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INDIAN INSTITUTE OF NATURAL RESINS AND GUMS
भारतीय प्राकृतिक राल एवं गोंद संस्थान
(Indian Council of Agricultural Research)
(भारतीय कृषि अनुसंधान परिषद्)
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Published by
Dr R Ramani
Director

Compiled, Edited and Produced by
Dr Md Monobrullah
Dr A Mohanasundaram
Dr A Bhattacharya
Dr A R Chowdhury
Ms P R Ghatak
Dr Anjesh Kumar
Dr R K Yogi

Design and Layout
Dr A Mohanasundaram
Dr Md Monobrullah

Photographs
Shri R P Srivastava

Administrative Assistance
Shri Madan Mohan

Cover Page
Background - Gum exudation from *karaya* tree
Clock-wise from back cover - Inauguration of '*Palash* Conference Hall', Under-graduate trainees, Combined drying system for lac value-added products, Natural nail polish, FTIR spectra of lac and GM and *Aprostocetus purpureus*.

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INDIAN INSTITUTE OF NATURAL RESINS AND GUMS
Namkum, Ranchi – 834 010, Jharkhand, India
Phone: +91-651-2260117, 2261156 (Director)
Website: http://ilri.ernet.in,
E-mail: iinrg@ilri.ernet.in
iinrgmr@gmail.com

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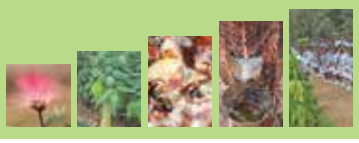


Preface

Past year had been very favourable for natural resins and gums sector. The production of NRGs in India during 2013-14 was about 8.41 lakh tonnes, marginally higher than the previous year; NRG production has doubled since 2006-07. India exported 4.36 million tonnes of NRGs valued at rupees 4.8 billion in 2013-14. This had been principally due to spurt in US demand for *guar* gum in oil drilling. The prices of *guar* touched new highs in recent years but subsequently fell. A large section of farmers and the industry reaped the economic benefits of the enhanced price and demand for this gum. Besides, during past 2 years, *guar* gum remained the top agri-export commodity in the country, with 18-19% share, with export earning of Rs 213 billion in 2012-13. While there is reason for rejoice on enhanced demand and price, fluctuations of the same could be counter productive. Thus, there is need for strengthening consumption base of NRGs to avoid large scale dependency on any single area of consumption. This would reduce the risk of violent fluctuation in prices due to major fluctuations in demand. This calls for constant endeavour to develop new areas of consumption for seed gums as well as insect resin, lac. For exudate gums, the main focus would be sustainable tapping methods, improved primary processing, value addition and expansion of resource base; currently the production levels are well below the demand mainly due to limited trees available and unscientific tapping.

The research programmes of the Institute during the current Plan period has been envisaged on the basis of current and emerging scenario of NRG sector. The Institute has now published the Vision 2050 document which incorporates long-term directions needed for the Institute's R&D programmes to take the country to new heights in the sector. The XII Plan SFC document of the Institute has been sanctioned, which would provide a major fillip to the Institute's activities. A new network project on Conservation of Lac Insect Genetic Resources will be launched with eight centres; existing network project on Harvesting, Processing and Value Addition of NRGs will be strengthened by addition of three new centres to address more NRGs. Substantial funds have also been earmarked for renovation of the old buildings of the Institute, which will be completing nine decades of its service to the nation, this year. In addition, sanction of a new KVK for Khunti district recently, under the administrative control of the Institute, would not only be helpful in taking the latest agricultural production technologies to the farmers of the district, but also help in promoting lac culture and lac-integrated farming systems in the region. The new KVK will be established in Diankel village, Torpa Block in an area of about 49 acres of land on the Khunti-Torpa State Highway. The State Govt. has already provided the land required for the KVK.

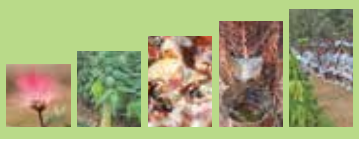
Keeping abreast with the scenario of the sector in major NRG-producing States is essential to enable right orientation of the research thrusts. Adequate provision has been made in the XII Plan for gaining first-hand knowledge of NRGs from the major producing countries. Besides, adequate emphasis has been given for HRD of scientists in frontier and specialised areas, in the current Plan.

The Institute is also alive to all the factors influencing the consumption of NRGs. The Institute is actively involved in the initiative for generation of fresh safety data on shellac (E904), as laid down by European Food Safety Authority. This is extremely important to unambiguously establish the safety of shellac to ensure its use in food, pharma and cosmetic applications. Establishment of safety would also pave way to opening up new horizons for shellac consumption. We feel that we are more responsible for the above initiative in view of the following considerations. India is the world leader in lac production and lac is a valuable means of livelihood for the growers, especially in the disadvantaged districts identified by the Planning Commission. Recent years have witnessed a large number of success stories of lac growers who had achieved impressive economic gains through lac cultivation.

NRGs have several advantages and offer tremendous scope for consumption in food, pharmaceuticals and cosmetics in years to come. All round support and dynamic response to emerging situations are paramount to keep the sector healthy. The Institute always strives to its best, in responding to the needs of the sector in the mandated areas.

May, 2014
Namkum, Ranchi

R Ramani
Director



Mandate

- To conduct basic and applied researches on lac production technologies.
- To conduct basic and applied researches on processing and value addition of natural resins (including lac), gums and gum-resins.
- Information dissemination and technology transfer to farmers, processors and entrepreneurs.
- To conduct research on harvest and post harvest processing and value addition of natural resins, gums and gum-resins in network mode.
- Conservation of lac insect genetic resources of the country in network mode.

Executive summary

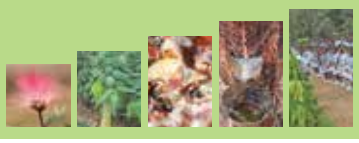
The following account summarizes the salient research findings and extension activities during the period.

Productivity and quality improvement

- Wide range of variability was observed for morphological traits in 23 *ber* varieties. Six varieties had significantly higher lac yield than CAZRI Gola. On the basis of lac yield, scrap lac yield and all biochemical and physiological parameters, seven *ber* varieties *i.e.*, Kaithali, Jogia, Seb x Gola (F_1), Banarasi Karka, Thornless, Kaitha and Banarasi Pebandi have been identified for high lac production potential in Ranchi conditions.
- Twenty eight collections varieties / germplasm/ land races of pigeon pea were evaluated for *baisakhi* crop. Only two varieties *i.e.*, Assam local and RCMP 5 showed significantly higher lac yield than Bahar. Ten varieties provided lac output ratio ranging from 4 to 6.4. There was a loss of 12.4% in grain yield/ plant in lac inoculated plants.
- Potential of swadi *palas* was assessed for *kusmi* lac production at farmers' field at Putadag, Angarha, Ranchi during winter season. A good lac crop with output ratio ranging from 5 to 6.5 was obtained.
- Seventy two lac insect lines are being conserved on potted plants of *Flemingia macrophylla* in NATLIGEC and 90 collections of 55 species of lac host are being conserved in the Lac Host Field Gene Bank at IINRG, Ranchi.
- A cross was made between *Kerria chinensis* (female) and *K. lacca rangeeni* (male). The crossed females showed enhanced resin production but failed to produce any progeny indicating reproductive isolation.
- Biochemical characterization of four lac hosts (*Calliandra calothyrsus, C. surinamensis, Malvaviscus penduliflorus* and *Flemingia semialata*) revealed high sugar content in *F. semialata* whereas high starch and low phenol content in *M. penduliflorus* among the host studied.
- Balanced ascorbate peroxidase activity was found in selected *F. semialata* line for drought tolerance compared to local line. Un-inoculated drought tolerant line maintained higher catalase activity than the local line. Drought tolerant line of *F. semialata* has high level of sugar, protein and chlorophyll content. The starch degradation is more in case of drought tolerant line as compared to local line. The selected *F. semialata* line was thus more efficient in stress tolerance (lac insect as well as abiotic stress) than the local line.

Production system management

- Three or more sprays of Cantaf and Kavach starting from 60 or 90 days after lac inoculation could reduce sooty mold with significant increase in lac yield. Maximum lac yield was achieved by 3 sprays at 90,105,120 days after inoculation in case of *ber*.
- Liming could increase summer season (*baisakhi* crop) lac yield in *palas* host to the tune of 45 percent. Interaction effect of liming and potassium levels revealed that, highest level of potassium could increase lac yield ratio up to 100 per cent under no liming condition. However, reverse trend was observed under liming condition.
- Two new lac integrated farming systems (*semialata* + papaya and *semialata* + vegetables) were developed at Institute Research Farm. LIFS models evolved earlier were also successfully replicated in farmer's field at two new locations in Mangoband and Kharsidag villages.
- Lac mud has been evaluated for manurial value on brinjal. Out of eight treatments, one with 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source was found best indicating its utility for brinjal crop.
- Flubendiamide was found safe to lac insect culture as topical application on summer and rainy season crops on *Butea monosperma* and for broodlac treatment through dipping. Significant reduction in the incidence of lepidopteran predators (*Eublemma amabilis* and *Pesudohypoptera pulverea*) were observed due to dipping of broodlac in the flubendiamide formulation for 5, 10 and 15 minutes.
- Twenty two genotypes of *litchi* trees were inoculated to raise summer *kusmi* crop at the farm of Regional Centre for Eastern Region, Ranchi Centre. The output: input of broodlac indicated that five genotypes namely L4/36 (12.0), Surguja selection- 1 (6.59), Late Bedana (5.70), CHES-2 (5.55) and CHES-2-1 (5.0) were promising for lac culture.



