. Vishal Nath	Dr. Vishal Nath Sh. A. K. Gupta
2	***Development and refinement of integrated production technologies for improved productivity of litchi***		
2.1.	Plant propagation and nursery management in litchi	Dr. Vishal Nath	Dr. S.D. Pandey Dr. Amrendra Kumar Dr. Vinod Kumar Dr. R.K. Patel
2.2.	Development and sustainable production techniques in litchi	Dr. S.D. Pandey	Dr. Amrendra Kumar Dr. R.K. Patel Dr. Kuldeep Srivastava
2.3.	Investigation and establishing the physiological and biochemical relations for improved litchi production	Dr. Amrendra Kumar	Dr. S.D. Pandey Dr. S.K. Purbey Dr. Sanjay Kumar Singh Dr. R.K. Patel Dr. Evening Stone Marboh Dr. Swati Sharma
2.4.	Studies on mycorrhizal association and role of bio-fertilizers for improved litchi production	Dr. Vinod Kumar	-
2.5.	Litchi-based cropping system for low-lying areas	Dr. R.K Patel	Dr. S.D. Pandey Dr. S.K. Purbey Dr. Amrendra Kumar Dr. Kuldeep Srivastava
2.6.	Nutrient deficiency symptoms in litchi	Dr. Amrendra Kumar	Dr. S.D. Pandey Dr. R.K. Patel Dr. I.S. Singh
2.7.	Identifying potential litchi growing areas	Dr. Gopal Kumar	
2.8	Integrated Soil health management for quality litchi production	Dr. Gopal Kumar	Dr. Amrendra Kumar Dr. Vinod Kumar Dr. S.D. Pandey
3	***Development and refinement of integrated crop protection technologies for improved productivity of litchi***		
3.1.	Investigation and management of pre-harvest diseases of litchi	Dr. Vinod Kumar	-
3.2.	Investigation and management of insect-pests complex in litchi	Dr. Kuldeep Srivastava	Dr. R.K. Patel
4	***Integrated postharvest management to reduce losses, improve marketing and product diversification***		
4.1.	Standardization of maturity standards, harvesting and postharvest handling techniques for litchi	Dr. S.K. Purbey	Dr. Sanjay Kumar Singh Dr. Vinod Kumar Dr. Alemwati Pongener
4.2.	Investigation and management of postharvest losses in litchi	Dr. S.K. Purbey	Dr. Vinod Kumar Dr. Alemwati Pongener
4.3.	Standardization of processing and value-addition techniques in litchi	Dr. S.K. Purbey	Dr. Vinod Kumar Dr. Alemwati Pongener
4.4.	Influence of polyamines on phenol-physiological attributes and fruit quality of litchi	Dr. Swati Sharma	Dr. Alemwati Pongener Dr. Sanjay Kumar Singh
4.5	Estimation and quantification of methylenecyclopropylglycine content in fruits of Litchi (*Litchi chinensis*) genotypes	Dr. Swati Sharma	Dr. Sanjay Kumar Singh Dr. S.D. Pandey Dr. Alemwati Pongener Dr. Kaushik Bannerjee Dr. Ahammed Shabeer T.P.
5	***Improving knowledge and skill of stakeholders for increasing production of litchi***		
5.1.	Strategic research in Tribal Sub Areas	Dr. S.D. Pandey	Dr. Amrendra Kumar
5.2.	Strategic research on North-Eastern Hill region	Dr. S.K. Purbey	Dr. R.K. Patel Dr. Vinod Kumar Dr. Alemwati Pongener
6	***Flagship projects***		
6.1.	Postharvest management with respect to pericarp browning and fruit decay	Dr. S.K. Purbey	Dr. Vinod Kumar Dr. Alemwati Pongener Dr. Swati Sharma Dr. Evening Stone Marboh
6.2.	Shoot physiology in relation to flowering and fruiting in litchi	Dr. Sanjay Kumar Singh	Dr. Amrendra Kumar Dr. Swati Sharma Dr. Evening Stone Marboh

