वार्षिक प्रतिवेदन
ANNUAL REPORT
2017-18

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भा.कृ.अनु.प.–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

Published by
Prof. (Dr.) Vishal Nath
Director
ICAR-National Research Centre on Litchi
Muzaffarpur - 842 002, Bihar, India
Phone: 0621 - 2281160, Fax: 0621 - 2281162
Website: http://www.nrclitchi.org

Compiled and Edited by
Dr. R. K. Patel
Dr. Abhay Kumar
Dr. Alemwati Pongener
Dr. Sanjay Kumar Singh
Dr. Kuldeep Srivastava

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Preface

ICAR-NRC on Litchi, Muzaffarpur continued its dedicated and ardent efforts in popularizing litchi as a commercial fruit crop in hitherto non-traditional areas of the country. The centre has been able to leave footprints in Shahdol district of Madhya Pradesh where more than 350 farmers have been benefitted through our outreach programme. In another significant step towards area expansion under litchi, quality planting material were provided to more than 150 farmers in Peren, Dimapur, Wokha and Kohima districts of Nagaland. In Peren district alone, a cluster spanning 87 ha has been established under our guidance and assistance.

The centre has made commendable 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.

Our scientists have been successful in refinement of technologies. We have been successful in collecting and introducing new germplasm of litchi, longan, and rambutan into our field gene bank. In a significant step towards tissue culture protocol for litchi propagation, our scientists have standardized M.S. media for callus induction using leaf explants. We have been able to establish nutrient deficiency symptoms in litchi, attained better understanding on the role of mycorrhiza, and canopy architecture management. Our studies on physiological and biochemical parameters have provided leads on flowering and bearing in litchi. We have also made significant progress under 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. Our knowledge on pericarp browning along with the possible means to reduce it further have been strengthened during the period under report.

The centre hosted a summer school on 'Understanding flowering mechanism and management of bearing in sub-tropical fruits', a national conference on perspective of challenges and options in litchi production and utilization, and a model training course on GAPs in litchi. In an attempt to upscale laboratory results to commercialisation, the centre in collaboration with BARC, Mumbai established a Litchi Treatment Plant with an installed capacity of 1 ton/hr. The facility was inaugurated and dedicated to the service of stakeholders by Hon`ble Union Minister Sh. Radha Mohan Singh; several entrepreneurs came forward and utilized the facility during 2017 litchi season. ICAR-NRCL actively participated in Kisan Mela / Kisan Gosthis, exhibitions and training to farmers all over the country. During the period, the centre 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 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.

The fruits and achievements of our labour and efforts give us contentment and encouragement to strive further towards our goal. It is with this background that I present to you the Annual Report for the period 2017-2018, I'm hopeful that you will find the report informative. Your valuable feedback would further encourage our team to work towards achieving more and attaining greater heights.

Muzaffarpur
June, 2018

Vishal Nath
Director

Contents

Executive Summary

ICAR-National Research Centre on Litchi has made commendable progress in basic and applied research under multi-disciplinary programme covering different aspects of litchi *viz.,* genetic resource management and crop improvement, crop production, crop protection and postharvest management. The centre also conducted training, organized outreach programmes, and transfer of technology activities to improve knowledge and develop skills of different stakeholders. A concise summary of salient achievements the centre has made during 2017-18 is presented below.

Research Accomplishments

Genetic Resource Management and Crop Improvement

- Six germplasm of litchi were collected from Kerala and Sabour (Bihar).
- Twenty-two litchi genotypes were characterized based on morphological and biochemical traits.
- MS media for callus induction in litchi has been standardized.
- One hundred and twenty seven litchi seedling populations based on morphological traits were evaluated.
- Seven longan seedlings from West Bengal 4 from Kerala and one from Faizabad, UP were collected and added to the existing collection.
- Fifty one longan genotypes have been characterized based on fruit morphological traits and 10 genotypes found superior with respect to fruit quality.
- Removal of 30-50% fruits, 25 days after fruit set in longan showed marked positive effect on fruit size compared to control.
- Ten cultivars of litchi were characterized as per DUS guidelines.
- DNA isolation protocol from litchi leaf samples, free from use of liquid nitrogen has been standardized.

Crop Production

- Potting media containing river bed soil (RBS): vermi-compost: cocopit: vermiculite (2:1:1:1) along with *Trichoderma viride* (50 g per polybag) was found superior for establishment of air-layered plants in nursery.
- Significantly higher yield **(**111.43 kg/plant) was recorded with application of 100:50:75g NPK/ plant/one year of age.
- Application of 70 kg FYM + 10 kg vermi-compost + 3 kg neem cake + bio- fertilizers was found best for high fruit yield (62.5 kg/tree).
- One block (1 ha) of Shahi and China litchi has been planted under organic management practices.
- Application of paclobutrazol @ 4 g per m canopy diameter through trunk soil line pore (TSLP) method yielded maximum no. of fruit per tree (2567.66) over control (32-140 fruits).
- Application of 4.0 g PBZ or 1.0% KNO_3 led to higher ABA and lower IAA contents; and over all content of zeatin.
- Significantly highest fruit yield (35.05kg/plant) obtained in 4mm trunk girdling. Lower levels of GA_3, auxins, and ABA had been found in girdled branches in comparison to ungirdled branches. Higher level of zeatin recorded in girdled treatment in comparison to control.
- Nutrient deficiency (N, P, K, Fe, Zn, Bo, Cu) symptoms in litchi have been characterized.
- Changes in endogenous hormones (IAA, ABA, GA_3, CKs) and gaseous exchange parameters in leaves during floral bud differentiation (FBD) stage of litchi cv. China has been worked out.

- Application of microbial inoculants to litchi trees improves fruit quality parameters and influenced post-harvest life of fruits.
- Nitrogen content in vermi-compost made up with litchi leaves ranged with 2.14-2.5%, banana waste: 1.97-2.34% maize straw: 2.0-2.24% and farm grasses: 1.43-1.73%.
- Soil moisture content in different low lying conditions was recorded during January to October 2017 revealed that the upper 10 cm soil depth recorded higher moisture content (January: 13.3-28.9%, April: 8.4-21.7%) which was gradually decreased up to 40 cm depth and again increased from 60-100 cm soil depth.
- FYM, fertilizer and microbial consortium applied in litchi tree influenced the flowering, fruiting, plant growth, spread and fruit quality.

Crop protection

- Aetiology of panicle and fruit blight to fulfill Koch's postulates established.
- *T. viride* isolate NRCL T-01 controlled the wilt pathogen and trees recovered in 20-35 day.
- Study on antifungal activity against *Alternaria alternata* revealed that the leaf extracts of *Datura stramonium* and *Calotropis procera* possess antifungal compounds.
- Spray of flubendiamide 19.92% + thiacloprid 19.92% followed by spirotetramat 11.01% + imidacloprid 11.01% (5.89%) found effective to curb the fruit borer damage in litchi.
- Mixture of major agro-chemical applied on litchi trees, no adverse effect like burning of the leaf, fruit or any undesirable changes were noticed.
- Infestation of litchi fruit & shoot borer (*Conopomorpha sinensis*) ranged from 2.67% to 61.33% at early stage and harvest stage, respectively.
- Incidence of litchi fruit & shoot borer has been observed in all litchi growing areas *viz*., Bihar, West Bengal, NEH, U.P., Uttarakhand, Punjab, J&K, H.P., Karnataka and Kerala whereas, litchi bug (*Tessaratoma javanica*) was observed at Uttarakhand, Punjab, J&K, Jharkhand and Bihar.
- At harvest stage, minimum fruit borer infestation (4.54%) was recorded with spray of flubendiamide 19.92% + thiacloprid 19.92% against in control (59.67%).
- Maximum reduction of litchi mite infestation noticed with two spray of chlorfenapyr along with pruning of affected shoots during July and October.

Postharvest management and value addition

- Time of harvest is a significant factor in maintaining fruit quality post harvest. Litchi fruit harvested between 4-6 AM were superior in quality with significantly higher quantum of marketable fruits (75%) during 5-day storage in ambient condition, compared to late-harvested fruit.
- Litchi fruit treated with ethrel @ 600 ppm and abscisic acid @ 250 ppm had significantly higher red colour development, as evidenced by higher Hunter 'a' values, over control.
- Blanching litchi aril in combination with KMS (1500 ppm), 0.2% $CaCl_2$ and 0.2% ascorbic acid resulted in highest sensory and organoleptic rating.
- Pre-harvest application of polyamines (0.5 mM spermine) was found effective for lowering of POD and PPO enzymatic activity, thereby reducing pericarp browning after harvest.
- Application of *Bacillus subtilis* isolate NRCL BS-01 and its combination with other strains was found effective in controlling fruit decay as compared to control.
- Methylenecyclopropylglycine (MCPG) content in Shahi and China litchi fruit at various stages revealed that fresh ripe fruits (pulp) showed ~10 ppm.

Improving knowledge and skill of stakeholders

- During the year more than 3000 stakeholders were benefitted through various training and extension activities.

- More than 50 formal trainings including one winter school and a National conference on litchi have been organized at centre.
- Training, demonstration, promotion of kitchen gardening and input distribution activities to 385 farmers families of Khetoli (Shahdol, MP) under TSP programme has been completed.
- Training cum demonstration programme on establishment of litchi orchard and best management practices in litchi has been organized at Medziphema, Nagaland. Training programme was attended by 54 participants from Peren, Dimapur, Wokha and Kohima districts of Nagaland. About 150 farmers have established new litchi orchard.

Externally Funded Projects

- Under the Farmers FIRST Programme, more than 1000 beneficiaries from eight identified villages in East Champaran, Bihar were impacted through improved livelihood by intervention of good practices in agricultural production system under four major modules, viz. crop, horticulture, livestock, and microenterprise-based modules.
- Approximately 30000 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.
- Character detailing of 10 varieties of litchi as per DUS guidelines have been completed
- Under BRNS-funded project 'Development of synergistic hurdles for preservation of litchi pulp and products', the preservation of litchi pulp and products were standardized.

Linkages and Collaborations

The centre is working on different aspects in close collaboration with other organizations such as Agricultural Universities (BHU, 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

Two MoU was signed between ICAR-NRCL and M/s. Muzaffarpur Agro Pvt. Ltd, Muzaffarpur and M/s. Ram Sarvowar Agro Foods, Muzaffarpur for 'Technology Transfer and Commercialization of process for preparation of litchi squash and RTS' on 23Rd June 2017. 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

'National Science Day' was organized by the centre at Ujhilpur village of East Champaran and the stakeholders were encouraged to adopt the new technology of litchi production. Hindi Chetna Maas was organised and the use of official language in all communication is being attempted. Swachh Bharat abhiyan and International Day of Yoga was organised at the centre where personnel from the NRCL took part. Other activities where the centre joined the rest of the nation in commemorating included Vigilance Awareness Week, Field Day, World Soil Day, etc.

Infrastructural development

A Litchi Treatment Plant was established at the centre. In addition, guesthouse, protected shade house and integrated farming system were additions to the centres infrastructure. 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 yearsas more scientists and staff were allotted from the council. The centre can boast today of having almost its 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 equipment like 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 1874 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 12 technical bulletins, 15 technical folders and 25 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 soft wares. 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. The centre has also launched a mobile app (ICAR-NRCL) for android devices and is available for free download on google play store.

Research and Development activities

ICAR-NRC on Litchi carries out its research and development programmes under five main thematic areas

- Conservation, characterization, and utilization of genetic diversity for improvement of litchi
- Development and refinement of integrated production technologies for improved productivity of litchi
- Development and refinement of integrated crop protection technologies for improved productivity of litchi
- Integrated postharvest management to reduce losses, improve marketing and product diversification
- Improving knowledge and skill of stakeholders for increasing production of litchi

The centre has also undertaken two flagship projects taking into consideration the challenge of pericarp browning and understanding shoot physiology with respect to flowering and fruiting in litchi. In addition to these, the centre also has seven ongoing externally funded projects to address issues and challenges in litchi production and utilization.

Financial Statement 2017-18

(in Rs. lakh)

Sl. No	Head-wise break up	RE 2017-18	BE 2017-18	Release	Expenditure
(A)	**Recurring:**				
a.	Establishment (including pension)	310.00	380.00	310.00	309.54
b.	T.A.	8.50	10.00	8.50	8.28
c.	Contingency	255.50	389.00	255.50	255.71
d.	HRD	1.00	5.00	1.00	1.09
e.	Loans and advances	7.00	2.00	7.00	6.66
	Total (A)	**582.00**	**786.00**	**582.00**	**581.28**
(B)	**Non-Recurring:**				
a.	Equipment	2.02	-	2.02	1.97
b.	Works (Minor)	142.76	7.00	142.76	142.76
c.	Furniture & Fixture	2.22	-	2.22	2.25
d.	Library	1.00	-	1.00	0.92
e.	Vehicle	-	-	-	-
f.	Live Stock	-	-	-	-
g.	Land	-	-	-	-
	Total (B)	**148.00**	**7.00**	**148.00**	**147.89**
	Grand Total (A +B)	**730.00**	**793.00**	**730.00**	**729.17**

The centre regularly conducts training programmes and activities for transfer of technology to farmers and various stakeholders. Under the TSP and NEH component, the centre has laid out structured programmes for area expansion and technology dissemination in tribal belts and Northeastern hill regions of the country.

Staff Strength

Staff	Sanctioned	Filled	Vacant
Scientific	15+1	14+1	1
Technical	8	2	6
Administrative	12	11	1
Skilled Supporting Staff	3	3	0

Resource Generation

(in Rs. lakh)

Sale of farm produce	10.66
Interest earned on short term deposits	7.16
Income generated from internal resources (including recovery of loans and advances)	2.88
Miscellaneous receipts	3.39
Total	24.09

Receipts and Expenditure Statement of Externally Funded Projects

(in Rs. lakh)

Externally funded projects	Opening balance	Receipt during 2017-18	Expenditure
Total	(-) 3.69	93.72	95.05

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

The centre made exploratory visits to source litchi germplasm from the states of Kerala and Bihar. Six novel germplasm of litchi were identified and added to the collection of germplasm block of the centre.

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

Twenty-two litchi genotypes including three new varieties were evaluated based on 13 quantitative fruit traits. Results revealed considerable variability for fruit traits (Table 1.1). High phenotypic and genotypic coefficients of variation were noted for pulp weight, seed weight, peel thickness, pulp thickness and fruit weight. High heritability coupled with high genetic advance was recorded for fruit weight, fruit length, fruit

Table 1.1. Analysis of variance for 13 quantitative morphological characters

Source	df	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Pulp weight (g)	Pulp thickness (mm)	Seed weight (g)	Peel thickness	Peel weight (g)	Seed length (mm)	Seed width in x axis (mm)	Seed width in y axis (mm)	TSS (°B)	Yield per plant (kg)
Replication	2	0.93	2.94	5.04	0.29	1.79	0.10	0.02	0.33	14.21	0.36	1.08	0.39	3.73
Genotypes	21	68.10**	113.71**	65.81**	61.92**	10.58**	2.81**	0.32**	2.20**	57.85**	7.71**	6.96**	5.40**	302.39*
Error	42	3.11	2.34	5.77	2.31	0.80	0.17	0.05	0.34	15.28	1.34	0.72	0.35	6.46

Table 1.2. Estimates of various genetic parameters of litchi genotypes

Parameter	Range	Mean	PV	PCV	GV	GCV	h2	h2 (%)	GA	GA (%)
Fruit weight (g)	15.65-36.85	21.98	24.78	22.65	21.66	21.17	0.87	87.43	8.96	40.78
Fruit length (mm)	15.62-46.47	37.93	39.46	16.56	37.12	16.06	0.94	94.07	12.17	32.09
Fruit width (mm)	15.66-41.92	33.07	25.78	15.36	20.01	13.53	0.78	77.63	8.12	24.56
Pulp weight (g)	8.76-18.28	14.33	22.18	32.86	19.87	31.11	0.90	89.58	8.69	60.65
Pulp thickness (mm)	5.62-13.47	8.13	4.06	24.79	3.26	22.22	0.80	80.34	3.33	41.03
Seed weight (g)	1.19-4.30	3.36	1.05	30.56	0.88	27.93	0.84	83.54	1.76	52.59
Peel thickness (mm)	0.82-2.14	1.48	0.14	25.07	0.09	20.21	0.65	64.98	0.50	33.55
Peel weight (g)	3.30-7.04	4.29	0.96	22.83	0.62	18.35	0.65	64.62	1.30	30.39
Seed length (mm)	18.31-31.73	25.68	29.47	21.14	14.19	14.67	0.48	48.14	5.38	20.96
Seed width in x axis (mm)	11.64-17.10	15.10	3.46	12.32	2.12	9.65	0.61	61.39	2.35	15.58
Seed width in y axis (mm)	9.69-16.31	12.70	2.80	13.18	2.08	11.36	0.74	74.32	2.56	20.17
TSS (°Brix)	15.54-21.79	19.40	2.03	7.35	1.68	6.68	0.83	82.63	2.43	12.51
Yield (kg tree^{-1})	37.29-73.51	56.36	105.10	18.19	98.64	17.62	0.94	93.86	19.82	35.17

Table 1.3. Eigen values and percent of variation in respect of 13 characters of litchi as explained by the first 4 principal components

Traits	PC1	PC2	PC3	PC4
Fruit Weight	0.022	0.484	-0.018	0.085
Fruit Length	0.347	0.149	-0.368	-0.316
Fruit Width	0.263	0.171	-0.546	-0.227
Pulp weight	0.142	0.455	-0.059	0.069
Pulp thickness	0.307	0.343	0.064	0.087
Seed weight	0.449	-0.038	0.185	0.089
Peel thickness	0.121	0.291	0.545	0.019
Peel weight	0.059	0.411	0.226	-0.196
Seed Length	0.340	-0.040	0.234	-0.256
Seed width (x)	0.422	-0.030	0.125	0.262
Seed width (y)	0.335	-0.045	0.001	0.509
TSS	-0.084	0.056	-0.289	0.609
Yield/plant	0.249	0.357	-0.149	0.134
Eigen values	2.089	2.017	1.157	1.141
Proportion of Variance (%)	33.50	31.30	10.30	10.00
Cumulative Proportion (%)	33.60	64.90	75.20	85.20

width, pulp weight, pulp thickness, seed weight, peel thickness, peel weight, seed width (y-axis) and yield per plant (Table 1.2).

Principal component analysis of data revealed that the first 4 PC explained 85.20% of the total variation (Table 1.3). The first and second PC accounted for 34% and 31% of the variation, respectively. Seed weight, seed width in 'x' and 'y' axis, fruit length, seed length, fruit weight, pulp weight, peel weight, pulp thickness and yield/plant are the traits that contributed most to total variation explained by the 4 principal components. A biplot depicting association among various traits and genotypes revealed a high correlation between traits related to seed weight, seed width in 'x' axis, seed width in 'y' axis and seed length and maximum genotypes clustering in PC1 were under the influence of these traits (Fig. 1.1). A high correlation was also observed between traits related to fruit weight, pulp weight, pulp thickness and peel weight which are responsible for discriminating high pulp content cultivar, Gandaki Sampada from the rest of the genotypes. In essence, as indicated by PCA and variability estimates, fruit weight, pulp weight, peel weight, peel thickness, seed weight and seed size were identified as important traits for identifying high yielding genotypes.

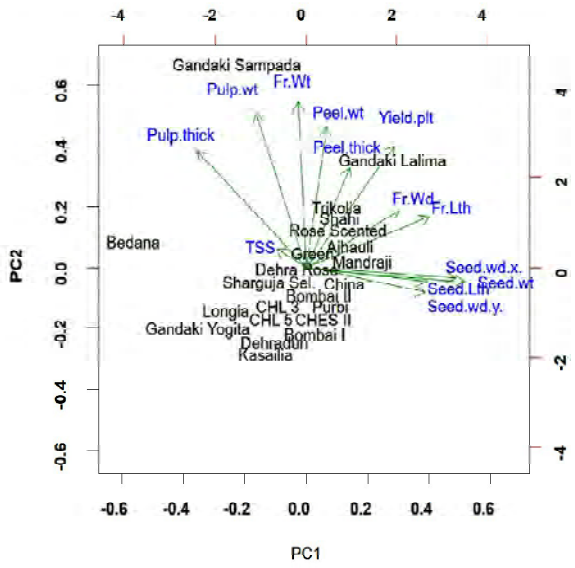


Fig. 1.1. PCA plot depicting the association among traits and genotypes correlated with PC1 and PC2

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

Murashige and Skoog basal medium of different compositions (Table 1.4), poured in petri plates were autoclaved at 15 psi at 121 °C temperature for 15 minutes. This was followed by cooling at 25±2 °C in

Table 1.4. Effect of different concentration of 2,4-D supplemented in MS basal media on callus induction of litchi after 4 weeks

Casien enzymic hydrolysate (mg/l)	Activated Charcoal (mg/l)	Sucrose (%)	Agar (%)	NAA (mg/l)	Kinetin (mg/l)	2,4-D (mg/l)	Callus Induction (%)
500	30	3.0	0.7	0.5	2.0	0.5	9.48
						1.0	15.20
						1.5	37.40
						2.0	90.78
						2.5	58.35
						3.0	42.17

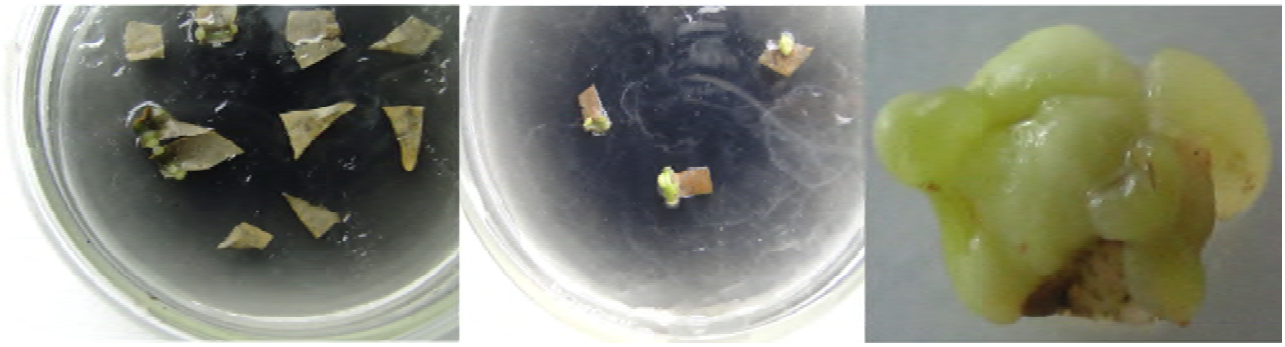
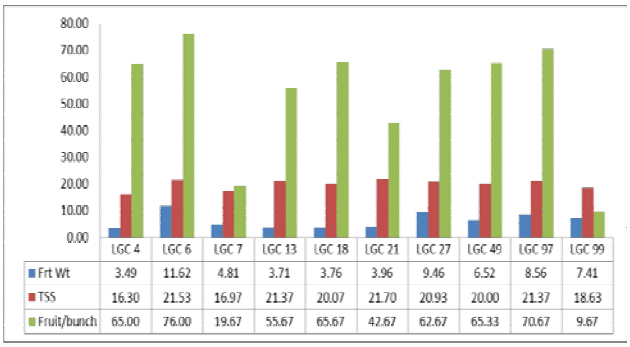


Fig. 1.2. Callus induction in litchi after 4 weeks

growth chamber for gelling of the medium. Newly emerged leaf of Shahi (1 cm^2) was used as explant. They were surface sterilized followed by inoculation in different culture medium and kept in culture room maintained at 25±2 °C. These cultures were exposed to 16/8 h light/dark period regime provided with photon flux at 30 µmol m^{-1} s^{-1} by cool white fluorescent lamps. After 4 weeks of culturing, callusing ranging from 9.48–90.78% in different media (Table 1.4 and Fig. 1.2). The highest callusing (90.78%) was recorded in MS media containing casein enzymic hydrolysate (500 mg/l), activated charcoal (30 mg/l), sucrose (3%), agar (0.7%), NAA (0.5 mg/l), kinetin (5 mg/l) and 2,4-D (2mg/l).

Collection, characterization, evaluation, documentation and utilization of Longan

ICAR-NRC on Litchi currently maintains 141 accessions of longan in its field gene bank. A survey was conducted in Boinganthakur area of South 24 Parganas district during which 7 longan seedlings were collected and added to the existing collection. Additionally, 5 seedling genotypes, including 4 from Kerala and 1 from Faizabad (UP) were also procured and maintained in field. Fifty one genotypes came into fruiting and were characterized based on fruit



	LGC 4	LGC 6	LGC 7	LGC 13	LGC 18	LGC 21	LGC 27	LGC 49	LGC 97	LGC 99
Frt Wt	3.49	11.62	4.81	3.71	3.76	3.96	9.46	6.52	8.56	7.41
TSS	16.30	21.53	16.97	21.37	20.07	21.70	20.93	20.00	21.37	18.63
Fruit/bunch	65.00	76.00	19.67	55.67	65.67	42.67	62.67	65.33	70.67	9.67

Fig. 1.3. Graphical representation of physical fruit quality traits of identified superior longan genotypes

Fig. 1.4. Variability in fruit traits among the identified longan genotypes

morphological traits. Ten superior genotypes of longan were identified with respect to fruit quality (Fig. 1.3). The key characters among the characterized genotypes are presented in Table 1.5 and Fig. 1.4.

Effect of fruit thinning in longan

Fruit thinning at different levels (10%, 20%, 30%, 40% and control) was tested for its effect on fruit size in NRCL Longan-1. Removal of 30-50% fruits at 25 days after fruit set showed marked effect on fruit size compared to control. Trees where fruits were thinned to 40% produced the highest fruit weight (16 g) followed by 30% (15g) and 50% (14g) fruit thinning.

Ultrastructural studies of longan pollen grains

Pollen grains of longan were examined using scanning electron microscope (SEM). The shapes of pollen in all the three stages of flowers are triangular-obtuse-convex in the polar view while it is elliptic-acuminate-acute in the equatorial axis. Pollen class is trizonocolpateobtus-triangular. The sculpturing of exine surface is striate. Pollen is tricolpate and tricolporate while the spines are absent (Table 1.6 and Fig. 1.5). This study on morphological properties of pollen grains in longan cultivar are relevant for taxonomical, phylogenetical and palaeobotanical studies and in breeding programmes and germplasm evaluation.