Processing, storage and quality management

- Moisture content, total colour difference (ΔE), ash content, specific rotation [a], total tannin content, presence of heavy metals, viscosity, FT-IR, TGA and DSC studies were carried out on babool gum samples from different agro-climatic zones of the country.
- Different type of modified churning blades were evaluated to improve churning mechanism for easy removal of lac dye and other impurities from sticklac for conversion to seed lac.
- Drying characteristics of aleuritic acid was studied in hot air tray drier at different temperature 35, 40, 45 and 50°C at five different layer thicknesses (0.5, 1.0, 1.5, 2.0 and 2.5 cm) to standardize drying conditions.

Value addition, application development and product diversification

- Post harvest storage studies, using lac-based coating formulations on ginger, coriander and cumin indicated that moisture loss in ginger could be effectively contained over a storage period of 45 days.
- Seed quality parameters in the case of above seed spices were enhanced due to reduced pest infestation and reduced seed damage through encapsulation. Seed viability as well as consumer preference was enhanced by the treatment, over a storage period of six months.
- Use of lac-based coating formulations as post harvest dip could extend the shelf life of pomegranate fruit (*cv.* Bhagwa) to 16 days at room temperature and upto 61 days (as compared to control) in cold storage conditions.
- Viscosity of sticker *bindi* adhesive (30% solution in isopropyl alcohol) was increased for screen printing using rheology modifier. The bulk density of modified adhesive formulation was found to be 0.86g/cc and pH value was around 5. Single coat of modified adhesive composition and air drying appeared to be suitable.
- Different concentrations (0.001-100 ppm) of policosanol isolated from lac wax were prepared in aqueous medium and tested on wheat seedlings. Plant growth promotion activity of lac policosanol was highest at 0.1 ppm concentration.
- Method was standardized for isolation of tannin present in *palas* gum; the yield of tannin content was 42% (w/w). Crack cream formulation, with *palas* gum as active ingredient was prepared. Similarily, another formulation based on tannin from *moringa* gum was also prepared.
- Gummy mass obtained from the effluent in aleuritic acid manufacture was modified and air dried and baked films were evaluated. Air dried films were inferior to baked films. Baking at 180°C for 20 minute was most appropriate, using synthetic resin: gummy mass (w/w) in 3: 7.
- Carboxymethyl derivative of *guar* gum was synthesized by semi-dry and non-aqueous method with varying ratio of reagent. The viscosity of the synthesized derivative increased with higher degree of substitution and ranged from 2010 cP to 3359 cP.

Capacity building of farmers and entrepreneurship development

- Farmers' training programmes on scientific lac cultivation, processing and utilization: Twenty seven programmes were organized benefiting 1046 farmers from Jharkhand, West Bengal, Maharashtra, Bihar, Madhya Pradesh, Odisha, Chhattisgarh and New Delhi.
- Master trainers' training programme on scientific lac production, processing and uses: Seven courses were organized benefiting 216 participants which include unemployed educated rural youth, junior lac executives, managers, primary forest committee members and others.
- Ten days education programme on production, processing and uses of natural resin and gums were organized for agricultural graduate students: Two courses one each for Sam Higginbottom Institute of Agriculture Science & Technology, Allahabad and Institute of Agriculture Science, Banaras Hindu University, Varanasi, Uttar Pradesh were organized wherein 73 students were educated and trained.
- On-farm training programme on lac cultivation: Fourteen programmes in collaboration with various NGOs and GOs of Jharkhand and Odisha were organized benefiting 1569 participants.

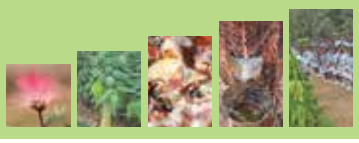
- On-farm motivational/ supplementary training programme on lac cultivation: 2217 participants from Jharkhand, West Bengal, Chhattisgarh, Odisha, Assam and Nagaland were covered.
- Process know-how were transferred to self sponsored participants on aleuritic acid, bleached lac, dewaxed decolorized lac and nail polish.
- One to one programme was organized to provide consultancy to different stakeholders of NRG, wherein 283 personnel visited the division and interacted with the experts of Institute on the technical aspects of NRG.
- The institute participated in seven Exhibitions / *Kisan Melas* and displayed various technologies in the form of posters, charts and other exhibits. Experts of IINRG also participated in 12 *Kisan Gosthis* organized in different districts of Jharkhand and West Bengal benefiting 3986 stakeholders on NRGs.
- Monitoring of lac crop, technical guidance, diagnostic services for forecast of larval emergence, cause of lac insect mortality, quality of broodlac, incidence of insect predators and parasites, remedial measures for pest attack, demonstration of pruning, inoculation, spraying etc. at different locations were done throughout the year in the respective seasons.

Technology evaluation, refinement, dissemination and demonstration

- Five demonstrations and on farm trial for winter *kusmi* lac cultivation was carried out at Saraikela and Bokaro (Jharkhand), Patna (Bihar), Gondia (Maharashtra) and Allahabad (U.P.) in collaboration with NGOs and KVKs. One demonstration for *rangeeni* rainy season crop was also carried out at Saraikela- Kharsawan.
- The estimated national production of sticklac during 2012-13 was approximately 19,577 tons. Jharkhand ranked 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal. These five states contributed around 96% to the national lac production. At national level, the production of lac was observed around 9.36% more than the previous year.
- Analysis of year wise lac production data in India during XI Plan (2007-2008 to 2011-2012) indicated average production by the country to the tune of 16.246 thousand tons. The Jharkhand registered highest average annual production (6.306 thousand tons), sharing 38.82 per cent of total lac produced in the country followed by Chhattisgarh (30.21%), Madhya Pradesh (13.66%), West Bengal (6.97%), Maharashtra (4.96%), Odisha (2.27%), Uttar Pradesh (1.94%), Assam (0.52%), Andhra Pradesh, Gujarat (0.30% each) and Meghalaya (0.06%).
- A total of 31,490 seedlings including *S. oleosa* (490), *Z. mauritiana* (5000) and *F. semialata* (26000) were planted across 16 villages in Torpa and Rania blocks of Khunti district.

Network Project on HPVA-NRG

- A study at CAZRI, Jodhpur revealed that gum production using gum inducer technique was of higher order in local *Acacia senegal* trees compared to exotic trees. A stand of high gum yielding plant type of *A. senegal* (Nigerian origin) was established on Central Research Farm of CAZRI during monsoon season of 2010. The survival percentage after 3 years was more than 96%.
- The trials on gum tapping using gum inducer method using ethephon were conducted in Sagatpuria, Birdhol and Mansa villages of Kotari block of Bhilwara district of Rajasthan in February, 2013. The average yields of gum obtained were 137.3g/tree.
- The viscosity of gum in genotypes was found to vary from 3050 to 6164 mpa.s. Genotype HGS-563 showed maximum mean viscosity of 5765 mpa.s. Jodhpur ranked 1st in viscosity of 5336 mpa.s followed Durgapura (5321 mpa.s). Viscosity profile of *guar* gum solution as a function of concentrations of *guar* gum revealed that they exhibited pseudoplastic/ non-Newtonian behavior at relatively higher concentrations.
- The viscosity profile as a function of temperature of *guar* gum solutions indicates that apparent viscosity of *guar* gum solution was stable up to 70^{0}C. Further, it was observed that the apparent viscosities decreased considerably at higher temperature (80^{0}C).



- Among 22 progenies of *Pinus roxburghii* selected for tapping, Kopra has performed best in oleoresin yield (1182 g/season). Dibkon and Leda progenies of *P. roxburghii* have recorded maximum (6.5) number of stomatal rows on round surface. Maximum number of stomata per mm of a row (12) was obtained in Bagthan.
- Genotypic and phenotypic correlation coefficients have been found to be significant for oleoresin *vs* needle length, oleoresin yield *vs* needle thickness, oleoresin yield *vs* number of stomata per mm of a row.
- Out of five characters (bark thickness, needle length, needle thickness, number of stomatal rows on round surface and number of stomata per mm of a row), three characters (needle length (cm), needle thickness (mm) and number of stomata per mm of a row) have been found to be significant in the multivariate analysis. Thus oleoresin yield can be predicted on the basis of three characters *i.e.*, needle length, needle thickness and number of stomata per mm of a row.
- The reason for the death of most of the *guggul* plants is due to tapping from main stem and deep incisions. Selection of secondary or tertiary branches (as the case) will save the plants as these branches grow faster than the primary stem.
- The oozing of the gum-resin varied in different *guggul* plants and it was negatively co-related with soil moisture. There was an increase in density (mg/ml) of the gum at low soil moisture.