Externally funded projects

Sl. No.	Title	Funding agency	PI & Co-PI
1.	Improved livelihood through good practices in agricultural production system (Farmers FIRST programme)	ICAR, New Delhi	Dr. Gopal Kumar (PI) Dr. S. D. Pandey (Co-PI) Dr. S. K. Purbey (Co-PI) Dr. Vinod Kumar (Co-PI) Dr. Kuldeep Srivastava (Co-PI) Dr. Sanjay Kumar Singh (Co-PI) **Associated Scientist for the Project** Dr. Amrendra Kumar Dr. R. K. Patel Dr. Prabhat Kumar Dr. Alemwati Pongener Dr. Swati Sharma, Sh. Alok K Gupta, Dr. Evening Stone Marboh
2.	Development of National Database on Mango	DBT, New Delhi	Dr. Vishal Nath Dr. Sanjay Kumar Singh Dr. Kuldeep Srivastava Sh. Alok K Gupta
3.	Studies on the feasibility of intercropping under partial shade of litchi	ATMA, Muzaffarpur	Dr. Amrendra Kumar Dr. S.D. Pandey Dr. R.K. Patel
4.	Consortia research platform (CRP) on borers	ICAR, New Delhi	Dr. Kuldeep Srivastava Dr. R.K. Patel
5.	ICAR Seed Project – Seed Production in Agricultural Crops and Fisheries (RFS)	ICAR, New Delhi	Dr. Amrendra Kumar
6.	Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology scheme	ICAR, New Delhi	Dr. Vishal Nath Dr. S.K. Purbey (Nodal officer)
7.	Livelihood and Nutritional Improvement of tribal farm women through horticulture	ICAR, New Delhi	Dr. R. K. Patel Dr. Alemwati Pongener

List of Publications

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Peer recognition

Prof. Vishal Nath

- Appointed as external examiner to evaluate the Ph.D. thesis and conduct viva-voce of student of BAU, Kanke, Ranchi.
- Chaired a technical session on "Crop Improvement' and delivered a plenary lecture during *National Conference on Farmers' Centric Agri-Innovation for Sustainable Development* at C.S.A University, Agri. & Technology, Kanpur during 24-25th March, 2017.
- Co-Chaired the Session on "HDP and Canopy Management" during 7th Indian Horticulture Congress-2016 at Dr. B.P. Pal Auditorium, IARI, New Delhi on 16th November, 2016.
- Co-Chaired the interactive Poster Session on "Post-Harvest Technologies of Agricultural Produce for Sustainable food and Nutritional Security" on International Congress during 10-12th November, 2016 at Integral University, Lucknow.

Dr. S.K. Purbey

- Act as Chief Editor of *Litchima* Rajbhasha Patrika published by ICAR-NRC on Litchi, Muzaffarpur.
- Act as member Editorial Board of *Muz Darpan,* Rajbhasha Patrika published by NRAKAS, Muzaffarpur, Bihar.
- Nominated as Jury Member of evaluation committee for Science projects during 24thState Level Children's Science Congress - 2016 held at Gopalganj, Bihar during 22-24th Octr., 2016.
- Acted as Co-chair and lead presenter (Session – 6: Postharvest biology and technology, processing, marketing and export) *In*: Vth International Symposium on "Lychee, Longan and Other Sapindaceae Fruits" at BAU, Sabour, Bihar during 31st May to 3rd June, 2016.
- Appointed as Centre Supervisor to ensure smooth and fair conduct of "Common Written Examination for the Post of Technician (T-1) at ICAR Institute – 2016" held on 04.09.2017 at RPS college , Patna.
- Appointed as member of JPIC for Setting up and operation of DAE, BARC, Mumbai, Litchi Technology Demonstration cum Treatment facility at ICAR-NRC on Litchi.
- Acted as external examiner for evaluation of UG (final year) copy of DRPCAU, Pusa, Samastipur.

Dr. Amrendra Kumar

- Nominated as external examiner for evaluation of thesis of M. Sc. Ag. (Hort.), BAU, Sabour, Bhagalpur.

