वार्षिक प्रतिवेदन
ANNUAL REPORT
2011-12



भाकृअनुप
ICAR

राष्ट्रीय लीची अनुसंधान केन्द्र
National Research Centre on Litchi

(Indian Council of Agricultural Research)
मुशहरी, मुजफ्फरपुर – 842 002, बिहार, भारत
Mushahari, Muzaffarpur – 842 002, Bihar, India

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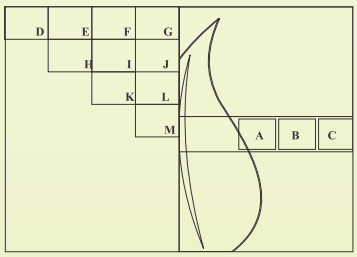

Cover layout:

Front Cover : A. Hybridization in litchi, B. Production of quality planting material of litchi, C. Litchi fruits at full maturity

Back Cover : D. Commencement of new flush after pruning, E. A promising genotype of pummelo, F. A bunch of mature fruits of litchi cv. Purbi, G. A fruit bunch of promising litchi clone, H. Raising seedling rootstocks of litchi for grafting, I. Bagging of litchi fruits for extending maturity and improving quality, J. Symptom of damage by twig blight disease, K. Heavy infestation of semilooper in a litchi tree, L. Training on litchi based farming system M. FAO expert at NRCL

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Contents

Preface

This is my great privilege to bring out the 10th Annual Report (2011-12) of the National Research Centre on Litchi, Muzaffarpur. This Centre, which was established in 2001 in the Nations' Prime Litchi hub, just completed a decade. During the last 10 years the Centre has acquired the experimental farm, basic infrastructure for research and the modest scientific, technical and administrative manpower. The Centre has established itself as a knowledge centre on all aspects of litchi and participated in various activities of litchi research and development in the country as a whole and Bihar in particular.

During the year 2011-12, the Centre has operated and successfully completed prestigious project on "Improving productivity and quality of litchi in Bihar" funded by FAO. The NRCL team consisting of scientists, technicals, administrative and financial personnel and other staff members, is putting its all efforts to provide a technical solution to the problems of litchi production and helping the various stakeholders in policy planning and implementation.

The NRC on Litchi is working on focused mandate to achieve the targeted results in crop improvement and plant genetic resources management, plant canopy architecture and its management, plant health management and minimization of post-harvest losses. Through some externally funded projects, the Centre has been able to address the problem of biodiversity conservation in pummelo and mango (Bioversity International), pollinators in litchi (NHB), variability in soil Mycorrhiza (AMAAS), technology commercialization (IPR-ITMU) and technology refinement (ATMA).

The Centre has actively participated in ***Kisan Mela, Sangosthis,*** ICAR sports, ***Rajbhasha*** programmes and technology dissemination events organized by various agencies in its juridicaiton area. The Centre has provided expertise in litchi production through various print and electronic media.

I would like to thank Secretary DARE and DG, ICAR, DDG (Horticulture), ICAR and Chairman and members of RAC for their guidance, support and encouragement during the year.

I will be highly thankful for any suggestions and comments on information presented in this report, which will in turn help us for further improvement.

July, 2012

Vishal Nath
Director

Executive Summary

National Research Centre on Litchi, Muzaffarpur made steady progress in the field of research and extension under multidisciplinary programme covering the different aspects of mandate *i.e.*, genetic resource management, crop production, crop protection and post-harvest management. The salient achievements for the year 2011-12 are summarized below.

Research Accomplishments

1. Genetic Resource Management and Crop Improvement

Attempts were made to collect the elite genotypes of litchi from different variability hot spots. In the process, nine cultivars were collected from Spain under FAO project, out of which eight are surviving. Thirty nine clones have been identified from North-Eastern region and 30 identified clones have been propagated for Field Gene Bank. Morphological characterization of 30 genotypes of litchi vis-a-vis molecular characterization of 20 genotypes have been carried out. Yield data of 11 logan accessions have been recorded. Augmentation of rambutan genotypes and some potential germplam from different litchi growing countries is under process through NBPGR, New Delhi and import permit has been obtained.

Conventional breeding approach for combining the positive characters of 5 different parents through direct and reciprocal crosses have been attempted. The smaller seed character of cultivar Bedana has inherited in China fruits. Further, more than 8000 crosses have been attempted to verify the inheritance pattern and raise a large population of F_1 generation for further programmes. Harnessing the precaucious genes through natural bud control pollination, evaluating provincial populations for desired characteristics and evaluating segregating populations from elite mother plants have been initiated to widen the genetic base of litchi and exploring the possibilities of selecting an ideal litchi cultivar.

2. Crop Production

Initial grafting success through wedge graft technique have been encouraging and therefore rootstocks of seedling origin have been raised for large scale multiplication. Mound layering block has been established with two commercial cultivars of litchi. A solution consisting of *kamdhenu* (20%), bavistin (0.4%) and rhizobacteria (1%) has been found to be the most effective solution for dipping of litchi layers before planting in polythene bags. Application of 75:50:100 g NPK/plant/year in Shahi and 100:50:100 g NPK / plant/year in cultivar China has been found most effective for vegetative growth of plants. Twenty kg FYM, 2 kg vermicompost and 1 kg neem cake along with biofertilizer showed the better growth and flowering performance in six year old Shahi plants.

Rejuvenated plants took 16-30 days for development of sprouts from latent buds. Pruning at 2 m height and application of recommended dose of fertilizers produced 0.82 m height in more than 70 years old senile orchards after six months of rejuvenation operation. An equivalent yield of 197.56 q/ha turmeric, 259.3 q/ha elephant foot yam and 241.46 q/ha colocasia have been recorded from eight years old orchard of cultivar Shahi. The total available space for intercropping in eight years old orchard was only 40.13% and the intercrops did not have any antagonistic effect on main crop. A spacing of 6 x 4 m and 6 x 6 m has been found to be the most ideal distance for medium density planting in litchi. The flush of July-August bore maximum percentage of pure panicle and flower in cultivar Shahi. The flushes appeared during July followed by 2nd extension growth in August and subsequently in September recorded the maximum sex ratio and fruit set. This clearly indicated that flushes appearing immediately after the previous crop are the best for ensuring the fruiting in the next season in litchi tree. Hundred per cent pure and fruit brearing panicle and the highest number of branched panicle were recorded by treatment of MH (20 ppm). The maximum fruit weight was recorded in GA_3 (50 ppm) whereas at its 75 ppm dose the maximum

firmness was recorded. Bagging of individual litchi bunches in cultivar Shahi with perforated butter paper has been found to be the best for produciton of good and more class-I category fruits and reduction in sun burn and cracking of litchi fruits.

3. Crop Protection

The leaf and twig blight disease in vegetative phase on litchi and anthracnose on fruits of litchi were the major diseases recorded. Among new threats of insect pests, red weevil, semiloopers, bagworm (encased caterpillar), and among minor pests aphids have been recorded on litchi plants. While diseases on litchi plants are found to be of less significance with very low per cent disease severity Index (PDI), some of the pest particularly red weevil except during April-June and the semiloopers during September-October become more devastating. Effective control measures for each pest have been worked out and suggested.

4. Post-harvest Technology

Combined spray of bavistin (0.2%) and GA_3 (100 ppm) at 10 days interval after fruit set gave the maximum fruit retention and TSS and minimum discarded fruits. KNO_3 spray delayed the fruit maturity by three days while GA_3 advanced the maturity by two days. Post harvest dip of fresh litchi fruits in 0.5% citric acid and oxalic acid solution reduced the percentage of discarded fruits at ambient temperature up to three days. The sulphited fruits do better with oxalic acid treatment up to 4-5 days at normal condition. Shading of litchi trees with 30% green shade-net or 50% white shade net at colour break stage extended the harvesting period and reduced the discarded fruits in cultivar Shahi. Litchi fruits attained optimum maturity during 28th May to 3rd June, 2011 at Muzaffarpur. Lining of CFB boxes with litchi leaves at bottom and paper cuttings at top resulted into less discared litchi fruits at 4 days of transportation. Thermocol boxes however were more effective up to 5 days without any lining material. MAP with O_2 level between 12-16% and CO_2 level between 3-6% gave satisfactory shelf life up to 15 days under 8-10^{0}C temperature.

Quantification of post-harvest losses in litchi reveals a high percentage due to PLW and physical damage. Loss of colour in fruits leads to poor market acceptance. At retailer level as high as 30 per cent losses have been observed. By adopting the efficient post harvest handling procedures like sorting and grading, pre cooling and packing with proper lining material and maintaining cool chain during transport can reduce the losses up to 15-17%. A low temperature tolerant stain of *Aspergillus flavus* has been identified which seems to be responsible for spoilage of litchi juice. High concentration of methyl propanol, ethlyl ester and methyl acetate compounds were related to fresh and fruity aroma of litchi wine at 15^{o}C for fermentation and 15-20^{o}C maturation temperature. KMS (0.1%) followed by citric acid (2%) treatment was found good for preparation of litchi nuts. KMS (1000 ppm) was found best up to 12 months of storage of litchi concentrated pulp at low temperature (7-8^{0}C) where as at low temperature pulp starts yellowing only after six months.

5. Externally funded project

Ten genotypes of pummelo and 14 of mango have been identified from Pusa cluster under UNEP-GEF project of Bioversity International. A citrus diversity fair was also organized to locate the variability in pummelo. Good Agriculture Practices for litchi was demonstrated at 9 clusters under IND/TCP project of FAO. Pollination behaviour in litchi was studied under NHB supported project on honey bee. Intercropping protocol for growing litchi orchard was standardized under ATMA sponsored project and biodiversity of mycorrhiza is being studied under AMAAS project. Under Mega Seed Project, 41000 quality litchi saplings been produced and supplied to various stake holders specially to Manipur, Tripura, Sikkim, Bihar and Uttar Pradesh.

6. Linkage and Collaboration

The centre is working on different aspects in close collaboration with other organizations such as SAUs (RAU, BAU), NHB, APEDA, State Agriculture/ Horticulture department and other ICAR institutes and centres.

7. Transfer of Technology

NRC on Litchi has taken initiative for effective transfer of litchi based technologies, through off campus and on campus training and demonstrations to farmers , field visits, timely advice through print and electronic media. The Centre has developed documentaries on GAP and post-harvest management and value addition for dissemination of litchi technologies to a large number of beneficiaries.

8. Other Activities

Three meetings of *Rajbhasha Karyanwayan Samiti,* were organized at the centre. "***Hindi Chetna Maas***" was organized during 14th Sep.-13th Oct. 2011. Various competitions were organized and winners were awarded to encourage the use of *Rajbhasha* Hindi. The Centre has participated in regional ICAR sports meet 2012 at ICAR-RCER, Patna, Litchi Mahotsava at Patna (6 districts for Bihar), Litchi Extension programme in Maharashtra, Kerala, Karnataka and Tamil Nadu. NRCL also organised a Litchi Show at Dehradun, Uttarakhand.

9. Infrastructural Development

Laboratory facilities for the molecular characterization and other biotechnological studies is being developed at the centre. Laboratory equipments for soil and plant analysis were procured and other facilities are being developed. Development of laboratory facilities for plant pathological and microbiological research, soil sciences, and state-of-art facilities for post-harvest management is under progress. Facility for isolation and studies of pathogens has been created. MAP unit has been installed in Post Harvest Management laboratory. GCMS, AAS, UV-VIS spectrophotometer, flame photometer and nitrogen analyser installed in Central Laboratory facility at the Centre.

Director, NRCL observing progress of installation of weather station

INTRODUCTION

The Institute

The National Research Centre on Litchi (NRCL) was established on 6th June, 2001 at the fag end of IXth Plan by Ministry of Agriculture, Government of India under the aegis of Indian Council of Agricultural Research to act as a Nodal Centre to work exclusively on litchi Research and Development in India. The Centre started functioning from 2002 with a small budgetary allocation and the joining of two scientists at the Centre in March, 2002. The lease deed for land was signed on 25th June, 2002 between the ICAR and Government of Bihar to transfer 100 acres of land to the Centre at Mushahari, Muzaffarpur. The Centre was strengthened during 2005 and onwards by redeploying scientific, technical and supporting staff along with administrative support and financial assistance for developing infrastructural facilities and to carry out the research work.

Mandate

- Systematic collection, conservation characterization and documentation of litchi cultivars/species.
- Undertake basic, strategic and applied research to enhance productivity, processing and utility of Litchi fruits.
- Evolution of high quality cultivars for tropics through breeding, genetic engineering and bio-informatics.
- Develop centre of excellence for litchi and act as repository/data base/ware house on litchi.
- Act as centre for HRD and capacity building in modern technology on all aspects of litchi.
- Establish linkages with National and International organizations.

Past Achievements

(i) The Centre collected 47 cultivars of litchi and related species from Bihar, Jharkahand, West Bengal, Karnataka, Punjab and Uttarakhand and 46 cultivars were planted in the field germplasm repository for detailed evaluation. Efforts are being made to collect more indigenous germplasm especially from North-Eastern states as well as exotic germplasm. Molecular characterization using RAPD and ISSR markers with the help of CISH, Lucknow for 20 ltichi cultivars is in progress.

Crop Production

Block plantations of commercial litchi cultivars *viz.* Shahi (11 ha) and China (4 ha) have been completed at research farm of the Centre for conducting various trials/experiments. A mother block of 1.5 ha, having 625 plants was developed with nine commercial cultivars of the region. A new germplasm block consisting of 36 collections of commercial varieties and land races/ clones has been maintained as field repository in a systematic manner.

The Progress

To fulfill the mandate, the Centre has oriented its research focus in four theme areas.

1. Plant Genetic Resource Management and Crop Improvement

Under this theme area, the centre has been able to collect 52 native and 8 exotic accessions of litchi and 11 of longan species. The plan for fine grid survey of existing variability has been developed, and North-Eastern states, West Bengal, Muzaffarpur and Samastipur districts of Bihar has been undertaken in the first phase. The conventional breeding programme has been initiated and molecular characterization of 20 genotypes using ISSR markers has been completed.

Plantation of various experimental blocks with most common cultivars, Shahi and China has been completed in 15 ha area to conduct different trials. A mother block of 1.5 ha, germplasm block of 3 ha, seedling block of 2 ha has also been planted for different studies at the Centre.

2. Crop Production

Presently, the following work is under progress in crop production:

- Standardization of optimum nutrient requirement and fertilizer doses of different litchi varieties.

- Effect of growth regulators and micronutrients on production of quality fruits.
- Organic cultivation of litchi for quality fruit production.
- Development of litchi based cropping system model and estimating cost: benefit ratio.
- Standardization of high density orcharding in litchi.
- Development of tree architecture through different pruning system like :

  (a) Centre open system and (b) Selective pruning along with recommended doses of mineral nutrition for enhanced production of quality fruits.

(vii) Soil moisture conservation through use of mulch materials and employing drip irrigation.

(viii) Reiterative pruning for rejuvenation of old senile orchards for promoting quality fruit production.

(ix) Study of mychorrhizal association for plant vigour, yield and quality.

3. Crop Protection

Identification of major pest and diseases and developing pest forecasting model, integrated pest management against major pests and diseases are the focus area under Plant Protection theme. During the year following activities were undertaken:

- Survey and surveillance of major pests of litchi, borers & mites and their identification with pest forecasting model.
- Working out an integrated pest management (IPM) system for the management of fruit borer complex of litchi.
- Survey of litchi orchard and soil sampling for mycorrhizal diversity and mass scale production and field application.

4. Post Harvest Technology

Determination of maturity indices, time, and method of harvesting, sorting and grading standards, standardization of precooling, Cold room storage, MAP, refer van transport, and packaging protocol are the major focus area in Post-harvest Management. During the year following activities were undertaken:

- Determination of maturity standards for harvesting of fruits in different cultivars.
- Use of SO_2 for sulphitation, pre-cooling and cold storage for extending the shelf life of litchi fruits.
- Standardization of packaging materials and packing systems for distant transportation.
- Preservation and preparation of different processed and value added products from litchi fruits

Transfer of Technology

The Centre has undertaken a model project of FAO to disseminate and refine the litchi production and post-harvest management technologies which has culminated in the State Horticulture Mission. Under this programme batches of master trainers and entrepreneurs have been trained at the centre to make them aware about good management practices in litchi. Through Litchi Pathshala, Litchi Library, Print and electronic media appropriate technologies on litchi have been disseminated to end users. The important activities during the year were as under :

- Training programmes on *Improved Technologies for Litchi Cultivation* for one batch (20 farmers) of 5 days duration was conducted during the year for the farmers of Samastipur, Motihari and Vaishali districts under cluster approach with follow up action for production of quality litchi fruits for export.
- Scientists participated in number of district level training programmes, seminars, *Kisan Melas, Kisan Ghostis* and field visits to educate the growers on scientific orchard management, insects and disease management and also post-harvest management to increase the shelf life and reduce the post harvest losses.

Library

- NRC on Litchi is trying to establish a quality library at the Centre. The Centre has acquired 1207 books including 16 Encyclopedia on various aspects along with Britannica (30 vol.) and Wealth of India (27 Vol.) Centre has subscribed 11 Indian and 11 foreign Journals to facilitate the research activity. The Library also maintains record of all other publications from institute as well as in the externally funded project.