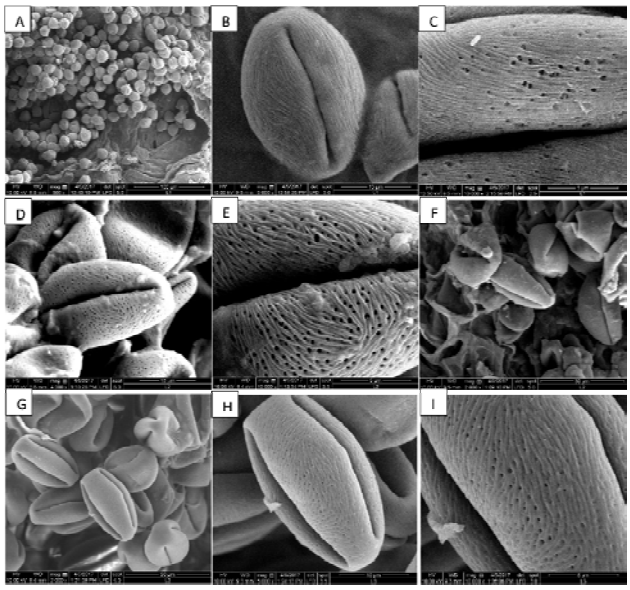


Fig. 1.5. Pollen shape and exine pattern in three different stages of flower in longan. A, B and C: pollens from M1 flower; D, E and F: pollens from F flowers; G, H and I: pollens from M2 flowers

Table 1.5. Key characters of 51 longan genotypes

Characters	Range		Mean	SeM	CD	CV (%)
	Minimum	Maximum				
Fruit length (mm)	15.93	22.72	19.56	0.62	1.75	5.52
Fruit width (mm)	17.06	25.33	20.77	1.24	3.49	10.41
Fruit weight (g)	2.75	11.62	5.49	1.14	1.08	35.57
Pulp thickness (mm)	1.05	4.63	2.12	0.32	0.91	26.28
Pulp wt (g)	1.20	8.87	2.92	0.64	1.79	38.18
Seed wt (g)	1.09	1.77	1.44	0.248	0.088	10.571
Peel thickness (mm)	0.39	0.98	0.59	0.08	0.23	23.03
TSS (°B)	12.60	21.70	18.75	1.27	3.59	12.37
Fruit/bunch	5.33	85.33	35.10	10.09	28.37	50.15

Table 1.6. Morphological characteristics of pollen grains of longan

Longan flower stage	Parameter			
	Polar axis (µm)	Equatorial diameter (µm)	P/E ratio	Shape
M1	29.63±0.09	16.57±0.06	1.78	prolate
F	28.37±0.12	17.39±0.09	1.63	prolate
M2	28.13±0.15	15.73±0.10	1.78	prolate

Collection, characterization and evaluation of rambutan germplasm

Two accessions of rambutan (red and yellow type) was collected from Kerala and planted in the nursery for survival and further study.

1.2. Development of improved cultivars in litchi

Development of improved hybrids of litchi

A total of 13,246 crosses were attempted during the reporting period involving Shahi × China, Shahi × Bedana, China × Longia, Rose Scented × Gandaki Lalima of which 128 hybrid fruits were harvested and

sown in nursery. However, owing to outbreak of flood, all seedlings got vitiated. For assessing the self-fertility in litchi, 150 panicles of the selected cultivars were bagged. No fruit set was observed in bagged panicles irrespective of cultivars.

Evaluation of seedling population of litchi for improved plant types

Evaluation of 127 litchi seedling populations of more than 10 years based on 16 morphological traits revealed significant variation among populations which was largely displayed by traits like plant height, leaf length, leaf width, ratio of length:leaf width, leaf tip length and petiole length (Table 1.7). A marked variation in qualitative traits was also observed; however, cuneate base, caudate apex, entire margin, leaves cupping upwards from midrib and green leaf colour were found most predominant (Fig. 1.6). Cluster analysis performed using ward linkage delineated the entire population into 2 major groups, each group which was further subdivided into 2 sub-groups (Fig. 1.7). As presented in Table 1.8, Sub-Group I constitute 18 seedlings predominantly marked by attenuate leaf base, caudate leaf apex and upward curving leaf from midrib. However, lanceolate leaf shape was a general representation of this group. This group was also presented by low vigour seedlings having bark:wood ratio of 1.08. Sub-Group II comprised 33 seedlings which predominantly possessed elliptic leaf shape, cuneate base, caudate apex, entire leaf margin, green leaf colour and upward curving leaf from midrib. The maximum bark:wood ratio and lowest plant height was

Table 1.7. Range and variation of 127 seedlings population of litchi

Traits	Min	Max	C.D.	SE(m)	C.V.
Plant height (m)	1.31	5.24	0.51	0.18	9.55
Girth (cm)	11.56	48.10	1.12	0.40	2.40
Internode Length (cm)	14.38	37.09	0.48	0.17	1.32
B:W ratio	1.01	1.18	0.04	0.01	2.23
Leaf length (mm)	9.33	17.82	1.56	0.56	7.21
Leaf width (mm)	2.24	6.36	0.56	0.20	9.23
Leaf length:width	2.22	5.86	0.65	0.23	10.62
Leaf tip lenth (mm)	0.38	2.50	0.17	0.06	8.55
Petiole length (mm)	0.34	1.37	0.14	0.05	11.77

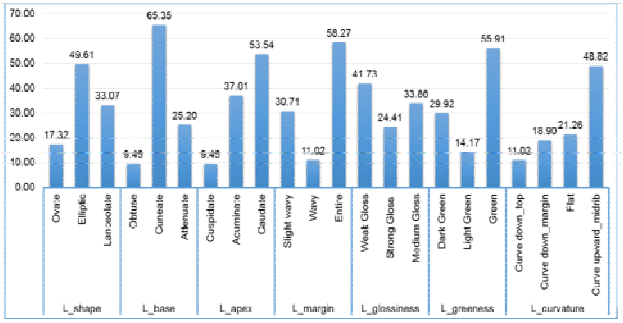


Fig. 1.6. Proportion of qualitative traits (%) among seedlings population

Table 1.8. Group wise variations among seedlings population based on quantitative traits

	Group I						Group I					
	Sub-Group I (18)			Sub-Group II (33)			Sub-Group III (18)			Sub-Group IV (56)		
Traits	Mean	Range	CV (%)	Mean	Range	CV (%)	Mean	Range	CV (%)	Mean	Range	CV (%)
Plant height (m)	3.09	1.31-4.51	9.39	2.86	1.81-4.31	9.31	3.73	2.32-5.24	6.80	3.57	2.03-4.96	10.45
Girth (cm)	27.47	11.56-39.12	1.55	23.05	6.59-37.91	4.53	34.25	23.61-40.21	1.49	31.71	17.61-48.10	1.61
Internode Length (cm)	21.20	16.50-27.66	0.94	19.76	14.38-28.66	1.89	25.86	18.22-37.09	0.55	23.51	16.89-31.34	1.33
Bark:Wood ratio	1.08	1.04-1.14	1.95	1.10	1.05-1.18	2.03	1.05	1.01-1.08	2.42	1.06	1.02-1.11	2.37
Leaf length (mm)	13.65	10.67-14.94	7.16	13.51	9.33-17.82	7.29	13.73	11.04-15.70	7.19	13.31	9.83-17.74	7.29
Leaf width (mm)	2.86	2.24-4.15	18.86	3.88	2.41-5.49	5.82	3.06	2.30-4.24	6.56	4.16	2.27-6.36	8.70
Leaf length:width	4.89	3.86-5.86	12.15	3.59	2.50-5.26	9.08	4.57	3.46-5.43	7.65	3.35	2.22-5.05	11.57
Leaf tip lenth (mm)	1.46	0.68-2.48	6.02	1.25	0.38-2.27	8.06	1.51	0.81-2.50	5.67	1.12	0.38-2.46	11.06
Petiole length (mm)	0.78	0.53-1.26	10.97	0.77	0.34-1.25	11.12	0.78	0.37-1.27	11.15	0.67	0.35-1.37	12.74

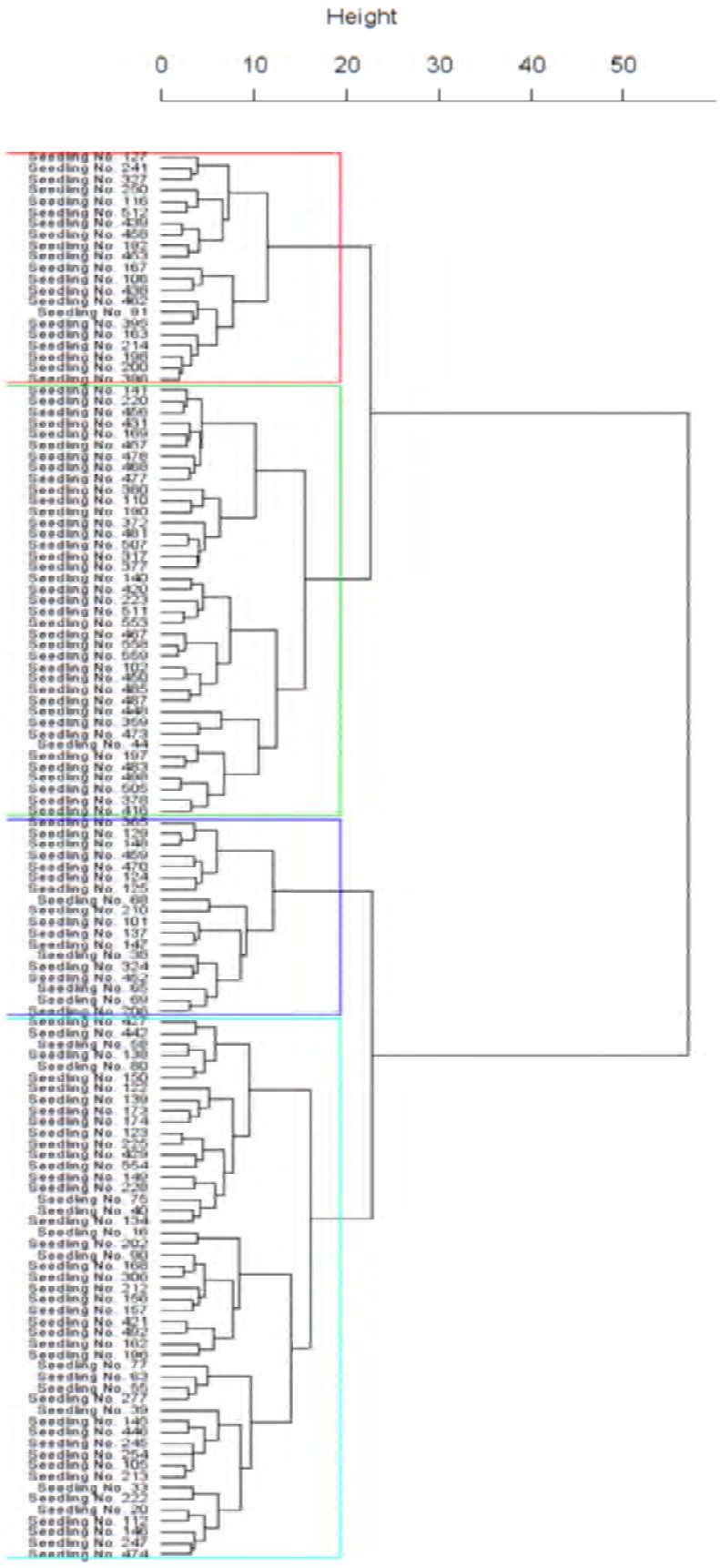


Fig. 1.7. Dendrogram indicating clustering of 127 litchi seedling genotypes based on ward linkage

observed in this group which reflect seedlings with the lowest vigour. Sub-Group III contains 18 seedlings which were majorly represented by lanceolate leaf shape, caudate leaf apex and vigorous seedlings. Sub-Group IV comprise the largest number of seedlings (56) constituting moderately vigourous seedlings with a predominance of elliptic leaf shape, cuneate base, entire leaf margin and green leaf colour. Principal component analysis revealed that the first seven PC accounted for 73% of the variation in the entire population of which 35.50% variation was explained by the first two PC (Table 1.9). A biplot graph based on PC1 and PC2 was plotted which illustrates the importance of traits contributing to explained variation by the corresponding principal components (Fig. 1.8). It was found that leaf shape, leaf margin, leaf curvature, plant height, girth, internode length, B:W ratio, leaf width and leaf length:width ratio are the important contributing traits which can be considered useful in quantifying the diversity within population.

1.3 Molecular finger-printing in litchi cultivars through micro-satellite markers

Representative leaf samples from litchi genotypes were collected for the isolation of genomic DNA. Genomic DNA was isolated from two samples each from each of the cultivars using a new DNA isolation protocol which was standardised. The DNA isolation protocol is free from use of liquid nitrogen and doesn't require specialized equipments. The DNA preparations were purified, estimated and stored for the fingerprinting and further characterization. Availability of

Table 1.9. Importance of components and their factor loadings based on seven principal components

Traits	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Height	0.43	-0.05	-0.29	0.00	-0.11	0.14	-0.10
Girth	0.41	-0.06	-0.27	-0.01	-0.13	-0.03	0.00
Internode Length	0.41	-0.10	-0.21	-0.10	0.13	-0.02	-0.05
Bark:Wood ratio	-0.40	0.10	0.14	-0.06	-0.04	0.09	-0.07
Leaf Length	0.20	-0.14	0.47	-0.38	0.24	0.02	0.05
Leaf Width	0.29	0.37	0.34	0.15	0.17	0.14	0.10
Leaf Length: Leaf Width	-0.22	-0.47	-0.08	-0.39	0.02	-0.09	0.01
Tip Lenth	0.24	-0.15	0.48	-0.18	0.11	0.17	-0.22
Petiole Length	0.24	-0.13	0.24	0.01	-0.16	-0.56	0.16
Leaf shape	0.02	0.39	0.12	0.11	-0.16	-0.31	-0.55
Leaf base	0.03	0.26	-0.20	-0.50	-0.07	0.10	-0.47
Leaf apex	-0.02	0.28	-0.20	-0.51	0.18	-0.02	0.26
Leaf margin	0.12	-0.37	-0.08	0.24	0.02	0.12	-0.17
Leaf glossiness	0.06	0.08	0.13	-0.04	-0.53	0.61	0.24
Leaf greenness	0.08	0.12	0.06	-0.21	-0.56	-0.32	0.30
Leaf curvature	0.08	0.32	-0.17	0.08	0.40	-0.04	0.36
Eigen Values	1.855	1.498	1.274	1.146	1.133	1.001	0.935
Proportion of Variance	0.215	0.142	0.101	0.082	0.08	0.062	0.055
Cumulative Proportion	0.215	0.355	0.457	0.539	0.619	0.682	0.736

polymorphic markers in a crop species is a prerequisite for genetic improvement through marker-assisted selection and construction of high density genetic linkage map. Simple sequence repeat (SSR) markers are widely employed in molecular breeding programmes and thus are needed to be developed and validated. Conventional methods for developing SSR markers are laborious and expensive. The alternative and cost effective way is to explore the existing public databases harboring abundant number of genomic and genic (expressed sequence tag, EST) sequences for the development of new SSR markers. The SSR markers developed from ESTs leverages functional aspect of transcripts and thus associated with its function. Insufficient number of polymorphic molecular markers is an obstacle for current molecular breeding research in litchi.

A total of 98691 EST sequences of litchi were downloaded from NCBI public databases and pre-processed for assembling. In order to find novel non-redundant EST-SSR markers, 111 publically available SSR primer sequences were subjected to sequence similarity search with the downloaded EST sequences. A total of 48179 (48.81%) very similar sequences were excluded and the remaining non-redundant sequences

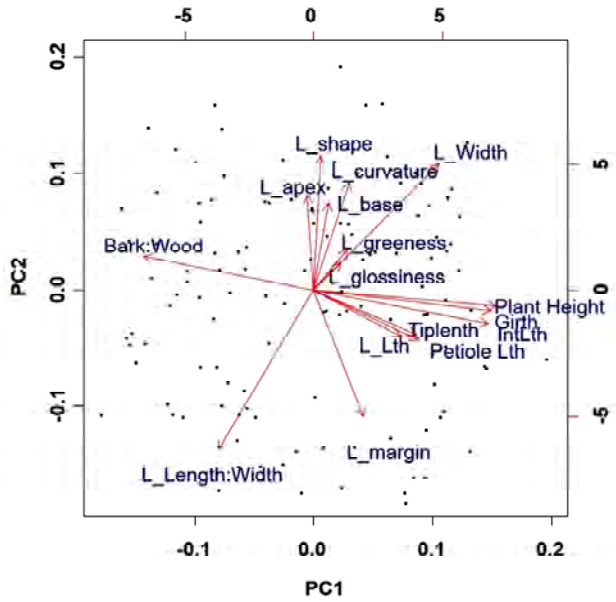


Fig. 1.8. Biplot showing the relationship between traits correlated with PC1 and PC2

(50512) were further pre-processed for removal of low complexity sequences, poly A and poly T tail and vector sequences, were assembled using TGICL software, which yielded 3423 SSR containing sequences. The number of sequences containing more than 1 SSR were 337 and 142 SSRs were present in compound formation.

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

2.1. Plant propagation and nursery management in litchi

Refinement of potting media

Several potting media combinations were tried for higher survivability of litchi air-layers in nursery. The potting media combination river bed soil (RBS): vermi-compost: cocopit: vermiculite (2:1:1:1) along with *Trichoderma viride* (50 g per polybag) was found better.

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

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

The litchi trees under experiments showed regularity in bearing and fruiting. Fruit weight was significantly higher where maximum doze of nitrogen and medium dose of potassium were applied as 2/3rd and 1/3rd at after harvest and fruit development stage, respectively. Significantly higher plant yield (111.43 kg/plant) was recorded with application of 100:50:75g NPK/plant/year age in 13th year which was at par with 100:50:100g NPK/plant/year. The fruit yield increased with increasing the dose of N and K fertilizers. The same treatment recorded higher fruiting density (124.67/m^2) and total fruting area (41.49 m^2). Available soil nitrogen (233.23 kg/ha) and leaf N (1.98%) were higher in 100 g N and K combination. Fruit colour and ascorbic acid content found better in lower level of N and K combinations. Fruit quality was found better in application of higher level of N and K as 2/3rd and 1/3rd after harvest of fruit and duirng fruit development stage.

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

The litchi cv. China trees under experiments showed irregularity in the bearing and fruiting. Fruit weight was significantly higher where maximum doze of nitrogen and medium dose of potassium were applied as 2/3rd after harvest and 1/3rd during fruit development stage.

Standardization of organic inputs for litchi production

Plants showed the response of organic input application in terms of better flowering, fruiting and fruit quality. The highest fruit yield (62.5 kg/tree) was recorded with application of 70 kg FYM + 10 kg vermi-compost + 3 kg neem cake + bio-fertilizers in 10 years old plant.

Development of package of practices for organic litchi production

One block (1 ha) of Shahi and China litchi has been planted under organic management practices during February 2017 at 6 × 6 m spacing after receding of flood water entered in the month of August 2017 which damaged the 3-year old plantation of litchi. Faba bean has also been grown as intercrop in between two rows of organic litchi block during *rabi* season. The average yield of faba bean was recorded 13.5 q/ha.

High density planting in litchi cv. Shahi

Corrective prunning was imposed after harvesting of fruit during 2016 which led to no flowering and fruiting during the current season. As during backward pruning thicker fruiting terminals, foliage and some thick branches were removed and next season vigorous growth had taken place.

Nutrient deficiency symptoms in litchi plants

Nitrogen deficiency symptoms (yellowing of older leaves, shortening of new leaves and premature fall of older leaves) appeared after 5 months of treatment application. In P deficient plants symptoms appeared as pin discoloration of older leaves turning to dark green and dead patch on tip with coppery brown margins. Potassium-deficient plant showed necrosis from the leaf tip and spread along margins; older leaves turned yellow.

In iron-deficient plant young leaves showed whitish yellow discoloration with loss of chlorophyll and later on appeared bleached with necrosis. Zn deficiency symptoms appeared on young leaves with first appearance as interveinal chlorosis. Growth was stunted with little leaf symptoms; interveinal chlorosis become severe giving plant rosette appearance.

In 2nd set of experiment air-layered plants were planted in pots under sand culture to create deficiency of nutrients. Removal of nutrients from the stock is in progress as per technical programme. From April onward different treatment will be imposed for creating the deficiency symptoms in litchi cv. Shahi.

Effect of micronutrients on fruit yield and quality under cv. Shahi

As per approved technical programme the leaf and soil samples were collected for base line information of the block of different micro- nutrient content in leaf and soil. Good flowering and fruiting has been observed and fruits are in the developmental stage.

Doubling the productivity of litchi through advance approaches

For doubling the production of litchi a trial has been started during the year. Initial frame working of plant is going on as per the technical programme. Flowering panicle emergence has been recorded in the few plants.

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

Different doses and methods of application of paclobutrazol on induction of litchi flowering was studied. Results showed that paclobutrazol (1-4 g per m canopy diameter) applied either ring basin (RB) or trunk soil line pore (TSLP) during September significantly affected various yield and fruit quality attributes. Maximum panicles emerged in the canopy due to 4.0 g PBZ applied through TSLP method, this dose and methods also led to highest percentage of shoots to flower (60%) and 3.0 g led to early emergence

Table 2.1. Effect of methods of application and doses of paclobutrazol on floral and yield attributes in litchi cvs. Shahi and China

Treatments	Dose of PBZ	Percent shoot flowered	Sex ratio	Panicle length (cm)	No. of fruits/ panicle	No. of fruit/ tree	Fruit yield/ tree
Ring Basin Methods	1.0	30.00 (33.19)	2.77	15.86	22.00	330.00	8.29
	2.0.	15.00 (22.77)	2.76	16.06	5.00	20.00	0.48
	3.0	5.00 (12.87)	0.00	0.00	5.00	23.00	0.58
	4.0	5.00 (12.87)	0.00	0.00	6.00	26.00	0.61
	Control (China)	28.00 (31.93)	2.75	15.90	21.00	140.00	5.13
	Control (Shahi)	30.00 (33.19)	2.99	13.53	18.00	120.00	2.46
TSLP	1.0	10.00 (18.41)	0.00	0.00	7.00	28.00	0.70
	2.0.	20.00 (26.55)	2.83	14.63	6.00	30.00	0.76
	3.0	55.00 (47.85)	2.86	16.61	8.00	736.00	19.35
	4.0	60.00 (50.75)	2.89	17.81	22.00	2,567.66	70.00
	Control (China)	5.00 (12.87)	0.00	0.00	12.67	32.00	0.81
	Control (Shahi)	11.00 (19.35)	0.00	0.00	27.00	35.00	0.74
$CD_{0.05}$	A	0.44 (0.40)	0.008	0.21	0.43	0.57	0.20
	B	0.76 (0.70)	0.014	0.37	0.74	0.98	0.35
	A x B	1.08 (0.99)	0.02	0.52	1.05	1.39	0.50
SEm±	A	0.15 (0.14)	0.003	0.072	0.14	0.19	0.07
	B	0.26 (0.24)	0.005	0.125	0.25	0.33	0.12
	A x B	0.37 (0.33)	0.007	0.17	0.35	0.47	0.17

Table 2.2. Physico-chemical characters of litchi fruit affected by methods of application and doses of paclobutrazol in litchi cvs. Shahi and China

Treatments	Dose of PBZ	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Seed weight (g)	Pericarp weight (g)	Aril content (g)
Ring Basin Methods	1.0	3.25	3.45	25.20	1.32	4.02	18.40
	2.0.	3.55	3.47	24.63	1.35	3.82	18.80
	3.0	3.15	3.42	25.60	1.36	3.80	19.10
	4.0	3.19	3.46	23.60	1.32	4.04	18.30
	Control (China)	3.54	3.51	26.67	1.33	4.05	18.80
	Control (Shahi)	3.26	3.28	20.43	3.82	3.42	15.18
TSLP	1.0	3.15	3.52	25.30	1.36	4.02	18.80
	2.0.	3.43	3.54	25.53	1.34	4.04	18.90
	3.0	3.45	3.56	26.30	1.32	4.03	19.10
	4.0	3.56	3.58	27.30	1.37	4.05	19.20
	Control (China)	3.36	3.52	25.37	1.32	3.80	19.00
	Control (Shahi)	3.27	3.27	21.30	3.82	3.42	15.12
$CD_{0.05}$	A	0.006	0.003	0.117	NS	0.033	0.039
	B	0.010	0.004	0.203	NS	0.057	0.068
	A x B	0.014	0.006	0.287	NS	0.081	0.096
SEm±	A	0.002	0.001	0.040	0.001	0.011	0.013
	B	0.003	0.001	0.069	0.001	0.019	0.023
	A x B	0.005	0.002	0.097	0.001	0.027	0.032

of panicle. TSLP method delayed (2-3 days) the panicle emergence over RB method. PBZ applied (4 g) through TSLP method yielded maximum no. of fruit per tree (2567.66) over control (32-140 fruits) (Table 2.1). PBZ @ 3 g was also found better for enhancing yield, pulp (aril) content over untreated trees. Fruit Size was also affected by methods and doses of application of paclobutrazol but average fruit weight was reduced over control due to RB methods, however fruit weight was increased by almost 10 percent over control by application PBZ @4.0 g through TSLP. Reduction in peel weight upto some extent has been recorded with PBZ applied through RB method (2-3.0 g per m canopy diameter). Application of PBZ reduced leaf nitrogen content during October, which was conducive for flower bud differentiation (Table 2.2).

In general, 3.0 g PBZ per m canopy diameter has been found to be better for enhanced net photosynthetic rate (*A*), transpiration rate (*E*) and stomatal conductance (*gs*) during 'off' and 'on' year in litchi cv. China. During '*on*' year *A* was more than in '*off*' year in contrast to *E* and *gs* (Table 2.3). While paclobutrazol was effective in controlling vegetative growth, conflicting evidence on paclobutrazol induced changes in growth and fruit quality attributes in litchi suggests that further investigation is required.

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

Changes in endogenous hormones (IAA, ABA, GA_3, CKs) and gaseous exchange parameters in leaves were examined during floral bud differentiation (FBD) stage of litchi cv. China (12 year old). Results showed that *paclobutrazol* (PBZ) application during September month has reduced gibberellic acid (GA_3) content almost by 20 per cent with increased abscisic acid (ABA) over control trees. Lower dose of PBZ (i.e <2.0 g per m canopy diameter) was not able to increase ABA content but retained higher indole-3-acetic acid (IAA). In contrast, IAA content reduced with increase in PBZ dose. Application of 4.0 g PBZ or 1.0%

Table 2.3. Effect of paclobutrazol and KNO_3 on leaf gaseous exchange parameters in litchi cv. China

Treatment	Photosynthetic rate (A) (m mol CO_2 m^{-2} s^{-1})		Transpiration rate (E) (m mol H_2O $\cdot m^{-2} s^{-1}$)		Stomatal conductance (gs) (m mol H_2O $m^{-2}s^{-1}$)		Photosynthetically active radiation (PAR)		Leaf temperature (°C)	
	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)
1.0 g PBZ	5.26	2.56	1.33	0.17	88.00	2.00	915.33	1,472.33	31.63	37.46
2.0 g PBZ	1.30	4.90	1.26	1.53	67.00	27.66	609.33	846.66	33.56	37.36
3.0 g PBZ	4.20	6.53	2.10	1.30	108.33	23.33	1,059.66	1,406.00	33.50	37.00
4.0 g PBZ	3.30	4.93	1.10	1.43	74.33	26.66	498.33	1,409.00	32.06	37.13
1% KNO_3	3.43	4.13	0.90	1.13	45.66	18.00	1,364.33	1,484.66	31.06	38.00
2% KNO_3	2.83	2.30	1.73	0.56	92.00	9.00	966.66	1,357.33	34.23	37.96
Un-treated	4.96	3.93	2.03	0.60	108.66	11.00	1,252.66	1,631.66	33.13	32.33
C.D.	2.15	2.15	0.59	0.43	NS	6.95	328.68	NS	1.24	NS
SE(m)	0.69	0.69	0.19	0.13	13.45	2.23	105.50	155.33	0.40	1.80
SE(d)	0.97	0.97	0.27	0.19	19.02	3.15	149.20	219.67	0.56	2.54
C.V.	33.07	28.64	22.08	24.87	27.92	22.99	19.18	19.60	2.12	8.48

KNO_3 led to higher ABA and lower IAA contents; and over all content of zeatin (Z), dihydrozeatine riboside (DHZR) and zeatin riboside (ZR) marginally improved in higher dose of PBZ application. In litchi cv. Shahi (8 year old), PBZ did not reduced GA_3 but increased ABA with increasing dose. Less concentration of ABA, IAA, DHZR and high ZR was recorded with 1.0 g PBZ in 'China' litchi.