NAIP-LID (Component- 4)

- Surveys in Kerala, Assam, Meghalaya and Nagaland were made. Three new lac insect lines were collected from Assam, Meghalaya and Nagaland. Six new species of lac insects were described; three new collections made from Madurai, Manipur and Thrissur and three from Karnataka, Orissa and Punjab conserved in the Field Gene Bank of the NATLIGEC.
- Polymorphism was observed between *K. lacca* and *K. chinensis* lines using microsatellite genotyping of lac insects using fluorescent primers. A SNP based genotyping screening was done in selected SNP domain using lac insect lines. SNPs were found in the genes *viz.*, N-methyltransferase, guanylate cyclase, e3 ubiquitin-protein, mitochondrial bc1 complex, transport protein.

NAIP-LVC (Component-2)

- Under NAIP on Lac Value Chain project, 16,100 seedlings of *F. semialata* and 3,715 seedlings of *ber* were distributed among 41 farmers of 30 villages to raise plantation and carry out lac cultivation on plantation basis under the project during June- July, 2013. To promote high yielding *kusmi* lac cultivation on *ber* 915 kg *kusmi* broodlac was distributed among 147 farmers of 26 villages in Ranchi and Khunti districts during June-July, 2013 to inoculate 1087 lac host trees *ber* through five associated NGOs in the project.
- To promote primary processing of lac at village level 550 farmers and 90 students of agricultural universities were imparted training on primary processing of lac on model small scale lac processing unit established in IINRG Research farm under NAIP.
- Four training-cum-production centres were established in Ranchi and Khunti districts for training and demonstration on making lac based handicrafts.
- 20 rural youths from project area were trained on making lac handicraft at BRIAT, Allahabad to work as Master Trainer. 360 rural youths from the project area were further trained at four training-cum-production centre by these Master Trainers. Beneficiaries are now earning > Rs. 2250 per month as their part time activity in making lac handicraft.
- M/s Gupta Brothers, Bundu consortium partner is manufacturing quality lac dye in his modified lac dye plant developed by the institute and fetching higher price (Rs. 2,500 /kg) for his product.

NAIP (Component-3)

- Ten household of Jamtara and nine from Dumka districts had produced 143 and 107 kg *rangeeni* broodlac, respectively during July 2013 from *B. monosperma* tree. In addition, 36 kg of sticklac was also produced during November 2013. Around 88 man-days were generated by intervention of this activity in the adopted village.

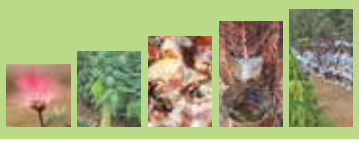
- A total of 242 and 296 kg *rangeeni* broodlac was produced from Jamtara and Dumka districts, respectively from *rangeeni* rainy season crop harvested during November 2013. In addition, 184 kg of scraped lac was also produced during this period. Around 233 man-days generated by intervention of this activity in the adopted village.

NICRA - ICAR

- A comparison between good summer (*baisakhi*) producing year and poor summer producing year revealed, positive correlation of RH with summer production and an inverse relationship with monthly mean temperature during January to April (critical growth stage of lac insect). High rain during January month showed negative impact on summer lac crop.
- Analysis of weather data for the period (1984 to 2012) of Ranchi, Jharkhand reveals increase in mean temperature of 0.23^0C, decrease in mean RH of 6.2% and decrease in rainfall of 64.6 mm.
- The proline content was found to have negative correlation with RH and positive correlation with mean daily temperature during December to May.
- *Aprostocetus purpureus* abundance showed significant positive correlation with temperature and negative correlation with RH during critical crop growth period.
- Eighteen (18) insect species were recorded for first time associated with lac fauna, out of which 10 parasitoids; 4 Syrphids and one fruit fly were collected from Jammu center and two new lac associated parasitoids *viz.*, *Mischotetrastichus* sp. (Eulophidae), *Dolichogenidea* sp. (Braconidae) and one predator, *Oryzaephilus surinamensis* (Silvanidae) from Ranchi.

NFBSFARA

- Study was carried out on use of lac and modified lac as matrix for development of Jute-lac based natural biocomposites. The density of composite boards ranged from 0.82-1.07 gm/c.c. Highest matrix loading 45.95% was for modified lac-thiourea based biocomposites. Mechanical strength properties like flexural modulus, modulus of elasticity, interlaminar shear strength etc. were measured and found that the boards were having adequate strength near to composite made of synthetic matrix/binder.



Introduction

Historical Perspectives

India is the one of the largest producer of natural resins, gums and gum-resins (NRGs) along with China, Indonesia, Russia and Brazil. India is the world leader in production of *guar*, *karaya* and *psyllium* gums as well as lac. The production level of NRGs in India during 2012-13 was 8.41 lakh tonnes and had been growing during the last decade; doubled since 2006-07. *Guar* holds the largest share of NRGs produced in India. During last 2 yrs, *guar* gum had been top agri-export commodity in the country, with 18-19% share, with export earning of Rs 213 billion in 2012-13. *Guar* production 2013-14 was 2715 t tons. NRGs are important source of subsidiary income to farmers in around 70 disadvantaged districts, identified by the Planning Commission. *Guar* cultivation is an excellent source of income for farmers in drier tracts of north-eastern states (Rajasthan, Gujarat, Haryana, Punjab, etc.), as rain-fed crop. With enhanced interest in safe and natural material for consumption in various areas, the demand is expected to grow steadily in future.

IINRG fills in the lacuna of a national R&D Institution to the NRG Sector, which is important from social, export and ecological angles. The Institute provides holistic support in research to the sector (NRGs), under one roof, from production - processing – value addition-application development, related areas like quality control; capacity building, to augment the sector in the country. The origin of the Institute dates back to 1920s during the British era, when the need for establishment of an R&D organization for lac, a natural resin of insect origin was felt.

Realizing the strategic importance of this commodity, the then Imperial Government of India constituted the Lindsay-Harlow Committee in 1920 to look into all aspects of the country's lac trade and its development. On the suggestions of this Committee, lac merchants organized themselves into the Indian Lac Association for Research, under the aegis of which, the foundation stone of the Indian Lac Research Institute was laid on September 20, 1924 at Ranchi.

Subsequently, on the recommendations of the Royal Commission on Agriculture, the Indian Lac Cess Committee (ILCC) was constituted, which took over the reins of the Indian Lac Research Institute in 1931. As a result of reorganization of agricultural research and education within the country after independence, the ICAR took over the administrative control of the ILRI from April 1966. This Institute is thus, one of the oldest within the ICAR system, having completed more than 89 years of existence. It has contributed immensely towards all-round development of lac besides maintaining India's leadership in production, installed processing capacity and export of the commodity.

Recognizing the importance of other natural resins and gums, which are cultivated / collected in the Indian sub-continent, and are of tremendous industrial importance in divergent industries and export markets, the ICAR revised the mandate of ILRI and renamed it as IINRG. All natural gums and resins were brought under its scope, under the revised research mandate of the Institute w.e.f. September 20, 2007. Subsequently, the ICAR also sanctioned a new network project on Conservation of Lac Insect Genetic Resources will be launched with eight centres; existing network project on Harvesting, Processing and Value Addition of NRGs will be strengthened by addition of three new centres to address more NRGs.

Location and Agro-Climate

The Institute is located 9 km south-east of Ranchi city, on the Ranchi–Jamshedpur highway (NH 33) at an altitude of 650 m above mean sea level, $23^0$23" N latitude and $85^0$23" E longitude. The soil status of the Institute indicates advance weathering on granitic gneiss. The soil of the experimental farm is of lateritic type. The area experiences mild, salubrious climate, with a rather heavy rainfall pattern of about 1400 mm average, of which about 1250 mm is during the monsoon

Organizational Structure

The IINRG has responded to the globalization of industries and agricultural enterprises of the country as well as functional reorganization of ICAR. The Institute also has undergone structural changes and the priorities have been redefined. In 1995 - 96, the erstwhile Divisions and Sections were abolished and the scientific manpower divided into three divisions, *viz.*, Lac Production, Processing and Product Development, and Transfer of Technology. The Institute is headed by the Director.

Staff

Institute has a sanctioned strength of 1 RMP, 46 scientific, 61 technical, 31 administrative and 82 supporting grade with total of 221 sanctioned posts, out of which 34

scientific including RMP, 50 technical, 24 administrative and 54 supporting posts with total of 162 staff are in position.

Infrastructure

Manned by dedicated scientists from various disciplines including entomology, plant sciences, organic chemistry, physics, engineering, bio-technology etc., the Institute has about 162 staff in scientific, technical, administrative and supporting categories. The Institute has several prestigious labs, *viz.*, High Voltage Laboratory, Biotechnology, Bio-control Laboratory, Instrumentation Laboratory, an ISO-certified Quality Evaluation Laboratory etc. There are several well-organized and equipped service sections to support research activities of the Institute. The administrative wing comprises of Director's Office, Administrative Section, Audit and Accounts Section, Purchase and Central Stores. The following sections provide the technical support: Library, Prioritization, Monitoring and Evaluation Cell, Institute Research Farm and Maintenance & Workshop Unit. The Auxiliary units are: Hindi Cell, Security, Medical and Estate Maintenance services.