Dr. Kuldeep Srivastava

- Nominated as Editor (Plant Protection) in editorial board (2017) of *HortFlora Research Spectrum* Journal published by Biosciences and Agriculture Advancement Society, Meerut, Uttar Pradesh.
- Act as a convener of technical session-08 on "Perspective of future challenges and options in plant health management" d*uring* Global Conference on perspective of future challenges and options in agriculture (28-31 May, 2016) at Jalgaon, MS, India.
- Reviewed one article (MS-61469) of Journal of Agricultural Science, Toronto, Canada.

Dr. R.K. Patel

- Nominated as Editor of *Hortflora Research Spectrum* journal published by Biosciences and Agriculture Advancement Society, Meerut, U.P.
- Reviewed research article of Journal of Food Science and Technology (JFST-D-16-01632)
- Reviewed research article of Indian Journal of Agricultural Sciences.

Dr. Vinod Kumar

- Editor of "Pharmaceuticaland Biomedical Sciences: An International Journal (PBIJ)"
- Editor of "Journal of Crop Research and Fertilizers- an Open Access peer reviewed journal"
- Reviewer of seven National and international journals - *The Coleopterists Bulletin, Journal of Crop Research and Fertilizers, Crop Protection, Mycosphere, Pest Management in Horticultural Ecosystem, International Journal of Agriculture Science, Journal of Environmental Biology, Indian Phytopathology*
- Acted as judge for exhibits on fruits and vegetables during 'Kisan Mela and Horticultural Show-2016' at RAU, Pusa, Bihar

Dr. Gopal Kumar

- Reviewer of Indian Journal of soil conservation, Journals of Agro meteorology, Agronomy Journal, Paddy and Water Environment and International Journal of Agricultural Research.

Dr. Sanjay Kumar Singh

- Nominated as Judge, Evaluation Committee for Exhibitions on Horticulture at KisanMela, 2016 at DRPCAU, Pusa, Samastipur during 3-5th December, 2016.
- Acted as external examiner of UG courses of Dr. RPCAU, Pusa, Samastipur

Dr. Alemwati Pongener

- Acted as external examiner of courses AHT-301 and AHT 201 for under-graduate students of Dr. RPCAU, Pusa, Samastipur.

Dr. Swati Sharma

- External examiner of M.Sc. Thesis entitled, "Microencapsulation of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) juice powder by spray drying" of ID No. UHS14PGM442, M.Sc. (Hort.) in Post Harvest Technology, UHS, Bagalkot, Karnataka.
- Evaluation of foliage exhibits displayed in Horticulture show during 3-5th December, 2016 at Dr. Rajendra Prasad Central Agricultural University, Pusa campus, Samastipur, Bihar.
- External examiner for course AHT-401 of Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur

Dr. Evening Stone Marboh

- Reviewed an article (Manuscript No. - IJAS-141216-86021-55435) for *International Journal of Agricultural Science.*

Awards and Honours

Awards and honours conferred to the centre

Dr. Vishal Nath

- Elected as Chairman Working Group on Litchi, Longan and other sapindaceae fruits. ISHS, Belgium.
- Elected as Chairman CHAI, Pusa Chapter Bihar.
- Nominated as reviewer Society for Science and Nature, Lucknow.
- Nominated as member, Editorial Board for *Indian Horticulture* by Secretary, DARE and DG, ICAR, New Delhi vide.
- Appointed as convener (Advisory Committee) for conduct of National Conference on Perspective of Challenges and Options in Maize Production and Utilization at Dr. RPCAU, Pusa, Samastipur, Bihar (3rd -4th March, 2017).

Dr. S. K. Purbey

- Received best oral presentation award for the paper entitled "Advance practices and treatments to minimize the postharvest losses in litchi". *In:* National Conference on Innovative Food Processing Technologies for food and nutritional security at CIPHET, Ludhiana (29-30th September, 2016).