Improving bearing potential though use of girdling cv. China

No new vegetative flushes was recorded after imposition of girdling treatment in the branches of 10 year old litchi tree however, ungirdled branches showed continuous vegetative flushes during November and February month resulted into no flower initiation. Branch and trunk girdling (4 mm) recorded longer healing duration 185.19 and 193.50 days, respectively. Smaller panicle length was recorded in trunk girdling. Girdling (4mm) has significant more number of female flowers in all the treatments. Significantly higher fruit yield of 35.05 kg/plant was obtained in 4mm trunk girdling. Girdling size of 4 mm in 25% primary branches (PB) expressed bigger sized fruit (23.25g) which was at par with 4mm and 75% PB. Endogenous hormones (IAA, ABA, GA_3 and CKs) and gaseous exchange parameters in leaves of China cv. were analysed during floral bud differentiation (FBD) stage and showed variation in floral bud hormonal content due to girdling treatments. Lower levels of GA_3, auxins, ABA and higher level of zeatin was recorded in girdled branches in comparison to ungirdled branches.

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

Effect of application of AMF and other microbial inoculants on fruit quality parameters

The purpose of this study was to evaluate the effect of different microbial inoculants on fruit quality parameters such as TSS, titratable acidity, anthocyanin content, polyphenol oxidase (PPO) activity, peroxidase (POD) activity, and total phenolics. The trees receiving microbial inoculants flowered and fruits were harvested but none of the control trees flowered during 2017 season. Hence for comparison, control fruits were obtained from neighboring plot tree. Physio-chemical changes in litchi fruit packed in perforated polybags stored at ambient condition showed that there was slight increase in TSS from day of harvest to 3rd day but a decrease on 6th day of storage was recorded in all the

treatments including control (Fig. 2.1). The titratable acidity gradually decreased during the storage but the decline was significantly less in fruits obtained from trees receiving microbial inoculants than in control (Fig. 2.1). Anthocyanin and phenol content decreased with increase of storage period in all the treatments. However, fruits of microbial inoculated trees showed significantly less declining trend in anthocyanin and phenol content as compared to other treatments during storage period (Fig. 2.2). Application of microbial inoculants influenced the antioxidant enzyme activity like PPO and POD in the litchi pericarp during storage of fruits. With the lapse of time, activity of these enzymes was enhanced. A significantly lesser values of the enzyme activity were recorded at 0 day, 3rd day and 6th day of storage in fruits obtained from tree receiving microbial inoculants compared to control fruits (Figs. 2.3). Thus these results conclusively prove that application of microbial inoculants to litchi trees improves fruit quality parameters and they have a positive influence on post-harvest life of fruits. A close perusal of the data showed that AMF + TR and AMF+AZ+TR had outperformed than other treatments/combinations.

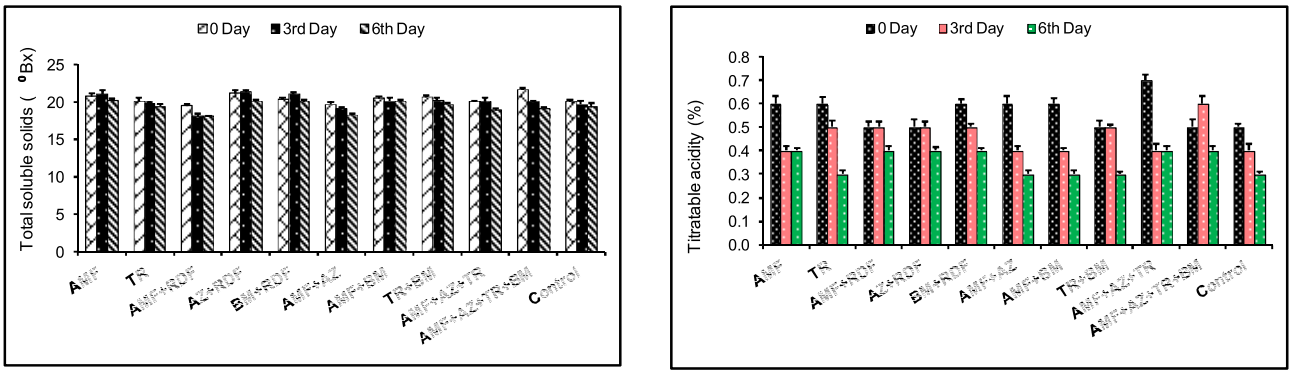


Fig. 2.1. Effect of application of microbial inoculants on total soluble solids (TSS) and titratable acidity (TA) of fruits. The vertical bars indicate standard error (SE) of the mean.

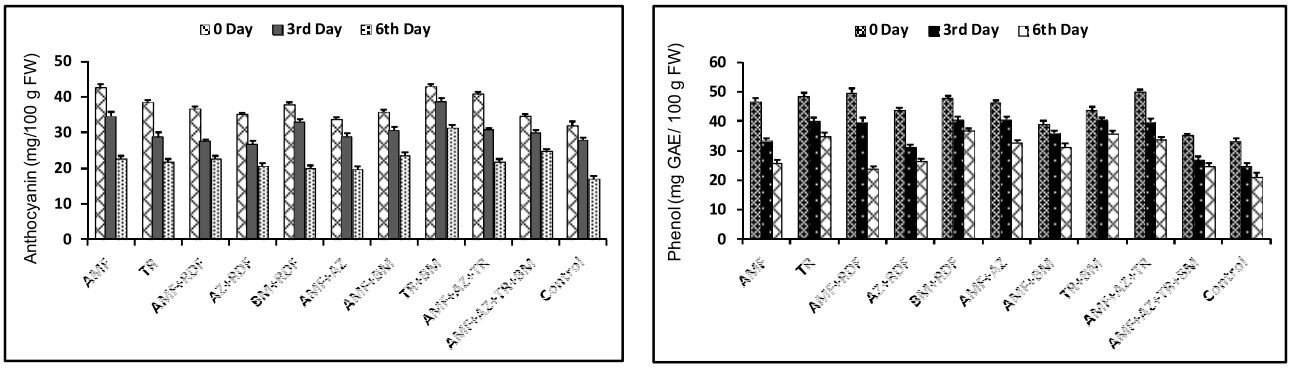


Fig. 2.2. Effect of application of microbial inoculants on anthocyanin and phenol content of fruits. The vertical bars indicate standard error (SE) of the mean.

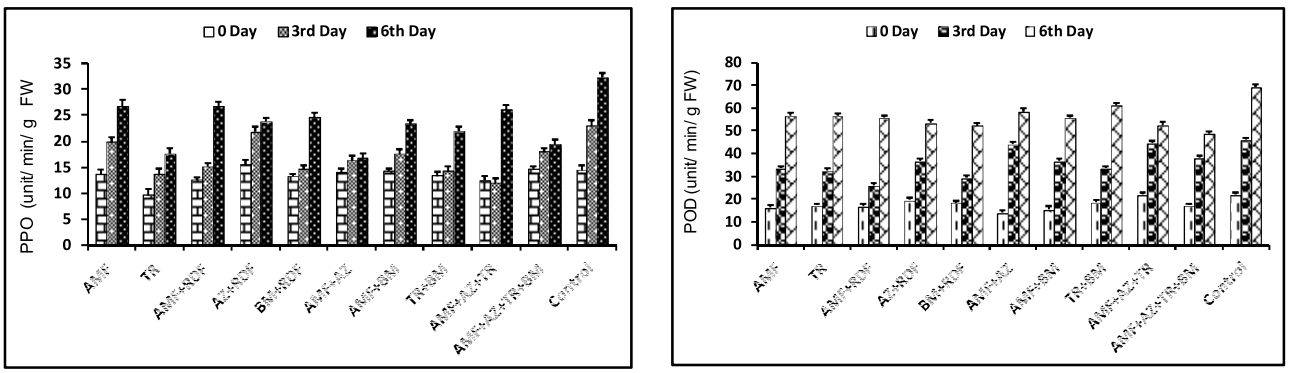


Fig. 2.3. Effect of application of microbial inoculants on polyphenol oxidase (PPO) and peroxidase (POD) activity in fruits. The vertical bars indicate standard error (SE) of the mean.

Effect of application of AMF and other microbial inoculants on fruit diseases

The results showed that all the microbial inoculants had significant effect on reducing incidence of sunburn, cracking, and diseases like anthracnose and fruit blight (Table 2.4). Not only they positively influenced the fruit size but also the percentage of good quality fruits was enhanced (71.9-83.6%) as compared to control (52.6%). Incidence of anthracnose and fruit blight was 0.6-2.7% and 0.0-2.9%, respectively as against 7.0 and 6.4%, respectively in control. No incidence of fruit blight caused by *Alternaria alternata* was observed in some treatments *viz*., TR, AMF+AZ and AMF+AZ+TR. These results clearly reinforce the hypothesis that applications of these microbes protect plants from foliar pathogens by means of activating defence genes responsible for systemic acquired resistance (SAR) thus regulating physiology of plants.

recorded by portable CO_2 gas analyzer. A marked difference in CO_2 emission in tree rhizosphere having application of microbial inoculants was observed compared to control, thus, indicating population difference and increment in cfu with the lapse of time following soil inoculation.

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

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

Treatment	Treatment details*	Good fruit (%)	unburn (%	Cracked (%)	Diseased (%)	
					Anthracnose	Fruit blight
T_1	AMF	81.2	15.4	2.2	0.6	0.6
T_3	TR	78.2	16.9	3.2	1.6	0.0
T_5	AMF+RDF	74.8	18.0	3.6	1.8	1.8
T_6	AZ+RDF	76.8	15.2	4.9	1.8	1.2
T_8	BM+RDF	79.1	12.6	3.8	2.7	1.6
T_9	AMF+AZ	83.6	11.2	4.3	0.9	0.0
T_{11}	AMF+BM	71.9	18.7	5.3	1.2	2.9
T_{14}	TR+BM	77.1	16.0	2.4	3.5	1.0
T_{15}	AMF+AZ+TR	75.7	20.7	3.2	0.4	0.0
T_{18}	AMF+AZ+TR+BM	72.9	20.0	2.9	2.1	2.1
-	Control	52.6	22.7	11.3	7.0	6.4

*AMF (Arbuscular mycorrhizal fungi) @200 g/tree, AZ (*Azotobacter chroococuum*) @100 g/tree, TR (*Trichoderma viride*)@100 g/tree, BM (*Bacillus megatarium*) @100 g/tree; RDF = N 100 g + P 50 g + K 50 g per tree; Control = without any application. Soil based inoculums of AMF contained 25-30 spores per gram, and minimum cfu g^{-1} formulation of AZ, TR and BM was 1×10^6.

Monitoring of microbial activity by measuring soil respiration

The respiration of micro organisms in soil is one of the earliest and still is one of the most frequently used indexes of the microbial activity in soil. Microbial activity by measuring soil respiration in rhizosphere of all the trees receiving different treatments has been

cropping system on bunds includes three tier model 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). Entire system has been damaged due to severe flood occurred during Augut 2017. All the plants of banana, papaya and seasonal crops (cow pea and maize) have been damaged. About 50% litchi plants (both Shahi and China cvs.) were also died due to submergence in water. It was observed that litchi plants which submerged completely for more than 5 days died but some of the plants which had not been completely submerged in water were not died in spite of water stagnation for more than 7 days. Planting of Shahi and China litchi has been done on pond bunds as mortality replacement.

During *rabi* season 2017, maize, lentil, faba bean and mustard crops have been shown in between litchi planted on pond bunds under different models. Among the different seasonal crops, maize recorded the highest green cob yield (14.6 t/ha) followed by faba bean (2.17 t/ha), mustard (1.85 t/ha) and lentil (1.38 t/ha).

Nutrient contents in vermi-compost produced through crop waste utilization: Vermi-compost production with use of crop residues like banana pseudo stem, maize straw, litchi leaves, peels and farm grasses has been done. It is observed that banana pseudo stem was easily decomposed and converted into vermi-compost by the earth worm (*Eisenia foetida*) followed by farm grasses and litchi leaves. Vermiwash was also produced during vermi-compost making. Nitrogen content in vermi-compost made up with litchi leaves ranged with 2.14-2.5%, banana waste 1.97-2.34%, maize straw 2.0-2.24% and farm grasses 1.43-1.73%.

Litchi based cropping system for low land/wet land

Litchi based cropping for waterlogged low lying area has been developed under three planting system (PS I: ridges 3 m bottom width, PS II: ridges 2.5 m bottom width & PS III: mound 1 m bottom dia.) with provision of furrows. All the plants of litchi, banana and papaya were died due to flood; therefore replanting of litchi was done during October 2017 at 8.25x4 m spacing on ridge and mound system. Litchi cvs. Shahi and China were planted with plant population of 61 plants under ridge system and 36 plants on mound system.

Performance of different seasonal crops grown in furrows system of low lying area: Cucurbitaceous vegetables (pumpkin and bottle gourd) and mung bean were grown in furrow system of low lying area during summer season 2017. The highest yield was obtained in pumpkin with the tune of 9.28 t/ha followed by bottle gourd 8.42 t/ha and mung bean 1.92 t/ha. Wheat crop has been sown in furrows during *rabi* season. The grain yield in wheat ranged from 1.82-1.95 t/ha.

Fish culture in deep furrows of litchi based cropping system: Fish culture has been initiated in furrows system maintaining the water depth of about 1-1.5 m throughout the study period under litchi based cropping system models. Fish fingerlings of Indian carp of about 80-100 g weight were released during November 2016 and reared for 6 months. After 6 months of release, fish attained the average body weight of 450-750 g/fish.

Soil pH, EC and nitrogen content in different soil depth (profile) of furrows after receding of water: Soil pH, EC and nitrogen content of soil sediment carried with water runoff and deposited (different layers of soil profile depth) in furrows system (ridge and mound) of low lying area was analyzed after receding of water. The soil pH varied from 8.10 to 8.3 in mound furrow of upper layer to ridge furrow of middle layer. EC value showed decreasing trend (0.28-0.18) with increase in soil depth/layer under ridge furrow while mound furrows showed reverse trend (0.15-0.33). Soil nitrogen content increased with increasing soil profile depth under both the furrows of ridge (92.93-164.61 kg/ha) and mound system (62.26-161.62 kg/ha.).

Study on soil moisture status of ridge and mound system at various soil profile depth: Soil moisture content in different low lying conditions was recorded during January to October 2017. Data showed that the soil moisture content varied with soil profile depth and situation (ridge & mound). Upper 10 cm soil depth recorded higher moisture content (January 13.3-28.9%, April 8.4-21.7%) which was gradually decreased up to 40 cm depth and again increased in 60-100 cm soil depth.

Weather parameters (Temperature & RH) of low lying ridge & furrow system of planting: Temperature and relative humidity of furrows in low lying area were recorded during February to April, 2017 and compared with open area. Data revealed that temperature was little bit less and humidity was more in furrow system than open condition. Furrows system recorded slightly lower temperature (0.3-0.94°C) and high RH (0.5-6.66%) than open condition.

2.5. Integrated soil health management for quality litchi production

The experiment was planned on 96 Litchi tree of cultivar Shahi of age group of 10-12 years in RBD, four trees per unit with 3 replications. Treatments comprising, FYM, fertilizer and microbial consortium were imposed. Observations on flowering, fruiting, plant growth, spread and fruit quality parameters were recorded. The canopy spread during Oct-2017 in east west direction was in the range of 5.9 to 7.2 meter diameter; whereas the spread in north -south direction was 5.8 to 6.8 meter. Plant canopy spread area across the treatment was found in the range of 28.6 to 38.8 m^2 (Table. 2.5). The Plant girth was in the range of 28.36 to 35 cm where as plant height was in the range of 4.82 to 5.54 m (Table 2.6). Out of 96 plants, 94 was under various degree of fruiting during 2017 whereas 66 plant came under fruiting during 2017. Highest fruit yield for a well flowered tree was about 53.75 kg/tree (Table. 2.7).

Table 2.5. Plant canopy spread in east west and north-south direction

Treatments	North-South Spread (m)				East-West Spread (m)			
	Block-I	Block-II	Block-III	Mean	Block-I	Block-II	Block-III	Mean
T 1	7.0	7.3	5.9	6.7	7.3	6.9	5.5	6.6
T 2	6.2	6.9	5.7	6.2	7.0	7.0	6.1	6.7
T 3	7.1	7.1	6.3	6.8	7.3	7.4	6.8	7.2
T4	6.7	6.9	5.6	6.4	6.5	7.4	5.3	6.4
T 5	7.0	7.2	6.3	6.8	7.1	6.2	6.3	6.5
T 6	6.0	6.6	5.7	6.1	6.9	6.7	5.7	6.4
T 7	6.3	6.8	5.1	6.1	7.7	7.0	5.1	6.6
T 8	6.3	6.7	4.3	5.8	6.5	6.5	4.8	5.9
Mean	6.6	6.9	5.6	-	7.0	6.9	5.7	-

Table 2.7. Fruit yield under different treatments across the block

Treatments	Block-I	Block-II	Block-III	Yield (kg/tree)
T 1	28.25	50.25	23.25	33.9
T 2	30.0	32.0	48.25	36.8
T 3	48.75	44.25	47.75	46.9
T4	40.25	37.75	43.0	40.3
T 5	53.75	30.5	37.5	40.6
T 6	40.75	28.0	22.0	30.3
T 7	44.0	38.25	14.75	32.3
T 8	46.75	31	14.25	30.7

Table 2.6. Plant girth (cm) and height (m) under different treatments

Treatments	Block-I		Block-II		Block-III		Avg. girth	Avg. height
T 1	40.20	5.58	39.22	5.88	25.50	4.50	34.98	5.32
T 2	33.81	5.40	37.65	5.93	27.21	5.15	32.89	5.49
T 3	41.05	5.94	41.05	5.61	33.61	5.08	38.57	5.54
T4	34.19	5.11	40.13	5.70	23.26	4.58	32.53	5.13
T 5	38.67	5.88	34.91	5.64	30.97	4.83	34.85	5.45
T 6	32.82	4.88	34.45	5.58	25.64	4.58	30.97	5.01
T 7	38.47	5.63	37.31	5.06	20.85	4.06	32.21	4.92
T 8	32.28	5.61	33.87	5.20	18.93	3.64	28.36	4.82

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

Alternaria alternata has been an important pathogen of litchi causing blights of leaf, panicle, and fruits. Incidence and severity of leaf blights in nursery plants recorded during April-July 2017 revealed that mean disease incidence among plants in six nurseries ranged between 5.7-20.0%. The mean and range of disease incidence among leaves of infected plants were 12.0-65.0% and 5.3-80.0%, respectively (Fig. 3.1). Further, the mean percent disease severity index (PDI) ranged from 37.8 to 78.1. It is also observed that initially senescing leaves were infected but with the progression of the disease all the leaves become blighted except a few upper leaves.

Disease incidence of panicle blight ranged from 12.0-28% in cv. Shahi' and 23.8-47.6% in China (Table 3.1). The distribution of trees based on severity scale (% infected panicles on trees) is given in Fig. 3.2. The mean disease incidence of fruit blight on trees in farmers' orchard in Muzaffarpur, Bihar during June 2017 varied from 5.3 to 12.7% while the range was 2.3-17.6% (Fig. 3.3). The trend of incidence is similar to 2015 and 2016 seasons where the mean incidence remained between 6.6 to 17.3%. The distribution of blighted fruits in the tree in four cardinal directions (N, S, E, and W) showed no association with particular direction. The fruit blight incidence was sporadic in nature. Weather parameters during flowering and fruiting period of litchi during 2014-2016 were: T_{max} = 31.1-40.7 °C, T_{min} = 17.4-27.2 °C, RH_{max} = 60.0-85.0%, RH_{min} = 23-57%. The analysis of prevailing weather conditions revealed that a temperature of about 28-30 °C and humidity 60 to 85% were congenial for panicle and fruit blights disease. Trend lines plotted on weather graph showed that the disease severity were more between T_{min} 20-22 °C and T_{max} 32-35 °C.

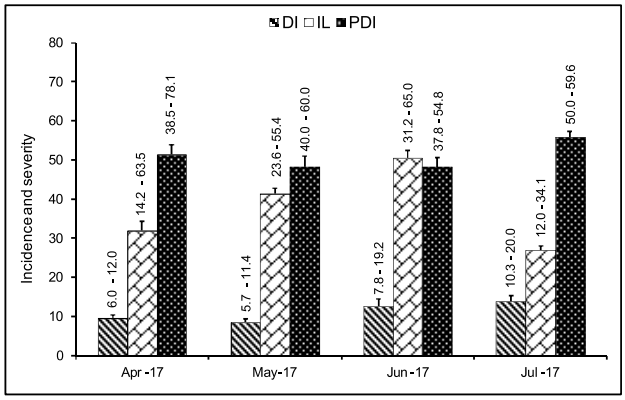


Fig. 3.1. Disease incidence (DI), percent infected leaves (IL) and percent disease severity index (PDI) of leaf blight disease on nursery plants of litchi during 2017 at NRCL Experimental Farm, Muzaffarpur. Height of columns indicates the mean value of parameters in six nurseries, whereas the value above bars indicates the range in samples; the vertical bar indicates standard error (SE) of the mean. The least significant difference (LSD) at *P*=0.05 for DI, LI and PDI were 3.75, 5.64, and 5.90, respectively.

Table 3.1. Disease incidence and severity of panicle blight during 2017 season*

Block/ Orchard	Disease incidence (%)	% distribution of trees in various severity categories				
		<20	21-40	41-60	61-80	>80
cv. 'Shahi', April 2017						
I	20.8	40.0	60.0	0.0	0.0	0.0
II	28.0	71.4	28.6	0.0	0.0	0.0
III	25.4	20.0	53.3	26.7	0.0	0.0
IV	12.0	100.0	0.0	0.0	0.0	0.0
V	27.0	83.3	8.3	8.3	0.0	0.0
VI	18.5	60.0	20.0	20.0	0.0	0.0
cv. 'China', May 2017						
I	37.5	83.3	16.7	0.0	0.0	0.0
II	23.8	70.0	30.0	0.0	0.0	0.0
III	31.6	75.0	16.7	8.3	0.0	0.0
IV	47.6	90.0	5.0	5.0	0.0	0.0
V	31.4	75.0	12.5	12.5	0.0	0.0

*Values in the table are based on observations taken on all the trees (n = 60-78) of the orchard.

Aetiology of panicle and fruit blight to fulfill Koch's postulates

Panicle inoculation tests were conducted by spraying four bunches of panicles on orchard trees with 20 mL of a 10^6 conidia/mL suspension per bunch under natural daylight conditions. The panicles were then covered with thin plastic bags that had several small holes for aeration. Six developing fruit (approx. 45 days after fruit set) were inoculated with 20 mL of a conidial suspension following similar methods as for the panicle inoculation tests. Symptom development was monitored daily. Fungi from lesions which formed on the inoculated plant tissues were re-isolated on PDA as described above. The morphological and cultural characteristics of the re-isolated organisms were compared with the original isolates. Panicle blight and fruit blight symptoms appeared apparent after 10 days. No symptoms were observed on control panicles, or fruit. Re-isolation of fungi with the same morphological characters was achieved from symptomatic plants/tissue, but not healthy control plant tissue, confirming the causal agent as *A. alternata*. Cross infectivity of the three leaf blight strains for panicles and fruit infection was observed with varying severity, and conversely panicle and fruit blight isolates caused leaf infection.

Thermal death point of conidia of *Alternaria alternata*

The conidia (spores) were harvested from actively growing culture of *Alternaria alternata* on PDA. These spores were suspended in 100 ml sterile distilled water (stock solution). An aliquot of 10 ml each in culture tubes were incubated at different temperature and time duration in a precision water bath. 0.5 ml spores suspension was then spread on PDA plate and incubated at 28 ±1 °C. Plates were observed for spore germination and development of mycelia mat at 24 hr interval. Results showed that conidia of *A. alternata* was not able to germinate and produce mycelia when exposed up to 45 °C incubated for 15 minutes duration but it tolerated an exposure upto 10 minute at 45 °C. The highest conidial germination was observed at 35 °C and the lowest at 50 °C. The highest radial mycelia growth was recorded at a temperature of 30 °C.

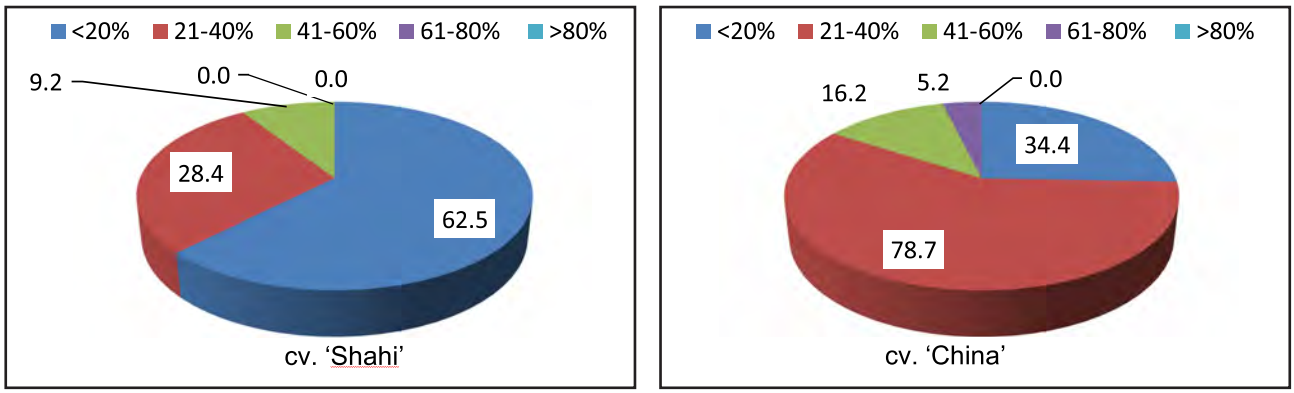


Fig. 3.2. Percentage distribution of trees in various severity categories of panicle blight during 2017 season; data presented is the average value of 6 and 5 orchard of cv. 'Shahi' and 'China', respectively

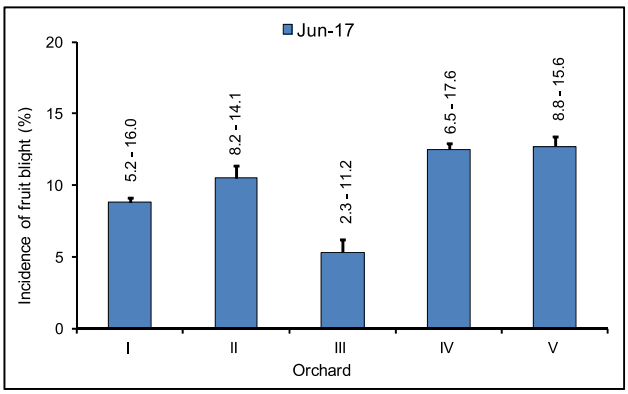


Fig. 3.3. Incidence of fruit blight disease during 2017 seasons recorded in June month on litchi cv. 'China' on trees in farmers' orchard in Muzaffarpur, Bihar. Height of columns indicates the mean disease incidence, whereas the value above bars indicates the range in samples; the vertical bar indicates standard error (SE) of the mean. The least significant difference (LSD) at *P*=0.05 for disease incidence is 1.06.