The Institute Research Farm spread over 36 ha. has all conventional and cultivated lac host plants. The Institute is responsible for the collection and maintenance of germplasm of lac insect lines as well as lac host trees. Presently, the IINRG is maintaining more than seventy lines of the lac insect, which include collection from different parts of the country, inbred and crossbred lines. Similarly, the Institute Research Farm has approx. 1550 host trees of *S. oleosa* (*kusum*), 2480 trees of *B. monosperma* (*palas*), 1351 trees of *Z. mauritiana* (*ber*) and 8700 minor host plants. The field gene bank of the Institute has 12 genera and 55 species covering tree, medium and bushy type of lac host plants. Ninety collections of 55 lac host species collected from different agro climatic regions have been planted in the field gene bank. The IRF also maintain a nursery of host plants for meeting demand from institutions as well as farmers. More than 1800 cultures of 72 lac insect lines are being conserved live on potted plants of *bhalia* (*F. macrophylla*) under protected conditions in the Field Gene Bank of National Lac Insect Germplasm Centre (NATLIGEC).

The IINRG Library has holdings of more than 35,000 volumes of scientific journals, 2000 rare books, including back volumes of research periodicals in the field of resins and gums including lac and surface coatings. Since the holdings of back volumes of certain journals date back to circa 1868, the library is also a partner of the Consortium for e-Resources in Agriculture (CeRA), of ICAR. Besides catering to the scientists and staff of the Institute, the library also attracts researchers of neighboring educational and research institutions, including BIT, RU, BAU and ICAR-RCER-RC, Ranchi; IIT, Kharagpur; RAU, Samastipur; PU, Patna; NIT, Jamshedpur etc.

The Quality Evaluation Laboratory of the Institute accredited under ISO 9001:2000, caters to the quality control needs of the lac processing/lac product industries as well as exporters of lac/lac products. The lab has facilities for carrying out testing of lac/lac products as per BIS requirements.

The PME cell provides access to internet and e-mail facilities for communication and information retrieval to the scientists. The Institute website at: **http://ilri.ernet.in/~iinrg/** is a valuable source of information on the Institute.

Administrative blocks of IINRG

Lac Production

1. Productivity and Quality Improvement

1.1 Collection, conservation, characterization and documentation of lac insect and host plant biodiversity

Lac insect biodiversity

Collection and conservation of lac insects

In a survey carried out in Imphal West, Bishnupur and Churachandpur districts of Manipur, lac insects were collected from different lac host plants *viz., Malvaviscus penduliflorus, Ziziphus mauritiana, Ficus spp, Cajanus cajan* and *Mallotus philippensis* (Fig. 1). Four more lac insect lines have been collected from Assam, Delhi, Meghalaya and Nagaland. Collected lac insects are being maintained on *Flemingia macrophylla* at Gene Bank of National Lac Insect Germplasm Center (NATLIGEC).

Fig. 1. Collection of lac insect on *M. philippensis* at Heigrujam, Manipur

1800 cultures of 72 lac insect lines are being conserved on potted plants of *F. macrophylla* in NATLIGEC, IINRG, Ranchi.

Evaluation of lac insect stocks

Evaluation of three lac insect stocks collected from Madurai (LIK 0067) (Tamil Nadu), Varanasi (LIK 0064) and Bhathat (LIK 0019) (Uttar Pradesh) was carried out during *baisakhi* (summer season) crop 2012-13. Male proportion was more in Madurai stock (99%) compared to Varanasi (60%) and Bhathat (66%) (Fig. 2). Average fecundity (315 and 407 nos.), cell weight (10.43 and 13.22 mg) and resin weight (6.6 and 9.35 mg) were recorded in Varanasi and Bhathat stocks, respectively (Fig. 3 & 4). Fecundity, cell and resin weight was more in Bhathat than Varanasi. Madurai stock could not be evaluated due to 99 per cent male population.

Evaluation of Varanasi and Bhathat (Uttar Pradesh) continued during *katki* (rainy season) crop 2013. Per cent male population was more in Bhathat stock (36%) compared to Varanasi (24%) (Fig. 5). Average fecundity (384 and 183 nos.), cell weight (11.72 and 10.07 mg) and resin weight (9.10 and 7.29 mg) were recorded in Varanasi and Bhathat stocks, respectively (Fig. 6 & 7). It was observed that fecundity, cell and resin weight were more in Varanasi than Bhathat, unlike in summer (*baisakhi*) crop 2012-13.