Dr. Vinod Kumar

- Awarded "Outstanding Scientist Award" during 3rd International Conference on Agriculture, Horticulture, and Plant Sciences, held at New Delhi from 25-26 June 2016.
- Approved for award of Fellow of Indian Phytopathological Society (FPSI).
- Best paper award in oral category during *3rd International Conference on Agriculture, Horticulture & Plant Sciences"* held at New Delhi, India, 25-26 June 2016, for research paper entitled "Effect of some fructoplane antagonists and postharvest dip treatments on litchi fruit rots and shelf life".

Dr. Gopal Kumar

- Awarded Gold medal in Discus throw and Bronze medal in Shotput throw in East Zone ICAR sports meet held at CRRI, Cuttack.

Dr. Sanjay Kumar Singh

- Awarded Best poster paper award for his paper entitled, "Flushing Pattern and Physiology of Flowering in Litchi' during 7th Indian Horticulture Congress held at ICAR-IARI, New Delhi. (15-18th November 2016).

Compilation, Editing, and Documentation

Sl. No.	Title	No. of pages	Year of publication	Scientists involved
1.	NRCL Annual Report, 2015-16 (English)	85	2016	Dr. R.K. Patel Dr. Sanjay Kumar Singh Dr. Alemwati Pongener
2.	ICAR-NRCL Annual Report, 2015-16 (Hindi)	86	2016	Dr. R. K.Patel Dr. Sanjay Kumar Singh Dr.Alemwati Pongener
3.	NRCL Newsletter Volume 2 Issue 1 & 2	12	2016-2017	Dr. R. K. Patel Dr. Sanjay Kumar Singh Dr. Alemwati Pongener
4.	NRCL Wall and Desk Calendar	12	2017	Dr. R.K. Patel Dr. Sanjay Kumar Singh Dr. Alemwati Pongener
5.	NRCL Year Planner 2016-17	4	2016-17	Dr. Alemwati Pongener Dr. R.K. Patel Dr. Sanjay Kumar Singh
6.	ICAR-AICRP (Fruits) on Litchi Annual Report 2015-16	-	2016-17	Dr. Evening Stone Marboh
7.	PERMISNET – II, PIMS-ICAR, HYPM, PMS, Monthly Cabinet Report, Uploading of AIPR	-	2016-2017	Dr. Sanjay Kumar Singh
8.	EFC/SFC-2017-2020		2017	Dr. Vishal Nath Dr. S.D. Pandey Dr. Sanjay Kumar Singh Sh. Abhisek Yadav
9.	RFD: Annual Draft, Monthly Report, Midterm Achievements, Annual Performance Evaluation; Citizen/Client Charter	-	2016-2017	Dr.Vinod Kumar Dr. Sanjay Kuamr Singh
10.	News and updates for NRCL Website and *ICAR NEWS*	-	2016-2017	Dr.Vinod Kumar
11.	10th RAC Proceedings, Recommendations of 9th RAC, Action Taken Report	-	2016-17	Dr. S.K. Purbey
12.	14th and 15th IRC Proceedings, and Action Taken Report		2016-17	Dr.Alemwati Pongener