FINANCIAL SET-UP

(Budget allocation and expenditure during 2011- 12; in Lakhs)

PLAN

Heads	Particulars	Allocation	Utilization
Recurring	Establishment	14.65	14.65
	TA	5.00	4.84
	HRD	1.15	1.14
	Contingencies	86.20	86.36
	Total	107.00	107.00
Non - Recurring	Equipments	93.75	93.28
	Works	302.10	302.58
	Land Development	0.00	0.00
	Library	18.10	18.10
	Vehicles	0.00	0.00
	Furniture & Fixtures	9.05	9.05
	Total	423.00	423.00
	Grand Total	530.00	530.00

NON-PLAN

Heads	Particulars	Allocations	Utilization
Recurring	Estts. Charge	111.00	109.71
	T.A.	4.00	3.99
	Contingencies	35.00	35.21
	Loan & advances	0.50	0.30
	Total	150.50	149.20
Non-recurring	Equipments	0.00	0.00
	Furniture & Fixtures	0.80	0.79
	Library	2.20	2.22
	Total	3.00	3.01
	Grand Total	153.50	152.22

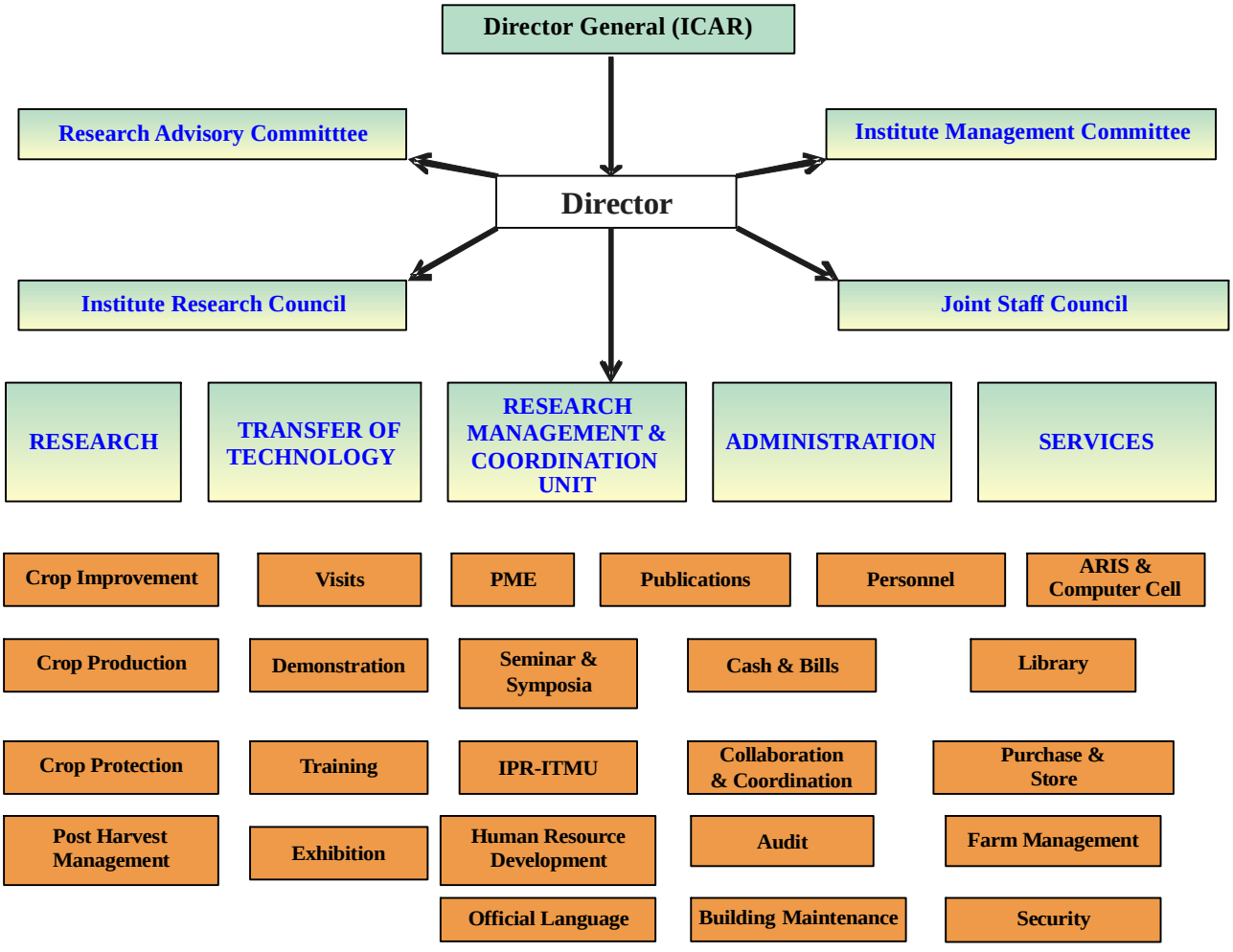
Revenue Receipt (2011-12)

SI. No.	Head	Amount (Rs.)
1	Farm Produce	3,23,563.00
2	Sale of Publications	59,920.00
3	Sale of tender papers	22,000.00
4	Interest on STDR	5,24,326.00
	Total	9,29,809.00
6	RFS	11,81,289.00

Staff Position (as on 31.03.2012)

SI. No.	Category	Sanctioned	Filled
Scientific			
1	R.M.P.	01	01
2	Principal Scientist	01	Nil
3	Senior Scientist	05	02
4	Scientist	09	06
Technical			
1	Technical Officer T-6	02	01
2	Field Technician T-3	03	01
3	Field/Lab Technician T-1	07	01
Administration			
1	AO	01	00
2	AAO	01	01
3	AF&AO	01	01
4	Assistant	03	02
5	UDC	01	01
6	LDC	03	01
Supporting			
01	SSG-I	10	03

NATIONAL RESEARCH CENTRE ON LITCHI MUZAFFARPUR, BIHAR



RESEARCH ACHIEVEMENTS

Theme Area 1 : Plant Genetic Resources Management and Crop Improvement in Litchi

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

Collection of litchi germplasm from indigenous and exotic sources: Nine cultivars of litchi (Table 1) were collected under the FAO project "Improving productivity and quality of litchi in Bihar" from Spain. The material was collected as air-layers and was planted in the quarantine screen house under the supervision of plant quarantine authority of Rajendra Agricultural University, Pusa, Bihar. All the cultivars, except Chakapat survived and are growing satisfactorily in the screen house (Fig. 1, 2). They are being observed regularly for the presence of any insect-pests and diseases. The process for the collection of germplasm from other exotic sources was also initiated through NBPGR, New Delhi by getting the import permits from different countries.

Characterization of litchi germplasm based on morphological, biochemical and molecular markers: The morphological characterization of the field planted (new) litchi germplasm was started during 2011-12 and the observations on plant height, stem girth, canopy spread, leaf type, new flush colour and initiation of flowering were recorded on 30 litchi cultivars and the related species like longan. The new flush colour exhibited a lot of variation. The flowering was observed only in Bedana and that too in only one plant. As the plants are quite young, there is little variation existing in different litchi cultivars based on morphological markers.

Table 1. Exotic Litchi Germplasm collected during the year 2011-12

S. No.	Date	EC No.	Variety	Country	Type of Material	No.	Surviving or not
1	22.9.2011	--	Kwai Mi	Spain	Air-layers	6	Yes
2	--do--	--	Wai Chee	Do	--do--	6	Yes
3	--do--	--	Kwai Mi Pink	Do	--do--	6	Yes
4	--do--	--	Kaimana	Do	--do--	6	Yes
5	--do--	--	Suey Tong	Do	--do--	6	Yes
6	--do--	--	Tai So	Do	--do--	6	Yes
7	--do--	--	Hak Ip	Do	--do--	6	Yes
8	--do--	--	Chakapat	Do	--do--	5	No
9	--do--	--	Fay Zee Siu	Do	--do--	6	Yes

Fig 1. Sprouting of the introduced litchi cultivars in the screen house

Fig.2. Exotic litchi germplasm growing in the screen house

Leaf samples of 20 litchi cultivars were collected for molecular characterization. The DNA was extracted again and the ICRISAT, Hyderabad was contacted for the synthesis of desired ISSR markers, which are exhibiting the polymorphism and are able to differentiate litchi accessions. The results are still awaited.

In the characterization of litchi germplasms based on fruit physico-chemical characteristics, eighteen litchi cultivars were characterized. A large variation was observed among the cultivars for the characters studied (Table 2). Maximum fruit weight was recorded in Kasba (28.83g) followed by Green (24.16g), whereas minimum fruit weight was recorded in Yogda 1 (10.44g). Yogda-1 produced mostly round fruits, whereas the fruits in Bedana were flattened and in Sarguja Selection 1, the fruits were elongated. In other cultivars, the fruits exhibited intermediate fruit shape of these extreme limits. TSS was recorded highest in Dehradun (19.93^{0}Brix) followed by Bombai 2 (18.43^{0}Brix) and minimum TSS was observed in Ajhauli (16.55^{0}Brix) and China (16.65^{0}Brix). Highest edible portion was recorded in Bedana (77.71%) and Rose Scented (71.91%), whereas it was minimum in Bombai1 (60.45%). Maximum fruit and seed borer infestation was recorded in CHES-2 and Shahi (100%), whereas Yogda-1 was free from this infestation. Maximum juice acidity was recorded in Dehradun followed by Dehra Rose, whereas the acidity was minimum in Ajhauli.

Collection, characterization and evaluation of longan (*Dimocarpous longan*) germplasms: Evaluation of eleven longan germplasm (seedlings of the same accession) reveal that the accession Lgc-9 recorded the highest plant height (3.45m) and girth (80 cm), while minimum plant height (1.50m) and girth (18cm) were recorded in Lgc-2. Among the parameters of reproductive phase, the panicle emergence started from first week of March and continued up to second week of March, while flowering started from last week of March and continued up to second week of April. The period of panicle emergence to flowering was recorded to be 17 days. Fruit set started from last week of April to first week of May. The period taken for flowering to fruit set was 11 days. It was observed that fruit set to fruit development and up to maturity period remained second week of May to first week of September and the period taken for this was 107 days. The highest fruit yield (10.50kg/plant) was recorded for the accession Lgc-6 (Fig. 3). The fruit weight varied from 3.5g (Lgc-10) to 10.10g (Lgc-7),

Table 2. Fruit physico-chemical characteristics of litchi germplasm

Germplasm/ cultivar	Fruit colour	Fruit wt. (g)	Fruit length (cm)	Fruit width (cm)	L:B	TSS (%)	Rind wt. (g)	Seed wt. (g)	Pulp wt. (g)	Edible portion (%)	Presence of fruit borer (%)	pH/ acidity
CHES-2	Dark red	21.64	3.91	3.51	1.11	17.59	4.09	3.85	13.70	63.13	100.00	5.58
Late Large Red	"	22.29	3.70	3.49	1.06	17.20	3.33	3.57	15.38	68.96	63.33	5.54
Bombai-1	"	20.46	3.89	3.42	1.13	16.98	4.46	3.62	12.39	60.37	86.66	5.19
Dehra Rose	"	20.80	3.65	3.29	1.11	17.49	2.80	3.24	14.75	70.99	43.33	5.52
Kasba	"	28.83	4.33	3.93	1.10	17.66	6.84	3.96	18.03	62.50	56.66	4.71
Purbi	"	21.75	3.94	3.46	1.14	17.37	4.15	3.83	13.56	62.43	83.33	5.13
Dehradun	Red pink	17.44	3.35	3.14	1.07	19.93	2.80	2.60	12.04	66.90	80.00	4.64
Green	D. red	24.16	3.80	3.55	1.07	17.10	3.26	3.73	17.16	71.08	40.00	5.57
Early Bedana	Light pink	17.07	3.52	3.11	1.07	18.19	2.71	2.40	11.95	69.77	63.33	4.85
Sarguja Sel. 1	D. red	18.50	3.77	3.23	1.16	17.14	3.68	3.30	11.51	62.54	90.00	4.99
Trikolia	"	21.52	3.67	3.26	1.12	16.87	3.00	3.35	15.17	70.22	63.33	5.56
Bombai-2	"	22.69	3.88	3.44	1.12	18.43	4.20	3.78	14.70	64.77	73.33	5.16
China	"	20.17	3.65	3.33	1.09	16.65	3.66	3.19	13.30	66.04	46.46	5.45
Bedana	"	21.93	3.14	3.53	0.89	16.84	3.09	1.69	17.14	77.71	30.30	5.56
Rose Scented	Red pink	23.63	3.68	3.46	1.06	17.28	3.07	3.53	17.02	71.91	70.00	5.36
Ajhauli	D. red	20.60	3.61	3.24	1.11	16.55	3.20	3.71	18.69	66.30	43.33	5.79
Shahi	"	19.79	3.59	3.26	1.10	16.73	3.46	3.49	12.84	64.42	100.00	5.53
Yogda 1	Pink green	10.44	2.59	3.62	0.99	16.95	1.79	1.66	6.98	66.62	0.00	4.68

while TSS varied from 19.0^{0}Brix (Lgc-1 and Lgc-11) to 21.5^{0}Brix (Lgc-6).

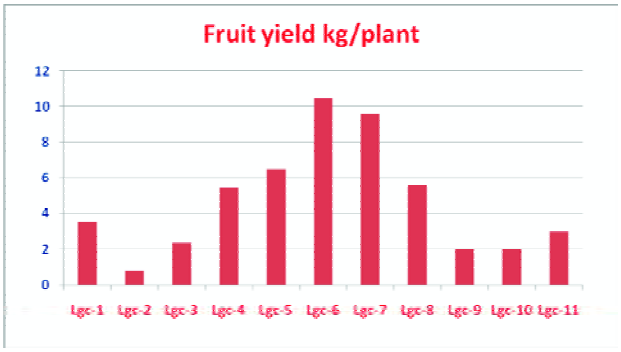


Fig. 3 : Fruit yield of longan germplasms during 2011-12

Collection, characterization and evaluation of rambutan germplasm: In order to collect the germplasm of rambutan from different growing areas of India, correspondence was made with the M.S. Swaminathan Research Foundation, Community Agrobiodiversity Centre Puthuvayal, P.O. Kalpetta, Wayanad, Kerala and Central Horticultural Experiment Station (IIHR), Chethali, Karnataka. They have suggested to visit the area during July-August for collecting the samples of rambutan and to lift the planting material of the available germplasm from these centres.

1.2. Clonal selection for improvement in litchi cultivars

Selection of litchi clones in Assam and Tripura: A survey was undertaken in the states of Tripura and Assam during May, 2011 to identify the superior clones of litchi. Different orchards were surveyed in both the states and 39 plants were identified and characterized based on fruit maturity period, yield and fruit physico-chemical characteristics (Fig. 4-11). The maturity in both the states was about 10 days earlier than Bihar. The fruit colour varied from green to dark red depending on the genotypes. Fruit weight was maximum in A26 (29.92g) followed by A11 (21.75g) and A15 (21.21g). The clone A13 produced round fruits, A26, A27 and A15 produced flattened fruits, whereas the fruits in A2 and T9 were elongated. Maximum TSS (20.88^{0}Brix) was recorded in T9 followed by A23 (20.16^{0}Brix) and A9 (19.68^{0}Brix), whereas the lowest TSS was recorded in A4 (12.34^{0}Brix), indicating its late maturity. Very large seeds were observed in A5 (4.32g/seed) followed by A11 (4.23g/seed) and T1 (4.22g/seed), but very small/chicken tongue seeds were observed in majority of fruits in BNJ (0.52g/seed), A26 (1.18g/seed) and A25 (1.13g/seed). Maximum edible portion was recorded in BNJ (83.65%) followed by A25 (79.78%) and A27 (68.23%), but this portion was minimum in A4 (35.75%), T11 (42.03%) and A2 (46.52%). The clones T3, T2, T13, A1, A3, A6, A8, A11, A13 and A22 were having high infestation of seed borer (>60%), whereas in many clones, viz. T5, T6, T7, T9, T14, T15, T16, A4, A5, A7, A14, A15, A18, A23, A24, A25, A26 and A27, the fruits were free from any infestation of the borer.

In general, the fruit characteristics were better in litchi clones from Assam as compared to Tripura. The litchi in Assam is exhibiting a wider variation and this offers good scope for the selection of superior litchi clones. The clones A11, A15, A25, A26 and A27 need

Fig. 4. Early maturing clone of litchi from Assam

Fig. 5. Late maturing clone of litchi from Assam


Fig. 6. Variants of the Bedana cultivar of litchi in Assam


Fig. 7. Early and late maturing plants of Shahi litchi in Assam

Fig. 8. A clone of Bedana litchi of Assam

Fig. 9. A clone of Elaichi litchi of Assam

Fig. 10. A late maturing Bedana litchi clone of Assam

Fig. 11. Variant of Bedana litchi of Assam

confirmation for their superior fruit quality and have to be propagated vegetatively for detailed evaluation. The clone A26 and BNJ were having higher fruit weight, higher edible portion, smaller seeds and round fruits, therefore, they are considered to be better clones, which need further studies.

The seeds of the characterized clones were sown in the nursery to raise the seedling population of these clones for comparison with the vegetatively propagated progeny and also to raise the provincial populations. The seed germination and polyembryony were recorded at weekly intervals. The germination was poor in seeds from both the states (44.35% and 40.48% in Tripura and Assam respectively), but the polyembryony level was almost same (21.57 and 20.59%, respectively). In individual plant seeds, maximum germination recorded in T19, A19 and A21 (50%) and the polyembryony was also good (67, 67 and 50%, respectively). The polyembryonic studies in litchi offers new scope for study in litchi.

Clonal selection of litchi in Bihar: Fine grid survey was conducted in Samastipur district of Bihar for selection of late maturing litchi clones. A large variation was recorded in late maturing clones of Shahi Litchi. Maximum fruit weight was observed in clone No. 58 (22.25g) followed by clone No. 49 (21.84g), whereas minimum fruit weight was recorded in clone No. 46 (13.63g) and 45 (14.11g). Seeds were biggest in clone No. 54 (4.03g/seed) and 55 (3.98g/seed), whereas small seeds were observed in clone No. 51 (2.52g/seed). There was not much variation among different clones as far as TSS is concerned and it ranges from 16.00 to 20.20^{0}Brix. Maximum pulp: seed ratio was recorded in clones 47 and 49 (4.81 and 4.60, respectively).

The colour of the skin in these clones was almost green at the time of survey. The late maturity of these clones has to be confirmed at later stages. But most of the fruits have already been harvested, the second sampling could not be done.

Vegetative propagation of the selected litchi clones: To multiply the selected clones, air-layering was done in 30 clones (Table 3). 15-65 air layers were prepared from each clone during October, 2011. The gooties were cut in the month of January from all the clones except three and were planted in the nursery (Fig. 2). The air-layers are presently growing in the nursery and will be planted in the field for their detailed evaluation.

Development of improved hybrids of litchi: From the crossing programme of year 2010-11, 35 fruits from China x Bedana and 25 fruits from China x Shahi cross were harvested along with the parents and the fruits were analyzed. The fruits of Shahi x China and Shahi x Bedana were not analyzed because they were harvested at physiological maturity and not at the ripening stage. Fruit weight was more in parents as compared to the hybrids (Table 4). The fruits were elongated in both the crosses, indicating the dominance of this character from cultivar China. TSS was *at par* in the hybrids and the parents however, the smaller seed character was inherited from the Bedana in both the crosses. Acidity was more in the fruits of hybrids.