Effect of environmental factors on growth and sporulation of *Alternaria alternata*

Ideal pH level for the growth was 6.0 (Fig. 3.4). The maximum growth rate of colony (mm/hr) was observed in litchi leaf extract dextrose agar medium though the highest sporulation was observed in the potato dextrose agar medium at 28 °C. Light had no significant influence on mycelium growth as it was found equally good under complete light, complete dark and alternate 12 hr light and dark conditions. The results of the studies conducted will be helpful in understanding the epidemiology of this important disease of litchi.

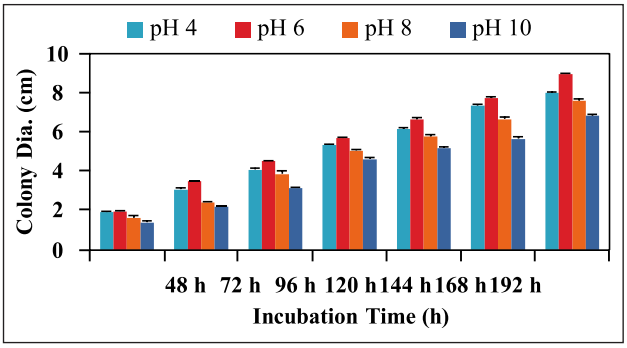


Fig. 3.4. Effect of pH on mycelia growth (colony diameter) of *Alternaria alternata* on PDA incubated at 28 ± 1 °C

Bioassay for antifungal activity of some plant extracts to manage *Alternaria alternata* in litchi

The bioassay of aqueous and methanolic extracts of some ethno medicinal plant infusions, and materials used in ZBNF (Zero budget natural farming) for the antifungal activity against *Alternaria alternata* was done under *in-vitro* conditions. The preliminary results suggest that the leaf extracts of *Datura stramonium* and *Calotropis procera* are important possess antifungal compounds (Fig. 3.5) that can be harnessed for development of formulations or simply as a crude extract application for the management of *A. alternata*. These observations, however, are just indicative and needs to be confirmed

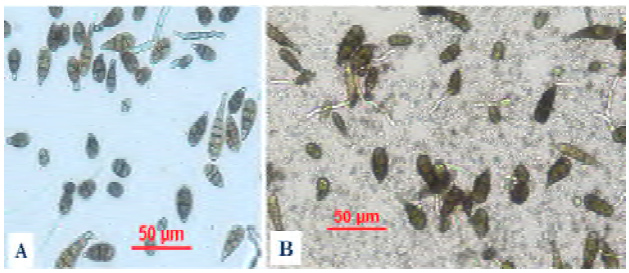


Fig. 3.5. *In vitro* spore germination test (Slide Germination Method): A. *Calotropis procera extract,* B. Control

Table 3.2. Effect of application of *Trichoderma viride* on litchi trees affected by wilt and its population dynamics at NRCL Experimental Farm, Muzaffarpur during 2015-2017

Tree no.	Age of the tree	Cultivar	Tree conditions before application	Time taken for complete recovery (days)	Population of *Trichoderma* sp. in rhizosphere (10^3 cfu /g of soil)			
					0 day	15 day	30 day	45 day
1	10	Shahi	Yellowing and drooping of leaves	25	6.67	19.33	38.00	27.91
2	15	Shahi	Tree decline, yellowing and drooping of leaves	30	4.30	15.07	37.33	28.83
3	5	China	Tree decline	25	5.00	13.02	30.99	27.91
4	6	Shahi	Early symptoms of tree wilting	20	5.63	15.99	32.86	28.83
5	5	China	Early symptoms of tree wilting	20	5.86	25.81	34.97	30.99
6	13	Shahi	Tree decline, partial wilting	35	4.90	23.16	42.86	35.33
7	2	China	Yellowing and drooping of leaves, stunted growth	20	6.47	18.62	34.97	27.91
8	4	Shahi	Yellowing and drooping of leaves, stunted growth	20	2.10	22.38	60.53	48.83
9	6	Shahi	Early symptoms of tree wilting	25	5.07	19.33	37.91	30.99
10	12	Shahi	Tree decline, partial wilting	30	3.67	19.67	35.33	32.86

by repeating aforesaid experiments and by studying some more parameters.

Evaluation of *Trichoderma* sp. against litchi wilt under glasshouse and field conditions

The results showed that all the potted plants having inoculation of only *F. solani* wilted in 20-30 days post inoculation, while the plants having application of talc based formulation of *Trichoderma viride* isolate NRCL T-01@ 50 g/plant plus *F. solani* did not wilt indicating the efficacy of the isolate to manage litchi wilt caused by *F. solani*. From the rhizosphere soil samples and fine root bits of wilted plants, *F. solani* was isolated on PDA medium that proves cause of wilting as inoculation with *F. solani.*

The results of the field evaluation of the *T. viride* isolate NRCL T-01 (Table 3.2) demonstrated that it effectively controlled the wilt pathogen and trees recovered in 20-35 day depending on the age and initial condition of the tree. Application of *Trichoderma* formulation resulted in not only 100% recovery of affected trees but also the trees regained vigour and returned to normal health (Fig. 3.6). The population dynamics of *Trichoderma* sp. in tree rhizosphere showed that at the time of application, the total count of viable prapagules were 2.10-6.67×10^3 cfu/g soils which increased up to 30 days of application (30.99-60.53×10^3 cfu/g soils). It is probably an important character in quick colonization of rhizosphere possibly because of the hydrolysed organic matter**s.**

Feasibility of mixing of recommended agrochemicals for litchi crop management

In litchi, various agrochemicals are recommended to be applied at different phenophases like at panicle emergence spray of chlorothalonil/carbendazim/ difenoconazole is recommended to control panicle blight and chlorphenpyr/propargite to control litchi mite. Likewise, just after fruit set application of planofix to check fruit drop, thiacloprids or imidacloropid to check fruit borer is recommended. During colour break stage, application of borax and GA_3 for quality fruits, thiacloropid/ë-Cyhalothin/emamectin benzoate/ novaluron to check fruit borer and carbendazim or difenoconazole or chlorothalonil to manage blight and postharvest diseases are recommended. Hence, experiment was conducted to see the feasibility of mixed spray application of these agrochemicals. The results showed that the liquid formulations of these agrochemicals mixed well compared to wettable powders. After spraying on litchi trees, no adverse effect like burning of the leaf, fruit or any undesirable changes were noticed (Table 3.3). However, the biological effect of mixed spray, need to be confirmed on litchi as well

Fig. 3.6. Effect of NRCL *Trichoderma* application; Left- A young tree of litchi whose growth was stopped, Right - Healthy tree after the use of *Trichoderma*

Table 3.3. Feasibility of mixing of recommended agrochemicals in litchi as mixed spray application

Treatment comb.	Treatment details	Observations		
		0 hour	2 hour	5 days
1	Planofix (2 ml/ 5L) + Thiacloprid (3.5 ml/ 5L)	Watery Transparent	No change in colour, no precipitation	Unchanged, No Precipitation, No change in colour
2	Planofix (2 ml/ 5L) + Thiacloprid (3.5 ml/ 5L) + Carbendazim (10 g/ 5L)	Thick off white milky Light reddish in colour	Light pink, no precipitation	Unchanged, No Precipitation, No change in colour
3	Planofix (2 ml/ 5L + Imidacloprid (3.5 ml/ 5L) + Difenoconazole (10 g/ 5L)	Watery, thin consistency milky	Unchanged	Unchanged, No Precipitation, No change in colour
4	Planofix (2 ml/ 5L) + Thiacloprid (3.5 ml/ 5 ml) + Chlorothalonil (10 g/ 5L)	Milky creamy white but lighter in colour than Treatment -2	Unchanged	Unchanged, No Precipitation, No change in colour

Table 3.4. Effect of application of different fungicide on incidence of fruit blight disease under field conditions during 2017 season

Treatments	Treatment detail	Dose		Fruit blight (%)
		Active ingredient (%)	Formulation (mL or g/L)	
T_1	Chlorothalonil (75%WP)	0.15	2.0	1.96
T_2	Thiophanate methyl (70 %WP)	0.14	2.0	1.89
T_3	Carbendazim (50%WP)	0.10	2.0	1.96
T_4	Copper oxychloride (50%WP)	0.10	2.0	1.76
T_5	Difenoconazole (25%EC)	0.05	2.0	1.80
T_6	Hexaconazole (5% EC)	0.01	2.0	2.67
T_7	Mancozeb (75%WP)	0.187	2.5	3.68
T_8	Propiconazole (25%EC)	0.05	2.0	8.15
T_9	Propineb (70%WP)	0.175	2.5	6.71
T_{10}	Azoxystrobin (23%SC)	0.023	1.0	2.43
T_{11}	Metiram+Pyraclostrobin (55%+5% WG)	0.055 + 0.005	1.0	3.10
T_{12}	Mancozeb +Carbendazim (63% +12% WP)	0.126 + 0.024	2.0	9.15
T_{13}	*Trichoderma viride*	2.0	*	4.74
T_{14}	*Bacillus subtilis* BS-01	2.0	**	3.96
T_{15}	Chitosan	1.0	-	4.80
T_{16}	Control (DW)	-	-	13.48
	C.D. (p=0.05)			0.68
	SE(m) ±			0.14

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

as on annual plants recording observations on expected biological effect of individual agrochemicals.

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

Twelve different fungicides, two antagonists and one defense activator (chitosan) were evaluated against fruit blight (*Alternaria alternata*) disease under natural infection field conditions. Results showed that the disease incidence of fruit blight was 1.76-3.68% in the effective fungicidal treatments as against 13.48% in control trees of orchard at NRCL experimental farm. Chlorothalonil, thiophanate methyl, difenoconazole and mancozeb were found effective and statistically at par in controlling fruit blight disease (Table 3.4).

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

Seasonal abundance of insect pests associated with litchi

Survey of litchi fruit & shoot borer (*Conopomorpha sinensis*) at farmers' field from early stage to harvest stage in 2017 revealed that infestation ranged from 2.67% to 61.33%. Incidence of litchi fruit & shoot borer has been observed in all litchi growing areas *viz*., Bihar, West Bengal, NEH, U.P., Uttarakhand, Punjab, J&K, H.P., Karnataka and Kerala. Litchi mite (*Aceria litchi*) another very serious pest of litchi was also noticed in all areas while, litchi bug (*Tessaratoma javanica*) was observed at Uttarakhand, Punjab, J&K, Jharkhand and Bihar. Among weevil complex, both ash weevil (*Myllocerus undecimpustulatus*) and red weevil (*Apoderus blandus*) were observed at all the places except red weevil in NE region. Among lepidopteran defoliators, leaf folder (*Platypeplus aprobol*) was observed as major defoliators of litchi in all the litchi growing areas while, litchi looper (*Perixera illepidaria*) was recorded at Bihar and U.P. Bark eating caterpillar (*Indarbela quardinotata*) is an another common lepidopteran pest, also infesting litchi plants while, semilooper (*Trichoplusia* spp.) was observed only at Uttarakhand.

Migration pattern of litchi fruit borer

To study the migration pattern of litchi fruit & shoot borer net caging of litchi plants were done at fortnightly interval from 1st March 2017 to 30th April 2017. No population was observed when plats were caged on 1st March and 15th March. Minimum borer population (3.67/plant) was observed on 31st March while maximum (54.28/plant) borer population was observed with plants caged on 30th April.

Management of litchi fruit borer using combination of insecticides based IPM modules

Field trials was conducted to evaluate the different insecticides combination 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%) + chlorantranilprole 18.5 SC (0.007%); Module 3: neem formulation 0.15% (0.009 %) + beta-cyfluthrin 8.49% + imidacloprid 19.81% (0.011%); Module 4: neem formulation 0.15% (0.009%) + flubendiamide 19.92% + thiacloprid 19.92% (0.48%); Module 5: neem formulation 0.15% (0.009%) + spirotetramat 11.01% + imidacloprid 11.01% (0.36%). 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 module at clove size fruit, cardamom size and after 10 days of third spray (about 15 days before harvest), respectively. At early stage, due to low population of borer, all the modules registered 0.00 borer population except Module 5 i.e. spirotetramat 11.01% + imidacloprid 11.01% (1.33%) against 3.00% in control. At harvest stage, minimum fruit infestation (4.54%) was recorded with Module 4 i.e. spray of flubendiamide 19.92% + thiacloprid 19.92% followed by Module 5 (5.89%) against 59.67% fruit damage in control.

Efficacy of spiromesifen against litchi mite

Litchi mite is the threat to litchi growers as both nymphs and adults damage the leaves, inflorescence and young developing fruits. Therefore, keeping in view the importance of litchi mite, *Aceria litchii* field trials was conducted for its management. Experiment was laid out in RBD design with seven treatments comprising pruning of affected twigs (July & October) and spraying of miticides (chlorfenapyr 10 EC (0.03%) & spiromesifen 22.9 SC (0.034%) twice in July and once in October to evaluate the efficacy of various integrated approaches. Litchi mite infestation on shoots was recorded at initial stage and after imposition of the treatments. Mite infestation ranged between 31.93 to 45.93% at initial stage of observation before imposing treatments. Maximum reduction (0.63%) of litchi mite infestation was noticed with spraying of chlorfenapyr along with pruning of affected portion followed by spiromesifen (2.33%) during July month observation after 15 days of spray schedule against pruning alone (7.33%) and control (47.18%). Least infestation under the treatments of pruning of infested shoots along with chemical spray proved their efficacy to check the further spread of mite population. The observation in the month of October revealed that litchi mite infestation gradually increased over July infestation. The infestation

level was highest (58.48%) in untreated plant (control) followed by pruning treatment alone (16.93 & 14.25%) with lowest level in treatments namely, chlorfenapyr (2.18%, 3.93%) and spiromesifen (4.67%, 5.66%) before imposition of treatments in October month. Increase in level of mite infestation during October month over July under all the treatments might be due to population of mite left over coupled with prevalence of favourable weather condition along with emergence of new flush resulted in higher infestation. At 15 days after management schedule followed in October, no further infestation of litchi mite was noticed in miticides sprayed plants coupled with pruning in July and October.

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

Although early morning commencement of harvest operation is a set practice in the litchi industry, growers normally resort to harvesting until evening or late day light hours. Due to high environmental temperature, fruits harvested during afternoon hours have high metabolic rate and reduced shelf life. In continuation of earlier studies, an experiment was conducted to ascertain the effect of harvest time on postharvest storage behaviour of litchi. Fruits were harvested at three different time slot viz. 4-6 AM, 6-9 AM and 9 AM-12 noon. Harvested fruit were packed in commercially-practised packaging methods *viz.* wooden boxes, CFB boxes with and without polymer lining. Fruits harvested between 4-6 AM recorded significantly higher peel thickness and peel moisture content, and lower fruit temperature and respiration rate, compared to fruits harvested in later period. After storage for 5 days at ambient condition, fruits harvested between 4-6 AM packed in polymer lined CFB boxes recorded significantly lower loss in weight (6.50%), higher anthocyanins content (30.15 mg/100g) and percentage of marketable produce (75%), as compared to fruits harvested after 6 AM. It was found that late-harvested fruits (harvested after 9 AM) did not store well and only about 58% remained marketable after 5 days.

4.2. Investigation and management of postharvest losses in litchi

Pre-harvest application of senescence regulators on colour development in litchi pericarp

Colour is one of the most important fruit quality parameters in litchi. It plays a vital role in fetching good prices for farmers and also weighs on the consumers' decision to purchase. Red colour of litchi fruit is due to the biosynthesis and accumulation of anthocyanins in pericarp. Fruits located under the dense canopy or under shaded portions do not exhibit proper colour development, and remain green or pale yellowish until maturity (Fig. 4.1). Poor colour development in litchi is also an issue in locations where climatic requirement is

Fig. 4.1. Poor colour development in fruits under shaded area or under dense canopy

Fig. 4.2. Colour development in response to pre-harvest application of ABA and ethrel

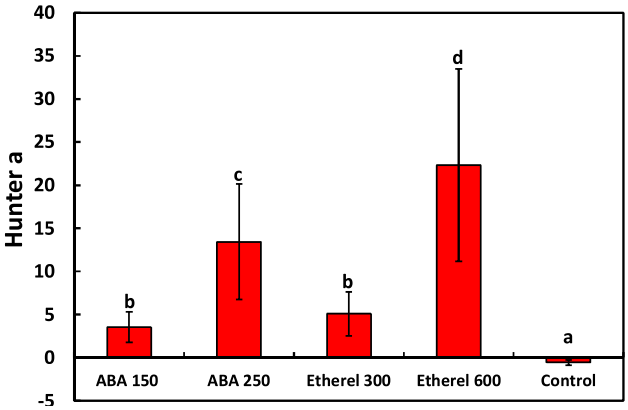


Fig. 4.3. Hunter 'a' values at harvest of litchi fruit subjected to preharvest application of ABA and Ethrel

far from optimum. An experimental trial was conducted to study the effect of pre-harvest application of senescence regulators on colour development in litchi pericarp. Absicic acid (ABA) and ethrel were applied at different concentrations during colour break stage (corresponding to 6th May 2017) in litchi cv. Shahi. Treated fruits had visible differences in fruit colouration over untreated fruits (Fig. 4.2). Among the treatments, fruits treated with ethrel @ 600 ppm, followed by ABA @ 250 ppm had significantly higher red colour development as evidenced by higher Hunter 'a' values over control (Fig. 4.3).

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

This study was conducted to compare the effects of various post harvest dip treatments including fruit plane antagonists, when fruits are stored at ambient conditions (36±2 °C temperature and 76±6% R.H.). The antagonists were *Bacillus subtilis* (isolate NRCL BS-01, BS-02, BS-03, BS-04 and BS-05), yeast (isolate Y1) and *Trichoderma* (NRCL T-01) and their combinations. The concentration of postharvest dip solution with *B. subtilis* and yeast isolates were 1×10^8 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, the lowest activity of PPO and POD on 3rd day (14 & 25 unit/min/g FW, respectively) and 6th day (19 & 44 unit/min/g FW, respectively) of storage was observed in fruits treated with *Bacillus subtilis* NRCL BS-01 as compared to control (Figs. 4.4 and 4.5).

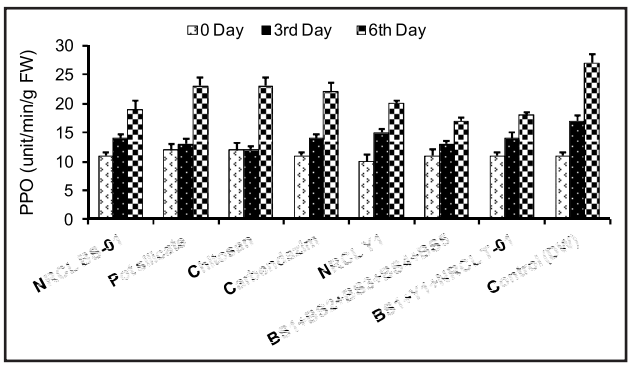


Fig. 4.4. Effect of various post harvest dip treatments on PPO activity. The vertical bars indicate standard error (SE) of the mean. The least significant difference (LSD) at *P*=0.05 for o day, 3rd day and 6th day were NS (Non-significant), 1.94 and 3.41, respectively.

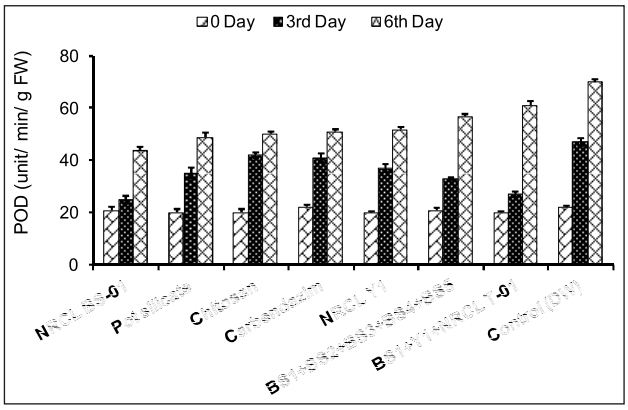


Fig. 4.5. Effect of various post harvest dip treatments on POD activity. The vertical bars indicate standard error (SE) of the mean. The least significant difference (LSD) at *P*=0.05 for DI, LI and PDI were NS (non-significant), 2.14 and 3.10, respectively.

Effect on changes in total soluble solids, titratable acidity, anthocyanin and phenol content: Total soluble solids of litchi fruits increased marginally up to 3rd day of storage with dip treatment of antagonists but decreased significantly in chemicals dip and control treatments. However, decline in TSS of fruits was observed from 3rd to 6th day in all the treatments. A non-significant decrease in titratable acidity of fruits was observed between different treatments (Table 4.1).

Table 4.1. Effect of antagonists and other treatments on TSS and titratable acidity

Treatment	TSS (°Bx)			Acidity (%)		
	0 d	3 d	6 d	0 d	3 d	6 d
Bacillus subtilis (NRCL BS-01)	21.5	22.3	19.6	0.5	0.4	0.4
Pot silicate	21.2	21.8	20.4	0.6	0.5	0.4
Chitosan	21.4	20.0	19.2	0.6	0.5	0.4
Carbendazim	21.3	20.1	19.0	0.5	0.4	0.4
NRCL Y1	21.1	22.0	21.0	0.5	0.5	0.3
BS1+BS2+BS3+BS4+BS5	20.3	21.5	20.0	0.5	0.5	0.4
BS_1+Y_1+ NRCL T-01	20.8	18.9	19.0	0.6	0.5	0.4
Control	20.5	19.7	19.4	0.5	0.4	0.3
C.D. (p=0.05)	0.70	1.01	NS	NS	NS	NS
SE(m) ±	0.10	0.13	0.38	0.06	0.05	0.09

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

The anthocyanin and phenol contents declined with progress of time in all the treatments but significantly less reduction was observed with antagonists' treated fruits (Table 4.2). Anthocyanin content in fruits treated with NRCL BS-01 on 3rd and 6th day after treatment was 32 and 24 mg/ 100 g FW compared to 28 and 18 mg/ 100 g FW in control, respectively. It was observed that fruits treated with carbendazim have a sort of bleach effect on colour of fruits. The treatments also resulted in better organoleptic quality of the fruits during storage at ambient conditions.

Table 4.2. 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)	36	32	24	39	30	23
Pot silicate	36	23	14	38	23	21
Chitosan	36	18	13	38	29	20
Carbendazim	34	22	12	37	26	19
NRCL Y1	37	24	20	39	32	25
BS1+BS2+BS3+BS4+ BS5	35	25	19	42	31	18
BS_1+Y_1+ NRCL T-01	37	29	22	41	30	18
Control	35	28	18	40	32	27
C.D. (p=0.05)	NS	1.3	1.9	2.0	2.2	2.7
SE(m) ±	0.3	0.6	0.4	0.7	0.6	0.8

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

Effect on post-harvest fruit decay: The data on progressive fruit decay (rots) up to 6th day of treatment is presented in Fig. 4.6. The results indicated that *Bacillus subtilis* isolate NRCL BS-01 and its combination treatment with other strains (BS1 + BS2 + BS3 + BS4 + BS5) was very effective in controlling fruit decay as significantly

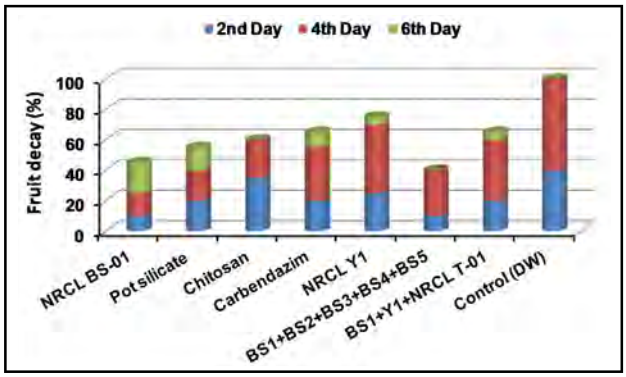


Fig. 4.6. Effect of postharvest dip treatments on progressive fruit rot

less rotting was observed in these treatments compared to control. All the fruits in the control treatment were rotten on 4th day.

4.3. Processing and value addition in litchi studies on preservation of litchi pulp

Development of minimally processed RTE litchi pulp

A study on minimal processing of litchi aril was conducted to develop ready-to-eat (RTE) pulp (Fig. 4.7). Minimal processing involved peeling and de-stoning of litchi fruit, and subjecting the edible pulp to mild antimicrobial treatments, anti-browning and firmness regulators. The de-stoned litchi fruits were packed in sterilized plastic trays, wrapped with cling films and stored under refrigerated conditions (5±1 °C). Blanching litchi aril in combination with KMS (1500 ppm), 0.2% $CaCl_2$ and 0.2% ascorbic acid resulted in highest sensory and organoleptic rating.

Fig. 4.7. Minimally processed litchi

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

Response of pre-harvest polyamines treatments on enzymatic activity of litchi pericarp

Polyphenol oxidase and peroxidase enzyme activities play a major role in litchi fruit pericarp browning. PPO and peroxidase enzyme activity in litchi pericarp was observed. These values displayed negative correlation with L* values, thus recording the decrease in bright red colour of litchi fruit pericarp. Polyphenol oxidase enzyme activity was about two fold higher in untreated fruits than treated fruit. Peroxidase enzyme activity in fruit pericarp was higher than polyphenol oxidase activity and it shooted upto ~250 units/min/g FW. Putrescine @ 0.5mM and Spermine @ 0.5mM do not show significant difference in PPO and POD enzyme activities and at the end of the storage period, the bright red colour of fruit pericarp had majorly disappeared (Fig. 4.8). Pre-harvest spray with spermine @ 0.5mM was found effective for lowering enzyme activity.