Personnel

A. Scientific

Name and Email	Designation	Area of Interest
Prof. (Dr.) Vishal Nath nrclitchi@yahoo.co.in	Director	Plant genetic resource management; Canopy architecture management; Dissemination of technology
Dr. S. D. Pandey pandeynrcb@yahoo.com	Pr. Scientist (Hort.)	High density planting; Canopy management; Nutrient management; Fertigation, Organic litchi production.
Dr.Sushil Kumar Purbey skpurbey_nrcl@yahoo.com	Pr. Scientist (Hort.)	Postharvest handling and packaging; Enhancement of shelf life of litchi; Value addition and processing; Utilization of litchi fruit waste through bio-processing
Dr.Amrendra Kumar amrendra_nrcl@yahoo.com	Pr. Scientist (Hort.)	Nursery management;Plant propagation and growth physiology of vegetatively propagated plants; Collection and characterization of rambutangermplasm
Dr. Kuldeep Srivastava kuldeep.ipm@gmail.com	Sr. Scientist (Entomology)	Management of insect pests of litchi; Insect pollinators of litchi.
Dr. R.K. Patel rkpatelicar@gmail.com	Sr. Scientist (Hort.)	Development of organic package of practices for litchi; Litchi-based cropping system for low-lying areas
Dr.Vinod Kumar vinod3kiari@yahoo.co.in	Sr. Scientist (Plant Pathology)	Management of pre- and postharvest diseases of litchi; Mycorrhizal association; Biocontrol and bio-fertilizers for sustainable production of litchi
Dr.Gopal Kumar gkcswcrti@gmail.com	Senior Scientist (Soil Science)	Climate Change, Exploring newer areas of litchi
Dr. Sanjay Kumar Singh sanjayhor@rediffmail.com	Scientist SS (Hort.)	Shoot physiology and biochemistry in relation to flowering and fruiting in litchi; Germplasm conservation and development of database on mango and pummelo
Sh. Prabhat Kumar prabhat.ssac@gmail.com	Scientist (Soil Science)	Nutrient diagnosis and management of litchi orchard
Sh. Narayan Lal narayanlal.lal7@gmail.com	Scientist (Hort.) On study leave	Collection and evaluation of litchi germplasm; Clonal selection; Development of hybrids
Dr. Alemwati Pongener alemwati.pongener@icar.gov.in alemwati@gmail.com	Scientist (Hort.)	Postharvest management for loss reduction; Processing and value addition
Sh. Alok Kumar Gupta alokguptabhu@gmail.com	Scientist (Hort.)	Collection and evaluation of litchi germplasm; Clonal selection; Development of hybrids
Dr. Evening Stone Marboh esmarboh@gmail.com	Scientist (Hort.)	Water management and plant physiology
Dr. Swati Sharma swtsharma92@gmail.com	Scientist (Hort.)	Postharvest management, and plant physiology

B. Administrative

Sh. Abhishek Yadav Administrative Officer	Sh. Ramji Giri Assistant Administrative Officer	Sh. Subhankar Dey Assistant Finance & Account Officer
Sh. Akshay Kumar Yadav Assistant	Sh. Avinash Kumar Kashyap Sr. Clerk (UDC)	Sh. Pawan Kumar Jr. Clerk (LDC)
Sh. Sawan Kumar Jr. Clerk (LDC)	Ms. Ekta Jr. Clerk (LDC)	Sh. Ritesh Kumar Jr. Clerk (LDC)
Sh. Ajay Kumar Rajak Skilled Supporting Staff	Sh. Surendra Rai Skilled Supporting Staff	Sh. Dharmendra Kumar Skilled Supporting Staff

C. Technical

Dr. Ramashish Kumar, T-3 (Field/Farm)	Dr. J.P. Verma, T-3 (Field/Farm)

Recruitment, Promotion and Transfer

New entry

1. Sh. Prabhat Kumar, Scientist (Soil Science) joined the centre on 13th May 2016 on transfer from ICAR-CSWCRTI, Dehradun.
2. Ms. Ekta joined as LDC on 18th May 2016 under direct recruitment.
3. Sh. Ritesh Kumar joined as LDC on 25th May 2016 under direct recruitment.

Promotion

1. Dr. Amrendra Kumar, Senior Scientist was promoted to Principal Scientist with effect from 3rd October 2014.
2. Dr. Vinod Kumar, Senior Scientist was promoted from RGP:8000 to next higher RGP: 9000 with effect from 16th April 2015.

Transfer& Deputation

1. Sh. Rajiv Ranjan Rai, ACTO (T-7/8) was relieved from the centre on 31st January 2017 on being transferred to ICAR-IISR, Lucknow.
2. Sh. Dileep Kumar, Assistant, was relieved from the centre on 28th February 2017 to join ICAR-CPRI RS, Patna as AAO on deputation.

Important Committees

Research Advisory Council

During 2016-17, the 10th Research Advisory Committee (RAC) meeting was held on 24.05.2016. Following members of the RAC committee attended.