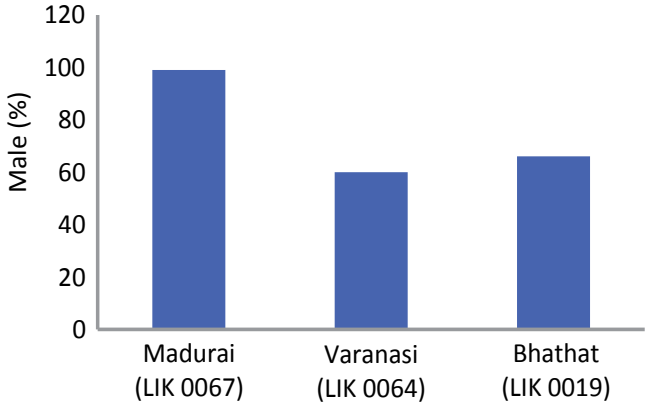


Fig. 2. Male sex ratio during summer (*baisakhi*) crop 2012-13

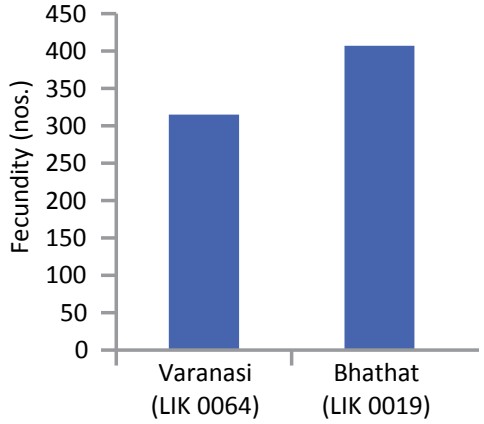


Fig. 3. Fecundity during summer (*baisakhi*) crop 2012-13

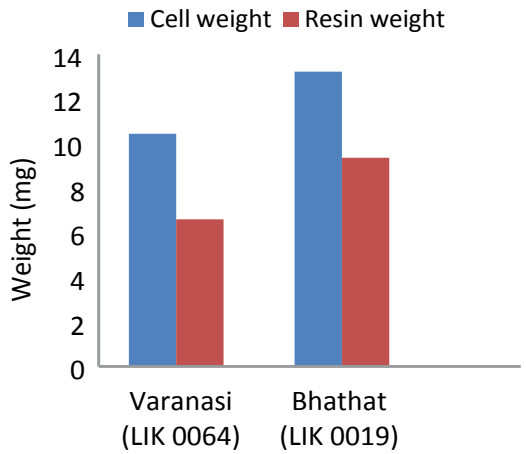


Fig. 4. Cell and resin weight during summer *(baisakhi*) crop 2012-13

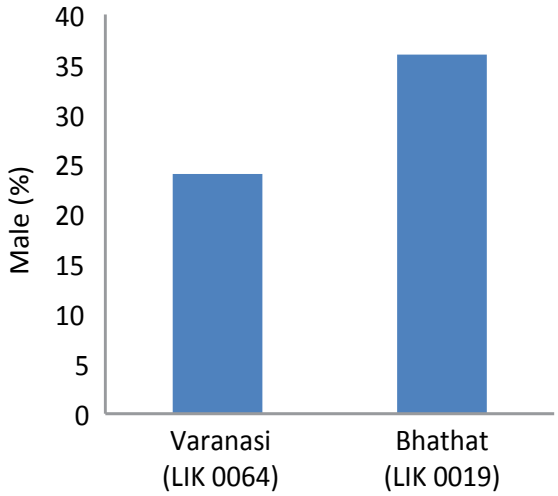


Fig. 5 Male sex ratio during rainy season *(katki)* crop 2013

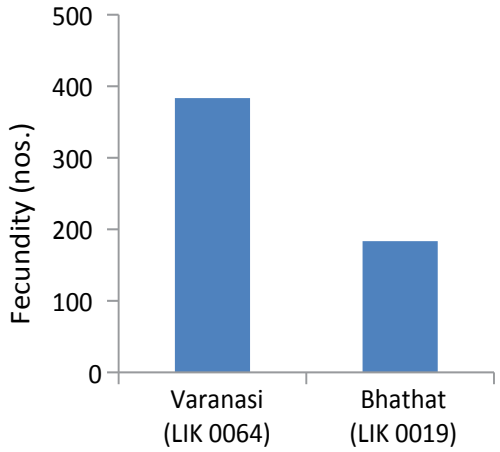


Fig. 6. Fecundity during rainy season (*katki*) crop 2013

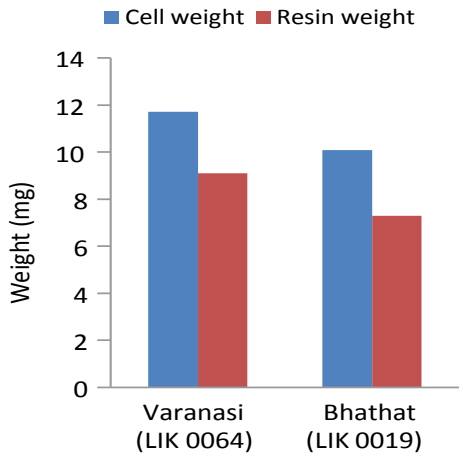


Fig. 7. Cell and resin weight during rainy season (*katki*) crop 2013

Lac insect breeding

Crossing was done between two lac insect species *viz., K. chinensis* (female, LIK0031) and *K. lacca* (male, LIK 0044) on potted plants of *F. macrophylla* at NATLIGEC during both *baisakhi* 2012-13 and *katki* 2013 crops. *K. lacca* males were released over *K. chinensis* females for fertilization. Interestingly, mated females of *K. chinensis* secreted more resin compared to virgin females, however, ovaries were not fully developed and no young ones emerged from mated *K. chinensis* (Fig. 8), indicating reproductive isolation. Female cell weight was recorded for both mated and virgin *K. chinensis* females, which revealed that female cell weight was more in mated *K. chinensis* (13.32, 28.06 mg) as compared to virgin *K. chinensis* (4.02, 7.24 mg) in *baisakhi* and *katki* crops, respectively (Fig. 9 & 10). Female cell weight of fertilized *K. chinensis* was also found more in *baisakhi* (3.3 times) as well as in *katki* (3.8 times) crops, compared to the virgin ones. However, no significant difference was observed for female cell weight between unsuccessful cross (*K. chinensis* × *K. lacca*) and successful crosses (*K. chinensis* × *K. chinensis*) during *katki,* 2013.

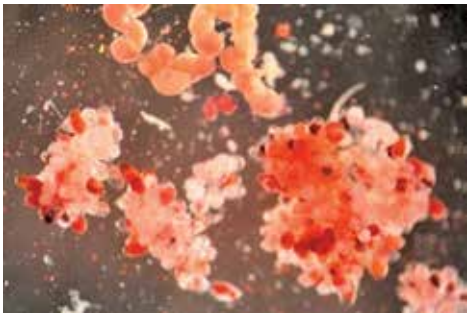


Fig. 8. Ovaries of cross (*K. chinensis* × *K. lacca*)

Fig. 9. Female cells of cross (*K. chinensis* × *K. lacca*)

Fig. 10. Virgin female cells of *K. chinensis*

Longan soft scale as a new pest on *Flemingia macrophylla*

New scale insects Longan - soft scale, *Drepanococcus chiton* (Green) and *Dicyphococcus castilloae* (Green) (Fig. 11) were recorded in *F. macrophylla* at NATLIGEC. It causes drying of shoots and flower stalks besides preventing lac insect settlement. The wax scale is also serious pest of *ber*, guava, pigeon pea, *Dalbergia sp*, *Ficus sp.* and *Carambola*. These pests may pose problem in lac ecosystem in future.

Fig. 11. Longan soft scale on *F. macrophylla*

Lac Host Biodiversity

Collection and conservation

During a survey conducted in Parasnath hills, Giridih district of Jharkhand, a p*alas* variant, having orange coloured flower was identified (Fig. 12). In another survey, seeds of *palas* variants for flower colour (chrome yellow, yellow, mustard yellow and orange colour) were collected from Bahadurpur (Bokaro) and Dumri (Giridih) of Jharkhand. Survey for availability of lac insect/lac host and its location was carried out in selected districts of Assam, Nagaland and Meghalaya. Various villages / hamlets / places in Dispur, Marigaon, Nagaon, Karbianglong, Diphu and Golaghat districts in Assam; Dimapur, Wokha districts in Nagaland and Ribhoi, Shillong districts in Meghalaya were visited.

Fig. 12. Orange coloured *palas* flower in the middle flanked by scarlet coloured flower

During the visit to Kolkata (West Bengal), lac was found on *Albizia saman* (Fig. 13a & b), *Peltophorum ferrugineum* (Fig. 13c) and *Ficus lacor* (Fig. 13d).

Fig. 13a-d. Lac encrustation found on plants in Kolkata city

Seeds of *swadi palas*, *palas* variants for flower colour (chrome yellow, yellow, mustard yellow and orange colour) and *F. stricta* were sown and maintained in the nursery. Ninety (90) collections of 55 species are being conserved in the lac host Field Gene Bank. *Swadi palas* plantation consisting of 75 plants was raised in a separate plot.

Characterization of lac hosts

Morphological characterization: Flower characterization

Calliandra calothyrsus

Flowers born on a subterminal inflorescence with numerous long, hair like stamens; flowers and sepals green; staminal filaments purple or red.

Calliandra surinamensis

The flowers are present as globose heads with small green petals and calyx, 100 stamens more or less united into a tube, stamens are long, hair like, colourful and protrude well beyond the petals, stamens are white towards the base and pink towards the top; stamens and anthers give the pink powder puff appearance to flowers.

Flemingia semialata

Papilionaceous flower; raceme inflorescence *i.e.*, stalked flowers from single axis (Fig. 14a); keel and standard petal is dark pink in colour with dark brown stripes; wing petal is dark pink in colour with no stripes (Fig. 14b).

Flemingia macrophylla

Papilionaceous flower; raceme inflorescence *i.e.*, stalked flowers from single axis (Fig. 15a); keel and standard petal is light pink in colour with pink stripes; wing petal is light pink in colour with no stripes (Fig. 15b).

Flemingia stricta

Papilionaceous flower; raceme inflorescence *i.e.,* stalked flowers from single axis (Fig. 16a); keel and standard petal is light green in colour with red stripes; wing petal is white in colour with no stripes (Fig. 16b).



Fig. 14a. Inflorescence of *F. semialata* Fig. 15a. *F. macrophylla* and Fig. 16a. *F. stricta*



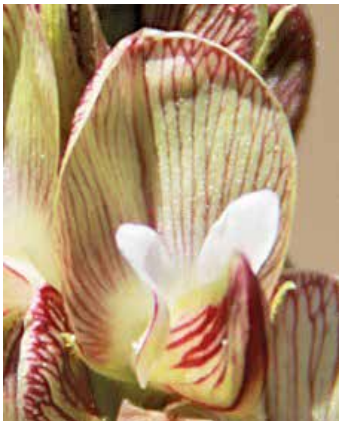


Fig. 14b. Flowers of *F. semialata*, Fig. 15b. *F. macrophylla* and Fig. 16b. *F. stricta*

Grewia hirsuta

White flowers are borne in cymes inflorescence; sepals are narrowly lance-shaped; petals are narrowly ovate; fruit is drupe, globose or 2-lobed, sparsely coarsely hairy; drupelets 2 per lobe.

Butea superba (Climbing/*Latar Palas*)

Large numbers of climbing *palas* are available at Parasnath hills of Giridih district of Jharkhand. Flowers are born in clusters (Fig. 17a). Flowers are twice the size of normal *palas*, *B. monosperma* flower. The flower length ranges from 8.0-10.5 cm whereas in *B. monosperma,* it ranges from 4.0 -4.5 cm (Fig. 17b). The width of the keel ranges from 2.0 - 3.0 cm. The petiole length ranges from 2.5 - 5.5 cm whereas it is 1.0 - 1.5 cm in *B. monosperma* (Fig. 17c). Calyx is cup like and light green in colour in *B. superba* where as it is dark green (almost black) in colour in *B. monosperma*. The variation in size of the flower is also observed within the *B. superba* (Fig. 17d).

Fig. 17a. Inflorescence of *Butea superba*

Fig. 17b. Flower of *B. superba* (a) as compared to *B. monosperma* (b)

Fig. 17c. Petiole and calyx of *B. superba* (a) as compared to *B. monosperma* (b)

Fig. 17d. Variation in flower size of *B. superba*

Biochemical characterization

Biochemical characterization of four lac host (*C. calothyrsus, C. surinamensis, M. penduliflorus and F. semialata*) was carried out using leaves during winter season collected at Institute Research Farm. *F. semialata* showed higher reducing and non-reducing sugar content than the other hosts whereas *M. penduliflorus* had the lowest non-reducing and total sugar content (Fig. 18a). *C. calothyrsus* showed maximum total soluble protein content followed by *F. semialata. M. penduliflorus* showed minimum protein content. Among all the hosts, *M. penduliflorus* showed more starch content followed by *F. semialata* whereas *C. calothyrsus* showed least starch content than the *C. surinamensis* (Fig. 18b). *M. penduliflorus* showed least free phenol content followed by *F. semialata* indicating that it is more suitable for lac production than *Calliandra* species as they provide least resistance to biotic stress. Among *Calliandra* species, *C. surinamensis* showed lower polyphenol content than *C. calothyrsus* indicating the acceptability of *C. surinamensis* towards lac insect. *C. calothyrsus* showed maximum chlorophyll 'a', 'b' and total chlorophyll carotenoid content followed by *F. semialata* whereas *M. penduliflorus* showed least content.