Response of post harvest polyamines treatments in combination with pre-harvest polyamine treatments on fruit pericarp colour

Pre-harvest sprays synergistic with postharvest immersion treatments of putrescine and spermine @ 0.5 mM were applied on Shahi litchi. Bright red pericarp colour of litchi fruit turns to brown colour. The colour value was expressed as L* (0: dark, 100: white), a* (negative value: green, positive value: red) and b*

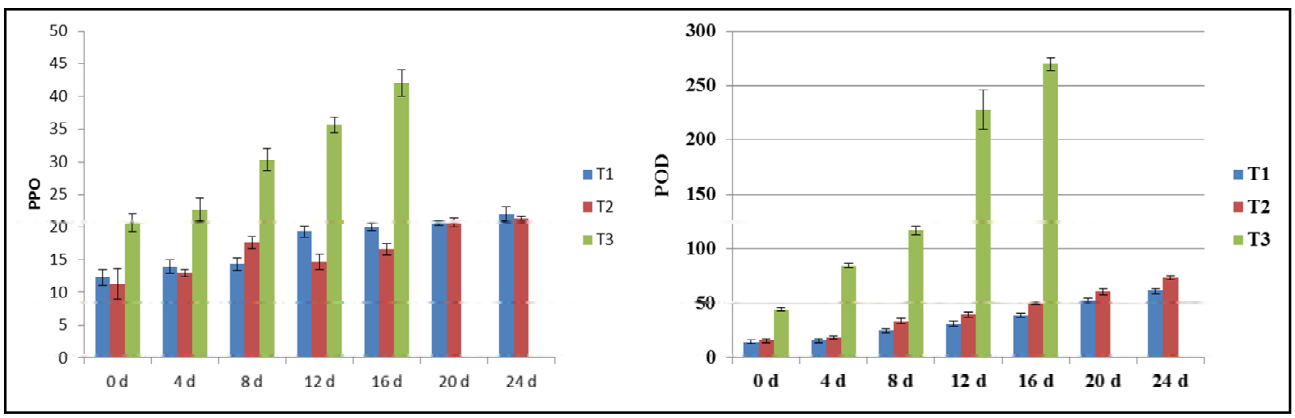


Fig. 4.8. PPO and POD enzyme activity (Unit/min/g FW) in litchi fruit pericarp

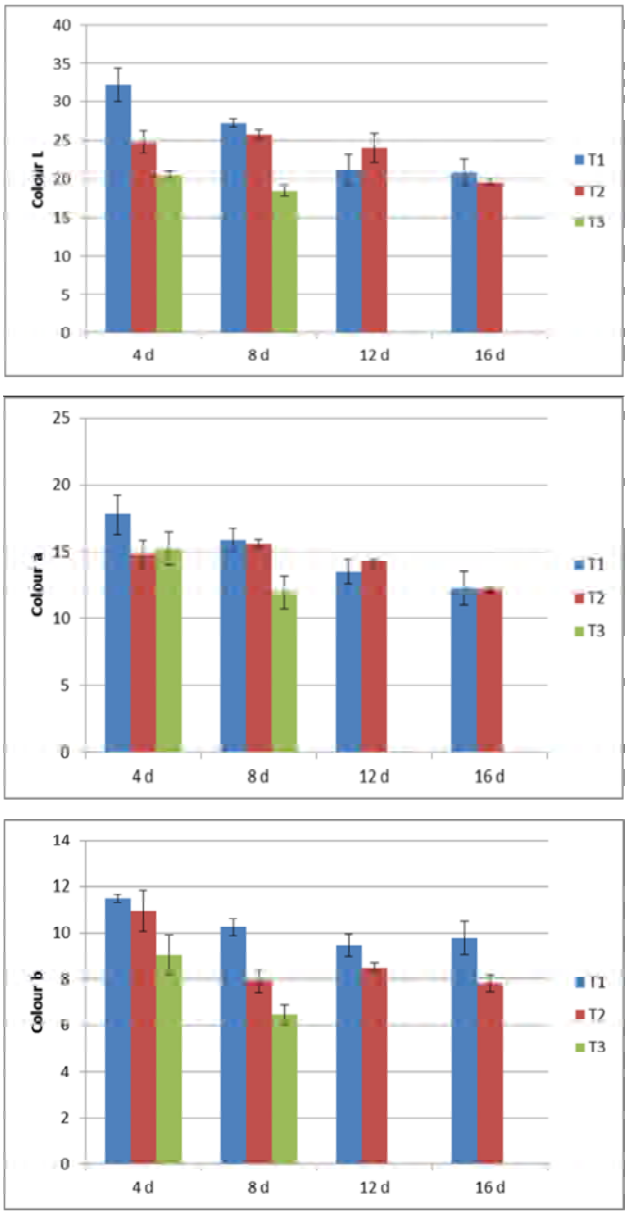


Fig. 4.9. Fruit pericarp colour (L*, a* and b*) value of Shahi litchi as influenced by different polyamine treatments

(negative value: blue, positive value: yellow). The L*, a*, b* values of litchi were significantly affected by treatments during storage. There is a continuous decrease in L*, a* and b* values in litchi with ripening. However, polyamine treatments maintained the pericarp colour significantly. Untreated litchi fruits showed a faster decline in L*, a* and b* values over treated fruit. Lowest a* value (~12) was recorded in control fruits on 8th day of storage while the treated fruits recorded on 16th day of storage (Fig. 4.9).

4.5. Estimation and quantification of methylene cyclo propyl glycine (MCPG) content in fruits of litchi genotypes

The study was conceptualized for developing an analytical method for estimation of MCPG in litchi fruit. Shahi and China litchi fruits of three different stages *viz.* stage 1 (30 days before harvest, DBH), stage 2 (15 DBH) and stage 3 (fresh ripe fruits) have been selected for study. The fruits were partitioned into pericarp, pulp and seed. MCPG concentration in Shahi litchi seeds was found to increase (11, 38 and 109 mg/kg FW, respectively) in stage I, followed by stage II and maximum amount in seeds of ripe fruit. Accumulation of MCPG showed a similar pattern during growth period of China fruit. Reduced MCPG levels were recorded in fresh ripe litchi peel than at stage 1 or stage 2 in Shahi and China cultivars.The MCPG content in peels almost doubled during growth while advancing from stage 1 to stage 2, followed by lower content in stage 3 peels. No pulp development was found in unripe stage 1 Shahi and China litchi fruits, when they are at clove stage of growth. Thus, there cannot be any MCPG at such growth stage. The fresh ripe fruits showed ~10 ppm MCPG in China and Shahi litchi. The MCPG content in pulp of litchi fruit is at very low level (Table 4.3).

Table 4.3. MCPG content (ppm) in different stages and parts of China litchi

Sample	MCPG content (ppm)
China seed stage (1)	20
China seed stage (2)	28
China seed (ripe)	77
China pulp stage (1)	NF
China pulp stage (2)	7.2
China pulp	8.7
China peel stage (1)	27
China peel stage (2)	29
China peel	21

*NF-Not Found

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

5.1. Tribal Sub Plan Project

Under TSP, a tribal farmer dominated district of Sahdol (M.P.) was selected to showcase the NRCL technologies and other interventions to enhance the knowledge and skill of the farmers, along with their income generation, nutritional and livelihood security. Four trainings on horticulture crop production were imparted to 385 farmers. Seeds of bottle gourd, pumpkin, sponge gourd, bitter gourd and cucumber were distribution to 170 beneficiaries. Kitchen garden activities were also promoted in Khetauli village.

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

During 2017-18, the centre made commendable inroads into widening its presence in the North Eastern state of Nagaland. ICAR-NRCL had provided 12000 plants of litchi cv. Shahi to 150 beneficiaries in four districts of Nagaland viz. Peren, Dimapur, Wokha, and Kohima (Fig. 5.1). In collaboration with ICAR RC NEH Region, Nagaland Centre, Medziphema, ICAR-NRCL conducted a demonstration programme on litchi cultivation and establishment of new orchard on 3rd May, 2017 at Ngwalwa village in Peren district of Nagaland (Fig. 5.2). Altogether 56 farmers from nearby villages of Punglwa, Ngwalwa, Heningkunglwa and Gaili participated in the programme. Under the collaborative venture more than 87 ha has been brought under litchi cultivation on cluster approach. Demonstration on litchi cultivation was also done at Kupehe and Molvomunder in Dimapur, Nagaland.

As a follow-up measure, a team of four scientists from ICAR-NRC Litchi conducted a 3-day training programme on 'Good Agricultural Practices in Litchi' from 3-5 August, 2017 at ICAR RC NEH Region, Nagaland Centre, Medziphema (Fig. 5.3). The trainees numbering about 60 were trained on different aspects of litchi production, protection, postharvest management and value addition (Fig. 5.4 and 5.5).

Air-layers of litchi cultivars Shahi, China, Kasba and Mandraji (25 each) were provided for studying the survival in nursery and subsequent establishment of litchi block at Research farm, Division of Horticulture, ICAR RC NEH Region, Barapani, Meghalaya.

Fig. 5.1. Planting material of litchi provided by ICAR-NRCL after arrival in Nagaland

Fig. 5.2. Demonstration programme on litchi cultivation an Ngwalwa village, Peren, Nagaland

Fig. 5.3. Training programme on GAP in Litchi from 3-5th August 2017 at ICAR RC NEH Region, Nagaland Centre, Medziphema

Fig. 5.4. Glimpses of training programme on GAP in Litchi from 3-5th, August 2017 at ICAR RC NEH Region, Nagaland Centre, Medziphema

Fig. 5.5. Practical sessions during training programme on GAP in Litchi from 3-5th August, 2017 at ICAR RC NEH Region, Nagaland Centre, Medziphema

6. Flagship Projects

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

Reducing pericarp browning in litchi through restriction of moisture loss from fruit pericarp

In earlier studies, we had established the role of pericarp dessication as the single most important factor for pericarp browning in litchi, also establishing the strong correlation between pericarp properties and browning. An experiment was conducted to study how restricting moisture loss from pericarp through LDPE packaging and low temperature storage can impact the incidence of pericarp browning. Litchi fruits were placed in plastic trays (with and without LDPE packing) and stored at ambient and refrigerated conditions. Fruit quality parameters were assessed over 48 hours with treatments and duration as sources of variation. Storage conditions during the study period are depicted at Fig. 6.1. Regardless of storage conditions, litchi fruit kept in open trays recorded significantly higher loss in weight (PLW) during storage compared to LDPE packed fruits (Fig. 6.2). Restricting moisture loss through LDPE packaging resulted in significant retention of pericarp colour under both ambient and refrigerated condition (Table 6.1). The highest Hunter 'a' value after 48 hours was recorded in LDPE-packed fruit stored under refrigerated condition, while fruit kept in open trays had the lowest 'a' values under both ambient and cold storage conditions. This confirms the dependency of pericarp colour retention on restricting moisture loss during postharvest storage.

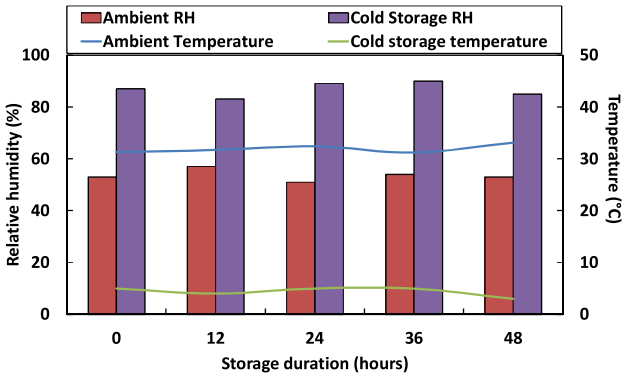


Fig. 6.1. Temperature and relative humidity of ambient and cold storage during 48 hour storage

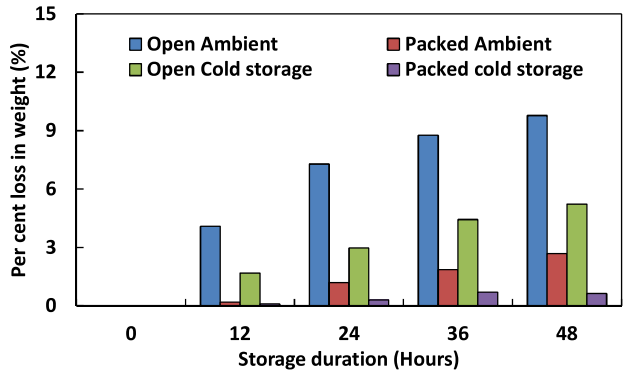


Fig. 6.2. Percent loss in weight (PLW) during postharvest storage of litchi under ambient and refrigerated conditions

Table 6.1. Changes in pericarp colour (Hunter colour 'a') during postharvest storage under ambient and refrigerated conditions

	0-hr	12-hr	24-hr	36-hr	48-hr	Mean
Open ambient	24.74^{aA}	19.87^{bB}	16.35^{cC}	9.08^{dD}	9.14^{cD}	16.04^{c}
Packed ambient	23.58^{aA}	22.36^{aAB}	21.39^{aBC}	20.65^{bc}	20.33^{aBC}	21.66^{a}
Open cold store	24.65^{aA}	22.69^{aB}	18.82^{bC}	17.12^{cD}	16.31^{bD}	19.92^{b}
Packed cold store	24.33^{aA}	23.36^{aAB}	22.93^{aAB}	22.44^{aB}	21.69^{aB}	22.95^{a}
Mean	24.57^{A}	22.06^{B}	19.87^{C}	17.32^{D}	16.87^{D}	

A: Treatment factor CD = 1.54, B: Storage duration factor CD=1.55; AxB = 2.479

Different superscripts in lower case indicate significant difference in colour due to treatment, while superscripts in upper case indicate differences in colour due to storage

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

During March 2018, most of the tress flowered ('on' year) but in 2017, litchi cv. Shahi did not flower in all the treatments except tree receiving 2.0 g paclobutrazol (PBZ) per m canopy diameter which showed partial flowering. PBZ or KNO_3 were not applied during 2017, however highest flowered shoots were observed in 2.0 g PBZ treated tree of 2016. Leaf gaseous exchange parameters did not show any significant effect due to application of PBZ, however the net photosynthetic rate (*Pn*), transpiration rate (*E*) and stomatal conductance (gs) increased with reducing dose of PBZ (Table 6.2).

Endogenous hormones *viz.* IAA, ABA, GA_3 and CKs in leaves during floral bud differentiation (FBD) stage were estimated in litchi cvs. Shahi and China. Results showed that PBZ application during September month in litchi cv. China (12 year old) has reduced gibberellin acid (GA_3) content almost by 20% with increased abscisic acid (ABA) content over control trees. Lower dose of PBZ (i.e. <2.0 g per m canopy diameter) was not able to increase ABA content but retained higher indole-3-acetic acid (IAA). In contrast, IAA reduces with increase in PBZ dose. Application of 4.0g PBZ or 1.0% KNO_3 led to highest ABA and lower IAA contents. Content of cytokinins in terms of zeatin (Z), dihydrozeatine riboside (DHZR), and zeatin riboside (ZR) marginally improved in higher dose of PBZ application. In litchi cv. Shahi (8 year old), PBZ did not reduce GA_3 but increased ABA with increasing dose. Less concentration of ABA, IAA, DHZR and high ZR was recorded with 1.0g PBZ in China cultivar (Table 6.3).

The overall concentration of endogenous hormones was lesser in 'Shahi' litchi (comparatively younger trees) over 'China' litchi. Based on observation recorded during 2017, 'China' litchi has lower photosynthetic rate (*Pn*), transpiration rate (*e*), internal CO_2 concentration (*Ci*), stomatal conductance (*gs*) and leaf temperature (*TL*) than 'Shahi' litchi. 4.0 g PBZ led to higher photosynthesic rate even at low *Ci*. It was also observed that WUE increased by 50-100 percent in tree applied with 2.0% KNO_3 and 2.0g PBZ over control trees during vegetative phase. The Leaf carboxylation efficiency (CE) also increased by 10-100% by various doses of PBZ and KNO_3. The highest no. of cauliflorus shoots in Shahi litchi was recorded due to high dose of PBZ (3-4g). These findings suggested that manual de-flushing during December month led to flowering in next season (off year); no flowering was induced even if tree sprayed with ethephon (1000 to 2000 ppm) or paclobutrazol application with trunk soil line pore method (TSLP) during the same period. It was also observed that there is strong tendency of alternate bearing in litchi trees of variety China and flowering was regular (in 2017 and 2018) in those plants which received sufficient moisture with heavy flushing in December, 2015. There is need of further studies to link endogenous hormonal level (vegetative and FBD) and flowering.

Table 6.2. Effect of paclobutrazol and KNO_3 on leaf gaseous exchange parameters in litchi cv. Shahi

PBZ treatment (ml per m canopy diameter)	Photosynthetic rate (A) (m mol CO_2 m^{-2} s^{-1})		Transpiration rate (E) (m mol H_2O $m^{-2}s^{-1}$)		Stomatal conductance (gs) (m mol H_2O $m^{-2}s^{-1}$)		Photosynthetically active radiation (PAR)		Leaf temperature (°C)	
	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)	Off year (2017)	On year (2018)
3.0	6.86	4.43	1.33	1.03	89.33	20.33	1,556.33	1,646.33	29.10	36.50
2.0	3.50	5.93	1.13	1.26	90.00	24.33	877.33	1,452.33	28.23	35.46
1.0	5.60	5.96	0.96	1.30	80.66	23.66	1,104.33	1,554.00	27.86	36.66
Un-treated	6.53	6.36	1.20	1.10	65.00	21.66	1,506.00	1,434.66	28.70	35.83
C.D.	NS	NS	NS	NS	NS	NS	469.09	NS	NS	NS
SE(m)	0.95	1.36		0.24	16.01	5.64	132.97	90.42	0.89	0.73
SE(d)	1.34	1.92	0.43	0.34	22.64	7.98	188.05	127.87	1.25	1.04
C.V.	29.27	41.58	45.79	35.32	34.13	43.43	18.26	10.29	5.40	3.53

Table 6.3. Effect of paclobutrazol and KNO_3 on endogenous hormonal status in litchi cultivars

Endogenous hormonal status in litchi cv. China affected by PBZ and KNO_3						
Treatment	**GA_3 (ngg^{-1})**	**ABA (ngg^{-1})**	**IAA (ngg^{-1})**	**Cytokinins (pgg^{-1})**		
				Z	**DHZR**	**ZR**
1.0 g PBZ	602.3	321.5	92.1	423.1	826.4	742.1
2.0 g PBZ	582.6	385.1	69.7	362.7	746.9	802.1
3.0 g PBZ	671.8	347.8	62.6	331.4	596.8	732.7
4.0 g PBZ	562.8	412.1	67.8	387.6	801.3	712.2
1 % KNO_3	589.7	431.7	73.4	441.7	735.9	869.2
2 % KNO_3	598.2	355.6	44.7	358.8	696.8	905.7
Un-treated	691.7	351.9	102.1	332.7	703.6	874.1
Endogenous hormonal status in litchi cv. Shahi affected by PBZ and KNO_3						
3.0 g PBZ	723.1	343.6	68.9	302.3	605.7	542.3
2.0 g PBZ	689.8	323.6	100.2	263.9	654.1	512.3
1.0 g PBZ	632.8	244.3	62.2	242.8	506.5	632.7
Un-treated	552.6	268.3	78.9	304.7	608.7	542.4

GA_3: Gibberellic acid; ABA: Absiscic acid; IAA: Indole-3-acetic acid; Z: Zeatin, DHZR: Dihydrozeatin riboside; ZR: Zeatin riboside; ngg^{-1}: nanogram per gm; pgg^{-1}: picogram per gm

7. Externally Funded Projects

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

Under crop based module, demonstrations on improved variety of wheat (BHU-3 and BHU-25) were conducted among 160 farmers covering 28 hectare area during *rabi* season 2017. The yield realised upto 18 q/ acre against 11.50 q in PBW-343 grown as check similarly trial conducted among 610 from field 610 farmers had conducted trial on improved variety of wheat (HD-2967, DBW-39, DBW-14 and WR-544) in 160 acres and received yield 17 q/ acre in HD-2967 against UP-262 (10 q/acre). Improved variety of lentil var. HUL-57 was also distributed among 100 farmers and yield up to 4.50 q/ acres against local variety 2.50 q/ per acre was recorded.

Under horticulture module, 2000 plants of litchi, 1000 plants of mango, 100 plants of guava and 50 plants of acid lime were planted in 550 farmers field. Besides, distribution of consortia kit for application in litchi orchards.

Seeds of cowpea, okra, bottle gourd, bitter gourd, cucumber and sponge gourd were provided to about 350 farm families covering more than 11 hectare area. Experimentation was also done on productivity enhancement and popularization of improved production technologies in vegetables by small and marginal farmers of Ujhilpur, Damodarpur, Ramgarhwa and Chintamanpur. Garden pea cv. Azad Matar 3, corainder cv. Pant Haritima, radish cv. Kashi Sweta and spinach cv. Arka Anupama were demonstrated in kitchen gardens of 50 farm families (Fig.7.1).

In livestock based module, groups of landless women were focused in all the eight villages and motivated to take up backyard poultry as source of increasing household income. One month old chicks of poultry and 3 weeks old quail chicks were distributed along with low cost night shelter house (3 floor, 5 x 5 x 2.5 ft) to save the chicks from predators. Out of 25 farmers, 5 farmers came forward and demanding the chicks for large scale rearing as their income have touched 12000 per annum by rearing 25 chicks (Fig.7.2).

Training on goatery was given to 3 groups (25 in each village) of 3 villages. Training on oyster mushroom with initial kit (wheat husk, polybags, rubbers and medicines) and spawn seed (40 kg) had been demonstrated in 3 villages (Bakhari Nazir, Ramgarhwa and Damodarpur). Training and initial kit demonstration on mixed pickle making have been demonstrated to two villages and it was found that drying of vegetable was the major obstacle. Demonstration on low cost solar drier (size 4 x 3 x 20 ft.) was also done in selected villages. Women group of 2 villages prepared 50 kg pickles and used for domestic consumption. To encourage organic farming in project villages, 60 farmers of Ujhilpur and Damodarpur, East Champaran got training on production of organic inputs (Fig. 7.3).

An Animal Health Camp at Ujhilpur, Mehsi, East Champaran was organised in which 200 animals (50 cow, 45 buffalo, 25 goats and others) were treated and artificial insemination completed in 30 pet animals. Most of the problems identified as ticks and worm infection, anorexia, pneumonia, dysglactoa and repeat breeding.

Fig. 7.1. Demonstration of *rabi* vegetables in Ujhilpur, East Champaran

Fig. 7.2 Training on goatery and backyard poultry

Fig. 7.3 Training on goat farming at Ujhilpur

7.2. BRNS-funded project 'Development of synergistic hurdles for preservation of litchi pulp and products'

This project was approved and sanctioned by the Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy, Government of India. With the aim to reducing postharvest losses and exploiting the huge potential of processing in litchi, this project envisages preservation of litchi pulp and products through safe preservation practices. Essential equipments like DG Set (82.5 KVA), refrigerator (565 L), and twin litchi pulper (2.5 tonne/hour capacity) had been procured. Research on preservation of litchi pulp and products was also initiated. Anaerobic yeast species were identified as major microbes responsible for fermentation and spoilage of litchi pulp. Among the

Fig. 7.4 Litchi Pulp and litchi squash

yeast, *Shizosaccharomyces pombe* has been identified in spoiled litchi pulp. Litchi pulp pasteurized at 90 °C for 15 min followed by addition of 1000 ppm potassium metabisulfite (KMS) resulted in preservation upto 9 months. Pulp spoilage could be stopped, and colour and aroma retained for nine months under refrigerated condition through addition of KMS @ 1500 ppm.

Litchi squash containing 40 °B soluble solids and 25% fruit pulp could be preserved up to four months through addition of 300 ppm KMS (Fig. 7.4).

7.3. Mega seed project on seed production in agricultural crops and fisheries

Maintenance of the mother block: Maintained the 1.2 ha mother block for large scale propagation of planting materials through air-layering. Mother block has 9 promising cultivars of litchi viz. Shahi (200 plants), Rose Scented (50 plants), Longia (25 plants), China (125 plants), Mandraji (50 plants), Purbi (50 plants), Swarnroopa (50 plants), Yogda Sel (25 plants) and Bedana (25 planta) all together 625 plants. Apart from litchi we have a mother block of Guava cv. Lalit (50 plants) for taking the scion/ bud wood and cutting for propagation of planting materials.

Propagation of quality planting material: Altogether, 40000 air-layering was made using soil less rooting media (vermi-compost, coco-pith and vermiculite in 1:1:1 ratio and *Trichoderma viride* during June to August. Due to flood situation and water stagnation in nursery for long period only 30000 well rooted air-layers were detached and planted in the nursery. Quality planting materials of litchi was maintained and kept for sale to farmers and stake holders. All the grafted plants died due to flood water accumulation in nursery.

7.4. Developing national repository and facilities for DUS testing in litchi

The character detailing of 10 varieties of litchi as per DUS guidelines, delineates the varieties into early, mid and late groups based on maturity period. The early group maturing less than 50 days includes Shahi, Dehrarose and CHES-II while China, Bombai-II, Purbi, Ajhauli and Bombai-I falls under mid maturity group (50-60 days). The third group comprised Gandaki Yogita and CHL-5 maturing more than 60 days. Crimson red fruit colour with high fruit shape index (length:width >1) was predominant and observed in Shahi, China, Bombai-II, Dehrarose, Purbi, CHL-5, CHES-II, Ajhauli and Bombai-I. Thin fruit peel was a major representation among varieties except for CHL-5 having thick peel. The highest pulp content was noted in Gandaki Yogita (>70%) while it ranges from 60-70% in Shahi, Dehrarose, CHL-5 and CHES-II. Different varieties possessed varying seed shape ranging from round in Gandaki Yogita to oblong in Shahi, Dehrarose, CHL-5 and CHES-II and elongated in China, Bombai-II, Purbi, Ajhauli and Bombai-I. Seed cylindrical index was high (H"1) in Shahi, China, Bombai-II, Dehrarose, Purbi, Gandaki Yogita, CHES-II, Ajhauli and Bombai-I while low index (<1) was noted only in CHL-5.

Human Resource Development

Participation of scientists/staffs in conference/seminar/symposia/workshop/training/meeting during 2017-2018.