The seeds of the litchi hybrids along with the parents were sown in the nursery. There was not much difference in the germination percentage of the seeds from the hybrids and the parents (Table 5). The seedling characteristics were studied in six months old

Table 3. Details of air-layering in the selected clones

S. No.	Address	Date of air-layering	No. of air layers done	Date of cutting	No. of successful layers
1	Sh. Ramchander Pandey	24/09/11	30	30/12/11	5
2	Sh. Ramchander Pandey	24/09/11	30	--do--	12
3	Sh. Ramchander Pandey	24/09/11	30	--do--	1
4	Sh. Ramchander Pandey	24/09/11	30	--do--	5
5	Sh. Jawahar Singh	24/09/11	30	--do--	10
6	Sh. Vipin Kumar Pandey	24/09/11	60		-
7.	Sh. Vipin Kumar Pandey	24/09/11	30	--do--	14
8.	Sh. Jagan Nath Pandey	24/09/11	60	--do--	1
9.	Sh. Shtrughan Singh	24/09/11	65	--do--	5
10	Sujay Prakash	25/09/11	30	31/12/11	7
11	--do--	25/09/11	30	--do--	1
12	--do--	25/09/11	30	--do--	18
13	--do--	25/09/11	30		--
14	Sh. Byas Ojha	25/09/11	30	31/12/11	11
15	Jitender Kumar Shah	25/09/11	22	31/12/11	2
16	Jitender Kumar Shah	25/09/11	20	31/12/11	8
17	Habib Ansari	25/09/11	30	31/12/11	17
18	Sh. Bhullan	25/09/11	30	31/12/11	14
19	Sh. Bhullan	25/09/11	30	31/12/11	16
20	Md. Sikander	25/09/2011	15	31/12/11	11
21	Sh. Billat Shah	5/10/2011	30	2/1/12	22
22	Sh. Billat Shah	5/10/2011	30	2/1/12	17
23	Sh. Billat Shah	5/10/2011	30	2/1/12	16
24	Sh. Billat Shah	5/10/2011	30	2/1/12	11
25	Sh. Vimal Chaudhary	5/10/2011	15	Already harvested	--
26	Sh. Sudhanshu Kumar	5/10/2011	10+10+ 12+10	2/1/12	-, 9, 10, 8,
27	Sh. Sudhanshu Kumar	5/10/2011	15	2/1/12	9
28	Sh. Mahender Prasad Singh	7/10/2011	15		--
29	Sh. Mahender Prasad Singh	7/10/11	15		--
30	Sh. Bhola Nath Jha	24/09/2011	35	30/12/11	32

Fig. 12. Selected litchi clones being maintained in the nursery

Table 4. Characters of fruits in hybrid fruits of litchi

Cross/Parent	No. of fruits harvested	Fruit colour	Fruit wt. (g)	Fruit length (cm)	Fruit width (cm)	L:B	TSS (%)	Seed wt. (g)	Edible portion (%)	pH
Bedana	5	Reddish green	18.39	3.12	3.46	0.90	18.62	1.29	76.81	5.02
Shahi	5	Red	20.19	3.60	3.30	1.09	18.90	3.65	70.53	4.57
China	5	Red	19.78	3.90	3.54	1.10	18.30	3.96	57.74	5.08
China x Bedana (4)	35	Red	15.83	3.68	2.87	1.25	18.02	2.86	54.63	3.71
China x Shahi (2)	25	Red	14.23	3.45	2.88	1.21	18.08	2.79	46.53	3.95

Table 5. Characteristics of seedling of litchi hybrids

Cross/parent	Plant ht. (cm)	Stem girth (mm)	No. of leaves	Leaf structure (E/B)	Leaf colour (DG/LG)	Leaf Type (S/C)
Shahi x China	22.67	3.67	13.33	2/1	3/0	0/3
China x Shahi	17.83	3.25	9.08	6/1	6/1	5/2
Shahi x Bedana	16.91	2.33	3.16	4/0	4/0	4/0
China x Bedana	20.70	3.27	9.04	17/9	26/0	13/13
Shahi	20.83	2.67	5.00	2/2	4/0	4/0
Bedana	12.17	2.00	5.50	4/2	6/0	6/0
China	25.30	3.89	11.78	8/1	9/0	1/8

E/B = Elongated/Broad;
DG/LG = Dark green/Light green;
S/C = Shahi type leaf/China type leaf

seedlings of the hybrids and the parents. Maximum height was recorded in China (25.30cm) and minimum in Bedana (12.17cm), and the hybrids exhibited intermediate plant height. For stem girth and number of leaves per plant, the seedlings from the hybrids exhibited the intermediate behaviour. All these characters clearly depicted the segregation in the vegetative characteristics of the seedlings.

To strengthen the breeding programme, more number of crosses were attempted during the current year (2011-12) involving three parents, viz. Shahi, China and Bedana in all possible combinations. More than 13000 crosses were made (Table 6). After one week of pollination, the bags were removed and the fruit set was counted. Subsequently, the fruit set was counted at weekly intervals (Fig. 13). After one week of pollination and crossing fruit set was maximum in China x Shahi (77.94%) followed by China x Bedana (69.48%), whereas minimum fruit set was recorded in Shahi x Bedana (1.88%). After two week of pollination and crossing maximum fruit retention was recorded in Bedana x China (47.46%), whereas there were no fruits in Shahi x Bedana and Bedana x Shahi. These studies clearly indicated the effect of pollen parent on the fruit retention.

Evaluation of seedling population of litchi for improved plant types: Five hundred and thirty five (535) seedling in 2007 and 201 seedlings in 2009 were planted in the field for detailed evaluation. All the seedlings were observed for vegetative characteristics,

Table 6. Hybridization programme taken during 2011-12

Cross	Flowers pollinated	Total fruit set after one week	per cent fruit set after one weeks of crossing (24/03/2012)	per cent fruit set after two weeks of crossing (31/03/2012)
Cross-1 (Shahi x Bedana)	1802	34	1.88	0.00
Cross-2 (Bedana x Shahi)	1021	165	16.16	0.09
Cross-3 (China x Shahi)	3907	3045	77.94	22.03
Cross-4 (China x Bedana)	3231	2245	69.48	18.11
Cross-5 (Bedana x China)	1815	1144	63.03	47.46
Cross-6 (Shahi x China)	1184	594	50.17	23.90

Fig. 13. Developing hybrid fruits of litchi

viz., plant height, leaf shape, flush colour, and reproductive characteristics viz., flower initiation and fruit set. Seedling height was recorded as dwarf, medium and tall. Most of the seedlings were tall in growth habit. The leaf shape was observed as boat shaped, similar to Shahi and reverse boat shaped, a characteristic possessed by the China cultivar. Some seedlings had wavy leaf shape. The fruiting was observed in nine seedlings and after preliminary observations on fruit physico-chemical characteristics with very less bearing and sufficient sample size was not available. This time flowering was observed in seven seedlings, but fruit set could not be observed due to prevelence of high temperatare during fruit set.

Establishment and evaluation of provincial populations of litchi: To establish the provincial population from different states, the fruit samples were collected from Assam, Tripura, Jharkhand and Bihar. The seeds from the selected clones were sown individually as well as composite samples. In total seeds of 14 selected clones and three composite samples were raised. The seedlings exhibited a lot of variation in morphological characteristics. The seedlings are presently being grown in the nursery and will be planted in the field during the rainy season for detailed evaluation.

Establishment and evaluation of segregating population of litchi: To establish the natural segregating population of litchi, fruits of the 26 (supposed) natural hybrids were collected and the seeds were sown in the nursery. Thirty seeds of each combination were sown only 14 natural hybrids showed seed germination. The natural hybrids exhibited a large variation for the morphological characteristics in the seedlings.The seedlings are being raised in the nursery (Fig. 14) and will be planted in the field during the rainy season.

Fig. 14. Segregating population of natural hybrids of litchi

1.3. Evaluation of litchi cultivars for superior horticultural traits

Evaluation of Litchi (*Litchi chinensis* Sonn.) cultivars for horticultural traits: The experiment started during the year 2008 in well laid out replicated trial. The data pertaining to growth parameters were recorded and presented in table 7 which revealed that maximum plant height was observed in Mandaraji (62.22 cm) followed by Rose scented (61.20 cm), while the minimum plant height (36.13 cm) was recorded in cv. Kasba.

Table 7: Initial growth parameters recorded for the newly established plants

Name of varieties/cultivars	Plant height (cm)	Girth (cm)	Number of branches
Mandaraji	62.22	9.33	6.0
Purbi	42.13	6.10	2.5
Shahi	44.33	7.25	3.5
China	52.33	7.70	3.0
Rose-Scented	61.20	8.75	3.0
Kasba	36.13	6.45	3.0
Trikolia	45.00*	7.60	3.0
Bombai	53.33	8.10	4.1
Calcuttia	42.00*	6.80	4.1
Late Bedana	58.16	8.38	3.6

Theme Area 2 : Development of Sustainable Production Technology in Litchi

2.1: Plant propagation and growth physiology of vegetatively propagated plants in litchi

Standardization of grafting technique: The initial attempt for grafting of litchi have shown some success. The revised experiment has been planned and will be executed. During the year 2011-12, more than 10000 seedlings have been raised as rootstocks. (Fig. 15) The grafting operations will be made and studied for survivability and successful union. The previous attempt revealed very negligible success as grafting made during January, February and March (Table-8), hence the experiment rescheduled (as per RAC advise) to restrict the attempt for three months of July, August and September accordingly.

Standardization of protocol for mound layering in litchi (*Litchi chinensis* Sonn.): The experiment has been laid out and planted during 2011. The girth of the established plants were recorded just before the stumping and subsequently observations pertaining to date of sprouts emergence, growth of emerged shoots and elongation rate, etc are being recorded as per approved technical programme (Fig. 16).

Table 8. The survivability of litchi grafted plants after the grafting operation

Treatment details	Survivability of grafted plant after 30 Days (Nos.)	Survivability of grafted plant after 60 Days (Nos.)	Survivability of grafted plant after 90 Days (Nos.)	Survivability of grafted plant after 120 Days (Nos.)
$B_1S_1M_1$	5	2	0	0
$B_1S_2M_1$	12	6	0	0
$B_1S_3M_1$	16	6	1	1
$B_2S_1M_1$	9	2	0	0
$B_2S_2M_1$	16	6	2	0
$B_2S_3M_1$	21	11	3	2
$B_1S_1M_2$	2	0	0	0
$B_1S_2M_2$	11	2	0	0
$B_1S_3M_2$	11	4	4	2
$B_2S_1M_2$	1	0	0	0
$B_2S_2M_2$	9	2	0	0
$B_2S_3M_2$	14	5	5	2

B_1 : S_1 : Scion stick non defoliated
B_2 : S_2 : Scion stick defoliated before 7 days of grafting
S_3 : Scion stick defoliated before 15 days of grafting
M_1 : Wedge grafting
M_2 : Side grafting

Fig. 15. View of seedling raised for root-stock (a), and a grafted plant of litchi (b)

Fig. 16. Emergence of sprouts in the cut plants for mound layering

Effect of various dip solutions on establishment of litchi gooties in nursery: Different dip solutions were prepared as per the technical programme of the experiment in the month of the October and sufficient number of air-layers of cv. Shahi were propagated in the mother block of seed project. Finally 200 numbers of healthy layers of uniform length were selected and used in the experiment. Standard procedure and standardized potting mixtures were used for filling and planting the air-layers after dripping in treatment solutions. Observations on growth parameters of litchi saplings were recorded and results revealed that rooted air-layers dipped in treatment T_7 (Kamdhenu : 20%) T_4 (Bavistin 0.4%), T_{11} (Rhizobacteria 1%) and T_{12} (Rhizobacteria 2%) had highest (100) survival percentage of litchi gooties at 5 month after planting and found to be significantly superior in comparison to water dip (control) (54.0%) and Vermi-compost thick paste (76%) (Fig. 17). The treatment T7, T4 T11 and T12 had significantly higher values with respect to vegetative growth character like plant height, girth (TCA), number of leaflets and their spread after planting in polybags under net house conditions. All due care like irrigation, plant protection measures, weeding and cleaning, etc. were taken to raise healthy saplings. Observation on other parameters will be taken in due course of time.

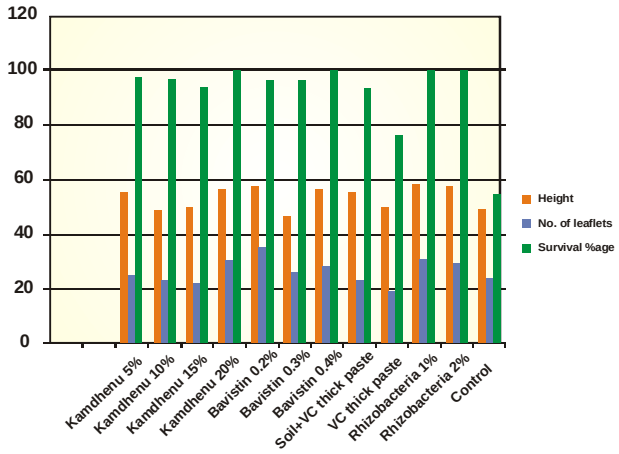


Fig. 17. Effect of various dip solutions on vegetative growth of litchi saplings

Table 9. Effect of graded level N and K on growth characters of litchi cv. Shahi

Treatment	Girth (cm)		Spread (N-S) (m)		Spread (E-W) (m)	
	June 2011	Sept. 2011	June 2011	Sept. 2011	June 2011	Sept. 2011
T_1	39.84	41.50	4.19	4.44	3.70	4.65
T_2	38.82	41.98	4.55	5.33	4.43	4.59
T_3	43.00	46.75	5.02	4.76	5.00	5.18
T_4	39.28	42.53	4.35	4.79	4.47	4.61
T_5	38.83	43.02	4.55	4.77	4.95	4.64
T_6	46.08	47.65	4.70	4.96	4.86	5.13
T_7	36.94	38.85	4.24	4.74	3.60	4.41
T_8	38.42	40.82	4.76	4.51	4.18	4.67
T_9	40.59	42.22	4.42	4.49	3.94	4.75
T_{10}	40.55	42.40	5.01	5.01	4.56	4.83
T_{11}	48.59	43.85	5.03	5.26	4.44	5.53
T_{12}	29.48	37.59	3.84	4.43	3.50	4.04
T_{13}	36.20	38.45	4.67	4.70	4.38	4.81
T_{14}	38.10	38.48	4.61	4.73	4.45	4.56
T_{15}	37.77	39.97	4.50	4.76	4.37	4.75
T_{16}	42.53	47.08	4.90	4.93	4.78	5.02
T_{17}	42.60	43.15	4.88	5.19	4.04	4.60
T_{18}	40.93	43.20	4.59	5.41	4.27	4.85
CD @ 5%	NS	NS	NS	NS	NS	NS

2.2. Development of sustainable production techniques in litchi

Effect of graded level NPK on vegetative and reproductive character of Shahi litchi: Observations recorded on growth parameters showed non-significant differences (Table 9). However application of 75 : 50 :100 g NPK / plant /year showed better growth response and plant girth, spread (N-S and E – W) were recorded 47.65 cm, 4.96 m and 5.13 m, respectively during Sept. 2011. Soil and leaf samples were collected and analysis will be done after installation of laboratory equipment which has already been purchased.

Effect of graded level NPK on vegetative and reproductive character of China litchi: Observations recorded on growth parameters showed non-significant differences (Table 10). However application of 100 : 50 : 100 g NPK / plant /year showed a better growth response and plant girth, spread (N-S and E – W) were recorded 36.55 cm, 3.66m and 3,66 m respectively during Sept. 2011. Soil and leaf samples were collected and analysis will be done after installation of laboratory equipment which has already been purchased.

Table 10. Effect of graded level N and K on growth characters of litchi cv. China

Treatment	Girth (cm)		Spread (N-S) (m)		Spread (E-W)(m)	
	June 2011	Sept. 2011	June 2011	Sept. 2011	June 2011	Sept. 2011
T_1	31.07	31.69	3.33	3.31	3.58	3.48
T_2	34.00	34.16	3.51	3.44	3.73	3.64
T_3	30.73	31.26	3.42	3.31	3.41	3.30
T_4	30.92	31.50	3.18	3.06	3.52	3.32
T_5	29.42	30.36	3.11	3.23	3.31	3.29
T_6	35.20	36.29	3.96	3.94	3.85	3.90
T_7	31.87	32.70	3.36	3.51	3.47	3.44
T_8	33.10	33.69	3.63	3.50	3.65	3.57
T_9	35.87	36.55	3.60	3.66	3.65	3.66
T_{10}	35.47	35.38	3.86	3.71	3.80	3.65
T_{11}	33.10	33.70	3.52	3.70	3.41	3.47
T_{12}	32.83	33.38	3.28	3.31	3.59	3.59
T_{13}	33.92	34.70	3.67	3.70	3.59	3.61
T_{14}	33.47	32.16	3.49	3.59	3.68	3.72
T_{15}	3080	31.75	3.52	3.42	3.45	3.23
T_{16}	31.53	32.03	3.29	3.31	3.39	3.47
T_{17}	35.17	35.84	3.54	3.66	3.52	3.57
T_{18}	31.43	32.26	3.38	3.43	3.43	3.31
CD @ 5%	NS	NS	NS	NS	NS	NS

Fig. 18. Growth of organically grown litchi plants

Organic Production in Litchi: Application of 20kg FYM + 2 kg Vermicompost + 1 kg, Neem cake + bio fertlizers showed better growth performance (Fig. 18) 30% flowering noticed in the experimental plants but due to prevalence of high temperature and low humidity fruit set was very poor.

Effect of nutrition and intercropping on canopy development, fruit bearing, yield and quality in reiteratively pruned litchi trees for rejuvenation: The reiterative pruning leading to top off the branches during September at a height of 2.0 to 2.5m from ground depending on the structure of the individual trees in the orchard, the treatments were imposed as per Technical programme (Fig. 19).

Table 11. Vegetative growth parameters after reiterative pruning of old litchi trees.

Treatment details	Number of trunks/ tree	Girth of the main trunk	Days after sprouts emerged	Number of sprouts per trunk
Pruning at 2.0 m height	3.33	1.98	17	16
Pruning at 2.0 m height + Organic manure (OM)	4.66	2.06	21	32
Pruning at 2.0 m height + Recomended dose of fertilizers (RDF)	4.33	2.23	17	23
Pruning at 2.0 m height + O.M. + Mulching	5.33	1.54	23	42
Pruning at 2.0 m height + ½ RDF + Mulching	4.00	1.72	23	30
Pruning at 2.5 m height	2.00	2.23	16	21
Pruning at 2.5 m height + Organic manure (OM)	5.33	1.83	26	28
Pruning at 2.5 m height + Rec. dose of fert. (RDF)	4.00	2.07	21	24
Pruning at 2.5 m height + O.M. + Mulching	5.00	1.50	30	33
Pruning at 2.5 m height + ½ RDF + Mulching	4.33	1.65	24	20
Un-pruned	-		-	-

Table 12. Vegetative growth parameters after reiterative pruning of old litchi trees.

Treatment details	Increase in height (m)	Increase in canopy E-W (m)	Increase in canopy N-S (m)
Pruning at 2.0 m height	0.62 (2.62)	0.57 (1.61)	0.67 (1.65)
Pruning at 2.0 m height + Organic manure (OM)	0.70 (2.70)	0.72 (1.80)	1.04 (1.59)
Pruning at 2.0 m height + Recommended dose of fertilizers (RDF)	0.82 (2.82)	0.67 (2.25)	0.71 (2.24)
Pruning at 2.0 m height + O.M. + Mulching	0.73 (2.73)	0.81 (2.32)	0.87 (1.78)
Pruning at 2.0 m height + ½ RDF + Mulching	0.78 (2.78)	1.00 (1.48)	0.86 (1.57)
Pruning at 2.5 m height	0.60 (3.10)	0.64 (1.54)	0.96 (1.66)
Pruning at 2.5 m height + Organic manure (OM)	0.64 (3.14)	0.30 (2.37)	0.78 (2.22)
Pruning at 2.5 m height + Rec. dose of fert. (RDF)	0.68 (3.18)	0.42 (2.52)	0.94 (2.02)
Pruning at 2.5 m height + O.M. + Mulching	0.65 (3.15)	0.40 (1.87)	0.91 (1.77)
Pruning at 2.5 m height + ½ RDF + Mulching	0.67 (3.17)	0.78 (1.84)	0.37 (1.99)
Un-pruned			

Fig. 19. View of the rejuvenated plants of litchi

The data pertaining to days taken to sprouts emergence were recorded and then thinning operation was done after six months. The open space created after pruning were categorically utilized for intercrops (as mustard and elephant foot yam). The growth of branches were recorded in the process of development of desired canopy build up (Table 11). The increase in height (m), canopy spread (E-W and N-S) (Table 12) were also recorded after one year. In the initial observation the treatment having pruning at 2.5 m height + RDF + mulching has shown better growth (increase in height : 0.78 m) and canopy spread (1.0 m E-W; 0.86 m : N-S) compared to other treatments.