This indicates that *C. calothyrsus* and *F. semialata* have more photosynthetic rate which ultimately leads to production of more food material for host plant and the lac insect (Fig. 18c). *C. calothyrsus* showed maximum carotenoid content followed by *F. semialata* whereas *M. penduliflorus* showed least content (Fig. 18d).

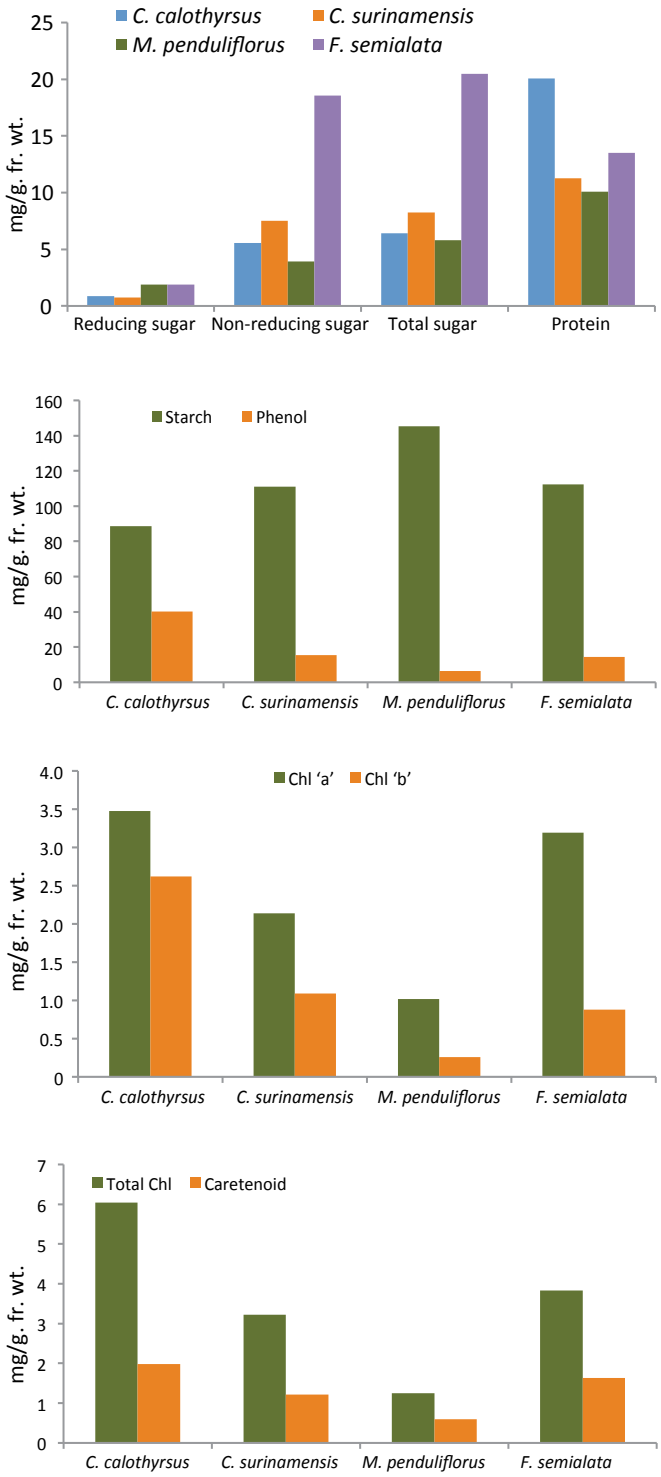


Fig. 18a-d. Biochemical characterization of lac host plants

This signifies that among all the hosts *C. calothyrsus* and *F. semialata* are more capable of detoxifying reactive forms of O_2, thus protecting the integrity of cell. Based on above parameters, it may be concluded that *F. semialata* is a superior host for lac cultivation as compared to the other hosts studied.

Molecular characterization of *Palas* variants for flower colour

The Random Amplified Polymorphic DNA (RAPD) analysis was carried out to assess the genetic divergence among six flower colour variants (wild-type scarlet, yellow, golden yellow, mustard, chrome yellow and white), *swadi palas* (a morphological variant) and *latar palas* (*B. superba*); and development of Sequence Characterized Amplified Region (SCAR) marker for scarlet (wild-type) colour variant. Out of 40 random decamer primers, 36 produced reproducible bands with a total of 463 bands. The resolving power of the primers ranged from 0.45 to 9.75. The UPGMA generated dendrogram grouped *palas* variants into two major clusters. Further, OPS-02 primer generated a unique polymorphic band (~700 bp) with scarlet colour variant of *palas* (Fig. 19). It was cloned in TA cloning vector and sequenced using vector specific primers. Based on the sequences, six sets of SCAR primers were designed. One of the primer pairs, sc.pal. F2XR2 amplified a ~700 bp region in scarlet and white *palas* variants. Sequencing the 700 bp fragments from both scarlet and white *palas* showed some variable sequences and further seven sets of primers were designed based on those sequences. However, none of the primers amplified specifically any variant.

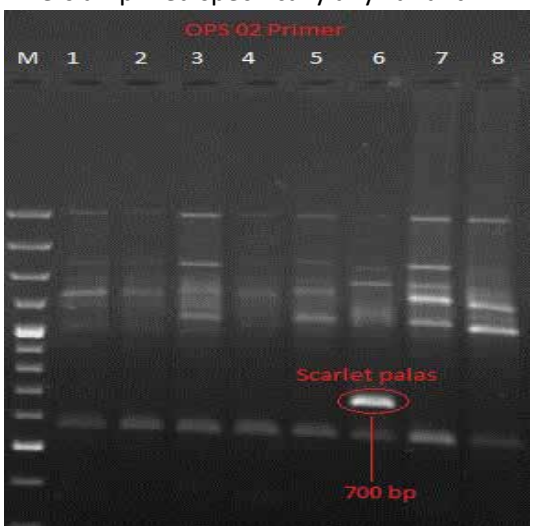
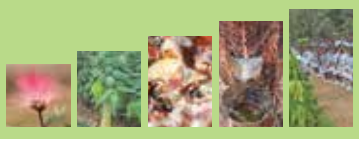


Fig. 19. RAPD profile of *palas* variants with OPS-02 primer (M-100 bp ladder, 1- yellow, 2- golden yellow, 3- mustard, 4- chrome yellow, 5- white, 6- scarlet, 7- *swadi palas* and 8- *latar palas*)



1.2 Potentiality trials of *Kerria chinensis* on new lac host plants

Evaluation of *K. chinensis* and *K. lacca* was carried out during both *rangeeni* and *kusmi* crops during 2013. Biological attributes *viz.,* pre harvest parameter (density of settlement, initial mortality and sex ratio) and post harvest parameters (fecundity, cell and resin weight) were recorded on newly raised host plants *viz., M. penduliflorus, D. assamica, C. calothyrsus* and *C. surinamensis* during *katki* 2013 and *aghani* 2013-14. Settlement density was the highest on *C. calothyrsus* (51.27 cm^2) and *M. penduliflorus* (51.13 cm^2) than other two hosts, whereas the lowest mortality was recorded in *C. calothyrsus* (12.48%) and *D. assamica* (22.36%); per cent male was more in *D. assamica* (34) than other hosts (Fig. 20a). Lac insect died due to unsuitable host and heavy settlement on *M. penduliflorus* and *C. calothyrsus,* respectively. Higher fecundity was observed in *D. assamica* than *C. surinamensis* whereas no difference for cell and resin weight was recorded for these hosts (Fig. 20b & c). Yield attributes, *viz.,* brood lac, rejected lac and scraped lac were obtained on both the host plants *viz., D. assamica* (450, 450 and 50 g per plant) and *C. surinamensis* (44, 644 and 13g per plant).