Sl. No.	Title	Venue and Date	Participant (s)
1.	National Conference on Climate Change & Agricultural Productivity	BAU, Sabour, Bhagalpur 06-08 April, 2017	Dr. Vishal Nath Dr. Gopal Kumar
2.	Consultation workshop on "Promotion of Farmer's Producers Organization" organized by JEEVIKA, BRLPS and State Rural Livelihood Mission	Patna, Bihar 27 April, 2017	Dr S K Purbey
3.	NRCL Foundation Day	ICAR-NRC on Litchi, Muzaffarpur 6 June, 2017	All Scientists
4.	National Conference on "Perspective of Challenges and Options in Litchi Production and Utilization"	ICAR-NRC on Litchi, Muzaffarpur 6-7 June, 2017	All Scientists
5.	3rd Krishi Road Map of Bihar Conference	Patna, Bihar 17 June, 2017	Dr. SD Pandey Dr. Amrendar Kumar
6.	ICAR sponsored CAFT Training programme on Use of ICT in agriculture education for accelerated learning	Bihar Agricultural University, Sabour 4-24 July, 2017	Dr. Evening S Marboh
7.	Workshop on "Regional Group Leaders and Guide Teachers orientation programme" in 25th National Children's Science Congress 2017 organized by Science for society, Bihar in collaboration with BCST and SCERT, Bihar	ICAR-NRC on Litchi, Muzaffarpur, Bihar 8-9 July, 2017	Dr. SK Purbey
8.	7th JPIC meeting pertaining to the operation of the DAE Litchi Technology Demonstration cum Treatment Facility & Centre of Excellence (DLTF-COE)	BARC, Mumbai 21 July, 2017	Dr. SK Purbey
9.	Summer School on "Analytical, Instrumental, and Imaging Techniques Related to Food Safety Management "	ICAR-CIAE, Bhopal 6-26 July, 2017	Dr. Alemwati Pongener
10.	Workshop on "District level Project Orientation for Group Leaders and Guide Teachers" in 25th National Children's Science Congress - 2017	Chapra, Saran, Bihar 27 July, 2017	Dr. SK Purbey Dr. SK Singh
11.	Workshop on "District level Project Orientation programme for Group Leaders and Guide Teachers" in 25th National Children's Science Congress 2017 organized by Science for society, Bihar in collaboration with BCST and SCERT, Bihar	Muzaffarpur, Bihar 1 August, 2017	Dr. SK Purbey
12.	Short training on "Selection, adjustment, operation and maintenance of Agricultural implements for field and Horticultural crops"	ICAR-CIAE, Bhopal 1-10 August, 2017	Dr. Ramashish Kumar
13.	Administrative Vigilance	ISTM, New Delhi 7-11 August. 2017	Sh. Abhishek Yadav
14.	CAFT training programme on Advanced Statistical Techniques in Biometrics	ICAR-IASRI, New Delhi 10 to 30 August, 2017	Dr. Evening S Marboh
15.	CAFT 21days training on "Challenges and opportunities in food processing in context to value addition and postharvest management of agricultural products.	CFST-Institute of Agricultural Sciences, BHU, Varanasi 1-21 September, 2017	Dr. Swati Sharma

16.	Meeting on SFC of SMD:Horticulture Division, ICAR HQ	Krishi Bhawan, Dr. New Delhi 13-14 September, 2017	Dr. Vishal Nath Dr. SK Singh
17.	National Seminar on Innovations in Horticulture: Production to consumption	GBPU&T, Pant Nagar 14-15 September, 2017	Dr. Vishal Nath
18.	Methodological Framework for implementation of FFP	Lucknow 3-6 October, 2017	Dr SK Purbey Dr Kuldeep Srivastava
19.	Review meeting of Vigilance Officers	New Delhi 9-10th October, 2017	Dr. Amrendar Kumar
20.	Training Workshop on 'Methodological Framework for Implementation of FFP'	ICAR-IISWC, Dehradun 6 -9 November, 2017	Dr. SK Singh
21.	3rd Krishi Road Map of Bihar Conference	Patna, Bihar 9 November, 2017	Dr. SD Pandey Dr. Amrendar Kumar
22.	One day seminar on " Marketing and Export"	MSME, Muzaffarpur 27 November, 2017	Dr. SD Pandey Dr. SK Purbey
23.	Eastern Zone Sports Tournament	ICAR Research Complex for Eastern Region, Patna, Bihar 13-16 November, 2017	Dr. SD Pandey Dr Amrendra Kumar Dr. RK Patel Dr. Kuldeep Srivastava Dr. Alok Kumar Gupta Dr. Evening S Marboh Dr Alemwati Pongener Sh. Abhishek Yadav Sh. Ramji Giri Sh. Shubhankar Dey Sh. Surendra Rai
24.	Winter School on "Understanding Flowering Mechanism and Management of Bearing in Sub-Tropical Fruits"	ICAR-NRC on Litchi, Muzaffarpur 01-21 December, 2017	Dr. Vishal Nath Dr. SK Singh* Dr. Alemwati Pongener* Dr. Alok K Gupta* *as co-ordinators
25.	Winter School on "Understanding Flowering Mechanism and Management of Bearing in Sub-Tropical Fruits"	ICAR-NRC on Litchi, Muzaffarpur 01-21 December, 2017	Dr. Abhay Kumar Sh. Prabhat Kumar *as participants
26.	World Soil Health Day	ICAR-NRC on Litchi, Muzaffarpur 5 December, 2017	Dr. Vishal Nath Sh. Prabhat Kumar Dr. S.K. Singh
27.	National Workshop on 'Let us listen to the Farmers'	ICAR-NAARM, Hyderabad. 22-23 December, 2017	Dr. SK Singh
28.	Rajbhasa Sangosthi	ICAR-NRC on Litchi, Muzaffarpur 10 January, 2018	Dr. Vishal Nath Dr. SD Pandey Dr. SK Purbey
29.	Brain storming session on increasing productivity of litchi	PAU, Ludhiana 28 January, 2018	Dr. Amrendra Kumar Dr. Vishal Nath
30.	National Symposium on "Plant Health Management: Embracing Eco-Sustainable Paradigm"	AAU, Jorhat, Assam 15-17 February, 2018	Dr. Vinod Kumar
31.	5th Group workers meet on AICRP on fruits	ICAR-NRCB, Trichy, Tamil Nadu 15 -18 February, 2018	Dr. Vishal Nath Dr. Amrendra Kumar Dr. SK Purbey Dr. Evening S Marboh
32.	Short course on "New Perspectives in Fruit Crops Research"	Horticulture College and Research Institute, TNAU, Coimbatore, 5-14 March, 2018	Dr. SK Singh

Meetings, Workshops and Events

Inauguration of Litchi Treatment Plant

A Litchi Treatment Plant (LTP) was established in NRCL campus. With the signing of MoU with Bhabha Atomic Research Centre, Mumbai, the LTP was commissioned, which will act as a model facility for litchi growers and entrepreneurs in postharvest management of litchi. The facility was inaugurated by Shri Radha Mohan Singh, Hon'ble Union Minister, Ministry of Agriculture & Farmers' Welfare, Govt. of India on 29th May, 2017.

Glimpses of inauguration of litchi treatment plant by Hon'ble Union Minister

National Conference on Perspectives of Challenges and Options in Litchi Production and Utilization

National Conference on Perspectives of Challenges and Options in Litchi production was organized by ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar in collaboration with Confederation of Horticulture Associations of India (CHAI), Pusa Unit from 6-7 June, 2017 to address the challenges and develop strategies for enhancing income of litchi growers. Deliberations in the conference were organized in nine technical sessions. Each session had 2-3 keynote speakers, well known in their field of expertise, followed by oral and poster presentations. The papers of keynote speakers and abstract of oral and poster presentation have also been compiled in the form of souvenir – Gyan Manthan vol. 6, for the benefit of the delegates. The conference was sponsored by ICAR, NHB, APEDA, NABARD, BARC, etc.

Dr. H.P. Singh, Former DDG (HS) and President, CHAI addressing the participants during the National Conference

Winter School

A Winter School on 'Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruits' was organized at the centre from 1-21, December 2017. Dr. Susheel Soloman, Vice-Chancellor, CSAUAT, Kanpur, UP was Chief Guest for the inaugural session. Nineteen participants from eight states (Rajasthan, UP, Bihar, MP, Jharkhand, West Bengal, Uttarakhand, and Arunachal Pradesh) of the country attended the school. This winter school covered different aspects on source-sink relationship and physiology of flowering in mango, citrus, grapes, guava, litchi, pomegranate and other sub tropical fruits, and managing its crop-load and bearing behaviour. There was special emphasis on managing alternate bearing tendencies in major tropical and sub tropical fruit trees through INM, IPM, canopy architecture management, rejuvenations etc. The trainees were taught about innovative approaches for estimation of various parameters on physiology and biochemistry using HPLC, GCMS, AAS, IRGA, UV-VIS spectrophotometers etc.

Participants of the winter school with the scientific staff of NRCL and invited dignitaries

National Science Day

National Science Day was observed on 28th Feb., 2018 at Ujhilpur village of East Champaran district selected under Farmers FIRST Project. The programme was organized among farmers and children of the village. The programme was celebrated on the theme: Science and Technology for a Sustainable future. Dr. Amrendra Kumar shared his views on role of science and technology for common people and urged the farmers to adopt the new technology of litchi production. During the occasion, Dr. Kuldeep Srivastava, Dr. R. K. Patel and Dr. Sanjay Kumar Singh also expressed their views on importance of science and technology for sustainable agriculture to improve the nutritional and economic security of the farmers.

Scientists of NRCL interacting with participants on National Science Day

17th Foundation Day

The 17th Foundation Day of the centre was observed on 6th June 2017. On this occasion, NRCL Muzaffarpur organized a 2-day National Conference on "Perspective of Challenges and Options in Litchi Production and Utilization". More than 200 farmers from Muzaffarpur, Vaishali, Samastipur, Sitamarhi, East Champaran and West Champaran districts of Bihar were present on this occasion. The Centre felicitated five progressive litchi growers with "*Litchi Ratna*" on the occasion that had played a leading role in litchi fruit production and cool chain management by adopting litchi technologies and skills developed by this Centre. Five eminent correspondents of local print and electronic media were also felicitated in recognition and appreciation of their role in active dissemination of NRCL Technologies, and establishing interface between farmers and scientists. Further, five eminent scientists

A glimpse of inaugural session of the 17th Foundation Day

A farmer being felicitated with Litchi Ratna on the occasion of 17th Foundation Day

from different states were also honoured in recognition and appreciation of their commitment to the furtherance of litchi research and development in different states of India. The programme was coordinated by Dr. Vinod Kumar, Senior Scientist and was supported by all the scientists, administrative and technical staffs of the centre.

Field Day

A Field Day was organized at Kankatti (East Champaran), an adopted village under *Mera Gaon Mera Gaurav Programme* on 13th September, 2017. Besides current problems of crops in fields and their management, zero budget natural farming (ZBNF) practices were advocated that eliminates the dependence of farmers on commercial inputs like fertilizers and pesticides. These measures use the ecological engineering principles which encourage beneficial microbes and pest predators to take care of crop health and productivity. Ethnomedicinal plants such as neem (*Azadiracta indica*), catnip or catmint (*Nepeta cataria*), karanj (*Pongamia pinnata*), goma or thumba (*Lucas aspera*), aak (*Calotropis procera*), datura (*Datura stramonium*), garlic (*Allium cepa*) etc. were extracted in cow urine was advocated as natural pesticides and preparation and application method was demonstrated. A practical demonstration of application of NRCL Trichoderma in litchi and vegetables were also undertaken during the programme. The programme was coordinated by Dr. Vinod Kumar, Dr. Sanjay Kumar Singh, and Shri Prabhat Kumar.

NRCL scientists demonstrating preparation of organic inputs

Another field day cum kisan gosthi on best management practices in litchi was organized at Bakhari, Muzaffarpur, Bihar on 3rd November, 2017. About 25 litchi growers of the village attended the programme. The participants were taught on modern canopy management practices to facilitate utilization of vacant space within litchi orchard through cultivation of locally popular intercrops like turmeric and mishrikand. Demonstration of girdling technology was also performed along with management of leaf litter in litchi orchard.

Field day on best management practices in litchi at Bakhari, Muzaffarpur

World Soil Day

World Soil Day was celebrated on 5 December 2017 at farmer's field in village Damodarpur, East Champaran, Bihar. On this occasion, Hon'ble MLA Sh. Shyambabu Prasad Yadav was invited as chief guest and various activities were carried out. Soil Health Card

was distributed to fifty farmers from the villagers of Ujhilpur and Damodarpur of East Champaran district of Bihar.

Yoga Day

ICAR – NRC on Litchi celebrated "International day of Yoga" on 21st June 2017 as per common yoga protocol issued by Ministry of Ayush, Govt of India and ICAR's guidelines. Yoga is an invaluable gift of India's ancient tradition. It embodies the unity of mind and body, a holistic approach to health and well-being. On the eve of "International day of Yoga" NRCL endeavoured towards making Yoga a part and parcel of daily lifestyle, motivating to practice yoga. All the staff of ICAR-NRC on Litchi participated in the yoga with great enthusiasm. The event was inaugurated by the Dr. Vishal Nath, Director, which was followed by talks on various topics including Yoga and consciousness. A Yoga practice session was conducted in the morning session.

Yoga session at ICAR- NRC on Litchi on *"International Day of Yoga"*

Swachh Bharat Abhiyan

ICAR–NRC on Litchi celebrated *Samagra Swachhata Diwas* on 24 Sept 2017 with full enthusiasm. A village Narauli Binda (Muzaffarpur) was selected which was under recent flood and suffering from after flood vagaries of sanitation and hygiene, in this mission employees of NRCL employees contributed their best and carried out following activities to make *Swachha Bharat Mission* successful.

- *Shramdaan*: NRCL employees devoted their work and time for cleanliness drive.
- Plantation: Plantation of Litchi plants and flowering plants done in village.
- Sensitization of villagers to develop proper toilet facility and discourage open defecation.
- Pledge: Villagers joined *Swachhta Mission* by taking pledge.
- Bleaching powder was dusted in after flood water logged areas.
- Villagers were sensitized to adopt modern methods of composting which will help in making better fertilizer from cow dung and farm waste/ household waste.

Sarwatra Swachhta Diwas celebrated on 25 September, 2017 in which all employees performed *shramdaan*. On this occasion cleanliness drive was organised in public place, cleaning of road, pathway, parking shade etc.

On 2nd October 2017, Gandhi Jayanti was celebrated with enthusiasm to spread the message of "*Swachha Bharat Swastha Bharat*" by employees. On this occasion cleanliness drive was organized in and around campus of NRCL. "*Swachhta Pakhwada*" was organized from 16 to 31 October 2017 at Mushahari, Muzaffarpur by spreading the message of cleanliness and hygiene *"Swachha Bharat Swasth Bharat"*. Director of the centre Dr. Vishal Nath administered "*Swachhta Pledge*" to the scientists and staff to bring the Mahatma`s dream into reality. In addition, several initiatives were taken for overall cleanliness of office building and premises, residential campus and research farm.

ATMA-sponsored 5 days training programme on production and marketing of export quality litchi

A five day training programme on production and marketing of export quality litchi sponsored by ATMA was organized at NRC on Litchi on 26-30 December, 2017. A total of 22 farmers from Samatipur district of Bihar were trained on various aspects of good agricultural practices in Litchi production, management of pests and diseases, water and fertilizer management and it's processing towards export quality production of litchi.

NHB-sponsored Seminar on Litchi Farming: A sustainable approach for production processing & marketing

A two day Seminar on "Litchi Farming: A sustainable approach for production, processing & marketing" sponsored by National Horticultural Board and Litchi Growers Association of Bihar was organized at NRC on Litchi, Muzaffarpur preservation of litchi was organised at the centre from 22-23th May 2017 in collaboration with BARC, Mumbai. Several litchi growers, entrepreneurs and stakeholders took part in the training.

Commemoration of Vigilance Awareness Week

Vigilance awareness week was organized by ICAR-NRC on Litchi, Muzaffarpur from 30th October – 4th November, 2017 with theme "My Vision-Corruption Free India". An oath towards Integrity Pledge was administered by the Director, Dr. Vishal Nath to all the staff of the centre acknowledging their commitment to uphold the highest standards of honesty and integrity. He extorted that the purpose of observing Vigilance Awareness Week is to educate the public at large about

the corruption related practices and also educating them how to report about it. He said that it acts like a mass movement of involving people in saying no to corruption.

ICAR-NRCL participated in the East Zone ICAR Sports Meet 2017

A 11-member contingent, led by Chief-de-Mission Dr. Kuldeep Srivastava and Team Manager Sh. Abhishek Yadav, represented ICAR-NRCL at the ICAR Sports Tournament for Eastern Zone being held at ICAR-RCER, Patna from 12-16 December, 2017. The team participated in various sports events, where the volleyball team secured the runners' up position.

Participants of ICAR-NRCL in the East Zone ICAR Sports Meet 2017

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इस अवधि के दौरान राजभाषा कार्यांवयन समिति की 4 बैठके और 3 कार्यशालाओ का आयोजन किया गया। राजभाषा हिंदी के प्रचार प्रसार हेतु 1–30 सितम्बर, 2017 के मध्य हिंदी चेतना मास का आयोजन किया गया। इस दरम्यान कुल 6 भिन्न प्रतियोगिता नामतः वर्ग पहेली, प्रश्नोंत्तरी, श्रुत लेखन, आशुभाषण, टंकन तथा निबंध लेखन प्रतियोगिता का आयोजन किया गया और उत्कृष्ट प्रदर्शन करने वाले प्रतिभागियों को पुरस्कृत भी किया गया। हिंदी कार्यशाला सह पुरस्कार वितरण समारोह 10 जनवरी, 2018 को किया गया। नराकास की पहली छह माही बैठक 30 सितम्बर, 2017 और दूसरी बैठक 10 जनवरी, 2018 को किया गया। श्री मनिन्दर कुमार बलियारसिंह, आंचलिक प्रबंधक, बैंक ऑफ इंडिया एवं सचिव, नराकास, मुजफ्फरपुर, समारोह के मुख्य अतिथि थे। श्री सुदीप सैनी, सचिव, नराकासा, मुजफ्फरपुर, समारोह के विशिष्ठ अतिथि थे। समारोह की अध्यक्षता डा. विशाल नाथ, निदेशक रा. ली. अनु. केंद्र ने की। सचिव, नराकास, मुजफ्फरपुर ने हिन्दी के प्रचार प्रसार मे कम्प्यूटर के योगदान पर प्रशिक्षण दिया। मुख्य अतिथि ने सभी विजेताओं को पुरस्कृत किया। अपने सम्बोधन मे उन्होंने कहा कि हिंदी भाषा विविधता में एकता का प्रतीक है। हिंदी पुरातन भी है और आधुनिक भी। हिंदी भारतीयता की चेतना है। यही कारण था कि विभिन्न भाषा–भाषी लोगों ने हिंदी को ही पूरे भारतवर्ष की एकमात्र संपर्क भाषा माना और उसे ही आजादी की लड़ाई का माध्यम भी बनाया। हिंदी और अन्य भारतीय भाषाओं के बीच अनुवाद बढ़ाए जाने की आवश्यकता है। हिंदी का विकास देश की उन्नति के लिए आवश्यक है। ज्ञान विज्ञान, प्रौद्योगिकी एवं उद्योग आदि में हिंदी का प्रयोग कर हम और आगे बढ़ सकते हैं। राष्ट्रीय लीची अनुसंधान केंद्र, मुजफ्फरपुर को केंद्र सरकार के संगठनों में अत्युत्तम प्रदर्शन के लिए राजभाषा शील्ड प्रतियोगिता में द्वितीय स्थान प्राप्त हुआ।

नराकास, मुजफ्फरपुर को हिन्दी में उत्कृष्ट प्रदर्शन के लिए पूर्व जोन का तीसरा पुरस्कार प्राप्त हुआ

नराकास द्वारा 2016–17 का द्वितीय पुरस्कार प्राप्त करते डॉ एस. के. पूर्वे, नोडल अधिकारी (हिन्दी)

Distinguished Visitors

Dr. AK Singh, Deputy Director General (Agricultural Extension & HS), ICAR, New Delhi, at the centre on 2nd April 2017

Shri B.B. Singh, Chairman and Managing Director of MSTC Ltd, a Mini-Ratna PSU, under the Ministry of Steel, at the centre on 20th February, 2018

Dr. Prem Kumar, Hon'ble Minister for Agriculture, Govt. of Bihar, visited the centre on 5th December, 2017


Shri Ram Surat Rai, Ex-MLA, Aurai (Muzaffarpur) visited the centre on 24th January, 2018


Dr. W.S. Dhillon, ADG (HS) visited the centre on 24th February, 2018

List of other dignitaries visited NRCL

S.No.	Distinguished Visitors	Affiliation	Date
1.	Dr. Suraj Nandan Kushwaha	MLC, Bihar	22 May, 2017
2.	Shri. Radha Mohan Singh	Union Minister of Agriculture and Farmer's Welfare, Govt of India	29 May, 2017
3.	Shri. Ram Vichar Rai	Minister of Agriculture, Govt of Bihar	29 May, 2017
4.	Shri. Kedar Prasad Gupta	MLA, Kurhani, Bihar	29 May, 2017
5.	Smt. Baby Kumari	MLA, Bochaha, Bihar	29 May, 2017
6.	Shri. Ashok Kumar Singh	MLA, Paroo, Bihar	29 May, 2017
7.	Dr. Shekhar Basu	Chairman, AEC, BARC, Mumbai	29 May, 2017
8.	Shri. Abhay Kumar	Director (Finance), DAE, Mumbai	29 May, 2017
9.	Dr. AK Singh	DDG (HS), ICAR, New Delhi	29 May, 2017
10.	Dr. SK Ghosh	Head, FTD, BARC, Mumbai	29 May, 2017
11.	Dr. H.P. Singh	Former DDG (HS) ICAR, New Delhi	6 June, 2017
12.	Dr. R.C. Srivastava	VC, DRPCAU, Pusa, Bihar	6 June, 2017
13.	Dr. S. Rajan	Director, ICAR-CISH, Lucknow	6 June, 2017
14.	Dr. A.S. Panwar	Director, ICAR-IIFSR, Meerut	6 June, 2017
15.	Dr. Neeraj Sinha	Technical Director, Add State Informatics Officer, NIC, Bihar	21 June, 2017
16.	Dr. Navin Suman	Scientist E & DIO, Muzaffarpur	21 June, 2017
17.	Dr. S.K. Singh	Head, Divison of Fruits and Hort. Tech. IARI, New Delhi	8 December, 2018
18.	Dr. B.K. Pandey	ICAR SMD-Hort. Sc., New Delhi	8 December, 2017
19.	Dr. Devendra Pandey	CISH, Lucknow	8 December, 2017
20.	Dr. Sushil Solomon	VC, CSAUAT, Kanpur (UP)	8 December, 2017
21.	Dr. Dilip Kumar	Ex-Director, ICAR-CIFE, Mumbai	23 December, 2017
22.	Dr. Vijay Singh Thakur	Ex VC, DrYSPUH&F, Solan (HP)	18 January, 2018
23.	Dr. S.S. Mishra	Director, ICAR-CIFA, Bhubaneswar	5 March, 2018

Transfer of Technology

Dissemination of technologies have been done through organizing training, demonstration, field day, *Kisan Gosthi*, delivering lectures, showcasing NRCL technologies in farmer fairs 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	Participating/Resource persons	No. of beneficiaries
Farmer's training on GAP in Litchi under BAGRI project	Raghunathpur, Muzaffarpur 6 April 2017	Dr. SK Purbey	25
Farmer's training on GAP in Litchi under BAGRI project	Chhapramegh, Muzaffarpur 7 April 2017	Dr. SK Purbey	30
Bagging technology explained and demonstrated under "Mera Gaon Mera Gaurav" programme	Binda, Narauli, Muzaffarpur 12 April 2017	Dr. SK Purbey	5
Kisan Kalyan Mela	Motihari, East Champaran 15-19 April 2017	Dr. SK Purbey	150
Training and demonstration of Bagging technology under "Farmer FIRST project"	Chintamanpur, Pipra, Ujhilpur and Damodarpur East Champaran, 22 April 2017	Dr. SK Purbey	30
Training and demonstration on Fertilizer application in litchi under 'Farmer FIRST project'	Chintamanpur, Pipra, East Champaran 22 April 2017	Dr. Amarendra Kumar Dr. Gopal Kumar	20
Training and demonstration of Bagging technology under "Mera Gaon Mera Gaurav" programme	Kattarmala village, Vaishali 29 April 2017	Dr. Amrendra Kumar Dr. RK Patel Dr. Alemwati Pongener	25
Good Agricultural practices in litchi for marketing and export in collaboration sponsored by APEDA	NRC on Litchi, Muzaffarpur 13-14 May 2017	Dr. SK Purbey	65
Good Agricultural practices in litchi for marketing and export in collaboration with APEDA	NRC on Litchi, Muzaffarpur 29-30 May 2017	Dr. SK Singh	48
Exposure visit of Farmers from Sahebganj, Jharkhand	NRC on Litchi, Muzaffarpur 1 June 2017	Dr. SK Purbey	25
Good Agricultural practices in litchi for marketing and export in collaboration with APEDA	NRC on Litchi, Muzaffarpur 6 June 2017	Dr. SK Purbey Dr. Alemwati Pongener	45

Scientist –Farmer interaction-cum-Kishan Gosthi on GAP in Litchi	NRC on Litchi, Muzaffarpur 7 June 2017	Dr. S.D. Pandey Dr. RK Patel Dr. Kuldeep Srivastava Dr. Vinod Kumar	140
Field day input distribution litchi planting material under Farmers FIRST project	Chintamanpur and Ujhilpur, East Champaran, 22 July 2017	Dr. Amrendra Kumar Dr. Gopal Kumar	100
Advance techniques for establishment of new litchi orchard	Chintamanpur and Ujhilpur, Motihari 22 and 29 July 2017	Dr. Amrendra Kumar Dr. SK Singh	280
Training on establishment of new orchard of mango, litchi, citrus and guava under Farmers FIRST project	Mahuawa Khairwa and Ramgarhwa in East Champaran 26 and 28 July 2017	Dr. SK Singh	390
Good Agricultural Practices in Litchi	ICAR RC NEH Region, Nagaland Centre, Medziphema, Nagaland, 3-5 August 2017	Dr. Vishal Nath Dr. RK Patel Dr. Alemwati Pongener Dr. Kuldeep Srivastava	54
Two days training on preparation of beverages from litchi	NRC on Litchi, Muzaffarpur 7-8 August 2017	Dr. SK Purbey	4
Field day cum training on "Canopy management and nursery management of litchi"	Yercaud, Salem, Tamil Nadu 8 August 2017	Dr. Amrendra Kumar Dr. SD Pandey	45
Field day cum Kisan Gosthi on "Girdling techniques for regularization of bearing in China litchi"	Waynad, Kerala 10-11 August 2017	Dr. Amrendra Kumar Dr. SD Pandey	65
GAP in Litchi and propagation technique	Vythri and Adivaum, Kerala 12 August 2017	Dr. Amrendra Kumar Dr. SD Pandey	50
Model Training Course Programme on "GAP in Litchi" sponsored by ATMA, Madhubani, Bihar	NRC on Litchi, Muzaffarpur 17-21 August 2017	Dr. Vishal Nath Dr. SK Purbey	24
GAP in litchi and mango and distribution of planting materials under Farmers FIRST project	Ujhilpur and Chintamanpur, East Champaran 23 September 2017	Dr. SK Singh	150
Tribal farmers training programme on litchi and vegetable cultivation	Khetauli, Shahdol, M.P. 7-8 September 2017	Dr. SD Pandey Dr. Kuldeep Srivastava Dr. Alok K Gupta	105
Training and demonstration on Swachhata and plants revival after flood	Narauli Binda, Muzaffarpur 24 September 2017	Dr. Vishal Nath Dr. SD Pandey Dr. SK Purbey Dr. Kuldeep Srivastava Dr. RK Patel Sh. Prabhat Kumar Sh. Abhishek Yadav & Other staff	36