Studies on effective utilization of interspaces in young bearing litchi orchards for income and soil health improvement: Intercrops yield (197.56 q/ha of turmeric, 259.30 q/ha of Elephant foot yam and 242.46 q/ha of arwi (Colocasia) were harvested from the 8th year old litchi orchard covering 40.13% total area of the orchards. No antagonistic allelopathic effects on sole and inter crops were observed. Soil samples were analyse for nitrogen content which was found to be 125.74, 114.58 and 119.73 kg/ha under turmeric, elephant foot yam and arwi, respectively against control.

Table 13. Effect of High Density Planting on Plant height and girth during 2011

Treat-ments	March 2011		June 2011		September, 2011	
	Plant Height (m)	Plant Girth (cm)	Plant Height (m)	Plant Girth (cm)	Plant Height (m)	Plant Girth (cm)
$T_{1(8x8m)}$	2.29	18.86	2.30	18.88	2.51	21.42
$T_{2(8x4m)}$	2.46	22.38	2.57	23.11	2.64	24.14
$T_{3(8x6m)}$	2.38	22.00	2.50	23.19	2.57	24.16
$T_{4(6x4m)}$	2.38	23.73	2.49	25.02	2.57	26.05
$T_{5(10x10m)}$	2.18	20.13	2.31	21.89	2.40	23.14
$T_{6(6x6m)}$	2.24	19.82	2.36	21.32	2.46	22.27
$T_{7(4x4m)}$	2.47	21.63	2.57	24.58	2.66	25.54
$T_{8(2x2m)}$	2.49	18.85	2.43	20.42	2.76	22.63
C.D.@5%	NS	2.28	NS	2.26	NS	2.81

Table 14. Effect of high density planting on canopy diameter (m)

Treatments	March 2011		June 2011		September, 2011	
	N-S	E-W	N-S	E-W	N-S	E-W
$T_{1(8x8m)}$	2.53	2.65	2.69	2.49	3.06	3.02
$T_{2(8x4m)}$	3.17	3.18	3.24	3.26	3.36	3.37
$T_{3(8x6m)}$	3.12	3.06	3.31	3.30	3.37	3.34
$T_{4(6x4m)}$	3.27	3.31	3.45	3.52	3.57	3.65
$T_{5(10x10m)}$	2.67	2.74	3.02	3.27	3.14	3.15
$T_{6(6x6m)}$	2.50	2.50	2.85	3.00	2.97	2.97
$T_{7(4x4m)}$	2.73	2.51	3.21	3.09	3.31	3.25
$T_{8(2x2m)}$	2.18	2.21	2.63	2.57	2.77	2.76
C.D.@5%	0.38	0.52	0.42	0.28	0.36	0.38

High density planting in litchi cv. Shahi: Observations recorded on growth parameters in different densities during September, 2011 (Table 13, 14) revealed significant differences in plant girth and spread. Maximum plant girth (TCA) 26.05cm and spread N-S 3.57 and E-W 3.65 m were recorded in 6 x 4 m planting density. In general up to 5th year of plant growth medium density i.e. 6 x 4 m, 8 x 4 m and 4 x 4 m orchard recorded significantly better growth performance. In this year, nearly 20 % plants showed flowering, but fruit set was very poor.

Standardization of pruning intensity in high density planting: Layout of experiment completed and pruning treatments were imposed at spacing of 2 x 2 m with different height (1 m , 1.5 m and 2 m) and pruning intensity; 25 and 50 % of annual shoot growth (back pruning one time during June). Next spacing is 4 x 4 m with different height of 2 m, 2.5 m and 3 m with pruning intensity (25 and 50 % of annual shoot growth) and back pruning done during June.

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

Effect of vegetative flushing and shoot maturity on flowering, bearing behaviour, fruit yield and quality of litchi: In this investigation, the observations recorded with respect to time of appearance of vegetative flush, further vegetative growth and reproductive phase (Fig. 20, 21). The sequence of floral formation exhibited obvious phase

Table 15. The growth parameters recorded during the vegetative phase.

Treatment details	Length of the flush (cm)	Times of extension growth	Number of branched shoots	Total length of shoot at the time of flowering (cm)	Total length of the panicle the time of flowering (cm)
July - 2011	7.35	3.64	8.2	79.24	22.24
August – 2011	6.96	2.28	6.2	54.32	23.32
September – 2011	7.25	1.81	5.1	32.28	19.28
October – 2011	7.45	1.22	3.2	30.56	13.56
November – 2011	6.97	1.11	2.2	28.26	14.28
December - 2011	7.10	1.08	0.6	16.54	14.62

Table 16. The parameters recorded during the reproductive phase.

Treatment details	Nos. of flowers /panicle	Male / Hermaphrodite / Female (Nos:)	Sex ratio	Fruit set (%)
July - 2010	1730	936:360:288	1.44:1	1.32 (23)
August – 2010	1680	903:387:387	1.16:1	0.95 (16)
September - 2010	1260	672:192:384	1.14:1	1.26 (16)
October - 2010	980	560:80:320	1.40:1	0.91 (09)
November - 2010	780	430:110:240	1.23:1	1.02 (08)
December - 2010	360	196:56:108	1.20:1	1.38 (05)

Fig. 20. Appearance of vegetative and reproductive growth in Litchi

Fig. 21. Flushes in litchi after regular pruning.

change leading to flowering and fruiting. The data showed that the earliest flush tagged in July and August bore maximum percentage of pure panicle and maximum numbers of flowers in different phases of appearance. The fruit set percentage responsible for quantum of fruit yield was also recorded comparatively higher in the panicle emerged during July, August & September. The length of pure panicles, number of flowers per panicle were also recorded higher (Table 15 and 16) in shoots emerged during the months of July (22.24 cm, 1730), August (23.32 cm, 1680) and September (19.28 cm, 1260). The fruit set were also recorded higher on panicles appeared on respective shoots that emerged in July (1.32 %), August (0.95 %) and September (1.26%).

Effect of PGR sprays on yield, maturity and quality of litchi fruits cv. Shahi: Uniform size of newly emerged shoots of July flushes (20 numbers in each treatment) were selected in month of August for recording the observation. Minimum three vegetative flushes were found in different treatments except in control (4-5 flushes have been observed till December/ January month in the continuous manner). Foliar spraying of growth regulators was done in the 1st week of October and January. Pure and mixed flowering panicle initiation appeared during 2nd week of January to 2nd week of February in the tagged shoots. Significant variations were observed among different treatments in respect of twig diameter, twig length, number of leaves/leaflets and types of panicles (Table 17).

Nitrogen content in the leaf tissues did not vary significantly and the highest values (1.34 % N) were recorded in the treatment Ethrel 150 ppm. Pure panicle emergence was recorded in treatments with GA_3 75 ppm, MH 15 ppm and MH 20 ppm with their corresponding values 75, 95 and 100 % of shoots. Others treatments showed mixed panicle with less than 50% or even lower panicle in the shoots in very late stage. Treatments GA_3 75 ppm, MH 15 ppm and Ethrel 150 ppm showed continuously 3rd year flowering panicle emergence. The longest panicle (25.93 cm) with highest number of branched panicle (15.10) was found in treatments MH 20 ppm followed by GA_3 (75 ppm and 50 ppm) and MH 15 ppm. Significant treatment variations were showed in physico-chemical character of fruits harvested on 25th May, 2011. The maximum fruit weight was observed in GA_3 (50 ppm) (21.90g) followed by Ethrel (100 ppm) and GA_3 (75 ppm). Maximum firmness (1.36 lb/cm pressure) was observed in fruit of the GA_3 (75 ppm) followed by NAA (15 and 25 ppm). Highest TSS (20.47 ^{0} brix) and fruit volume (21.50 cc) were also recorded in GA_3 (50 ppm) application.

Table 17: Effect of PGRs on physiochemical analysis of fruit 2011

Treatments	Fruit Wt (g)	Seed Wt. (g)	Peel Wt (g)	Pulp wt. (g)	Fruit Vol. cc	Fruit firmness	TSS (^{0} Brix)
T_1 (GA_3 25 ppm)	19.96 (4.58)	3.51 (2.12)	3.19 (2.05)	13.44 (3.80)	19.50 (4.53)	1.07 (1.44)	20.60 (4.65)
T_2 (GA_3 50 ppm)	21.90 (4.79)	4.03 (2.24)	3.68 (2.16)	14.80 (3.98)	21.50 (4.74)	1.19 (1.48)	20.47 (4.63)
T_3 (GA_3 75 ppm)	20.42 (4.63)	3.55 (2.13)	2.96 (1.99)	12.39 (3.66)	18.97 (4.47)	1.36 (1.54)	19.10 (4.48)
T_4 (Ethrel 100 ppm)	21.11 (4.70)	3.83 (2.20)	3.26 (2.06)	12.53 (3.68)	20.00 (4.58)	1.00 (1.41)	19.33 (4.51)
T_5 (Ethrel 150 ppm)	19.21 (4.50)	3.23 (2.06)	2.86 (1.96)	12.27 (3.64)	18.00 (4.36)	1.17 (1.47)	20.03 (4.59)
T_6 (NAA 15 ppm)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
T_7 (NAA 25 ppm)	18.71 (4.44)	3.61 (2.15)	2.91 (1.98)	11.46 (3.53)	18.73 (4.44)	1.36 (1.54)	19.80 (4.56)
T_8 (NAA 40 ppm)	18.98 (4.47)	3.67 (2.16)	3.07 (2.02)	12.51 (3.68)	18.67 (4.43)	1.35 (1.53)	19.80 (4.56)
T_9 (MH 15 ppm)	18.34 (4.40)	4.19 (2.28)	3.14 (2.03)	10.75 (3.43)	17.00 (4.24)	1.12 (1.45)	20.37 (4.62)
T_{10} (MH 20 ppm)	5.48 (2.55)	1.37 (1.54)	0.99 (1.41)	7.65 (2.94)	6.00 (2.65)	0.54 (1.24)	7.00 (2.83)
T_{11} (MH 25 ppm)	7.38 (2.89)	1.49 (1.58)	1.34 (1.53)	4.47 (2.34)	7.00 (2.83)	0.33 (1.15)	6.17 (2.68)
T_{12} (Control)	5.53 (2.56)	1.28 (1.51)	1.11 (1.45)	2.79 (1.95)	5.33 (2.52)	0.44 (1.20)	6.53 (2.74)
CD 5%	1.65	0.64	0.54	1.27	1.65	0.28	1.72

Figure in parenthesis is angular transformed value

Effect of bagging on maturity, yield and quality of litchi fruits: The bagging of individual litchi bunches has significantly improved the fruit weight, size and colour (Fig. 22). The development of sunburn spot on the sunny side was also significantly reduced in bagged fruits. Bagged fruits have about 34% less cracking and spotting. There was about 30% higher Class I fruits in bagged bunches than in bagged control. The percentage of the skin with red colour and its intensity, decreased with increasing duration of bagging. Among the different types of bags, perforated butter paper bag was found best followed by brown paper bag for total quality parameters. Fruit flesh colour, total soluble solids, acidity and eating quality were not affected by bagging.

Fig. 22. Bagging of fruits of litchi

Theme Area 3: Standardization of plant protection technology and investigation on microbial association for litchi production

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

Survey for documentation of pre-harvest diseases and the extent of losses: Four different types of leaf spots were observed in nursery plants *viz,* (Fig. 23).

A. Dark brown circular spots on young leaves with concentric growth rings

B. Black circular ring spots on older leaves

C. Light brown marginal leaf blight starting from tip

D. Dark brown marginal blight of older leaves

The severity of leaf spots in nursery was recorded at NRCL farm and farmers' nursery. Disease incidence was calculated based on number of plants showing leaf spot symptoms on leaves. It was the 'C' and 'D' type symptoms that dominated. Further 20 plants were selected among the infected plants to record per cent infected leaflets. Per cent disease severity index (PDI) was obtained for quantitative estimate of the disease. For this a 9-point scale was adopted to record disease severity. Thirty leaflets were selected randomly in the population of nursery plants and were scored individually taking into account the per cent leaf area damaged by the disease. These grades were later converted into per cent disease severity index (PDI).

Fig. 23: Different types of leaf spot symptoms in nursery plants

The results indicated that incidence of leaf spots in nursery varied from 31.94 to 50.30%. The infected leaflets among the diseased plants in different nursery ranged between 7.10 to 100 %. The PDI ranged between 15.55 to 52.96.

Incidence of anthracnose caused by *Colletotrichum gleosporioidis* was observed on fruits at harvesting stage (Fig. 24). The incidence of the disease was between zero to 10%. Besides this, sporadic occurrences of 'bark splitting' on main trunk of 5-8 year old plants, between collar zones to a height of 2-3 feet, were observed in various orchards.

Fig. 24: Anthracnose on litchi fruits

A 'leaf and twig blight' disease was observed. The symptoms appeared as death of leaves on new shoots and a foliar blight and tip dieback which was difficult to separate. The leaf blight appeared as tan spots on the leaves. The afflicted leaves look like they were scorched from the sun (Fig. 25). The twig blight

Fig. 25: Severe symptoms of leaf and twig blight observed in farmers' orchard (A and B)

along with infestation of foliage feeding pest complex not only severely hampered the young plants' growth but also reduced the potential fruit bearing flushes in grown-up orchards.

The severity of leaf blight was recorded on 22nd August 2011 and 13th February 2012 at NRCL farm and farmers' fields respectively. Disease incidence in orchard was calculated based on number of plants showing blight symptoms on leaves. Further 10 plants were selected in an orchard to record per cent infected leaflets. Three branches were randomly selected in each of these plants for observing symptoms. A 9-point scale was adopted for recording the disease severity. Thirty leaflets were collected from three randomly selected branches of the plant canopy and scored individually in laboratory taking into account the per cent leaf area damaged by the disease, where 1 = 0%, 2 = 1-5%, 3 = 6 -10%, 4 = 11-20%, 5 = 21-30%, 6 = 31-40%, 7 = 41-60%, 8 = 61-80%, 9 = 81-100% disease severity. These grades were later converted into per cent disease severity index (PDI) by using the formula given by Wheeler (1969) as under:

$$PDI = \frac{S\,(\text{Severity grade} \times \text{no. of leaves}) \times 100}{\text{Total no. of leaves observed} \times \text{maximum grade}}$$

The results indicated that incidence of the disease was 44.5% to 61.8% in August 2011 at NRCL farm, whereas it was from 28.1% to 66.3% in farmers field in February 2012. The per cent infected leaflets in a tree varied from 21.0 to 37.0 in two litchi blocks at NRCL farm, whereas it was 26.7 to 69.3 in farmers' orchard. The per cent leaf area damaged *i.e.* the per cent disease severity index was in the range of 3.7 to 47.8 (Table 18).

Isolation and identification of the microflora associated with litchi tree diseases and their pathogenicity: Morphological characterization of thirty-six fungal cultures was done that were isolated from samples of fruit drop, leaf spots, bark splitting and from rhizosphere soil samples of litchi sudden death disease affected plants. *Colletotrichum gloeosporioides* and *Oidium* sp. were found consistently associated with fruit drops. There was invariable association of *Fusarium oxysporum* with "litchi sudden death", (Fig. 26) however its pathogenicity is to be confirmed.

Table 18. Incidence and severity of leaf and twig blight disease at NRCL research farm and farmers' fields

Name of the farmer/ Block no./ place/ date of observation	Per cent disease incidence in orchard	Plant number	Per cent infected leaflets *	Per cent disease severity index (PDI)
Pathology Block, NRCL, 22-08-2011	44.5	1	21.0	33.3
		2	31.0	30.0
		3	29.3	34.0
		4	30.0	37.8
		5	24.7	37.0
		6	22.3	35.9
		7	22.7	38.1
		8	27.7	33.7
		9	28.0	28.6
		10	30.0	31.9
Shahi-II Block, NRCL, 22-08-2011	61.8	1	34.3	21.6
		2	33.0	33.0
		3	37.0	28.5
		4	29.7	30.0
		5	31.0	33.7
		6	30.0	35.6
		7	27.7	29.3
		8	31.3	39.3
		9	26.7	36.3
		10	27.3	37.8
Farmer 1 Bakhari, Muraul / 13-02-2012	66.3	1	52.0	35.9
		2	44.0	37.7
		3	27.7	37.0
		4	39.3	43.3
		5	69.3	34.4
		6	64.0	43.0
		7	47.0	47.8
		8	37.0	39.6
		9	32.7	44.4
		10	48.7	31.9
Farmer 2 Mutlupur, Bandra/ 13-02-2012	28.1	1	34.3	38.1
		2	33.0	18.5
		3	37.0	7.0
		4	29.7	9.3
		5	31.0	18.1
		6	30.0	5.6
		7	27.7	16.3
		8	31.3	3.7
		9	26.7	18.9
		10	27.3	15.9

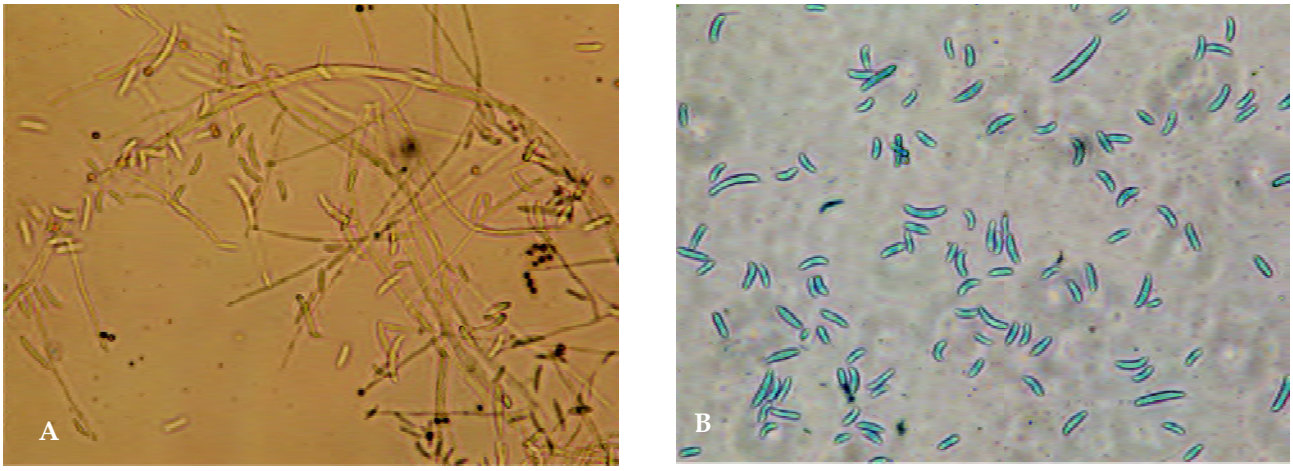


Fig. 26: *Fusarium oxysporum* isolated from rhizosphere soil of litchi sudden death affected plants: A. mycelia, conidiophores and conidia B. Conida stained with cotton blue

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

This project is under suspended animation till an Entomologist joins the Centre. However, one of the activity *i.e.* "Monitoring and surveillance of pest and diseases of litchi" is being carried out under AICRP on subtropical fruits. The detail activities undertaken during 2011-12 are given below:

- Pre-season survey was made during May-June 2011. The areas surveyed were Salha, Dwarikanagar, Manika, Narauli, Rohua in Mushahari block and adjoining areas near Kanti block, in Muzaffarpur, and Katarmala, Gaurol and Rekhar in Vaishali district of Bihar. Also, insect-pests and disease situation in Dehradun (Uttarakhand) was recorded during 17-18th June 2011.
- Also, incidence of pests and diseases were recorded in the litchi orchards at NRCL experimental farm and adjoining villages. Ten trees in each block were randomly selected for sampling foliage damage by insect pests. Infestation level of pests was recorded based on the per cent leaf area damaged during vegetative phase. The important pests recorded were fruit

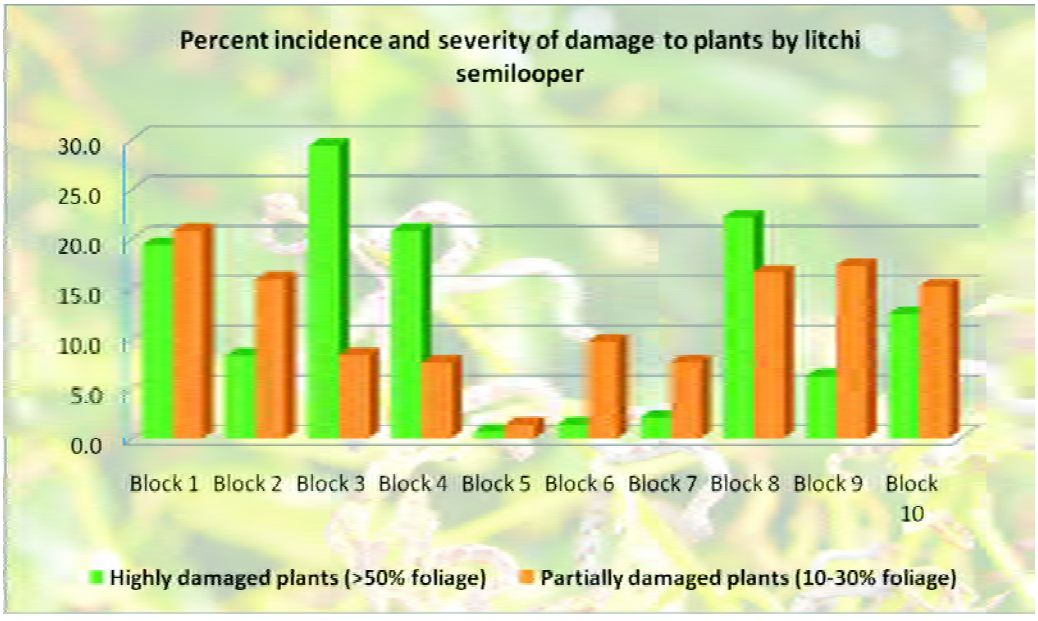


Fig. 27: Incidence and severity of damage to litchi plants by semilooper pest

borers, leaf miner, shoot borer, leaf roller, leaf mite, litchi bug and bark eating caterpillar. Borer complex of litchi were most important. Overlapping generations of the the fruit borer during the fruiting period was observed. Infestation of this pest was noticed as early as when the litchi fruit were <18 mm in length *i.e.* still in stage-I of development (growth of pericarp and seed coat).

- During October 2011 to February 2012, two new pests were recorded *viz*. Semilooper and Encased Caterpillar (Bagworm).
- Sporadic outbreak of semilooper was observed in September flush of litchi both in farmers' fields in Muzaffarpur and East Champaran, and at NRCL Experimental Farm. Observation on incidence and severity of the pest damage were taken in ten experimental blocks at NRCL Farm. Each block contained about 140 plants. Plants having highly damaged canopies (>50% top foliage) varied from 0.7-29.4% while partially damaged (10-30% foliage) plants were 1.4-20.8% (Fig 27). The total incidence of semilooper in these blocks was 2.1 to 40.3%. Semilooper voraciously fed on young foliage and in a few days only bare rachis left on the top canopy.

The biology of semilooper was studied in laboratory by rearing them (Fig 28). There was lot of variation in the colour of larvae of different instar from black to dark brown with banded appearances. In the last instar the dimension of larvae was 2 mm wide and 1.7-2.2 cm long. The size of the pupae was 0.8-0.9 cm and the size of the adult was 2.1-2.3 cm with wing fully spread. It completes its life cycle in 15-18 days out of which larval period is 10-12, pupal period is 2-3 days and adult 1-2 days. The adults however failed to mate and hence study of egg stage could not be done. The pest closely resembled to *Achaea janata* (castor semilooper). This seems to be a polyphagous pest which feeds on a variety of perennial plants. An effort for exact identification, however, is in progress.

- Another new pest observed was Bagworm or Encased caterpillar. The infestation of this pest was seen on few plants in orchards during December 2011 to February 2012. Once infestation occured, slowly the whole green area of leaf was eaten by the pest leaving behind only a network of vein and veinlets. From a distance, foliage of the plant looked bronze in colour or as if got scorched or suffering from any nutritional

Fig. 28. Litchi semilooper: A. Damaged tree, B. Heavy infestation of semilooper, C. Last instar larvae (Enlarged), D. Pupa and E. Adult

deficiency. Unlike other pests it preferred older leaves which had more tannin content. As the name suggest, the caterpillar of this insect is encased in a protective funnel shaped cap which always remain upright whether it feeds or move forward (Fig. 29). The case seems to be made from secreted material as well as from excreta and plant material. When the cap was forcefully removed, the caterpillar again synthesized the cap within two days. The movement of caterpillar was very slow and resembled that of snail *i.e.* only the head come out of the case during feeding or movement. Once all the green chlorophyllous tissue was exhausted it moved further for a few

milimeters on the leaf to eat new tissues. Feeding results in scrapping of green tissues leading to initial appearance of brown patches on the leaves. On a single leaf many encased caterpillar may be seen attached upright. The biology of this pest was tried to be studied but the caterpillar failed to pupate and metamorphose in next stage. The pest could be controlled by one spray of Carbaryl 50 WP @2 g/litre (0.1%). Based on its characteristics, the insect was identified as *Eumeta crameri* Westwood (Family: Psychidae, order: Lepidoptera).

Fig. 29. Bagworm or Encased caterpillar: A. Affected tree, B & C. Symptoms of damage on leaves, D. Fully developed larvae forcefully removed from its case, and E. Larvae out of its case under stereo-binocular microscope

- A green colour tiny aphid (0.2-0.4 mm) was seen to suck the sap from newly emerged leaves during January-February 2012. (Fig. 30.)

Fig. 30. Aphids on young litchi leaf: A. Actual view, B. As seen under Stereo binocular microscope

- Among the diseases at vegetative phase, leaf spot, twig blight and bark splitting were noticed. Pathogens were isolated and their morphology and colony characteristics were studied.

3.3 Investigation on mycorrhizal association and role of biofertilizers for sustainable production of litchi

The project entitled "Investigation on mycorrhizal association and role of biofertilizers for sustainable production of litchi" has been recently initiated at Experimental farm vis-à-vis farmer's field (for survey of strains of mychorza).

Effect of application of mycorrhiza, biofertilizers and organic amendments on growth and development of litchi : Field experiment was laid out in randomized block design with twenty treatments having components *viz*., VA mycorrhiza (*Glomus mosseae*), *Azotobacter chrococcum, Bacillus megatarium* and *Trichoderma harzianum* to study the effect of combination of mycorrhiza, biofertilizers and biocontrol agents on growth and initial establishment of litchi. Planting was done between 12th to 15th October 2011. Three replications (one plant in each) were kept under each treatment. Vermicompost was applied in all the treatments @1 kg/plant. The treatment having recommended dose of fertilizers (RDF) will be scheduled when the plants will complete one year of age.

Studies on initial microflora of experimental plots: The microflora was enumerated by serial dilution technique. Population of *Trichoderma* and *Azotobactor* increased after planting. The mycorrhizae inoculated plants also showed colonization of roots of litchi plants. The microbial population will be monitored after second application of biofertilizers *i.e.* in July 2012.

Studies on effect of various treatments on growth and establishment of litchi: The initial observations on three parameters *viz*., no. of leaves, no. of branches and girth were taken at three months interval. The results so far indicated that all the biofertilizers had positive effect on growth and establishment of plants. The highest increase in no. of leaves was in the application of consortium of VA Mycorrhiza+ *Azotobacter chrococcum.*

Survey and sampling for diversity of mycorrhizal fungi in litchi orchards: A total of 49 soil samples were collected from rhizosprere of litchi in Muzaffarpur district covering four blocks *viz.* Muraul, Bandra, Mushahari and Kanti. The other variables considered while sampling were different age group of orchards (10-50 yr), nutritional status (well managed

vs. neglected or poorly managed), dry and damp places within the orchard and light or shady area. Samples were collected from the place where the periphery of plant canopy falls. The rhizosphere soil of test plant was collected in polybags. The depth of sampling was 10-15 cm and care was taken to get the fine roots along with soil samples. While collecting the samples from plants, hand fork and spade were used. The top soil of test plants was removed and then the rhizosphere soil was collected from three different places and were pooled and thoroughly mixed. Finally a ½ kg sample was retained for investigations. Passport data for each sample were also collected in the form of a questionnaire. The samples were processed for enumeration of spores and colonization of roots by arbuscular mycorrhizae (AM).

Resting spores of AM fungi consisting of sporocarps, chlamydospores and azygospores were extracted by wet sieving and decanting method of Gerdemann and Nicolson (1963), and Pacioni (1992). Fifty grams of collected soil was poured into 500 ml of water and subjected to shaking on horizontal shaker for 30 minutes and allowed to settle. The supernatant liquid was poured through a coarse sieve (BSS 20 and 30; 710 µm and 500 µm respectively) to remove large pieces of organic matter. The lower collected liquid was passed through sieves (BSS 60, 100, 300) of decreasing pore space (250 µm, 150 µm and 53 µm, respectively). This process was continued till all colloidal materials passed through the sieves. All the debris collected on sieves were taken into a Petri dish and observed for resting spores under stereo binocular microscope. Spores were carefully extracted with needles and brushes and slides were prepared in lactophenol for further study and identification (Fig. 31-32).

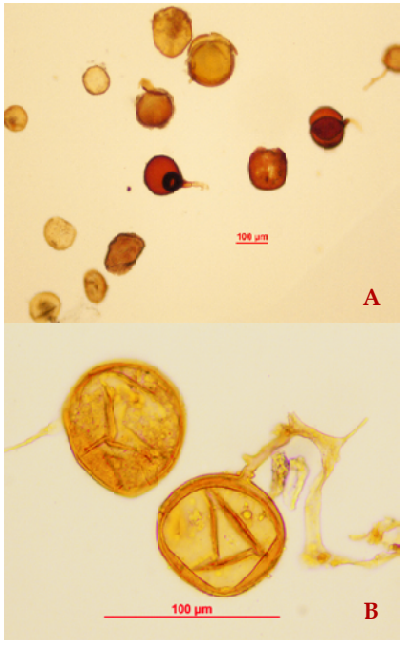


Fig. 31. Photomicrograph of spores of *Glomus* sp. (A & B)

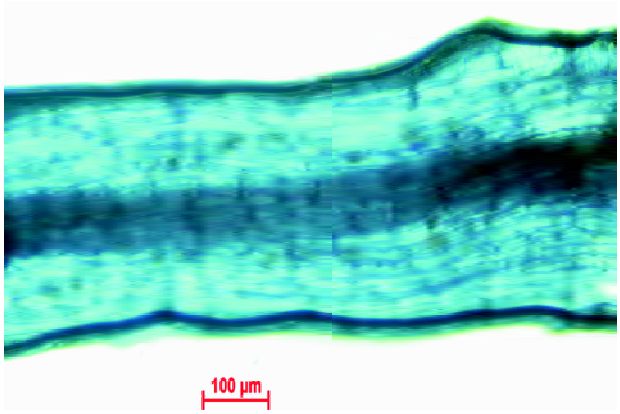


Fig. 32. Photomicrograph of vesicles and arbuscules of *Glomus* sp. in the roots of litchi

The initial results showed that the number of spores in soil was low. The roots were colonized with AM fungi. The prominent genera of AM fungi associated were *Glomus* and *Sclerocystis*. Besides this roots were also found colonized with ectomycorhizae (Fig. 33). The detail study however is under progress.

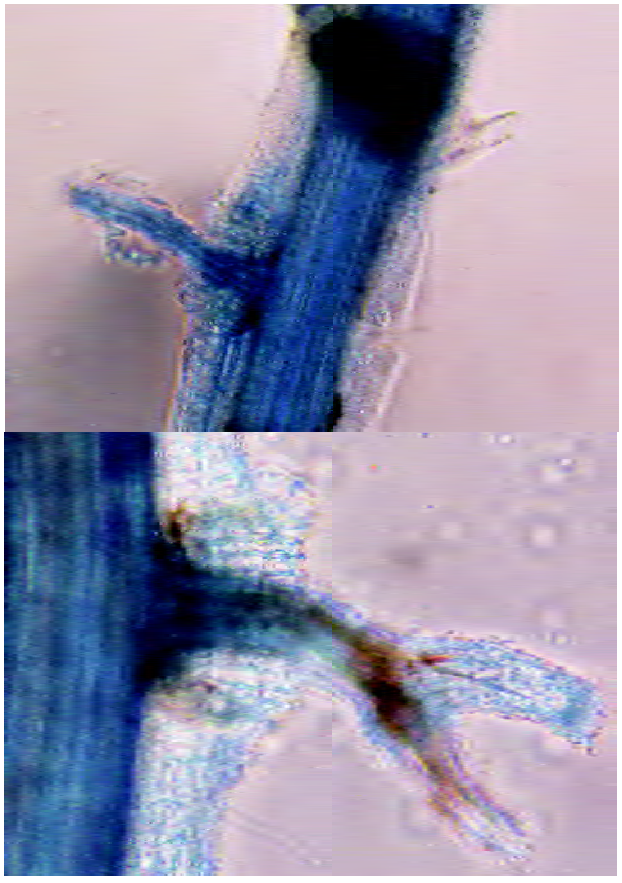


Fig. 33: Photomicrograph of colonization of roots of litchi by ectomycorrhizae

Theme Area 4 : Post-harvest Management and Value Addition

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

Pre-harvest spray of various chemicals to study the quality of litchi fruits: Considering the significant effect of boric acid in controlling the fruit cracking, it was uniformly sprayed twice (at 10 days interval) after fruit set. The combined spray of Bavistin (0.2%) and

Fig 34. Mature litchi fruits

GA_3 (50, 100 ppm) gave the maximum percentage of fruit retention (84.77%) and TSS (19^0 Brix) and least discarded fruits (4.53 %) followed by combined spray KNO_3 + bavistin and lone spray of bavistin. Whereas minimum percentage (49.98%) of fruit retention and maximum percentage of discarded fruits (22.93%) were observed in control (water spray). KNO_3 treatments delayed the maturity of litchi fruits by 3 days whereas GA_3 has advanced the maturity by 2 days (Fig. 34).

Post harvest treatments to enhance the shelf life of litchi fruits: Litchi fruits treated with various weak acids viz. citric acid (CA), acetic acid (AA), oxalic acid (OA) and their different combinations. The litchi fruits with stalk and without stalk were dipped in different acids in concentration of 0.5%. Fruits treated with CA and OA gave minimum percentage of discarded fruits (10 and 20%) followed by CA alone after 3rd day of storage at ambient temperature whereas suphited fruits gave better results with oxalic acid. There was about 44% unmarketable fruits in control (water dipped) on 4th day of storage.

Effect of various shades net on date of harvesting and quality of litchi fruits: Shade nets have significant effect on fruit weight, less discarded fruits and extending the harvesting period irrespective of colour and per cent shading by shade net. During year 2011, due to periodic cloudy weather shade net exhibited less effect in extending the harvesting period however the discarded fruit percentage was merely 5.18% in case of 30% green shade net followed by 50% white (7.85%) (Fig. 35).

Standardization of maturity indices in litchi cultivars: Physico-chemical studies of litchi fruits (cv. Shahi) during fruit development stage reveal that due to periodic cloudy weather during fruit development stage colour development and maturity of the fruits was delayed by 7-10 days with less acidity. It has been observed that during 15th -27th May fruits have the optimum growth and the optimum maturity in cv Shahi was attained during 28th May– 3rd June, 2011.

Fig. 35: Fruits of Litchi cv. Shahi produced by shading them with 30% green shade net (A-E)

Effect of different packaging and lining materials and other treatments on shelf life of litchi fruits: A trial was carried out during May-2011 to study the effects of various lining materials for packing and transportation to enhance the shelf life of litchi fruits. Four different lining materials viz. litchi leaves, Dalbergia leaves, bamboo leaves and paper cuttings were tried alone and in combinations having 9 treatments. The results revealed that litchi leaves at bottom and paper cuttings at top have minimum percentage of discarded fruits (14.5%) followed by lower paper cuttings and top litchi leavs (18%) lower litchi leaves and top bamboo leaves ensured 25% discarded fruits than control (i.e. both side litchi leaves) with discarded fruits 44 per cent on 4th day after litchi harvest (Fig. 36). There was gradual decrease in TSS and acidity of the fruits. Thermocol packaging of different varieties of litchi fruits were just like farm fresh litchi up to 5th day of harvest (Fig. 37).

Fig. 36. Packging of litchi fruits with lining material

Fig. 37. Litchi fruits from the thermocol boxes

Development of modified atmospheric packaging technologies for extending the shelf life of litchi fruits: A preliminary trial was carried out to find out the best gaseous composition and polyethylene film for MAP of litchi fruits (Fig. 38). There were 18 different gaseous compositions ranging from 5-18% oxygen and 2-6 % CO_2 and two types of polyethylene bags (PP and LD). It was observed that O_2 level in between 12-16 % and CO_2 level in between 3-6 % gave satisfactory shelf life (12-15 days) under refrigerated conditions whereas at ambient condition, the shelf life was 5-8 days.

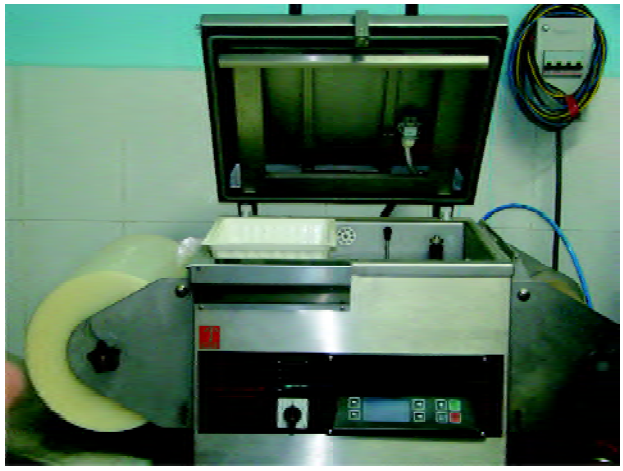


Fig. 38: MAP unit of NRCL

4.2. Investigation and management of Post harvest losses in litchi

Quantification of losses at different stages of fruit handling: Reduction of post harvest losses has become prime issue to increase the litchi fruits availability at household level. Keeping in view of highly perishable [litchi] fruits, a study made at Varanasi Mandi, Uttar Pradesh after litchi fruits transported from Muzaffarpur, Bihar. Initially it was found that no losses observed at harvest, if the best practices adopted by farmers. During handling and transport, 2.77 per cent fruits got bruised/cracked or pressed, 3.65 per cent of total fruits showed colour changed to brown and physiological loss in weight (PLW) was 4.29 %. At wholesaler site, 4.48% fruit had cracking and bruising, while category of pressed fruits had drastically increased to 23.62 % (Table 19). Physiological loss in weight (PLW) was recorded highest (34.83%) at wholesale mandi and slightly reduced at retail mandi (30 %).