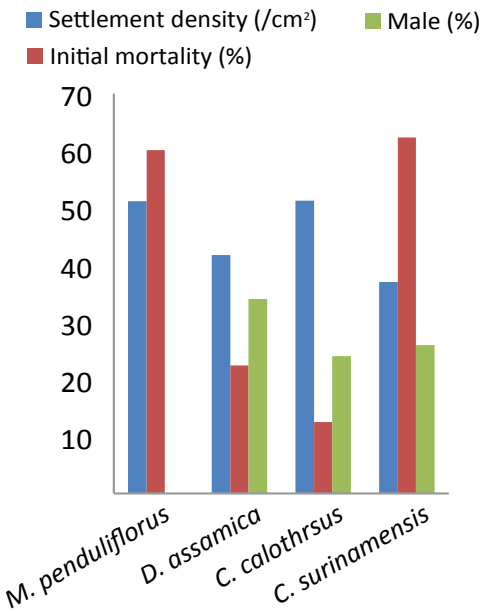


Fig. 20a. Pre harvest biological parameters during rainy (*katki*) crop 2013

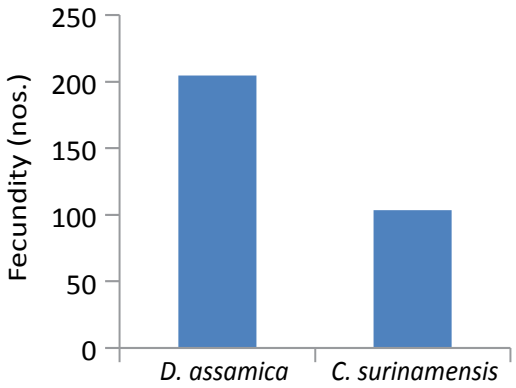


Fig. 20b. Fecundity during rainy (*katki*) crop 2013

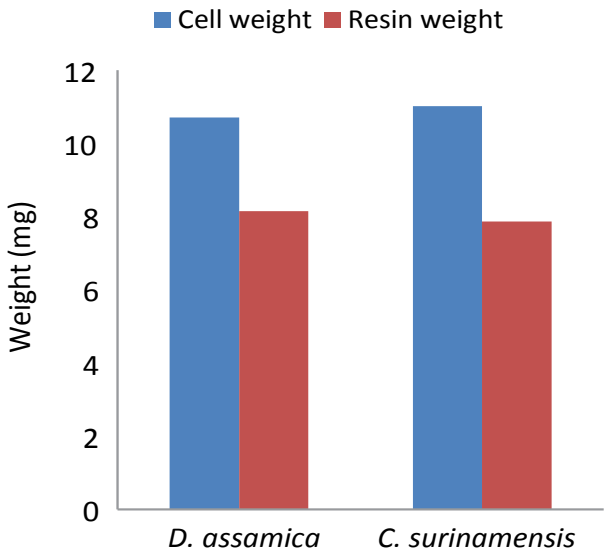


Fig. 20c. Cell and resin weight during rainy (*katki*) crop 2013

In *aghani* crop, higher settlement density (73.4 cm^2) with lesser mortality (10.63 %) was observed in *C. calothyrsus*. No significant difference was observed for per cent male population in three new host plants, *M. penduliflorus, D. assamica* and *C. calothyrsus.* Recommended agronomic practices, *viz.,* weeding, earthing up, FYM, fertilizer, pesticide application, irrigation, drainage and pruning were followed at appropriate time.

1.3 Host plant evaluation and improvement for lac productivity and summer sustainability

Selection of *F. semialata* for summer sustainability of *kusmi* lac crop

Antioxidant activity in *F. semialata*: Antioxidant (Ascorbate peroxidase and Catalase) study was conducted during May 2013 in selected *F. semialata*

line for drought tolerance *vis-à-vis* local, *F. semialata* in inoculated as well as un-inoculated condition. Ascorbate peroxidase activity was found more in selected *F. semialata* line for drought tolerance than the local line in both the conditions, but it recorded less catalase activity than the local line in inoculated condition. In contrast un-inoculated drought tolerant line maintained high catalase activity than the local line (Fig. 21a & 21b). Since catalase is considered a less efficient system of H_2O_2 scavenging compared to ascorbate peroxidase, preliminary result shows that the selected *F. semialata* line for drought tolerance is more efficient in stress tolerance (lac insect as well as abiotic stress) than the local line.

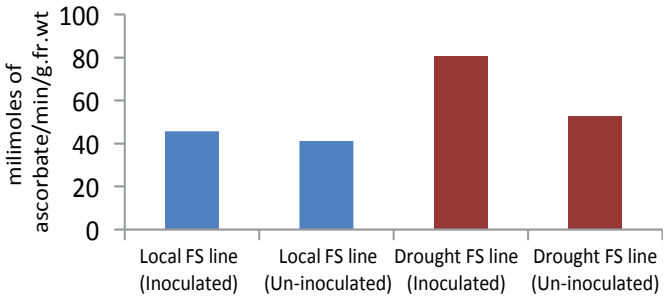


Fig. 21a. Ascorbate peroxidase activity *in F. semialata* lines

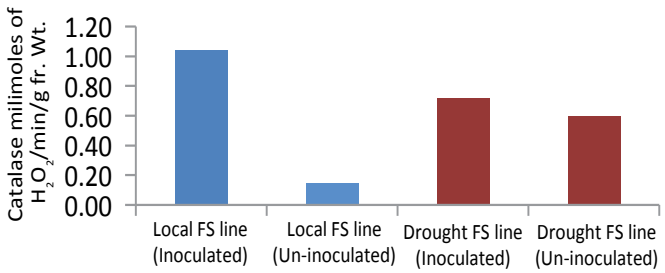


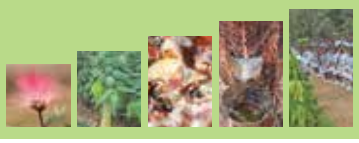
Fig. 21b. Catalase activity in *F. semialata* lines

Biochemical evaluation of *F. semialata*: Biochemical status study was carried out in selected *F. semialata* line for drought tolerance *vis-à-vis* local *F. semialata*. The biochemical parameters *viz*., chlorophyll 'a', chlorophyll 'b', total chlorophyll, carotenoid, reducing sugar, non-reducing sugar, total sugar, protein, starch and free phenol were studied for five months. Both the lines were evaluated for *aghani* crop during 2013. Chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid content decreased at lac insect maturity (end of December) in all the lines (Table 1). Drought tolerant line showed more chlorophyll 'a', chlorophyll 'b', total chlorophyll and carotenoid content than the local line. The mean data of five months of the inoculated drought tolerant line indicated the same trend. It also revealed that inoculated drought tolerant line maintains high level of non-reducing sugar than the inoculated local line (Table 1).

Table1. Pooled data of reducing sugar, non-reducing sugar, Chlorophyll 'a', Chlorophyll 'b' and Carotenoid content from Aug-Dec 2013

Lines of *Flemingia semialata*	Reducing sugar	Non-Reducing Sugar	Chl. a	Chl. b	Carotenoid
Drought FS line (inoculated)	0.87	11.27	2.69	0.81	1.42
Local FS line (inoculated)	0.78	9.94	2.07	0.61	1.10
Drought FS line (un- inoculated)	0.68	10.15	2.23	0.64	1.15
Local line FS (un- inoculated)	0.75	11.10	1.95	0.62	1.05

In inoculated condition, total soluble protein increased most of the time but showed decline at end of December *i.e.,* towards lac insect maturity in both the lines (Fig. 22a). However, drought tolerant line maintains high protein level than the local line. The mean data of five months also shows that inoculated drought tolerant line maintains high level of protein than the local line. The mean protein content was more in case of inoculated than the un-inoculated condition.



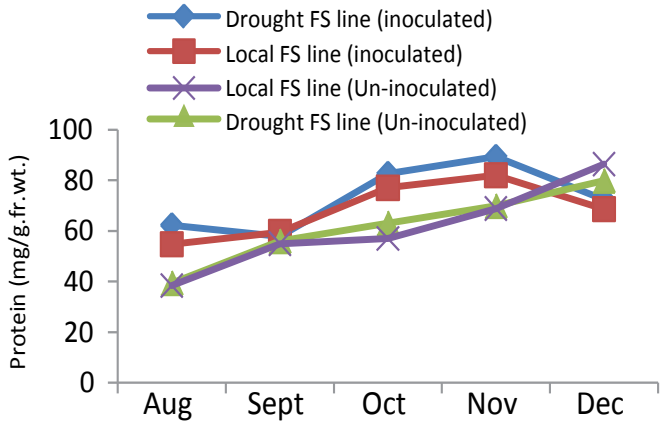


Fig. 22a. Protein content in *F. semialata* from Aug-Dec 2013

The inoculated condition maintains low starch level than the un-inoculated condition (Fig. 22b). Starch content showed increasing trend in most of the time after inoculation but decreases towards lac insect maturity (end of December) in both the lines. Drought tolerant line showed more decline in starch content as compared to local line. The mean data of five months showed that inoculated condition maintained low level of starch than the un-inoculated condition. The mean data also revealed low level of starch in drought tolerant line than the local line.

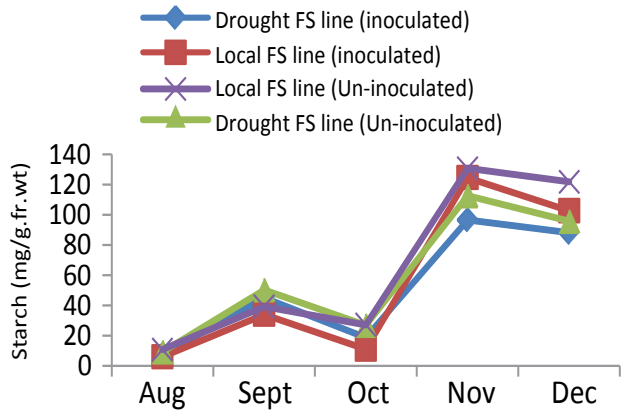


Fig. 22b. Starch content from Aug.-Dec. 2013

Free phenol level showed increasing trend throughout the life cycle of lac insect in both the lines in both the conditions (Fig. 22c). The mean data of five months also show that the inoculated condition maintains high level of free phenol than the un-inoculated condition. The high level of sugar maintained by drought tolerant line in inoculated condition is due to high chlorophyll content. This resulted in production of high protein in drought tolerant line as compared to local line. In case of starch, level decreases in the inoculated condition.