Training on poultry and goat rearing under Farmers FIRST project	Ujhilpur and Chintamanpur villages of East Champaran, 11 October 2017	Dr. SK Singh	80
Mera Gaon Mera Gaurav (MGMG) programme in the adopted village	Kankati (Kothia Hareram), Mehsi, East Champaran 13 September 2017 23 October 2017 16 February 2018	Dr. Vinod Kumar Dr. SK Singh Dr. Alok Kumar Gupta Sh. Prabhat Kumar	74
Training on improved vegetable production under Farmers FIRST project	Ujhilpur, Chintamanpur and Ramgarh in East Champaran 1-5 November 2017	Dr. SK Singh	120
Field day cum Kisan Gosthi on best management practices in litchi	Bakhari, Muzaffarpur 3 November 2017	Dr. Vishal Nath Dr. SD Pandey Dr. Amrendra Kumar Dr. Kuldeep Srivastava Dr. R.K. Patel Dr. Alemwati Pongener Dr. Evening S Marboh Dr. Alok K Gupta	25
One day training programme on "Trial Shipment of litchi to Middle east Market"	NRC on Litchi, Muzaffarpur 10 November 2017	Dr. Vishal Nath Dr. SK Purbey Dr. Alemwati Pongener	28
Distribution and training on improved cultivation practices of wheat under Farmers FIRST project	7 villages of East Champaran 6 and 26 November 2017	Dr. SK Singh	600
Demonstration of NRCL technologies in Bihar Kisan Sashaktikaran Abhiyan for Shashwat Yougic evam Jaivik Kheti programme	Jubbasahani Park Auditorium, Muzaffarpur 16 November 2017	Dr. Kuldeep Srivastava	105
Training programme on quail rearing under Farmers FIRST project	Chintamanpur in East Champaran 21 November 2017	Dr. SK Singh	25
Training on "Improved cultivation of mango" under Farmers FIRST project	Ujhilpur and Bakhari Nazir of East Champaran 28 November 2017	Dr. SK Singh	80
Field day cum input distribution of litchi planting material	Bakhri Nazir and Rampurwa, East Champaran 30 November 2017	Sh. Prabhat Kumar Dr. Abhay Kumar	60
Kisan Mela 2017, DRPCAU, Pusa	DRPCAU, Pusa, Samastipur, Bihar 3-5 December 2017	Dr. SD Pandey Dr. RK Patel Dr. Vinod Kumar Dr. Alemwati Pongener	305

Advance technology for Vegetable production under Farmers FIRST project	Damodarpur and Ujhilpur of East Chamapran 15 December 2017	Dr. SK Singh	200
Distribution of Soil Health Card	Damodarpur and Ujhilpur village of East Champaran 15 December 2017	Dr. Vishal Nath Dr. SK Singh Sh. Prabhat Kumar	60
ATMA, Samastipur sponsored training programme on export quality litchi production and marketing	NRC on Litchi, Muzaffarpur 26-30 December 2017	Dr. SK Purbey Dr. RK Patel Dr. Vinod Kumar Dr. Swati Sharma	22
Field visit of Farmers of ATMA, Muzaffarpur	NRC on Litchi, Muzaffarpur 26 December, 2017	Dr. SK Purbey Dr. Swati Sharma	33
Training on processing and value addition in fruits and vegetables under Farmers FIRST project	Pipra Kothi, Motihari, Bihar 6 January 2018	Dr. SK Purbey Dr. Vinod Kumar Dr. Prabhat Kumar Dr. SK Singh Dr. Swati Sharma	25
Awareness programme on Organic Farming under Farmers FIRST project	Ujhilpur, Chintamanpur villages of East Motihari 6 January 2018	Dr. SK Singh	20
Field day cum distribution of animal health kit	Chintamanpur and Rampurwa, East Champaran	Sh. Prabhat Kumar Dr. Abhay Kumar	45
Improved cultivation practices in wheat under Farmers FIRST project	Ujhilpur, Chintamanpur, Ramgarhwa, Khairwa of East Champaran, 16 January 2018	Dr. SK Singh	35
Insect pest management in vegetables and other crops under Farmers FIRST project	Ujhilpur, Damodarpur, Bakhari Nazir, Chintamanpur, of E. Motihari, 23 January 2018	Dr. Kuldeep Srivastava Dr. SK Singh	25
One day brain storming session on GAP in Litchi	Gangian, Pathankot and Gurdaspur, Punjab 27-30 January 2018	Dr. Vishal Nath Dr. Amrendra Kumar	25
Training on traditional organic tools like Jeevamrit, Panchgavya and Jaivik keetnashi for cultivation under Farmers FIRST project	Ujhilpur, Motihari, Bihar 30 January 2018	Dr. Vinod Kumar Dr. SK Singh Sh. Prabhat Kumar Dr. Swati Sharma	68
Training on chick and quail farming under Farmers FIRST project	Bihar Veterinary College 31 January 2018	Dr. SK Singh	30
Agri Expo 2018	ICAR-RCER, Patna 11-13 January 2018	Dr. SK Purbey Dr. Amrendra Kumar	120
Training on mushroom production under Farmers FIRST project	Bakhari Nazir, East Champaran 03 February 2018	Dr. SK Singh	40

Kisan Prashikshan Shivir on GAP in litchi sponsored by ADB Japan Fund for Poverty Reduction and Global Agr. System, New Delhi	NRC on Litchi, Muzaffarpur 5-7 February 2018	Dr. SD Pandey Dr. SK Purbey Dr. Kuldeep Srivastava	75
Farmer training programme on litchi production	NRC on Litchi, Muzaffarpur 5-6 February 2018	Dr. SD Pandey Dr. Amrendra Kumar Dr. Kuldeep Srivastava	40
Tribal farmers training programme on improved vegetable production and litchi cultivation	Khetauli, Shahdol, M.P. 7 February 2018	Dr. SD Pandey Dr. Kuldeep Srivastava	105
Training on rearing of chicks and distribution of chicks under Farmers FIRST project	Ujhilpur, Damodarpur, Bakhari Nazir and Chintamanpur, East Champaran 8-9 February 2018	Dr. S.K. Singh	30
Training on mushroom production under Farmers FIRST project	Ramgarhwa, East Champaran 16 February 2018	Dr. SK Singh Dr. RK Patel	35
Training on canopy management and GAP in Litchi	Palini hills of Didigul District of TN and Wayanad District of Kerala 19-21 February 2018	Dr. SK Purbey Dr. Amrendra Kumar Dr. Evening S Marboh	4
Farmers' fair during Foundation day celebration of ICAR-RCER Patna	ICAR-RCER, Patna 22 February 2018	Dr. Abhay Kumar	65
North Zone Regional Farmer's Fair	ICAR-IIVR, Varanasi 23-25 February 2018	Dr. Swati Sharma	165
Regional Agriculture Fair for Eastern Region	Bihar Agricultural University, Sabour, 24-26 February 2018	Dr. Abhay Kumar	200
Kisan Gosthi cum National Science Day	Ujhilpur, East Champaran, Bihar 28 February 2018	Dr. Amrendra Kumar Dr. Kuldeep Srivastava Dr. RK Patel Dr. SK Singh	45
Showcasing of ICAR-NRCL technologies in International Agri-Tech, Bihar	Gandhi Maidan, Patna, Bihar 9-11 March 2018	Dr. SK Purbey	316
Training on preparation and demonstration of pickle making under Farmers FIRST project	Damodarpur, Mehsi, East Champaran, 10 March 2018	Dr. SK Purbey	30
Training programme and exposure visit on GAP in litchi sponsored by ADB Japan Fund for Poverty Reduction and Global Agr. System, New Delhi	NRC on Litchi, Muzaffarpur 13-14 March 2018	Dr. SD Pandey Dr. SK Purbey Dr. Kuldeep Srivastava	52
Training programme on Agricultural and Horticultural crops towards doubling the farmer's income under Farmers FIRST project	Chakia, East Champaran 17 March 2018	Dr. Vishal Nath Dr. SD Pandey Dr. SK Purbey Dr. Vinod Kumar Dr. SK Singh Sh. Prabhat Kumar	300
Showcasing of ICAR-NRCL technologies in Bihar Diwas	Gandhi Maidan, Patna 22-24 March 2018	Dr. Vinod Kumar	71
Animal Health Camp and Gosthi under Farmers FIRST project	Ujhilpur, East Champaran, Bihar 28 March 2018	Dr. Kuldeep Srivastava Dr. RK Patel Dr. SK Singh Sh. Prabhat Kumar	80

Commercialization/ licensing of Technology

Name of Technology/Know-How	Name of Contracting Party	Mode of Partnership	Date of Licensing
Process for preparation of Litchi Squash and RTS	Mr. Pankaj Kumar, M/S Muzaffarpur Agro, Muzaffarpur	Licensing/ Know-How	23rd June, 2017
Process for preparation of Litchi Squash and RTS	Mr. Ram Sarowar Singh, M/S Ram Sarowar Agro Foods, Chhitrauli, Maniyari, Muzaffarpur	Licensing/ Know-How	24th June, 2017

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

Dr. Vishal Nath

- Delivered lecture on "Impact of climate change on tropical fruit production system and its mitigation strategies" during National Conference on Impact of Climate change of agricultural production on 06th April, 2017 at BAU, Sabour.
- Delivered lecture on topic "Litchi cultivation in humid tropics- scope and prospects" during "National Conference on Horticultural Crops of Humid Tropics - Diversification for Sustainability" on 20-21st May, 2017 at Madikeri, Coorg, Karnataka.
- Delivered lecture on topic "New Paradigm of Litchi Production and Value Chain Management" during National Conference on Challenges and options in litchi production and utilization" on 6-7th June, 2017 at NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on topic "Recent development in litchi production-An overview" during Training Programme on GAP in Litchi during 17-21st August, 2017.
- Delivered lecture on topic "Rejuvenation of old senile litchi orchard and canopy architecture in litchi during GAP in Litchi Training Programme on 26-30th December, 2017.
- Delivered lecture on topic "Doubling farmers income through horticulture based integrated farming system: a Concept and Experiences" during National Seminar on Transforming Agriculture to Doubling Farmers' Income" on 10th February, 2018 at BBAU, Lucknow.
- Delivered lecture on topic "Food value and nutritive benefits of litchi and pummelo" during twelth National Symposium on "Noni and Herbal Wealth for Sustainable Wellness" on 24-25th March, 2018 organized by International Society for Noni Science, World Noni Research Foundation & Noni Bio Tech, Chennai, at COA, Pune.

Dr. S.D. Pandey

- Delivered a lecture on "Canopy management of litchi" in training course on GAP in Litchi (18th June 2017) at Bakhari, Murol, Muzaffarpur
- Delivered lecture on "Nutrient and Water Management' during training course on GAP in Litchi (17-21 August, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "Organizational behaviour and nutrient water management in high density planting" during winter school Understanding flowering mechanism and management of bearing in sub-tropical fruits (1-21 December, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered talk on GAP in litchi and nutrient and water management in *Rabi Mahotsava* organized by ATMA, Muzaffarpur on 12th October, 2017.
- Delivered talk on nutreint and water management on ATMA training programme for agri product dealers certification course on 15th October, 2017.
- Delivered lecture on 'GAP and nutrient and water management in litchi' during training course on Litchi production for export quality and marketing (26-30 December, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on GAP in Litchi organized by Govt of Bihar sponsored by Asian Development Bank on 5th February, 2018.

- Acted as resource person in training programme organized by JEEVIKA at Digra and Motipur on 20th March, 2018.

Dr. S.K. Purbey

- Delivered lead presentation on "*Innovations in Post harvest management and Value addition in Litchi*". *In:* National Conference on Perspective of Challenges and Options in Litchi Production and Utilization" at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017.
- Delivered lecture on "*Innovations and Technologies for sustainable development in Agriculture*". *In:* Workshop on Regional resource persons and mentor on focal theme "Science, technology & innovation for sustainable development with special emphasis for person with disability" during 25th National Children science congress organized by Science for society, Bihar in collaboration with BCST and SCERT, Bihar Catalyzed and supported by NCSTC-DST, Ministry of Science and Technology, GOI.
- Delivered lecture on "*Post Harvest handling & Management of litchi fruits*". *In*: Five days training programme on GAP in Litchi sponsored by ATMA, Madhubani, Bihar during 17-21st Aug., 2017 at ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "*Processing and Value addition in Litchi*". *In*: Five days training programme on GAP in Litchi sponsored by ATMA, Madhubani, Bihar during 17-21st Aug., 2017 at ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "*Hi-tech Horticulture for export quality litchi production*". *In*: Five days training programme on Export Quality Litchi Production and Marketing, sponsored by ATMA Samastipur during 26-30th Dec., 2017, at ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "*Harnessing light energy for regular flowering and quality fruit production*". *In:* ICAR sponsored 21-day Winter School on, "Understanding Flowering Mechanism and Management of Bearing in Sub-Tropical Fruits" 01-21st December 2017 at ICAR-NRC on Litchi, Muzaffarpur.
- Delivered lecture on "*Extension activities and tools for promotion of technologies and products*". *In*: MANAGE sponsored six month training programme on "Diploma in Agricultural Extension Services for Input Dealers" (DAESI) organized by ATMA, Muzaffarpur on 31st December, 2017.
- Delivered lecture on "*Agricultural marketing and E-commerce*". *In*: MANAGE sponsored six month training programme on "Diploma in Agricultural Extension Services for Input Dealers" (DAESI) organized by ATMA, Muzaffarpur on 28th January, 2018.
- Delivered lecture on "*Post harvest handling, processing and marketing of litchi fruits*". *In:* Training programme and exposure visit of litchi growers from Mushari Block, Muzaffarpur sponsored by ADB Japan Fund for Poverty reduction and organized by Global Agr. System, New Delhi at ICAR-NRC on Litchi during 5-7th February, 2018.
- Delivered lecture on "*Post harvest handling and marketing of litchi fruits. In*: Training programme and exposure visit of litchi growers from Minapur Block, Muzaffarpur organized by Global Agri. System Pvt. Ltd., New Delhi at ICAR-NRC on Litchi during 6-7th February and 13-14th March, 2018.

Dr. Amrendra Kumar

- Delivered lecture on "Orchard plantation, care and maintenance of young orchard for GAP in litchi" in ATMA, Madhubani, Bihar sponsored training programme on "Good Agricultural Practices on Litchi" (17-21st August, 2017) at ICAR-NRC on Litchi, Muzaffarpur.
- Conducted practical session on "Exposure to layout of orchards for different densities and selection of site and planting material, Canopy architecture and management" in ATMA, Madhubani, Bihar sponsored training programme on "Good Agricultural Practices on Litchi" (17-21st August, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.

- Delivered lecture on "Efficient utilization of interspaces in litchi to enhanced income" in ATMA, Madhubani, Bihar sponsored training programme on "Good Agricultural Practices on Litchi" (17-21st August, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered lecture on "Establishment of new litchi orchard and bearing regulation in litchi" in the training on Litchi production for export quality and marketing (26-30 Dec., 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar.

Dr. Kuldeep Srivastava

- Delivered lecture on "IPM for litchi export' in training course on Litchi production for export quality and marketing (26-30 December, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th December, 2017.
- Delivered lecture on "Role of pollinators and pests affecting bearing in sub-tropical fruit crop" in winter school on "Understanding flowering mechanism and management of bearing in sub-tropical fruits" (1-21 December, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar on 15th December, 2017.
- Delivered a lecture on "Advanced IPM Practices in litchi" in training course on GAP in Litchi (3-5 Aug., 2017) at ICAR Research Complex for NEH Region Nagaland Centre, Jharnapani, Nagaland.
- Delivered a lecture on "Pest management in fruits and vegetables" at Ujhilpur village, East Champaran on 28th February, 2018 under Farmers FIRST Project.
- Delivered lecture on "Pest management in horticultural crops" under TSP Head at Khetauli, Shahdol, M. P. on 7th February, 2018.

Dr. R.K. Patel

- Delivered lecture on "Litchi based integrated farming system for different topography and organic litchi production system' in training course on GAP in Litchi (17-21 Aug., 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar on 20th August, 2017.
- Delivered lecture on "Litchi based integrated farming system for different topography and organic litchi production system' in training course on Litchi production for export quality and marketing (26-30 Dec., 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar on 28th December, 2017.
- Delivered a lecture on "Nursery management of litchi" in training course on GAP in Litchi (3-5 August, 2017) at ICAR Research Complex for NEH Region Nagaland Centre, Jharnapani, Nagaland.
- Delivered a lecture on "Package of practices in litchi & vegetables" at Ujhilpur village, East Champaran on 28th February, 2018 under Farmers FIRST Project.
- Delivered lecture on "Bearing management of litchi through organic inputs and developing IFS module for low lying areas" in winter school on Understanding flowering mechanism and management of bearing in sub-tropical fruits (1-21 December, 2017) at ICAR-NRC on Litchi, Muzaffarpur, Bihar on 15th December, 2017.

Dr. Vinod Kumar

- Delivered 2 lectures on the topics viz. "Important disease of litchi and their management" and "Importance of mycorrhiza for quality litchi production" in the ATMA, Madhubani sponsored training programme on "Good agricultural practices in litchi" held during 17-21 August, 2017 at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered a lecture entitled "Role of arbuscular mycorrhizal fungi and Trichoderma in improving growth and physiology of mango and litchi" in the Winter School on "Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops" held during 01-21 December, 2017.
- Delivered 2 lectures on the topics viz. "Important disease of litchi and their management" and "Importance of mycorrhiza for quality litchi production" in ATMA, Samastipur sponsored training programme held during 26-30th December 2017 at ICAR-NRC on Litchi, Muzaffarpur.

Dr. Sanjay Kumar Singh

- Delivered a lecture on *Project Proposal Formulation under Agriculture Stream* under '25th National Children Science Congress-2017: District Level Project Orientation Workshop for Group leaders and Guide teachers' (27 July, 2017) at Rajendra College, Chapra, Saran, Bihar.
- Delivered a lecture on '*Regulation of flower induction and quality litchi production*' during Training Programme on GAPs in litchi, Sponsored by ATMA, Madhubani, Bihar (17-21 August, 2017) at ICAR-NRCL, Muzaffarpur.
- Delivered lecture on '*Management of pests and diseases of mango and litchi' through newer molecules'* during one-day Farmer's meet at Muzaffarpur Sponsored by Bayer Crop Care India Limited (25 January, 2018).

Dr. Abhay Kumar

- Delivered a lecture on "Molecular Biology of Flowering in Perennial Plants" in the Winter School on *"Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops"*, 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.

Sh. Prabhat Kumar

- Delivered a lecture on "Quick and Qualitative Analysis of Nutrient Deficiency Symptoms and Managing Plant Nutrition" in the Winter School on "*Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops*", 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.

Dr. Alok Kumar Gupta

- Delivered a lecture on "Reality of Bearing Potential and Realized Yield of Litchi Cultivars" in the Winter School on "*Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops*", 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.
- Delivered a lecture on "Advances in improvement of litchi for domestic and export standards" in the ATMA, Madhubani sponsored training programme on "Good agricultural practices in litchi" held during 17-21 August 2017 at ICAR-NRC on Litchi, Muzaffarpur, Bihar.

Dr. Alemwati Pongener

- Delivered a lecture on "Postharvest storage behavior of litchi fruit cv. Shahi under ambient condition" during National Conference on Perspectives of Challenges and Options in Litchi Production and Utilization, 6-7th June, 2017, Muzaffarpur, Bihar.

Dr. E.S. Marboh

- Delivered a lecture on "Advances in water management of litchi under changing climatic condition" in the ATMA, Madhubani sponsored training programme on "Good agricultural practices in litchi" held during 17-21 August 2017 at ICAR-NRC on Litchi, Muzaffarpur, Bihar.
- Delivered a lecture on "Estimation of Total Carbohydrate" in Winter School on Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops, 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.
- Delivered a lecture on "Reality of Bearing Potential and Realized Yield of Litchi Cultivars" in Winter School on Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops, 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.

Dr. Swati Sharma

- Delivered a lecture on "Estimation of Total Carbohydrate" in Winter School on Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops, 01-21 December 2017, ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar, India.

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 indigenous and exotic germplasm, their characterization, evaluation, documentation and utilization	Dr. Vishal Nath	Sh. Narayan Lal Dr. Amrendra Kumar Dr. A.K. Gupta Dr. Evening Stone Marboh
1.2	Developing improved cultivars in litchi	Dr. Vishal Nath	Dr. Abhay Kumar Sh. Narayan Lal Dr. A.K. Gupta Dr. Evening Stone Marboh
1.3	Molecular finger-printing in litchi cultivars through micro-satellite markers	Dr. Abhay Kumar	Sh. Narayan Lal Dr. 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. S.K. Singh Dr. R.K. Patel Dr. Abhay Kumar Dr. Evening S Marboh Dr. Swati Sharma
2.4	Studies on mycorrhizal association and role of bio-fertilizers for improved litchi production	Dr. Vinod Kumar	Dr. Swati Sharma
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 Sh. Prabhat Kumar
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	Sh. Prabhat Kumar	Dr. Amrendra Kumar Dr. Vinod Kumar Dr. S.D. Pandey
2.9	Development of DRIS norms for nutrient management in litchi	Sh. Prabhat Kumar	-
2.10	Leaf nutrient dynamics in litchi	Sh. Prabhat Kumar	Dr. Evening S Marboh Dr. Swati Sharma
2.11	Screening of different microbial consortia for enhancement of productivity and quality of litchi fruits	Sh. Prabhat Kumar	-
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. S.K. 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. S.K. 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 Dr. Kuldeep Srivastava Dr. Alok K Gupta Dr. Evening Stone Marboh
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 S Marboh
6.2.	Shoot physiology in relation to flowering and fruiting in litchi	Dr. S.K. Singh	Dr. Amrendra Kumar Dr. Abhay Kumar Dr. Swati Sharma Dr. Evening S 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) upto 30 June 2017 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 (PI) from Ist July 2017 Dr. Prabhat Kumar (Co-PI) **Associated Scientist for the Project** Dr. Amrendra Kumar Dr. R. K. Patel Dr. Abhay Kumar Dr. Alemwati Pongener Dr. Swati Sharma Sh. Alok K Gupta Dr. Evening S Marboh
2.	ICAR Seed Project – Seed Production in Agricultural Crops and Fisheries (RFS)	ICAR, New Delhi	Dr. Amrendra Kumar
3.	Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology scheme	ICAR, New Delhi	Dr. Vishal Nath Dr. S.K. Purbey (Nodal officer)
4.	Developing national repository and facilities for DUS testing in Litchi	ICAR, New Delhi	Dr. Vishal Nath
5.	Development of synergistic hurdles for preservation of litchi pulp and products	BRNS, DAE, Mumbai	Dr. Vishal Nath (PI) Dr. S.K. Purbey (Co-PI) Dr. S. Gautam (PC) **Scientist associated** Dr. Vinod Kumar Dr. Alemwati Pongener

List of Publications

Research papers

Barman, K., Asrey, R., Singh, D., Patel, V.B. and Sharma, S. (2017). Effect of *Pseudomonas fluorescens* formulations on decay and quality of mango (*Mangifera indica*) fruits during storage. *Indian Journal of Agricultural Sciences* **87**(9): 1214-1218.

Barman, K., Patel, V.B., Sharma, S. and Singh, R.R. (2017). Effect of chitosan coating on postharvest diseases and fruit quality of mango (*Mangifera indica*). *Indian Journal of Agricultural Sciences* **87**(5): 618-623.

Gupta, A.K., Singh, M., Marboh, E.S., Nath, V., Pongener, A. and Anal, A.K.D. (2017). Pollen Quantity, Viability and in vitro Pollen Germination of Longan (*Dimocarpus longan* Lour.). *International Journal of Current Microbiology and Applied Sciences* **6**(7): 270-278.

Guroo, M.A., Pervez, A., Srivastava, K. and Gupta, R.K. (2017). Effect of nutritious and toxic prey on food preference of a predaceous ladybird, *Coccinella septempunctata* (Coleoptera: Coccinellidae). *European Journal of Entomology* **114**: 400-406.

Jadon, K.S., Thirumalaisamy, P.P., Kumar, V., Koradia, V.G. and Padavi, R.D. (2017). Integrated management of major foliar and soil-borne diseases of peanut (*Arachis hypogaea* L.) with fungicides, Trichoderma and castor cake. *International Journal of Current Microbiology and Applied Sciences* **6**(12): 1884-1899. https://doi.org/10.20546/ijcmas.2017.612.215.

Kumar, A., Singh. S.K., Pandey, S.D., Patel, R.K. and Nath, V. (2017). Effect of foliar spray of chemicals on flowering and fruiting in litchi. *International Journal of Current Microbiology & Applied Science* **6**(5): 1337-1343.

Kumar, V. and Anal, A.K.D. (2018). Incidence and severity of leaf, panicle and fruit blights of litchi caused by *Alternaria alternata*. *Indian Phytopathology* **71**(1): 153-157.

Kumar, V., Anal, A.K.D. and Nath V. (2018). Biocontrol fitness of an indigenous *Trichoderma viride*, isolate NRCL T-01 against *Fusarium solani* and *Alternaria alternata* causing diseases in litchi (*Litchi chinensis*). *International Journal of Current Microbiology and Applied Sciences* **7**(3): 2647-2662.

Kumar, V., Anal, A.K.D. and Nath V. (2018). Growth response of litchi to arbuscular mycorrhizal co-inoculation with *Trichoderma viride*, *Azotobacter chroococcum* and *Bacillus megatarium*. *Indian Phytopathology* **71**(1): 65-74.

Kumar, V., Anal, A.K.D., Rai, S. and Nath, V. (2018). Leaf, panicle, and fruit blight of litchi (*Litchi chinensis*) caused by *Alternaria alternata* in Bihar state, India. *Canadian Journal of Plant Pathology* **40**(1): 84-89.

Lal, N., Gupta, A.K. and Nath, V. (2017). Fruit retention in different litchi germplasm influenced by temperature. *International Journal of Current Microbiology and Applied Sciences* **6**(12): 1189-1194.

Lal, N., Marboh, E.S., Gupta, A.K. and Patel, R.K. (2017). A review on crop regulation in fruit cropsþ. *International Journal of Current Microbiology and Applied Sciences* **6**(7): 4032-4043.

Nath, V., Singh, H.S., Kishore, K. and Samant, D. (2017). Growth analysis of *in situ* raised mango plants under rain fed condition in Alfisols of eastern India. *International Journal of Innovative Horticulture* **6**(1): 84-88.

Pandey, A.K., Singh, P. and Singh, S.K. (2018). Impact of Different Doses and Methods of Application of paclobutrazol on leaf area and flush length of litchi cultivars. *International Journal Chemical Studies* **6**(1): 1422-1425.

Pandey, A.K., Singh, P., Singh, S.K. and Gupta, K. (2017). Application methods and doses of paclobutrazol affect growth, yield and fruit quality of litchi (*Litchi chinensis* Sonn.) cultivars. *International Journal of Current Microbiology and Applied Sciences* **6**(8): 3280-3288.