Table 19. Post harvest losses studies of litchi fruits at wholesale and retail mandi of Varanasi city

Stages of losses	Physical losses (%)		Physiological losses (%)		Pathological losses (%)
	Bruished/cracked	Pressed	Browning	PLW	Rotten/infected fruits
At harvest	0.00	0.00	0.00	0.0	0.0
During handling and transport	2.77	2.77	3.65	4.29	0.0
At wholesale market	4.48	23.62	11.75	34.83	6.45
At retail market/consumer plate	4.00	8.0	16.00	30.00	8.0
Cumulative losses (from harvesting to retail market)	11.25	34.39	31.40	69.12	14.45

Under this investigation, rottening of litchi fruits start only after packed fruit opened at wholesale/retail mandi. Total PLW from harvesting to ultimate consumer has reached 69.12 % indicates maximum losses are due to desiccation of fruits. Almost 35 per cent fruits got pressed from harvesting to retail mandi.

During 2011-12 it was found that just before maturity, if fruits are harvested there was less than 2 per cent loss at harvesting, packing and transportation whereas complete mature fruits having around 4-5 per cent losses at harvesting, packing and transportation. Over mature fruits work having around 10-14 per cent losses at same stages. The maximum losses was found during storage (10-15 %) and at retailer site (8-12%).

Investigation of losses due to post- harvest diseases and their management: Post-harvest fruit rot was caused by several fungi, which were isolated but pathogenicity test couldn't be carried out.

A low temperature tolerant strain of *Aspergillus flavus* (Fig. 39) spoiled the litchi juices stored in refrigerator. Its morphological characteristics and temperature tolerance was studied.

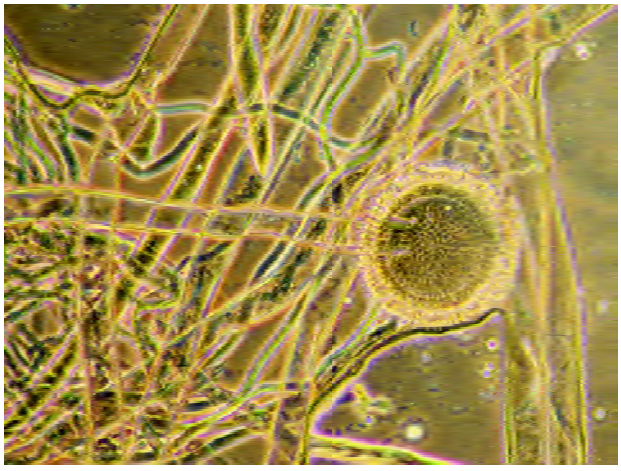


Fig. 39: Photomicrograph of coniodiophore and conidia of *Aspergillus flavus*

Isolation and identification of the pathogens and etiology of post harvest fruit rots of litchi: From the post harvest rotten fruits, three fungal pathogens were consistently isolated. They were brought to axenic culture. These were *Colletotrichum gloeosporioidis*, *Aspergillus flavus* and *Alternaria* sp.

4.3. Standardization of processing and value addition techniques in litchi

Standardization of techniques for preparation of litchi wine: PC I & EC-III-8 wine yeast strain obtained from NRC Grape, Pune and cultured at NRC Litchi gave good quality wine at 15-20^{0}C maturation temperature. The influence of litchi wine fermentation temperature (15 and 30 degree ^{0}C) on fermentation rate and synthesis of volatile compounds were carried out. It was found that higher concentration of compounds related to fresh and fruity aromas like methyl propanol, ethyl ester and methyl acetate etc, was higher in the fermentation at the lower temperature (15 ^{0}C).

Standardization of drying techniques for preparation of litchi nut: The experiment was conducted for standardization of techniques for preparation of litchi nuts with 5 pre treatments replicated four times. The result showed that the damaged nut was ranges from 11.03-76.4 per cent. The maximum damage percentage (76.04) was under boiling water pretreatment followed by dye treated fruits and minimum found in case of KMS (0.1%) followed by 2% citric acid treated fruits.

Techniques for preservation of concentrated litchi pulp: It was found that concentrated litchi pulp pasteurized and treated with 1000 ppm KMS and kept at low temperature (refrigerator) had acceptable quality and colour up to 12 months whereas at room condition the pulp turns yellowish brown after 6 month.

Externally Funded Projects

Conservation and Sustainable use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable Livelihoods, Food Security and Ecosystem Services

Under this project, the target crops are citrus and mango. The Project site is Pusa (Bihar) and the project communities are Mahamada, Jagdishpur, Murliyachak and Dhobgamma. Bhuskaul and Dighra were identified as control communities. MDST (Multidisciplinary Site Team), SMU (Site Management Unit) were constituted. The richness, divergence and evenness of diversity were studied for the project communities.

Evaluation of seedling population of mango and citrus (Pummelo): During the current year, a clonal selection survey was conducted in the four project communities for the selection of superior pummelo clones. Additionally, a Citrus Biodiversity Fair was also organized at Mahmada, Pusa to have an idea of genetic diversity present in the site for pummelo and to identify the desired ones. During the Biodiversity fair, 109 farmers participated with their fruit samples for different types of citrus. Various types include pummelo (*Citrus grandis*), acid lime (*C. aurantifolia*), sweet orange (*C. sinensis*), lemon (*C. limon*), rough lemon (*C. jambhiri*), Rangpur lime (*C. limonia*), Cleopatra mandarin (*C. reshni*) and sweet lime (*C. limettioides*). The clonal selection survey samples and the samples collected during the Citrus Biodiversity Fair were

Table 20. Physico-chemical characteristics of fruits in diverse population of pummelo

Fruit character	Range	Number (Percentage) of plants
• Fruit weight/fruit (g)	< 500	2 (1.48)
	501-1000	36 (26.67)
	1001-1500	67 (49.63)
	1501-2000	23 (17.04)
	> 2000	7 (5.18)
• Flesh colour	White/orange	13 (9.63)
	Pink	24 (17.78)
	Light red	3 (2.22)
	Red	58 (42.96)
	Dark Red	32 (23.70)
• Rind/Skin thickness (mm)	<0.50	0 (0.00)
	0.51-1.00	12 (8.89)
	1.01-1.50	47 (34.81)
	1.51-2.00	45 (33.33)
	>2.00	31 (22.96)
• Total Soluble Solids (T.S.S. %)	<8.00	5 (3.70)
	8.01-9.50	17 (12.59)
	9.51-10.50	33 (24.44)
	10.51-11.50	52 (38.52)
	11.51-12.50	21 (15.56)
	>12.50	7 (5.18)

• Number of seeds/fruit	<10	1 (0.07)
	11-50	13 (9.63)
	51-100	70 (51.85)
	101-150	46 (34.07)
	151-200	5 (3.70)
	>200	0 (0.00)
• Fruit Acidity (%)	<0.30	0 (0.00)
	0.31-0.50	36 (26.67)
	0.51-0.75	89 (65.93)
	0.76-1.00	8 (5.93)
	>1.00	2 (1.48)
• Fruit length: breadth (ratio)	< 0.80	4 (2.96)
	0.81-0.95	64 (47.41)
	0.96-1.05	46 (34.07)
	1.06-1.15	14 (10.37)
	>1.16	7 (5.18)
• 100 seed weight (g)	<30.00	8 (5.92)
	30.01-40.00	36 (26.67)
	40.01-50.00	58 (42.96)
	50.01-60.00	26 (19.26)
	>60.00	7 (5.18)

* Figures in paranthesis are the percent value of each character over total clours.

analyzed in the laboratory. In total 135 samples for pummelo were characterized (Table 20). After analysis for the fruit physico-chemical characteristics, a wide range of variation was observed for all the characteristics. The characterization of the pummelo clones indicated a large amount of variation existing for this species in Pusa site. It is obvious because in these communities, the pummelo is cultivated in almost all the houses and that too from seeds. Being a monoembryonic species, the seedlings exhibit a wide variation, because citrus/pummelo is cross-pollinated and the variation is exhibited in the F_1 itself (Fig. 40 to 47).

Fig. 40: Baramasi (three crops a year) genotype

Fig. 41: Oblong fruit type

Fig. 42: Profuse bearer genotype

Fig. 43: Oblong fruit type

Fig. 44: Round shaped and good bearing genotype

Fig. 45: Genotype with round shaped fruits

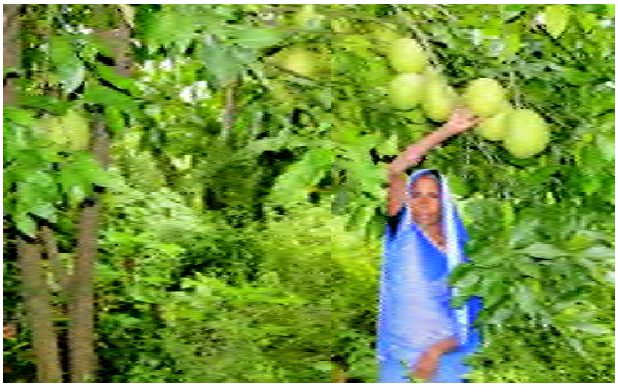


Fig. 46: Genotype with bunch bearing habit

Fig. 47: Round shaped and heavy bearing genotype

Identification, multiplication and distribution of elite types of red and low/nil bitterness pummelo: Five clones of pummelo and four of mango were propagated vegetatively for their detailed evaluation and distribution among the farmers of the project communities. About 300 mango grafts were prepared from the selected clones and the pummelo clones were multiplied as air-layers. About 140 air-layers were prepared in pummelo. Further, 1200 seedlings of Rangpur lime were collected from NRC for Citrus, Nagpur for large scale multiplication of superior pummelo clones. A Citrus Biodiversity Fair was organized to know the extent of variability in citrus at Pusa Site, Bihar. A huge response was received from the farmers and in total 109 farmers registered with their entries in the fair/competition. Many species like

Citrus grandis (pummelo/Gagar Nimbu), *C. sinensis* (Mosambi), *C. limonia* (Rangpur lime), *C. jambhiri* (rough lemon/Jambheri nimbu), *C. pseudolimon* (Galgal), *C. aurantifolia* (acid lime/kagzi, Banarasi Kagzi), *C. reshni* (Cleopatra mandarin/Hazari nimbu), *C. limettioides* (sweet lime) were exhibited by the farmers. Maximum variability was observed in pummelo and it is evident that almost all the pummelo trees are raised from seedlings.

Generating awareness about Good Agricultural Practices (GAP): The following Good Agricultural Practices were identified during the survey.

- **Multi fruit planting in the field: -** Farmers used to plant many fruits in their fields. These fields act as diversity gardens and also help in maintenance of interspecific diversity. The practice gives all the year round income to the farmers and the farmers get income regularly even if the fruit trees do not bear regularly. This practice is being followed by many farmers in the project communities.
- **Multi variety planting of a fruit: -** The farmers plant many varieties of a fruit mango in the orchard. This ensures regular income, increased duration of fruit availability and control of many insect-pests and diseases. This also ensures the conservation of the intraspecific diversity. This practice is also followed by many farmers. This will also lead to evolution of new types via out-crossing.
- **Planting of seedlings along with the grafted plants: -** This practice is generally followed in mango, where on the border, a line or two of the seedling plants are planted in addition to the grafted varieties. This provides opportunity for the evolution, development of new varieties and also adds to the income of the growers.
- **Kitchen gardening: -** Resource saving, fresh eatable, maintains different types of fruits and vegetables, ultimately leading to germplasm conservation and maintenance. Sometimes tries to have unique types.
- **Intercropping: -** Space utilization, regular income, maintenance of many crop types.
- **Non-interculture and no input use: -** Use of eroded lands, water conservation, organic farming, ultimately natural climate.
- **Puja celebrations: -** Uses many fruits for pujas specifically *Chhath puja*, leads to maintenance & conservation of different fruit species.
- **Linked to child welfare: -** Planting of trees/ horticultural plants at the birth of girl child.
- **Linked to improvement of fruit quality: -** Farmers maintain fruit crops without harmful chemicals.
- **Linked to soil/land degradation: -** Use of plants as mulches, wind breaks.
- **Brown bagging and seed distribution among farmers and relatives: -** Seed saving from the previous harvest to use for sowing in the next season. Distribution of seeds among relatives, leading to conservation of diversity.
- **Maintenance of sacred groves: -** People plants the fruiting trees in the proximity of village and do religious ceremonies inside the grove and no one among the villagers cut these trees, ultimately leading to germplasm conservation. Such groves are common near the places of *Puja*, like temples.
- **Potato- Seed production in net using Prozime: -** After mixing prozime in the soil, yield increased by 25%, good plant growth and frost-free.
- **Regular bearing in mango: -** After picking fruits, application of neem cakes, DAP, potash, thimet and lime ensures fruiting every year.
- **Use of only organic inputs: -** Use of vermi-compost and no other chemical fertilizers. Along with vermi compost, attention is paid on irrigation. By this way, fruiting and fruit size is very good. Every year fruit comes in mango. Chemicals fertilizers are sprayed only before and after flowering. In the same garden, turmeric is also grown in spaces and yield is very good.

The farmers were told about these practices during the survey, personal visits and the biodiversity fair. In Pusa site, most of the households are following these practices and the others agreed to follow in the future.

Rejuvenation of old mango trees and replacement of undesirable scions with desirable scions through top-working: It will be farmer's participatory programme. The farmers are very reluctant for the rejuvenation of old senile mango orchards. However, one farmer from the Jagdishpur community agreed for this during the next season after the harvest of the mango crop. The farmers are ready to maintain the old mango orchards, in public private partnership mode.

Development of home gardens with new and old biodiversity: The identified biodiversity was multiplied for distribution to the farmers in the project communities. Some farmers are interested in entirely new types of citrus, like Nagpur and Kinnow mandarin and mango, like Alphonso.

Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology scheme" (Up-scaling of existing component i.e. Intellectual Property Right (IPR) under ICAR Headquarters scheme on Management and information services)

This scheme was sponsored by ICAR to get the acquaintance with the IPR regime. The processes and technologies developed by various ICAR Institutes need to be protected by some law after their registration with the Government bodies. The plant wealth available with the farmers also need some protection and the owners of this wealth, the owners rights have also to be protected, so that they can have some benefit sharing from the material they owned. There should be proper implementation of IPR guidelines at the Institute level. Keeping these points in view, this scheme was sponsored by ICAR. Under this scheme, the progress made during the current year is as under:

1. The technology profile for the three technologies, viz. wine making, intercropping and rejuvenation was done. The technologies are being presented in various BPD meetings, Seminars, Symposia, workshops, *Kisan Melas*, public meetings and field visits.
2. One Manual of World Litchi Cultivars is in press.
3. Thirty clones of litchi, identified from the farmer's fields were regenerated for the detailed evaluation. Similarly, five clones of pummelo and four of mango were also regenerated for their detailed evaluation and distribution among the farmers.
4. Two blocks of litchi germplasm were maintained. Similarly, about 800 seedlings of litchi are also under evaluation.
5. The books on IPR and related matters were purchased.
6. The literature of various technologies was distributed to the farmers and litchi entrepreneurs.

Assessment and Refinement of Technology for Improving Productivity of Litchi by Enhancing Pollination and Honey production with Processing for Employment and Income Generation" (NHB funded)

The pollination studies in litchi have revealed that the Honey bees have 20-25% share in pollination of Litchi. The visit of bees was observed more during 6-8 am. Netted plants without bee boxes resulted in nil fruit restention till maturity (Fig. 48).

Fig. 48: Skilled manpower envolves in honey production from litchi orchard

Improving productivity and quality of litchi in Bihar"

Under this project a standard post harvest handling and processing laboratory was established at NRC on Litchi. Project was comprised of major 6 activities:

1. Introduction of elite varieties of litchi to widen the genetic base in India

2. Development of protocol for grafting in litchi to ensure quality planting material at large scale.
3. Training of farmers and stakeholders on improved method of litchi production and PHM to improve yield, and quality and enhanced shelf life.
4. Demonstration of improved orchard management practices including the efficient method of irrigation.
5. Infrastructure and equipment support for improvement in production and to reduce post-harvest losses.
6. HRD through Exposure Visit of two Scientists for appraisal of improved methods of litchi production and post harvest management of the important litchi growing Country.

Fig. 49: Dr. Danil Mazio interacting with scientists on progress of FAO project

Fig. 50: Talk on canopy development with FAO consultant

Major work done in project is completed. Training of farmers and stakeholders on improved method of litchi production, and demonstration of improved orchard management practices for litchi is also accomplished.

Fig. 51: Mulching with litchi leaves under the canopy of litchi

Network project on "Application of Microorganisms in Agriculture and Allied sectors (AMAAS) subproject "Harnessing arbuscular mycorrhizae for biofertilization in horticultural crops"

On the broader theme of mycorrhizal association and biofertilizers, we have an institute project *i.e.* project 3.3, entitled "Investigation on mycorrhizal association and role of biofertilizers for sustainable production of litchi". The major work done jointly under this projects and institute has been presented under the institute project 3.3 in detail.

Mega Seed project on Seed production in Agricultural Crops and Fisheries:

Approximately 48650/- air-layering / gooties were made and of which 42000 gooties proper root development takes place and 41000 air-layered gooties were planted in the polythene bags and finally 36000 quality planting materials were propagated in the projects. A sum of Rs.11.812 lakh was generated as revenue and Rs. 1.237 lakh was earned as profit from the RFS. Till the year 2011-12 a sum of Rs. 4.0 lakhs was returned to the Council with information to the

DSR Mau. Nine commonly cultivated varieties has been planted and maintained in the mother block for large scale propagation of quality planting materials. The elite mother plants are marked to collect the airlayers for large scale multiplication under this scheme. The quality planting were procured by the State Department of Manipur, Tripura, Bihar and Sikkim for their area expansion under litchi apart from farmers of the local area.