1.	Dr. S.D. Shikamany	Chairman
2.	Dr. D.S. Khurdiya	Member
3.	Dr. V.V. Ramamurthy	Member
4.	Dr. Jitendra Kumar	Member
5.	Dr. S.K. Mitra	Member
7.	Sh. Ranjan Kumar Sahu	Member
8.	Dr. S.K. Purbey, Principal Scientist, ICAR-NRCL	Member Secretary
10.	Dr. Vishal Nath, Director, ICAR-NRCL, Muzaffarpur, Bihar	Member

Institute Research Council

During the year, 14th and 15th Institute Research Council (IRC) meetings were held on 20-21st April, 2016 and 6-7th December, 2016, respectively. The IRC meetings were held under the chairmanship of Director, ICAR-NRCL. During the meetings, progress report of research projects along with technical programmes was discussed in detail. The new research projects were also discussed and finalized.

14th and 15th IRC meeting in progress

Institute Management Committee

The 11th Institute Management Committee (IMC) meeting was held on 28th November 2016 at the centre. The following members attended the meeting and discussed the agenda items relevant to IMC of the Centre:

The 11th IMC meeting in progress

1.	Prof. Vishal Nath, Director, ICAR-NRCL, Muzaffarpur	Chairman
2.	Dr. W.S. Dhillon, ADG (H.S.), ICAR, New Delhi	Member
3.	Dr. A. K. Mishra, Head (Retd), ICAR-CISH, Lucknow	Member
4.	Dr. V.K. Gupta, Pr. Scientist (Retd), ICAR-IISR, Lucknow	Member
5.	Sh. Ranjan Kumar Sahu, Progressive farmer, Muzaffarpur	Member
6.	Sh. Mukesh Kumar Sharma, Progressive farmer, Muzaffarpur	Member
7.	Dr. S.K. Purbey, Principal Scientist, ICAR-NRCL	Special Invitee
8.	Dr. Amrendra Kumar, Principal Scientist, ICAR-NRCL	Special Invitee
9.	Dr. Alemwati Pongener, Scientist, ICAR-NRCL	Special Invitee
10.	Sh. Ramji Giri, AAO, ICAR-NRCL	Special Invitee
11.	Sh. Subhankar Dey	Special Invitee
12.	Sh. Abhishek Yadav	Member Secretary

Other institutional committees

The composition of other important institutional committees during 2016-17 was as under:

Sl. No.	Name of committee	Members of the committee	
1.	Priority Setting Monitoring and Evaluation Committee (PME cell)	Dr. S.D. Pandey	Chairman
		Dr. Kuldeep Srivastava	Member
		Dr. Vinod Kumar	Member
		Dr. Sanjay Kumar Singh	Member
		Dr. Evening Stone Marboh	Member
		Dr. Alemwati Pongener	Member Secretary
2.	Price Fixation Committee (PFC)	Dr. Vinod Kumar	Chairman
		Dr. Sanjay Kumar Singh	Member
		Sh. Subhankar Dey	Member
		Sh. Ramji Giri	Member
		Sh. Rajiv Ranjan	Member secretary until transfer
		Dr. Ramashish Kumar	Member Secretary
3.	Works and Estate Committee	Dr. S.K. Purbey	Chairman
		Dr. Gopal Kumar	Member
		Sh. Rajiv Ranjan Rai	Member
		Sh. Prabhat Kumar	Member
		Sh. Subhankar Dey	Member
		Sh. Ramji Giri	Member secretary
4.	Farm Management Committee (FMC)	Dr. Amrendra Kumar	Chairman
		Dr. R.K. Patel	Member
		Dr. Kuldeep Srivastava	Member
		Dr. Alok Kumar Gupta	Member
		Dr. Ramashish Kumar	Member
		Sh. Rajiv Ranjan Rai	Member secretary until transfer
		Dr. Ramashish Kumar	Member Secretary
5.	Purchase and Store advisory Committee (PS&AC)	Dr. Kuldeep Srivastava	Chairman
		Dr. Gopal Kumar	Member
		Dr. Swati Sharma	Member
		Sh. Subhankar Dey	Member
		Sh. Abhishek Yadav	Member secretary
6.	Spot Purchase Committee (SPC)	Dr. Gopal Kumar	Chairman
		Dr. Evening Stone Marboh	Member
		Sh. Rajiv Ranjan	Member
		Dr. Swati Sharma	Member
		Sh. Subhankar Dey	Member
		Sh. Ramji Giri	Member secretary
7.	Training and Exhibition Cell	Dr. S.K. Purbey	Incharge
		Dr. Kuldeep Srivastava	Member (Museum)
		Dr. R.K. Patel	Member (I/c. IGNOU)
8.	Central Instrumentation Facility	Dr. Swati Sharma	Incharge
		Dr. Alemwati Pongener	Alternate In-charge
9.	Library Advisory Committee	Dr. Vishal Nath	Chairman
		Dr. S.D. Pandey	Member
		Dr. Kuldeep Srivastava	Member
		Dr. Alok Kumar Gupta	Member
		Dr. E.S. Marboh	Member
		Sh. Abhishek Yadav	Member
		Sh. Subhankar Dey	Member
		Dr. Alemwati Pongener	Member Secretary & Incharge
10.	Security Cell	Sh. Abhishek Yadav	Incharge
11.	Estate and Vehicle Cell	Sh. Ramji Giri	Incharge
12.	Women Cell	Dr. Swati Sharma	Incharge
		Sh. Ramji Giri	
13.	HRD Cell	Dr. Kuldeep Srivastava	Nodal Officer