Patel, K.G., Thankappan, R., Mishra, G.P., Mandaliya, V.B., Kumar, Abhay and Dobaria, J.R. (2017). Transgenic Peanut (*Arachis hypogaea* L.) Overexpressing *mtlD* gene showed improved photosynthetic, physio-biochemical, and yield-parameters under soil-moisture deficit stress in lysimeter system. *Frontiers in Plant Science* **8**, 1881.

Patil, A.S., Thankappan, R., Mehta, R., Yadav, R., Kumar, Abhay, Mishra, G.P., Dobaria, J.R., Thirumalaisamy, P.P.

and Jain, R. K. (2017). Evaluation of transgenic peanut plants encoding coat protein and nucleocapsid protein genes for resistance to tobacco streak virus and peanut bud necrosis virus. *Journal of Environmental Biology* **38**(2), 187-196.

Sagar, V.R. and Pongener, A. (2017). Effect of dying methods, pre-treatments, and slice size on quality of dehydrated okra (*Abelmoschus esculentus* L. Moench). *Beverage and Food World*. **44**(8): 30-33.

Sharma, D., Maqbool, A., Jamwal, V.V.S., Srivastava, K. and Sharma, A. (2017). Seasonal dynamics and management of whitefly (*Bemesia tabaci* Genn.) in tomato (*Solanum esculentum* Mill.). *Brazilian Archives of Biology and Technology*. **60**: e17160456.

Sharma, S. and Sharma, R.R. (2017). Salicylic acid treatment maintains fruit quality of Japanese plum (*Prunus salicina* Lindell) cv. 'Santa Rosa'. *Indian Journal of Agricultural Sciences*. **87**(9): 1209-1213.

Singh, S.K., Malhotra, S.K., Bhargava, R. and Singh, R.S. (2017). Morphological and physiological characterization of guava (*Psidium guajava*) under hot-arid zone of Rajasthan. *Indian Journal of Agricultural Sciences*. **87**(4): 491-495.

Srivastava, K., Patel, R.K., Kumar, A., Pandey, S.D., Reddy, P.V.R. and Nath, V. (2017). Integrated management of litchi fruit and shoot borer (*Conopomorpha sinensis*) using insect growth regulators under subtropics of Bihar. *Indian Journal of Agricultural Sciences* **87**(11): 1515-1518.

Srivastava, K., Sharma, D., Singh, S. and Ahmad, H. (2017). Foraging behaviour of honeybees in seed production of *Brassica oleracea* var. *Italica* plenck. *Bangladesh Journal of Botany*. **46**(2): 675-681.

Papers in seminars/symposia/conferences

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पाण्डेय, एस.डी., पटेल, आर.के., श्रीवास्तव, के., कुमार, ए., सिंह, एस. के. एवं नाथ, वि. (2018)। जैविक तकनीक द्वारा गुणवत्तायुक्त लीची उत्पादन'। प्रसार पुस्तिका-एन.आर.सी.एल.ई.बी.-25 (फार्मर्स फर्स्ट परियोजना). भा.कृ.अनु.प.-राष्ट्रीय लीची अनुसंधान केंद्र मुशहरी, मुजफ्फरपुर। 8 पृष्ट.

श्रीवास्तव, के., पटेल, आर.के., पाण्डेय, एस.डी., कुमार, ए., गुप्ता, ए. के. एवं सिंह, एस.के. (2018)। लीची एवं आमः एकीकृत कीट प्रबंधन। प्रसार पुस्तिका संख्या 5। (फार्मर्स फर्स्ट परियोजना)। भा.कृ. अनु.प.-राष्ट्रीय लीची अनुसंधान केंद्र मुशहरी, मुजफ्फरपुर। 6 पृष्ट.

Peer Recognition

Dr. Vishal Nath

- Acted as Organizing Chairman, National Conference on Perspective of Challenges and Options in Litchi Production and Utilization held at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017
- Member Editorial board, Current Horticulture
- Reviewed research articles of Indian Journal of Horticulture
- Empanelled as Co-Advisor for Ph.D. (Horticulture) students by JNKVV, Jabalpur to guide on characterization of litchi genotypes

Dr. S.D. Pandey

- Acted as Organizing Secretary, National Conference on Perspective of Challenges and Options in Litchi Production and Utilization held at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017
- Delivered the talk as invited speaker on 'High Density Planting in litchi' during National conference on perspective of challenges and options in litchi production and utilization organized by CHAI Bihar & Jharkhand chapter at ICAR-NRC on Litchi, Muzaffarpur, Bihar from 6-7 June, 2017

Dr. S.K. Purbey

- Act as member Editorial Board of *Muz Darpan,* Rajbhasha Patrika published by NRAKAS, Muzaffarpur, Bihar
- Acted as Co-organizing Secretary, Co-chair and lead presenter (Technical Session – VI: Industrial Utilization, Value Chain Management, Branding and Marketing for Better Farmer's Income) *In*: National Conference on Perspective of Challenges and Options in Litchi Production and Utilization" at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017
- Nominated as member of the Science project evaluation committee and resource person for Science Projects in District Level 25th National Children's Science Congress-2017 held at Mukherjee Seminary, Muzaffarpur, Bihar on 27 Sept, 2017
- Nominated as Jury Member of evaluation committee and resource person for Science projects in 25th State Level Children's Science Congress - 2017 held at Sri Laxmi High School, Sitamarhi, Bihar during 1-3rd Nov, 2017

Dr. Amrendra Kumar

- Associate Editor of Society for Horticultural Research and Development (Current Horticulture Journal), Ghaziabad, U.P.
- Acted as Convener, National Conference on Perspective of Challenges and Options in Litchi Production and Utilization held at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017

Dr. Kuldeep Srivastava

- Acted as Co-convener, National Conference on Perspective of Challenges and Options in Litchi Production and Utilization held at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017
- Associate Editor of International Journal of Life-Sciences Scientific Research, Barabanki, U.P. India
- Reviewed research articles of Journal of Agricultural Science, Toronto, Canada
- Evaluated and conducted vive voce exam of M Sc (Ag.) Entomology Students (02 No.), DRPCAU, Pusa, Samastipur, Bihar

Dr. R.K. Patel

- Acted as Co-convener, National Conference on Perspective of Challenges and Options in Litchi Production and Utilization held at ICAR-NRC on Litchi, Muzaffarpur, Bihar during 6-7th June, 2017
- 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-17-01600 & JFST-D-17-01902)
- Reviewed research article of *Applied Biological Research* (ABR 17-195)
- Review research article of *Journal of Environmental Biology* (MRN-865)
- Participated and act as member in judging committee of Horticulture show organised at DRPCAU, Pusa, Samastipur on 4th Dec., 2017
- Evaluated and conducted vive voce exam of M Sc (Ag) Hort. Student, BAU, COA, Sabour, Bihar

Dr. Vinod Kumar

- Editor in journal Pharmaceutical and Biomedical Sciences: An International Journal (PBIJ)
- Editor in Journal of Crop Research and Fertilizers- an Open Access peer reviewed journal published by Clerisy Publishers, Sunnyvale, USA
- Editor in International Journal of Agriculture Sciences, Bioinfo Publications, Pune, India.
- Reviewer for the following five journals *viz., Journal of Crop Research and Fertilizers, Crop Protection, Indian Phytopathology International Journal of Agriculture Science and Journal of Environmental Biology.*
- Acted as External Examiner to conduct viva-voce examination of one M.Sc. (Ag.) student at DRPCAU, Pusa
- Appointed as external examiner for evaluation of answer sheets of Written Comprehensive Examination of PG Programmes {M.Sc. (Ag.) & Ph.D} in Plant Pathology at DRPCAU, Pusa, Bihar
- Delivered a keynote lecture on "Advances in understanding beneficial plant microbe interaction and their applications in litchi" in the National Conference on "Perspective of Challenges and Options in Litchi Production and Utilization" at ICAR-NRCL, Muzaffarpur on 7th June 2017
- Judge for evaluation of exhibits displayed in Horticultural Show 2017 (*Kisan Mela*) at DRPCAU, Pusa held during 3-5 December, 2017

Dr. Sanjay Kumar Singh

- Appointed as question setter, for Course No. AHT-101, (Academic Session 2017-18) External Examination and Evaluation Cell, DRPCAU, Pusa, Samastipur, Bihar
- Acted as Co-chairman, Theme 5: *Horticulture, Forestry, Biological Science and Secondary Agriculture In: National Conference on Livelihood and Food Security* (LFS-2018) (27-28 January, 2018), Bihar Veterinary College, Patna
- Invited as lead speaker for 'Canopy management in fruit crops with special reference to pomegranate' *In*: 2nd National Seminar –cum-Farmer's Fair on Pomegranate for Health, Growth and Prosperity (28-30 April, 2017), ICAR-National Research Centre on Pomegranate, Solapur, MS
- Invited to deliver key note lecture on '*Physiological Basis of Flowering in litchi* (*Litchi chinensis* Sonn.) *trees In: National Conference on Challenges and Options in Litchi Production and Utilization*, (6-7th June, 2017), ICAR-NRCL, Muzaffarpur
- Acted as convener of session entitled '*Plant Canopy architecture, regulation of bearing and harvesting Systems*' *In: National Conference on Challenges and Options in Litchi Production and Utilization*, (6-7th June, 2017), ICAR-NRCL, Muzaffarpur
- Acted as course co-ordinator for Winter School on '*Understanding Flowering Mechanism and Management of Bearing in Sub-tropical Fruit Crops*', (1-21st December, 2017), ICAR-NRCL, Muzaffarpur
- Invited as lead speaker to deliver a concept paper on '*Physiological Basis of Flowering in Litchi* (*Litchi chinensis* Sonn.) Trees' *In: National Conference on*

Perspective of Challenges and Options in Litchi Production and Utilization (6-7th June, 2017), ICAR-NRCL, Muzaffarpur, Bihar

Dr. Abhay Kumar

- Associate Editor of International Journal of Agriculture Sciences, Bioinfo Publications, Pune, India.
- Reviewer for Heliyon Journal - Elsevier
- Reviewer for 3Biotech Journal - Springer
- Reviewer for Molecular Breeding Journal - Springer
- Reviewer for Journal of Plant Biochemistry and Biotechnology - Springer
- Reviewer for Proceedings of the National Academy of Sciences, Biological Sciences (NASB) –Springer

Dr. Alemwati Pongener

- Acted as judge for Horti-Exhibits during Kisan Mela at DRPCAU, Pusa, Samastipur from 3-5th December, 2017
- Reviewer for 'Journal of Food Processing and Preservation' and 'Journal of Functional Foods'

Dr. Swati Sharma

- Outstanding Reviewer Award from Scientia Horticulturae Journal
- Editorial Board Member in Trends in Horticulture Journal published by Enpress
- Invited as a reviewer for research articles submitted in Scientia Horticulturae, Elsevier and Indian Journal of Agricultural Sciences
- Awarded Excellence in Research award-2017 by Agricultural Technology Development Society, Ghaziabad, Uttar Pradesh

Awards and Honours

Awards and honours conferred to the centre

Dr. Vishal Nath

- Received Fellowship of International Society for Noni Science, Chennai.

Dr. S.D. Pandey

- Bharat Vikash Award, 19th November, 2017 by Institute of Self Reliance, Bhubaneswar, Odisha

Dr. Vinod Kumar

- Fellow of Indian Phytopathological Society (FPSI) Award, 2016 during the 70th Annual Meeting & National Symposium of the Society held at Jorhat, Assam (15-17, February 2018)
- Received 'Best Paper Award' for "Advances in understanding beneficial plant microbe interaction and their applications in litchi" presented at National Conference on "Perspective of Challenges and Options in Litchi Production and Utilization" (6-7 June, 2017), ICAR-National Research Centre on Litchi, Muzaffarpur

Dr. Sanjay Kumar Singh

- Best paper award for "Singh, S.K., Sharma, S., Kumar, A., Pandey, S.D. and Nath, V. (2017). Growth and physiology of flowering affected by paclobutrazol and potassium nitrate in litchi (*Litchi chinensis* Sonn.) trees." *In:* National Conference on Perspectives of Challenges and Options in Litchi Production and Utilization (6-7 June, 2017), ICAR-National Research Centre on Litchi, Muzaffarpur

Dr. Alok Kumar Gupta

- Fellow of CHAI Award-2017

Dr. Swati Sharma

- Awarded Excellence in Research Award-2017 by Agricultural Technology Development Society (Regd.), Muradnagar, Ghaziabad, Uttar Pradesh, India

Dr. Evening Stone Marboh

- Fellow of CHAI Award-2017

Compilation, Editing, and Documentation

Sl. No.	Title	Year of publication	Scientists involved
1.	NRCL Annual Report, 2016-17 (English)	2017	Dr. R.K. Patel Dr. Sanjay Kr. Singh Dr. Alemwati Pongener
2.	ICAR-NRCL Annual Report, 2016-17 (Hindi)	2017	Dr. R.K. Patel Dr. Sanjay Kr. Singh Dr. Alemwati Pongener Dr. Kuldeep Srivastava
3.	NRCL Newsletter Volume 3 Issue 1 & 2	2017-18	Dr. R.K. Patel Dr. Abhay Kumar Dr. Sanjay Kr. Singh Dr. Alemwati Pongener
4.	NRCL Wall and Desk Calendar	2018	Dr. R.K. Patel Dr. Sanjay Kr. Singh Dr. Alemwati Pongener
5.	11th RAC Proceedings, Recommendations of 10th RAC, Action Taken Report	2017-18	Dr. S.K. Purbey
6.	News and updates for NRCL Website and *ICAR NEWS*	2017-18	Dr. Vinod Kumar
7.	Technology and Publication Repository (Database), KRISHI (Knowledge Based Resources Information Systems Hub for Innovations in Agriculture)	2017-18	Dr. Vinod Kumar
8.	HYPM, Quarterly Report, Monthly Cabinet Report, PMS, PIMS-ICAR	2017-18	Dr. Sanjay Kumar Singh
9.	ICAR-AICRP (Fruits) on Litchi Annual Report 2016-17; AICRP (F) QRT Reports	2017-18	Dr. Evening Stone Marboh
10.	16th IRC Proceedings, and Action Taken Report	2017-18	Dr. Alemwati Pongener
11.	Compilation of Rajbhasa Hindi Patrika (लीचिमा)	2017-18	Dr. S.K. Purbey Dr. S.D. Pandey Dr. Swati Sharma Dr. J.P. Verma
12.	EFC/SFC for 2017-20	2017	Dr. Vishal Nath Dr. Sanjay Kr. Singh

Personnel

Scientific

Name and Email	Designation	Area of Interest
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 rambutan germplasm
Dr. Kuldeep Srivastava kuldeep.ipm@gmail.com	Pr. Scientist (Entomology)	Management of insect pests of litchi; Insect pollinators of litchi.
Dr. R.K. Patel rkpatelicar@gmail.com	Pr. 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. Sanjay Kumar Singh sanjayhor@rediffmail.com	Sr. Scientist (Hort.)	Shoot physiology and biochemistry in relation to flowering and fruiting in litchi; Germplasm conservation and development of database on mango and pummelo, Doubling farmer's income through innovative tech.
Dr. Abhay Kumar abhay.kumar1@icar.gov.in	Scientist SS (Biotechnology)	Molecular markers; diversity analysis and genetic transformation
Sh. Prabhat Kumar prabhat.ssac@gmail.com	Scientist (Soil Science)	Soil Science; climate change and climate resilient agriculture
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

Recruitment, Promotion and Transfer

New entry

1. Dr. Abhay Kumar, Scientist SS (Biotechnology) joined the centre on 10th July, 2017 on transfer from ICAR-Directorate of Groundnut Research, Junagadh, Gujarat.
2. Sh. Ranjit Kumar, Assistant joined the centre on 18th Sept, 2017 under direct recruitment through ASRB, New Delhi.
3. Sh. Dileep Kumar, Assistant, resumed his duty on 01st Nov, 2017 as Assistant on completion of deputation as AAO from ICAR-CPRI RS, Patna.

Promotion

1. Dr. R.K. Patel, Senior Scientist (Fruit Science) has been promoted to Principal Scientist with effect from 15th July, 2016.
2. Dr. Kuldeep Srivastava, Senior Scientist (Agril. Entomology) has been promoted to Principal Scientist with effect from 10th July, 2016.
3. Dr. Sanjay Kumar Singh, Scientist SS (Hort.) has been promoted to Sr. Scientist (Hort.) with effect from 7th January, 2017.

Transfer & Deputation

1. Dr. Gopal Kumar, Senior Scientist (Soil Science) was relieved from the centre on 31st July, 2017 on being transferred to ICAR-Indian Institute of Soil & Water Conservation, Dehradun.

Important Committees

Research Advisory Council

During 2017-18, the 11th Research Advisory Committee (RAC) meeting was held on 11th May, 2017. Following members of the RAC committee attended.

1.	Dr. S.D. Shikhamany	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. Vishal Nath, Director, ICAR-NRCL, Muzaffarpur, Bihar	Member
9.	Dr. S.K. Purbey, Principal Scientist, ICAR-NRCL	Member Secretary

11th RAC meeting in progress

Interaction of RAC members with the scientists of NRCL

Institute Research Council

During the year, 16th Institute Research Council (IRC) meetings were held on 11-16th December, 2017. The IRC meeting 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.

16th IRC meeting in progress

Institute Management Committee

The 12th Institute Management Committee (IMC) meeting was held on 24th February 2018 at the centre. The following members attended the meeting and discussed the agenda items relevant to IMC of the Centre:

1.	Dr. Vishal Nath, Director, ICAR-NRCL, Muzaffarpur	Chairman
2.	Dr. W.S. Dhillon, ADG (H.S.), ICAR, New Delhi	Member
3.	Dr. K.K. Jha, Chairman, Deptt. of Horticulture, Birsa Agricultural University, Ranchi, Jharkhand	Member
4.	Dr. AK. Singh, PS and Head, ICAR-RCER, Research Centre, Plandu, Jharkhand	Member
5.	Dr. V.K. Mishra, Head, ICAR-CSSRI Regional Research Station, Lucknow	Member
6.	Dr. S.K. Purbey, Principal Scientist, ICAR-NRCL	Special Invitee
7.	Dr. Amrendra Kumar, Principal Scientist, ICAR-NRCL	Special Invitee
8.	Dr. Kuldeep Srivastava, Principal Scientist, ICAR-NRCL	Special Invitee
9.	Dr. R.K. Patel, Principal Scientist, ICAR-NRCL	Special Invitee
10.	Dr. S.K. Singh, Sr. Scientist, ICAR-NRCL	Special Invitee
11.	Dr. Alemwati Pongener, Scientist, ICAR-NRCL	Special Invitee
12.	Sh. Ramji Giri, AAO, ICAR-NRCL	Special Invitee
13.	Sh. Subhankar Dey, FAO, ICAR-NRCL	Special Invitee
14.	Sh. Abhishek Yadav, AO, ICAR-NRCL	Member Secretary

Other Institutional Committees

The composition of other important institutional committees during 2017-18 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. S.K. Purbey	Chairman
		Sh. Narayan Lal	Member
		Dr. Alok K Gupta	Member
		Sh. Subhankar Dey	Member
		Sh. Ramji Giri	Member
		Dr. Ramashish Kumar	Member Secretary
3.	Works and Estate committee	Dr. Kuldeep Srivastava	Chairman
		Dr. Evening Stone Marboh	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 K Gupta	Member
		Sh. Narayan Lal	Member
		Dr. Ramashish Kumar	Member Secretary

5.	Purchase and Store advisory committee (PS&AC)	Dr. R.K. Patel	Chairman
		Dr. Vinod Kumar	Member
		Dr. Abhay Kumar	Member
		Sh. Subhankar Dey	Member
		Sh. Abhishek Yadav	Member secretary
6.	Spot Purchase Committee (SPC)	Dr. Kuldeep Srivastava	Chairman
		Dr. Evening Stone Marboh	Member
		Dr. Alemwati Pongener	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)
		Sh. Subhankar Dey	Member
8.	Central Instrumentation Facility	Dr. Swati Sharma	Incharge
		Dr. Alemwati Pongener	Alternate Incharge
9.	Library Advisory Committee	Dr. Vishal Nath	Chairman
		Dr. S.D. Pandey	Member
		Dr. Kuldeep Srivastava	Member
		Dr. Alok K Gupta	Member
		Dr. Evening Stone 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.	Internal Complaints Committee	Dr. Swati Sharma	Incharge
		Dr. Abhay Kumar	Member
		Miss. Ekta	Member
		Sh. Ramji Giri	Member
13.	HRD Cell	Dr. Kuldeep Srivastava	Nodal Officer
14.	Guest House, Sports, and Extra-curricular Activity Committee	Dr. S.D. Pandey	Chairman
		Dr. Alemwati Pongener	Member
		Dr. Swati Sharma	Member
		Sh. Subhankar Dey	Member
		Sh. Ramji Giri	Member Secretary
15.	Transfer of Technology Unit	Dr. S.K. Purbey	Chairman
		Dr. Amrendra Kumar	Member
		Dr. R.K. Patel	Member
		Dr. Vinod Kumar	Member
		Sh. Prabhat Kumar	Member
16.	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

17.	Climate change related matter, weather advisory, farm digitization, Farmers First cell	Dr. Prabhat Kumar	Incharge
18.	Official Language	Dr. S.K. Purbey	Incharge
19.	Swachh Bharat Abhiyan	Sh. Prabhat Kumar	Incharge
20.	Publication Committee	Dr. R.K. Patel	Chairman
		Dr. Kuldeep Srivastava	Member
		Dr. Sanjay Kumar Singh	Member
		Dr. Alemwati Pongener	Member
21.	ISO Management Committee	Dr. Amrendra Kumar	Chairman
		Dr. Alok K Gupta	Member
		Dr. Abhay Kumar	Member
		Dr. Subhankar Dey	Member
		Sh. Abhishek Yadav	Member Secretary

Infrastructural Development

The centre has developed well-equipped laboratories for conducting basic and applied research in litchi production and utilization. During 2017-18 the centre developed a Litchi Treatment Plant. With the signing of MoU with Bhabha Atomic Research Centre, Mumbai, a litchi treatment plant was commissioned in the centre's campus, which will act as a model facility for litchi growers and entrepreneurs in postharvest management of litchi. The Litchi Treatment Plant was inaugurated by Shri Radha Mohan Singh, Hon'ble Union Minister, Ministry of Agriculture & Farmers' Welfare, Govt. of India on 29th May, 2017. The capacity of the 'Visiting Scientists Home' has been increased as vertical extension work was completed. This will cater to the need of accommodation for farmers and trainees during training programmes at the centre. A screen house cum potting shed has also been developed in the centre's farm, to cater needs for better and efficient raising of plants and its multiplication. An Integrated Farming System (1 acre model) was also inaugurated on 24th February, 2018 by Dr. WS Dhillon, ADG (HS), ICAR, New Delhi.

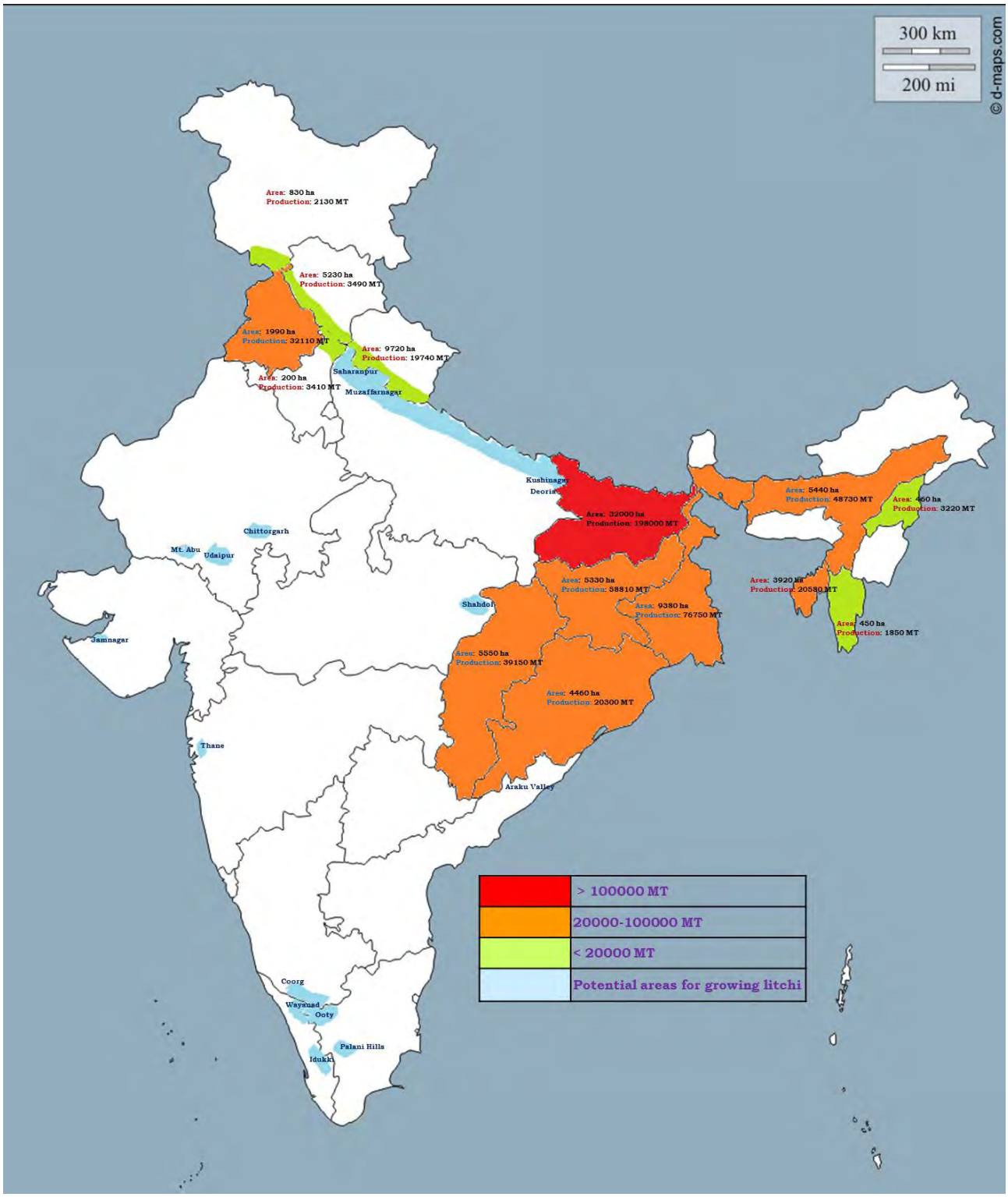
The capacity of the 'Visiting Scientists Home' has been increased with the completion of the vertical extension work

Inauguration of the Litchi Treatment Plant by Shri Radha Mohan Singh, Hon'ble Union Mininster, Ministry of Agriculture & Farmers' Welfare, Govt. of India

Screen House cum Potting Shed for multiplication of litchi planting materials

Dr. WS Dhillon, ADG (Hort. SC.) inaugurated the Integrated Farming System

Litchi Scenario



भा.कृ.अनु.प.–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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