Fig. 52: Production of quality planting material of litchi at NRCL Nursery complex

Human Resource Development

Participation of scientists / staff in Conference/ Courses / Workshops/ Symposia/ Training/ Meetings during 2011-12

Sl. No.	Title	Venue and Date	Name of the participant
1	ZTM-BP& D Unit, (Organized by NIRJAFT, Kolkata and Business Planning and Development Unit)	BAU, Ranchi April, 1-2, 2011	Dr. Vishal Nath
2	22nd IMC meeting of Central Institute of Sub-tropical Horticulture (CISH), Lucknow, U.P.	CISH, Lucknow 25th April, 2011	Dr. Rajesh Kumar
3	Meeting with Litchi growers and traders for facilitating its Marketing,	APC Conference Hall, Patna 4th May, 2011	Dr. Vishal Nath
4	Post Harvest Management and Marketing of Litchi fruits	NRC for Litchi, Muzaffarpur 9-10th May, 2011	Dr. Vishal Nath Dr. S.D. Pandey Dr. Awtar Singh Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Amrendra Kumar Dr. Vinod Kumar Dr. Sanjay Kumar Singh
5	National Workshop cum Seminar on Litchi " Plasticulture Applications in Production of Litchi"	PFDC, G.B.P.U.Agric.& Tech. Pantnagar, 24-25th May, 2011.	Dr. Vishal Nath Dr. S.D. Pandey
6	Training programme on rejuvenation of old litchi orchards	ONGC Campus, Dehradoon 28-29 May, 2011	Dr. Vishal Nath Dr.Rajesh Kumar
7	3rd Swadesh Prem Jagriti Sangosthi - 2011 organized by Lt. Amit Singh Memorial Foundation, New Delhi	Dehradoon 28-31st May, 2011	Dr. Vishal Nath Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Amrendra Kumar
8	Summer Training Programme to UG Students of BHU, Varanasi, on "Processing & Value Addition in Litchi Fruits"	NRCL Campus , Muzaffarpur, 06th-12th June, 2011	Dr. Vishal Nath Dr. S.K. Purbey
9	Divisional Committee Meeting for Monitoring and Reviewing Foreign Aided Projects	NASC Complex, New Delhi 6th June, 2011	Dr. Awtar Singh
10	One month training on "Pre and Post harvest technologies for quality litchi produce" to UG students of Amity Institute of Nano Technology, Amity University, UP	NRCL Campus , Muzaffarpur, 9th June to 8th July, 2011	Dr. Vishal Nath Dr. S.K.Purbey Dr. Sanjay Kumar Singh
11	15 days training on "Post harvest technologies handling and value addition in litchi" to UG students of AAI, Naini, Allahabad	NRCL Campus , Muzaffarpur, 14th June to 28th July, 2011	Dr. Vishal Nath Dr. S.K.Purbey
12	"International Conference on Organic Agriculture" (organized by Govt. of Bihar and ICAR Research Complex for Eastern Region, Patna)	Patna 21-22th June, 2011.	Dr. Vishal Nath Dr. S.D. Pandey Dr. I.S. Singh
13	Annual Technical Review and Planning Meeting and 4th NPSC Meeting of UNEP-GEF (TFT) Project	CISH, Lucknow 18-23 June, 2011	Prof. Vishal Nath Dr. Awtar Singh
14	"Augmenting production and utilization of mango: Biotic and Abiotic stresses"	CISH, Lucknow 22th-24th June, 2011.	Dr. Vishal Nath

15	National Seminar on Organic Farming, (Organized by NHM and Dept. of Horticulture, Govt. of Bihar)	Patna 22-23rd June, 2011	Dr. Vishal Nath Dr. S.D. Pandey Dr. I.S. Singh
16	Annual Technical Review and Planning Meeting of the UNEP/GEF (TFT) Project	IIHR, Bangalore 26-28 July, 2011	Dr. Awtar Singh
17	International training on Fermentation Training	Biotechnology Research Centre, UNCP, NC, USA 1st August to 29th October, 2011	Dr. S.K. Purbey
18	Brainstorming Session on "Prioritization of Plant Physiological Research for 12th Five Year Plan Period"	Division of Crop Physiology, IARI , New Delhi. 05th – 06th August, 2011	Dr. Sanjay Kumar Singh
19	"National Consultation meet of Litchi growers and stakeholders"	NRC L, Muzaffarpur 2 September 2010	Dr. Vishal Nath Dr. S.D. Pandey Dr. Awtar Singh Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Amrendra Kumar Dr. Vinod Kumar Dr. Sanjay Kumar Singh
20	मुजफ्फरपुर शहर का सिटी बिजनेस प्लान की तैयारी के विषय पर चर्चा	समाहरणालय सभाकक्ष, मुजफ्फरपुर 7 सितम्बर 2011	डॉ. विशाल नाथ
21	Dealers and Farmers Technical Seminar for Bihar State	Muzaffarpur 21st September, 2011	Dr. Vishal Nath
22	XXth Group Worker Meeting of AICRP(STF) 29th September -02nd October, 2011	HCRI, Periyakulam, Tamil Nadu 29th September -02nd October, 2011	Dr. Vishal Nath Dr. S.D. Pandey Dr. Rajesh Kumar Dr. Amrendra Kumar
23	20th Group Workers Meetings Session-IV (Use of Bio-regulators to Increase Productivity & Quality of Fruits)	TNAU, Periyakulam Tamilnadu. 29th October, 2011	Dr. Vishal Nath
24	38th Foundation day of ASRB, New Delhi	IARI, New Delhi 1th November, 2011	Dr. Vishal Nath
25	Meeting on "Socio Economic Dimensions in Horticulture"	IIHR, Bangalore 1th November, 2011	Dr. Rajesh Kumar
26	"Technology Valuation Programme" (organized by ITMU, BPD unit East Zone, NIRJAFT, Kolkata)	IINRG, Ranchi 9th November, 2011	Dr. S.K. Purbey
27	Summer School on "Diagnostics, Genomics, Implications and Integrated Management of Plant Pathogens"	Anand Agricultural University, Anand, Gujarat 2-22 November, 2011	Dr. Vinod Kumar
28	Short Course on "Nutrio-Hormonal Dynamics and Photosynthetic Efficiency in Crop Plants under Abiotic Stress"	TNAU, Coimbatore Tamil Nadu. 09th – 18th November, 2011	Dr. Sanjay Kumar Singh
29	Short Course on Enhancing the input efficiency by using precision farm machines, remote and ground sensors	PAU, Ludhiana 14-23 November, 2011	Dr. Madhubala Thakre
30	Interaction Meet with Scientists Trained abroad in frontier Areas of Agriculture Sciences	NASC Complex, Pusa, New Delhi 28th – 30th November, 2011.	Dr. S.K. Purbey
31	23rd Institute Management Committee Meeting of CRRI,	Cuttack,Orissa 10th December, 2011	Dr. Vishal Nath
32	Stakeholders' Consultative Meeting on Integrated Development of Horticulture-Role of CISH, Lucknow	CISH, Lucknow 19th December, 2011	Dr. Vishal Nath

33	SMS/Master trainer training programme of six litchi growing districts of Bihar (sponsored by Govt. of Bihar under National Horticulture Mission) on Litchi ''लीची के बागो में उत्तम कृषि क्रियाएं का प्रोत्साहन योजना''	NRC on Litchi, Muzaffarpur 23 December, 2011 – 4th January, 2012	Dr. Vishal Nath Dr. S.D. Pandey Dr. Awtar Singh Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Amrendra Kumar Dr. Vinod Kumar Dr. Sanjay Kumar Singh Dr. Madhubala Thakre
34	लीची की उत्पादकता, गुणवत्ता, ब्रांडिंग एवं विपणन को बढ़ावा देने तथा उत्तम कृषि क्रियाओं के प्रसार हेतु एक वर्षीय लीची महोत्सव	श्री कृष्ण मेमोरियल हॉल, पटना 28 दिसम्बर 2011	डा. विशाल नाथ
35	Concluding workshop of FAO Project entitled "Improving productivity and quality of Litchi in Bihar" as लीची महोत्सव (Co-organized by Govt. of Bihar)	Patna and NRCL, Muzaffarpur 28th – 29th December, 2011	Dr. Vishal Nath Dr. S.D. Pandey Dr. Awtar Singh Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Amrendra Kumar Dr. Vinod Kumar Dr. Sanjay Kumar Singh Dr. Madhubala Thakre
36	5th NPSC meeting of UNEP/GEF TFT Project	NRC on Citrus, Nagpur 7th January, 2012	Dr. Awtar Singh
37	Workshop on *Prospects of Food processing in Bihar State*	Bihar Agricultural University, Sabaur, Bhagalpur 27th-28th January, 2012	Dr. S.K. Purbey Dr. Sanjay Kumar Singh
38	National Dialogue on Climate Resilient Horticulture	IIHR, Bangalore 28-29th January, 2012	Dr. Vishal Nath Dr. Rajesh Kumar
39	Training programme on MDP	NAARM, Hyderabad 02 – 07 February 2012	Dr. S.D. Pandey
40	उत्तम कृषि क्रियायें (लीची) प्रोत्साहन योजना अन्तर्गत क्रेता–विक्रेता सम्मेलन	पटना 10 फरवरी 2012	डॉ विशाल नाथ डॉ राजेश कुमार
41	Meeting on Agribusiness Campaign (organized by ZTM- BPD unit)	NIRJAFT, Kolkata 13th February 2012	Dr. S.K. Purbey
42	Awareness seminar on "Quality Management System & Quality Technology Tools (QMS/OTT) for horticulture products"	MSME, Muzaffarpur 15th February, 2012	Dr. Vishal Nath
43	Training programme of trainers and farmers on "*Integrated Nutrient Management in aquatic crops*"	ICAR-RCER, Research Centre for Makhana, Darbhanga 846 005, Bihar. 15th -21st February, 2012	Dr. Sanjay Kumar Singh
44	Meeting of RFD Nodal officers of Horticulture Division	NASC Complex, New Delhi 21-24 February 2012.	Dr. Vinod Kumar
45	National Seminar on Beekeeping and Opening Ceremony under Public Private Partnership (PPP)	Bharatpur, Rajasthan 28th-29th February, 2012	Dr. Rajesh Kumar
46	Meeting with member delegation from USDA and US-AID	NRC L, Muzaffarpur 22nd March, 2012	Dr. Vishal Nath

Meetings, Workshops and Events Organized by NRCL

Sl. No.	Name of Event	Date	Venue
1	Post harvest Management and Marketing of Litchi	9-10th May, 2011	NRCL, Muzaffarpur
2	3rd Swadesh Prem Jagriti Sangosthi and Litchi Show	28-31 May, 2011	Dehradoon, Uttarakhand
3	Litchi Exhibition cum Horti. Expo- 2011	09-10 June, 2011	Patna
4	Horticulture show on occasion of Global Conference on Augmentation of Germplasm, Production and Management of Biotic and Abiotic Stress in Mango	21-24 June, 2011	CISH, Lucknow
5	Good Agricultural Practices in Litchi	17th June, 2011	Katarmala, Vaishali
6	Good Agricultural Practices in Litchi	18th June, 2011	Rikhar, Vaishali
7	Canopy Management of Litchi	07th July, 2011	Nayanagar, Samastipur
8	Canopy Management of Litchi	09th July, 2011	Rosara, Samstipur
9	Exhibition on occasion of Udyan Mahotsav	10-13 August, 2011	Patna
10	National Consultation Meet of Litchi Growers and Stakeholders	2nd September, 2012	NRCL, Muzaffarpur
11	Good Agricultural Practices in Litchi	23rd Sept., 2011	Bakhari, Muzaffarpur
12	Good Agricultural Practices in Litchi	10th Oct., 2011	Bandra, Muzaffarpur
13	Integrated Pest Management in Litchi	15th Oct., 2011	Chakiya, East Champaran
14	Integrated Pest Management in Litchi	16 th Oct., 2011	Harsiddhi, East Champaran
15	लीची महोत्सव 2011	28 दिसम्बर, 2011	श्रीकृष्ण मेमोरियल हॉल, पटना

IPM training programme on Litchi at Harsiddhi, East Champaran

GAP Training programme on litchi at Bakhari, Dholi, Muzaffarpur

Transfer of Technology

Sl. No.	Title	Venue and Date	Name of the participant
1	Doordarshan Talk on 'Litchi Mein Abhi Kya Karen ? Litchi mein poshan and sinchai kab awam kaise Karen? Litchi ko kit and bimari se kaise bachayen?'	Doordarshan. Muzaffarpur, 16th March, 2012	Dr. Rajesh Kumar
2	Doordarshan Talk on "Litchi ke mahatwapurn samsamayik prbandhan taknik"	Doordarshan, Patna 18th April, 2011.	Dr. Rajesh Kumar
3	Doordarshan Talk on " Litchi Main Manjar Suraksha"	Doordarshan, Muzaffarpur 20th April, 2011	Dr. Vishal Nath
4	Doordarshan Talk on 'Litchi Ke phalo ki turai, packaging, Bhandaran, prasanskaran aur vipparan'	Doordarsan, Patna 12th June, 2011	Dr. S.K.Purbey
5	Farmers Training Programme on "Good Agricultural Practices and Litchi Orchard Management"	Katarmala, Garoul, Vaishali 17th June, 2011	Dr. S.D. Pandey Dr. Amrendra Kumar
6	Farmers Training Programme on "Good Agricultural Practices and Litchi Orchard Management"	Rikhar, Lalganj, Vaishali 18th June, 2011	Dr. S.D. Pandey Dr. Amrendra Kumar
7	Farmers Training Programme on "Canopy Management and Good Agricultural Practices and Orchard Management"	Naya Nagar, Samastipur 7th July, 2011.	Dr. Vishal Nath Dr. S.D. Pandey Dr. Rajesh Kumar
8	Farmers Training Programme on Canopy Management and Good Agricultural Practices and Orchard Management"	Rosera, Samastipur 8th July, 2011	Dr. S.D. Pandey Dr. Rajesh Kumar
9	Training programme on Litchi based farming system model (organized by NRC for litchi in collaboration SADH, Gorakhpur)	KVK, Sargatia, Kushinagar, UP 11th July, 2011	Dr. S.D. Pandey Dr. S.K. Purbey Dr. Sanjay Kumar Singh
10	Training to litchi growers on "Adoption of rejuvenation techniques in old senile/unproductive litchi orchards for enhancement of quantity and quality production"	Motipur, Muzaffarpur 20-21st July, 2011	Dr. Rajesh Kumar
11	Udyan Mahotsava 2011	Patna 10th August, 2011	Dr. Rajesh Kumar
12	Udyan Mahotsava 2011	Chatauni, Motihari 11th August, 2011	Dr. Rajesh Kumar
13	Conducted survey on "Streamline of Litchi Potential" in non-traditional area of Bihar.	Motihari, Gopalganj (Bihar), and Maharajganj, Gorakhpur (UP) 30th August – 1st September, 2011	Dr. Awtar Singh
14	Kisan Gosthi at four litchi growing areas in Dehradun	KVK , Dhakrani, Uttarakhand 07th – 10th September, 2011	Dr. Rajesh Kumar
15	Farmers training programme on "Good Agricultural Practices and Orchard Management"	Bakhari, Murol, Muazafffarpur 23rd September, 2011	Dr. S.D. Pandey Dr. Amrendra Kumar
16	Biodiversity Fair on Citrus in collaboration with Bioversity International, New Delhi and Lt. Amit Singh Memorial Foundation, New Delhi	Mahmada, Pusa, Samastipur, Bihar 5th November, 2011	Dr. S.D.Pandey Dr. Awtar Singh Dr. Amrendra Kumar
17	FAO sponsored farmers training programme on "Integrated Pest Management (IPM) and Good Agriculture Practices (GAP)	Mehsi, East Champaran 17th November, 2011	Dr. S.D. Pandey Dr. Amrendra Kumar
18	Kisan Gosthi at Sonepur Fair-2012	Sonpur, Saran 27th November, 2011	Dr. Rajesh Kumar

19	"Litchi Mahotasava" organized by Department of Agriculture, Govt. of Bihar	Patna 28-29th December, 2011	Dr. Amrendra Kumar Dr. Rajesh Kumar
20	एक दिवसीय कार्यशाला शीर्षक ''लीची की उत्पादकता, गुणवत्ता, ब्रांडींग एवं विपणन को बढ़ावा देने तथा उत्तम कृषि क्रियाओं का प्रसार'' in three litchi growing district of Bihar organized at respective district headquarters.	District HQ of Motihari, Bettiah and Sitamadhi 09th – 11th January, 2012	Dr. Rajesh Kumar Dr. S. K. Purbey Dr. Sanjay Kumar Singh
21	प्रायोगिक व्याख्यान ''लीची के बागों में उर्वरक व्यवहार के तरीके'' लीची के बागों में उत्तम कृषि क्रियाओं का प्रोत्साहन योजना''	National Research Centre for Litchi, Muzaffarpur 23rd December, 2012	Dr. Sanjay Kumar Singh
22	State Level Seminar on Awareness, motivation and technology transfer for development of Beekeeping in Bihar	RAU, Pusa, Samastipur 06-07th January, 2012.	Dr. Rajesh Kumar
23	"Good Agriculture Practices for February 2012" under "Technology Awareness programme"	ATMA, Muzaffarpur 03rd February, 2011	Dr. Amrendra Kumar
24	Training Programme for Master Trainer's under Litchi Pathshala for SMS and Krishak Salahkar	ATMA, Muzaffarpur 6th February, 2012	Dr. Rajesh Kumar
25	Kisan Mela and Horticulture Show	RAU, Pusa, Samastipur 17th February, 2012	Dr. Rajesh Kumar
26	One day National Seminar on Beekeeping and Opening Ceremony under Public Private Partnership (PPP)	FICCI Building, New Delhi. 27th February, 2012	Dr. Rajesh Kuf mar
27	Horticulture Show 2011	Department of Horticulture, RAU, Pusa, Samastipur from 14th March 2012	Dr. S.D. Pandey
28	Kisan Mela 2012	IARI-RS, Pusa, Samastipur 17th March 2012	Dr. Vishal Nath Dr. S.K. Purbey Dr. Sanjay Kumar Singh

Litchi Growers/Traders observing tools to be used for GAP in litchi orchard

FAO sponsored training on "Litchi based cropping system" at Ramkola, U.P.