14.	RFD Cell	Dr. Vinod Kumar	Nodal Officer
		Dr. Sanjay Kumar Singh	Co-Nodal Officer
		Dr. Alemwati Pongener	Member
		Sh. Abhishek Yadav	Member
15.	Guest House, Sports, and extra-curricular activity committee	Dr. S.D. Pandey	Chairman
		Dr. Gopal Kumar	Member
		Dr. Alemwati Pongener	Member
		Sh. Subhankar Dey	Member
		Sh. Sawan Kumar	Member
		Sh. Ramji Giri	Member Secretary
16.	Transfer of Technology Unit	Dr. S.K. Purbey	Chairman
		Dr. Kuldeep Srivastava	Member
		Dr. R.K. Patel	Member
		Dr. Alok Kumar Gupta	Member
17.	Institute Technology Management Unit (ITMU)	Dr. Vishal Nath	Chairman
		Dr. S.D. Pandey, Chairman PME	Member
		Technology developer	Member
		Outside experts (2 Nos)	Members
		Dr. S.K. Purbey, Chairman ToT	Member Secretary
18.	Climate Change related matter, Weather Advisory, Farm Digitization	Dr. Gopal Kumar	In-charge
19.	Official Language	Dr. S.K Purbey	In-charge
20.	Swachh Bharat Abhiyan	Sh. Prabhat Kumar	In-charge
21.	Publication Committee	Dr. R.K. Patel	Chairman
		Dr. Sanjay Kumar Singh	Member
		Dr. Alemwati Pongener	Member

Infrastructural Development

The centre has developed well-equipped laboratories for conducting basic and applied research in litchi production and utilization. During 2016-17 the centre developed a tissue culture laboratory and created facility for molecular and biotechnological studies. With the signing of MoU with Bhabha Atomic Research Centre, Mumbai, a litchi treatment plant is being developed in the centre's campus, which will act as a model facility for litchi growers and entrepreneurs in postharvest management of litchi. The capacity of the Visiting Scientists' Home has been increased as vertical extension work is almost nearing completion. This will gather to the need of accommodation for farmers and trainees during training programmes at the centre. A farm store cum security room has also been developed near the northern boundary of the centre's farm, to store farm implements and inputs, as well as to improve vigilantism in watch and ward of the farm. A parking lot outside the main office building has also been inaugurated by Dr. W.S. Dhillon, Hon'ble ADG (H.S.) on.