Research Advisory Committee, Institute Management Committee and Institute Research Council

Research Advisory Committee

The 6th meeting of the Research Advisory Committee (RAC) of the Centre was held under the Chairmanship of Dr. G.L. Kaul, Ex. Vice-Chancellor, Assam Agricultural University Jorhat on 02nd – 03rd August, 2011 at NRC for Litchi, Muzaffarpur and was attended by the following members:

1.	Dr. G.L. Kaul, Ex-Vice Chancellor, Assam Agricultural University, 59(FF), Kaushambi, Ghaziabad- 201012, U.P.	Chairman
2.	Prof. S.K. Mitra, Faculty of Horticulture, BCKV, Mohanpur, Distt. Nadia – 741235, West Bengal	Member
3.	Dr. A.K. Singh, Ex-Assoc. Director, 101, Vishal Plaza, Maurya Path, Khajpura, Patna- 800014, Bihar	Member
4.	Dr. R.C. Rai, Chairman, Deptt. of Plant Pathology, Rajendra Agricultural University, Pusa, Samastipur, Bihar	Member
5.	Dr. S.K. Chandra, Director, Planning, Rajendra Agricultural University, Pusa, Samastipur, Bihar	Member
6.	Sh. Sudhansu Kumar, At- Nayanagar, P.O. Hasanpur, Dist. Samastipur, Bihar	Member
7.	Sh. Keshav Nandan, Shiv Shankar Path, Mithanpura, Club Road, Muzaffarpur, Bihar	Member
8.	Dr. Vishal Nath, Director, NRC for Litchi, Muzaffarpur	Member
9.	Dr. Awtar Singh, Pr. Scientist, NRCL, Muzaffarpur	Member Secretary

6th RAC Meeting under the chairmanship of Dr. G. L. Kaul, Ex. VC, AAU, Jorhat, Assam

6th IMC meeting held at NRCL, Muzaffarpur

Institute Research Council Meeting

The 6th IRC meeting was held under the Chairmanship of Director, NRC for Litchi, Muzaffarpur on 03-07th May, 2011 at 2.30 PM in the Conference/ Meeting Hall of NRCL to discuss the research achievements and finalize the research projects with technical programmes of the Centre. The new research projects were discussed at length and were approved after thorough discussion. The following members attended the meeting and presented their achievements:

1)	Dr.Vishal Nath, Director, NRCL	Chairman
2)	Dr. S. D. Pandey, Sr. Scientist	Member
3)	Dr. Awtar Singh, Sr. Scientist	Member
4)	Dr. Rajesh Kumar, Sr. Scientist	Member
5)	Dr. S. K. Purbey, Sr. Scientist	Member
6)	Dr. Indu Shekhar Singh, Scientist (S.S.)	Member
7)	Dr. Sanjay Kumar Singh, Scientist	Member
8)	Dr. Amrendra Kumar, Scientist (S.S.)	Member Secretary

Institute Management Committee

The 6th IMC meeting was held under the Chairmanship of Director, NRC on Litchi, Muzaffarpur on 23rd January, 2012 at 9.30 AM. The following members attended the meeting and discussed the matter relevant IMC of the Centre:-

1.	Dr. Vishal Nath, Director, NRC on Litchi	Chairman
2.	Dr. S. Rajan, ADG, (Hort.-I), ICAR, New Delhi	Member
3.	Dr. A.K. Singh, Head, Division of FHT, IARI, New Delhi	Member
4.	Dr. Neelima Garg, Head, Division of PHM, CISH, Lucknow	Member
5.	Dr. C. Aswath, Head, Division of Biotechnology, IIHR, Bangalore	Member
6.	Dr. I.P. Singh, Principal Scientist, NRC on Citrus, Nagpur	Member
7.	Dr. M.A. Hasan, Professor, BCKV, Kalyani West Bengal	Member
8.	Director, Horticulture, Govt. of Bihar	Member
9.	Dr. Raghwendra P. Singh, Joint Director, Horticulture, Basti (UP)	Member
10.	Sh. Rajpal Singh, Vill. Jagaha, P.O. Fandpuri, Sharanpur, (UP)	Member
11.	Sudhir Kumar Pandey, Vill. Bakhari, Dholi, Muzaffarpur	Member
12.	Sh. Shubhankar Dey, F&AO, NRCL, Muzaffarpur	Member
13.	Sh. Ramji Giri, Assistant Admn. Officer, NRCL	Member Secretary

Distinguished Visitors during 2011-12

Sl.N.	Name	Designation and Place	Date of Visit
1.	Dr. Danilo Mezia	FAO, Rome	8-10th May, 2011
2.	Sh. Gupteshwar Pandey	IG (Police),Tirhut Range, Muzaffarpur	19th June, 2011
3.	Dr. G.L. Kaul	Ex- VC, AAU, Jorhat	3rd August, 2011
4.	Dr. S.K. Mitra	Dean, BCKV, Kalyani, WB	3rd August, 2011
5.	Dr. P. Rethinum	Ex- Chariman CDB	4th August, 2011
6.	Dr. H.P. Singh	DDG (Horticulture), ICAR	2nd September, 2011
7.	Sh. Ashok Kumar Sinha, IAS	Agriculture Production Commissioner, Govt. of Bihar	2nd September, 2011
8.	Dr. Mathura Rai	Ex. Director, IIVR, Varanasi	2nd September, 2011
9.	Dr. Gorakh Singh	Horticulture Commissioner, GOI	23rd September, 2011
10.	Dr. Victor Galan	FAO Consultant, Litchi, Govt. of India	23rd September, 2011
11.	Ms. Renuka Taimani	FAO Representative, New Delhi	23rd September, 2011
12.	Dr. G.S. Prakash	IIHR, Bangalore	20th October, 2011
13.	Dr. Ramesh Chandra	CISH, Lucknow	20th October, 2011
14.	Dr. S. Kumar	Head, ICAR-RCER, Ranchi	20th October, 2011
15.	Dr. P.K. Ray	Professor, RAU, Pusa, Samastipur	20th October, 2011
16.	Dr. I.S. Singh	Ex- professor & Head, NDUAT, Faizabad	5th November, 2011
17.	Dr. B.P. Bhatt	Director, ICAR-RCER, Patna	5th November, 2011
18.	Dr. N. Sarangi	Ex. Director, CIFA, Bhubaneshwar	5th November, 2011
19.	Dr. R.P. Singh	Ex- VC, MPUAT, Udaipur	5th November, 2011
20.	Shri. Ramai Ram	Minister, Revenue and Land Reforms, Govt. of Bihar	16th November, 2011
21.	Dr. R.K. Pal	Head, Division of PHT, IARI, New Delhi	29th December, 2011
22.	Dr. A.S. Dasgupta	USAID, India, New delhi	22nd March, 2012
23.	Dr. Subhi Mishra	USDA, India, New delhi	22nd March, 2012
24.	Dr. David Leishman	USDA, India, New delhi	22nd March, 2012
25.	Dr. Srivalli Krishnan	USDA, India, New delhi	22nd March, 2012

USDA Delegation visits NRCL

Scientists of NRCL apprising development in PHM Laboratory to International FAO consultant

Publications

Research articles

1. Bharathi, L.K., Munshi A.D., Behra, T.K., Johan, K.J. Johan, Nath, V and Bisht, I.S. (2011). Genetic resources of spinegourd (Momordica dioica Roxb.ex Willd): an under explored nutritions India. Plant Genetic Resources: Characterization and Utilization, doi: 10-1017.1-4
2. Bharathi, L.K. and Nath, V. (2011). Phenotypic diversity analysis in pointed ground (*Trichosanthes dioica* Roxb). Cucurbit Genetics Cooperative Report :33-34
3. Bharathi, L.K., Das, Anath Bandhu, Ghosh N., Behera, T.K., Naik, G. and Vishal Nath, (2011). Cytomorphological and molecular characterization of interspecific F1 hybrid of *Momordica diocia* Roxb. x *Momoridca subangulata* subsp. *renigera* (G.Don). *de Wide African Journal of Agriculture Research* 6(13):2982-2990.
4. Bharathi, L.K., Munshi A.D., Behra, T.K., Johan, K.J., Nath, V and Bisht, I.S. (2011) Cytotaxonomical analysis of *Momordica* L. (Cucurbitaceae) species of India occurrence *Journal of Genetics*. 90(1):21-30.
5. Kumar V, Kumar A and Vishal Nath (2011). Emerging pests and diseases of Litchi (*Litchi chinensis* Sonn.). *Pest Management in Horticultural Ecosystems*. 17(1): 11-13.
6. Kumar V, Lukose C, Bagwan NB, Koradia VG and Padavi RD (2012). Occurrence of Alternaria leaf bight of groundnut in Gujarat and reaction of some genotypes against the disease. *Indian Phytopath.* 65(1): 25-30.
7. Kumar V, Rathnakumar, A.L. and Bagwan, N.B. (2012). Effect of crop residues and root exudates on mycelial growth, sclerotial formation, and *Sclerotium rolfsii*-induced stem rot disease of groundnut. *Indian Phytopath.* (In press).
8. Kumar V. and Thirumalaisamy, P.P. (2012). Major diseases of groundnut: current status and future research needs. *Indian Phytopathology* (In press).
9. Nath, V., Purbey S.K. and Singh, Sanjay Kumar (2011). Problems and Prospects in Marketing and Export of Fresh Litchi and Processed Products. *Sodh Chintan*: 161-166.
10. Singh, Sanjay Kumar and Bhargava, R. (2011). Evaluation of mango genotypes for morpho-physiological attributes under hot-arid zone of Rajasthan. *Journal of Tropical Agriculture*. 49 (1–2): 104–106

Papers presented in symposia/ meetings

1. Kumar, Amrendra and Pandey, S.D. (2011). Enhancing income through litchi based cropping system. *In*: Litchi Mahotsava and Workshop on Good Agricultural Practices (December, 28-29, 2011 organized by Department of Agriculture, Bihar / NRCL, Muzaffarpur, Patna.
2. Kumar, Amrendra, Pandey, S.D. and Nath, Vishal (2011). Intercropping in Litchi: A Technology to Secure Food, Nutrition and Health. In: *National Conference on "HortiBusiness - Linking Farmers with Market"* (29-31 May 2011), Organised by *Lt. Amit Singh Memorial Foundation, New Delhi*. at Dehradun, Uttrakhand.
3. Nath, Vishal, Pandey, S.D., Kumar Amrendra, and Purbey, S.K. (2011). Litchi Cultivation in India: An Overview. *Proceedings of National Workshop cum Seminar on Relevence of Plasticulture Applications in Production of Litchi*, GBPUAT, Pantnagar, Uttrakhand, May 24-25th, 2011 pp 01-09.
4. Pandey, S.D., Kumar, Amrendra and Nath, Vishal (2011). High Density Plantation and Canopy Management in Litchi Orchards. *Proceedings of National Workshop cum Seminar on Relevence of Plasticulture Applications in Production of Litchi*, GBPUAT, Pantnagar, Uttrakhand, May 24-25th, 2011 pp 69-80.
5. Purbey, S.K., and Nath, Vishal (2011). Litchi-A wonder fruit with packed nutrition for world trade. In: *National Conference on "HortiBusiness - Linking Farmers with Market"* (29-31 May 2011), Organised by *Lt. Amit Singh Memorial Foundation, New Delhi*. at Dehradun, Uttrakhand. pp 106
6. Nath Vishal, Purbey, S.K. and Singh, Sanjay Kumar (2011). Problems and prospects in marketing and export of fresh litchi and processed product. In: *National Conference on "HortiBusiness - Linking Farmers with Market"* (29-31 May 2011), Organised by *Lt. Amit Singh*

Memorial Foundation, New Delhi. at Dehradun, Uttrakhand.

7. Singh, Awtar (2012). *In*: National Dialogue on "Citrus Improvement, Production and Utilization" (27th -29th February, 2012). NRCC, Nagpur.
8. Singh, Awtar, Nath, Vishal, Pandey, S.D., Reddy, BMC and Sthapit, Bhuvan (2012). Citrus diversity fair: a means of locating biodiversity and selection of superior clones of pummelo (*C. grandis* (L.) Osbeck). *In*: National Dialogue on "Citrus Improvement, Production and Utilization", (27-29 February, 2012), NRCC, Nagpur.
9. Singh, Awtar, Nath, Vishal, Pandey, S.D., Rai, R.R., Reddy, BMC and Sthapit, Bhuvan (2011). Livelihood security in Pusa site through utilization of mango diversity. *In*: Annual Technical Review and Planning Meeting of the UNEP/GEF (TFT) (26th -28th July, 2011). IIHR, Bangalore.
10. Singh, Awtar, Nath, Vishal, Reddy, B.M.C. and Sthapit, Bhuwon (2011). Variability in pummelo- a scope for selecting new type in pummelo. *In*: Annual Technical Review and Planning Meeting of the UNEP/GEF (TFT) (26th -28th July, 2011). IIHR, Bangalore.
11. Singh, Awtar, Vishal Nath, Reddy, BMC and Sthapit, Bhuwon (2011). Pummelo biodiversity: a means for ensuring socio-economic conditions of marginal farmers in Pusa Site, Bihar. *In*: Annual Technical Review and Planning Meeting of the UNEP/GEF (TFT) (26th -28th July, 2011). IIHR, Bangalore.

Technical / Popular Articles

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4. Singh, Gorakh, Vishal Nath, Pandey, S.D., Ray, P.K. (2011). Good Management Practices in Litchi. (FAO funded) National Research Centre for Litchi, Muzaffarpur 842 002, Bihar.
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1. Kumar, Rajesh (2011). Aam awam Litchi Ke Purane Bagon Ka Jirnodhar. *Udyan Sandesh* Directorate of Horticulture, Ministry of Agriculture, Govt. of Bihar, Patna, Part – I, Chapter -4:16-20. .
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5. Singh D.N. and Vishal Nath (2011). Winter Vegetables. Advances and Developments. *Satish Serial Publishing House*, New Delhi pp. 1-854.

Compilations and Editing

Titles	Venue	Scientists involved
Annual Report 2010-11	National Research Centre on Litchi, Muzaffarpur 842 002, Bihar	Dr. Vishal Nath Dr. Sanjay Kumar Singh Dr. Awtar Singh Dr. S.D. Pandey
Vision - 2030	National Research Centre on Litchi, Muzaffarpur 842 002, Bihar	Dr. Vishal Nath Dr. Awtar Singh Dr. Sanjay Kumar Singh Dr. S.D. Pandey
World Litchi Cultivars	National Research Centre on Litchi, Muzaffarpur 842 002, Bihar	Dr. Awtar Singh Dr. S.D. Pandey Dr. Vishal Nath
GAP in Litchi	National Research Centre on Litchi, Muzaffarpur 842 002, Bihar	Dr. Vishal Nath Dr. S.D. Pandey
Off-season propagation of litchi by air layering	National Research Centre on Litchi, Muzaffarpur 842 002, Bihar	Dr. Rajesh Kumar

Research Programme and Projects

Institute Projects

Theme Area and Projects	Title	Principal Investigators (PI)
Theme Area 1. Plant genetic resources management and crop improvement in litchi.		
Project 1.1.	Collection of indigenous and exotic germplasm, their characterization, evaluation, documentation and utilization	Dr. Awtar Singh
Project 1.2	Evolving improved cultivars in litchi	Dr. Awtar Singh
Project 1.3	Evaluation of litchi cultivars for superior horticultural traits	Dr. Rajesh Kumar
Theme Area 2. Development of sustainable production technology in litchi.		
Project 2.1	Plant propagation and growth physiology of vegetatively propagated plants in litchi.	Dr. Rajesh Kumar
Project 2.2	Development of sustainable production techniques in litchi	Dr. S. D. Pandey
Project 2.3	Investigation and establishing the physiological and biochemical relations for improved litchi production	Dr. Rajesh Kumar
Theme Area 3. Standardization of plant protection technology		
Project 3.1	Investigation and management of pre-harvest diseases of litchi	Dr. Vinod Kumar
Project 3.2	Investigation and management of insect-pests complex in litchi	-------
Project 3.3	Studies on mycorrhizal association and role of biofertilizers for improved litchi production	Dr. Vinod Kumar
Theme Area 4. Post harvest management and value addition.		
Project 4.1	Standardization of maturity standards, harvesting and post harvest handling techniques for litchi fruits	Dr. Sanjay Kr. Singh
Project 4.2	Investigation and management of Post harvest losses in litchi	Dr. S.K. Purbey
Project 4.3	Standardization of processing and value addition techniques in litchi	Dr. S.K. Purbey

Externally Funded Projects

UNEP/GEF, Bioversity International, New Delhi	Conservation and Sustainable use of Cultivated and Wild Tropical Fruit Diversity: Promoting Sustainable Livelihoods, Food Security and Ecosystem Services	Dr. Vishal Nath, Director Dr. Awtar Singh, Site Coordinator Dr. Sanjay Kumar Singh, Project Associate
XI Plan Scheme (Intellectual Property Right (IPR) ICAR. New Delhi	"Intellectual Property Management and Transfer/ Commercialization of Agricultural Technology scheme" (Up-scaling of existing component i.e. Intellectual Property Right (IPR) under ICAR Headquarters scheme on Management and information services).	Dr. Vishal Nath, Director Dr. Awtar Singh, Nodal Officer
NHB, Gurgaon, Haryana	"Assessment and Refinement of Technology for Improving Productivity of Litchi by Enhancing Pollination and Honey production with Processing for Employment and Income Generation"	Dr. Vishal Nath Dr. Rajesh Kumar Dr. S.K. Purbey
ICAR [Plan] NBAIM, Mau (U.P)	Application of Microorganisms in Agriculture and Allied Sectors (AMAAS) – Theme - "Harnessing arbuscular mycorrhiza for biofertilization in horticultural crops"	Dr. Vishal Nath Dr. Vinod Kumar Dr. Rajesh Kumar
FAO, Rome	Improving productivity and quality of litchi in Bihar	Dr. Vishal Nath Dr. S.D.Pandey
ICAR revolving fund scheme	Mega Seed project on Seed production in Agricultural crops and Fisheries	Dr. Vishal Nath Dr. Amrendra Kumar

Direcor, NRCL participating in "Litchi Mahotsaw" at Patna

Personnel

Scientific

Dr. Vishal Nath M.Sc. (Ag.), Ph.D	Director
Dr. S. D. Pandey, M.Sc. (Ag.), Ph.D	Pr. Scientist (Hort.)
Dr. Awtar Singh, M.Sc. (Ag.), Ph.D	Pr. Scientist (Plant Breeding)
Dr. Rajesh Kumar, M.Sc. (Ag.), Ph.D	Pr. Scientist (Hort.)
Dr. S.K. Purbey, M.Sc. (Ag.), Ph.D	Sr. Scientist (Hort.)
Dr. Amrendra Kumar, M.Sc. (Ag.), Ph.D	Sr. Scientist (Hort.)
Dr. Vinod Kumar, M.Sc. (Ag.), Ph.D	Scientist SS (Plant Pathology)
Dr. Indu Shekhar Singh, M.Sc. (Ag.), Ph.D.	Scientist SS (Soil Science) (Up to 8th August, 2011)
Dr. Sanjay Kumar Singh, M.Sc. (Ag.), Ph.D	Scientist (Hort.)
Dr. Madhubala Thakre, M.Sc. (Ag.), Ph.D	Scientist (Hort.)

Technical

1.	Sh Rajiv Ranjan Rai, M.Sc. (Ag.)	T-6
2.	Sh Shayamji Mishra	T-3 (Farm)
3.	Smt. Pallavi	T-1 (Lab-Tech)

Administration

1.	Sh. Ramjee Giri	AAO
2.	Sh. Subhankar Dey	AF & AO
3.	Sh. Dileep Kumar	Assistant
4.	Sh. Avinash Kumar Kashyap	UDC
5.	Sh. Sawan Kumar	LDC
6.	Sh. Ajay Kumar Rajak,	S.S.G-1
7.	Sh. Surendra Rai,	S.S.G-1
8.	Sh. Dharmendra Kumar	S.S.G-1

Retirements / Recruitments / Promotions / Transfers

New Entrants

Dr. I.S. Singh, Scientist SS (Soil Science) joined this centre on 11th April, 2011 after getting transfer from CIAH, Bikaner, Rajasthan.

Dr. Sanjay Kumar Singh, Scientist (Horticulture) joined this centre on 11th April, 2011 after getting transfer from CIAH, Bikaner, Rajasthan.

Dr. Madhuabala Thakre, Scientist (Horticulture) joined this centre on 2nd September, 2011 after successfully completion of FOCARS training at NAARM, Hyderabad.

Promotions

Dr. Amrendra Kumar, Scientist SS (Horticulture) promoted to Senior Scientist (Horticulture) w.e.f. 05.10.2008.

Transfers

Dr. I.S. Singh, Scientist SS (Soil Science) transferred and relived on 8th August, 2011 to join ICAR-RCER Research Centre for Makhana, Darbhanaga, Bihar after getting selected as Senior Scientist (Soil Science).

Buyer - seller meet on litchi hosted by
NHB and Govt. of Bihar at Patna

Litchi Mahotsav organised by Govt. of Bihar at Patna

FAO sponsored training programme on
Good Management Practices in Litchi










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