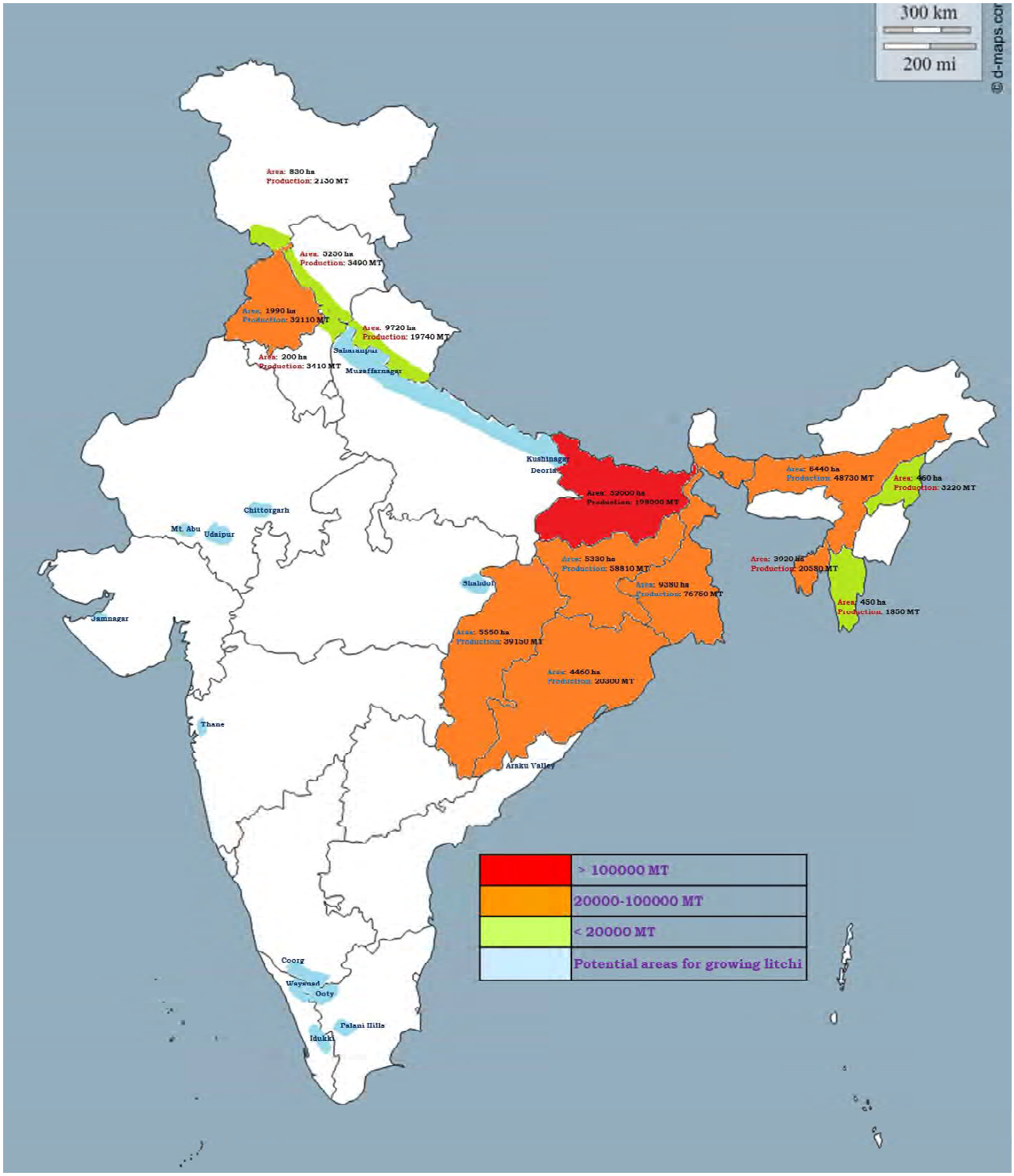
Shauchaalay-cum-washroom inaugurated

Vermicomposting unit developed

Inauguration of farm store-cum-security room

Dr. W. S. Dhillon, Hon`ble ADG (HS) inaugurating the vehicle parking shed

1. Litchi scenario



भाकृअनुप–राष्ट्रीय लीची अनुसंधान केन्द्र

ICAR-National Research Centre on Litchi

मुशहरी प्रक्षेत्र, मुशहरी, मुजफ्फरपुर–842 002 (बिहार), भारत

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