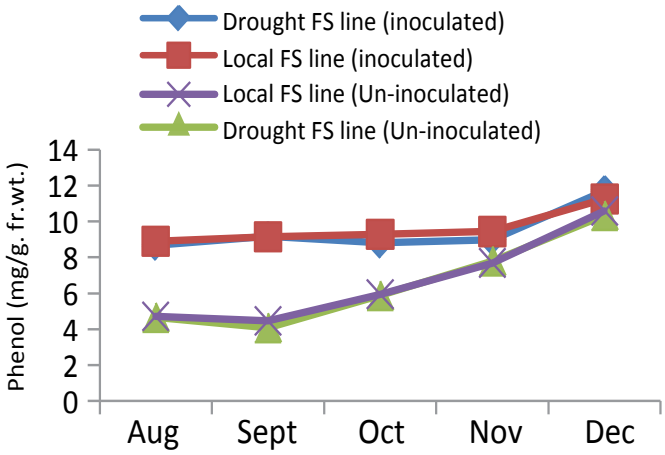


Fig. 22c. Phenol content in *F. semialata* from Aug-Dec 2013

The starch degradation is more in case of drought tolerant line as compared to local line. As the development of lac insect progresses, the phenol content also increases. In this preliminary study, it may be concluded that the lac insect feeding may trigger the biosynthesis of chlorophyll, sugars and protein in order to support the plant as well as lac insect survival.

Screening of varieties of *Z. mauritiana* for lac productivity and important plant characteristics

Aghani crop was raised on twenty three cultivars of *ber* @ 100 g/plant for two consecutive years *i.e.* during 2011-12 and 2012-13. Data were taken on morphological, physiological, biochemical and lac yield attributes. Six varieties, *i.e.,* Thornless, *Katha, Seb x Gola* F_1, *Jogia, Banarsi Karaka* and *Kaithali* had significantly higher lac yield (LY) than CAZRI *Gola* with a yield advance of 42 to 69% over check. Eight varieties, *i.e., Illaichi, Kali, Katha, Jogia, Banarsi Karaka, Kaithali, Banarsi Pebandi* and *Mundia* had significantly higher (17 to 84 %) scraped lac yield (SY) in comparison to check CAZRI *Gola*. LY and SY had significant positive correlation with ISD, MSL, SP and SY and significant negative correlation with SR. ISD, MSL, IM %, RS, NRS, TS and SP had high direct effect on LY. SR has indirect effect on LY via ISD, IM %, TS and NRS. Multiple regression coefficients of all 23 *ber* varieties were estimated to find out the maximum contribution of various traits towards LY. Estimates provided eight best subset regressions in *ber* varieties with LY as dependent variable and eight traits as independent variables. LY up to 62 % has been predicted by SR only. LY has been predicted up to 73% by considering all traits under investigation.

Hierarchical Cluster Analysis (using Ward Method) grouped 23 *ber* varieties in three distinct clusters. Cluster I with 7 varieties (*CAZRI Gola, Seb x Tikadi BC$_1$, Chhuhara, Umran, Mundia, Thornless, Katha*) having moderate scraped lac yield, cluster II with 11 varieties (with last four varieties of cluster I) and cluster III with 9 varieties. Most of the varieties (*Seb X Gola F$_1$, Jogia, Kaithali, Banarasi Karaka, Banarasi Pebandi*) lying in cluster III were having high SY**.** Rest of the five varieties were not able to form any cluster in this analysis (Fig. 23).

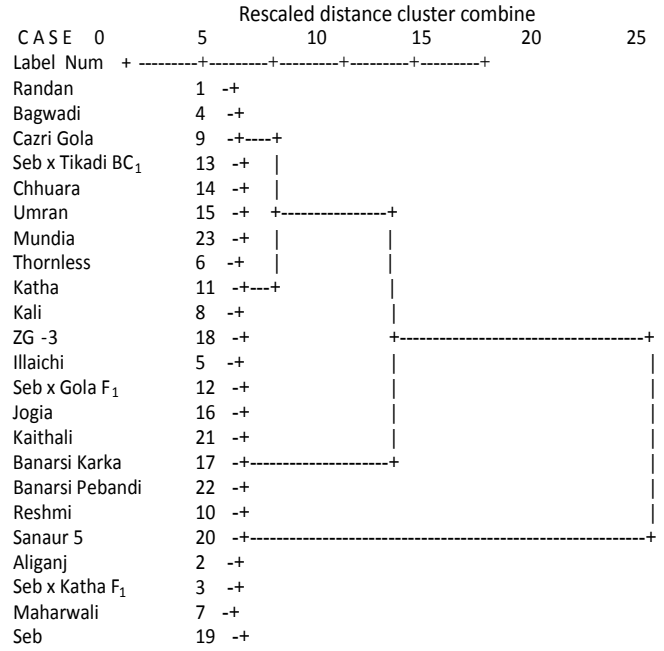


Fig 23. Hierarchical Cluster Analysis (Dendrogram using Ward Method)

Based on LY and SY and all biochemical and physiological parameters seven *ber* varieties *i.e., Kaithali, Jogia, Seb x Gola* (F_1), *Banarasi Karka,* Thornless*, Kaitha and Banarasi Pebandi* had high potential for lac production in our situation (Fig 24).

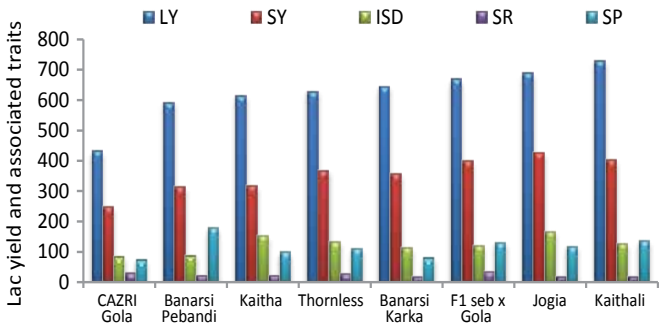


Fig. 24. Selected high lac yielding *ber* varieties

Screening of Pigeon pea varieties for *rangeeni* lac production

Pigeon pea is cultivated for grain purpose but it is also reported as a lac host. Twenty eight varieties / germplasm/ land races of pigeon pea were evaluated for *baisakhi* crop during 2012-13. Only two varieties *i.e.,* Assam local and RCMP 5 had significantly higher lac yield than *Bahar*. Based on lac yield and scrapped lac yield ten varieties *i.e.,* Assam local, Acc. No. 591139, RCMP 2, RCMP 4, RCMP 5, ICPR 2671, Bahar, KA 9-2, IPA 8-2 and IPA 9-2 had output ratio of 4 to 6.4. To know the significant change if any in quantitative and qualitative traits in grain after load of lac insect, 100 seed weight, grain yield/ plant and soluble protein % in seeds were measured in both inoculated and control conditions. 13.3% loss in 100 seed wt. was recorded in these pigeon pea varieties. The loss in grain yield/ plant ranged from 2.2% (ICP 13092) to 55.4% (Acc. No. 591139) with average loss of 12.4%. The average reduction in soluble protein % in seeds after lac inoculation was 10.17 %. Inoculated condition significantly affected 100 seed wt. and grain yield but it did not affect significantly the soluble protein % in seeds. Hence, selected pigeon pea varieties/ germplasm/ land races were used for lac cultivation as well as for grain yield without significant changes in protein quality of seeds. The lac attributing traits/quantitative traits are shown in Fig. 25a to 25d and Table 2.

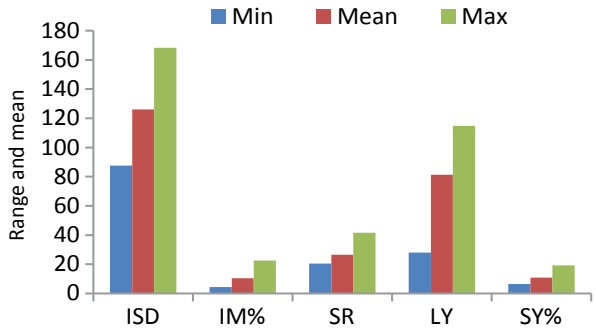


Fig. 25a. Range and mean of lac attributing traits in pigeon pea

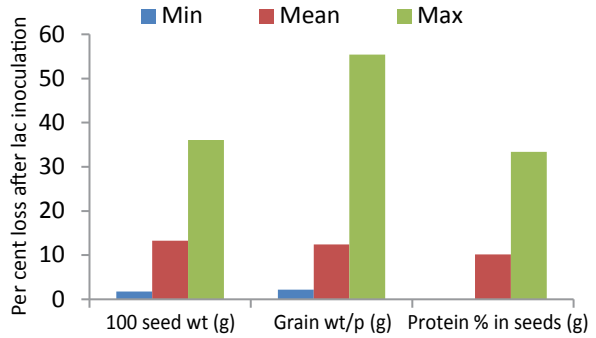
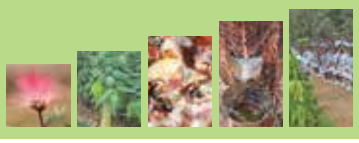


Fig. 25b. Loss in quantitative traits of grain in pigeon pea



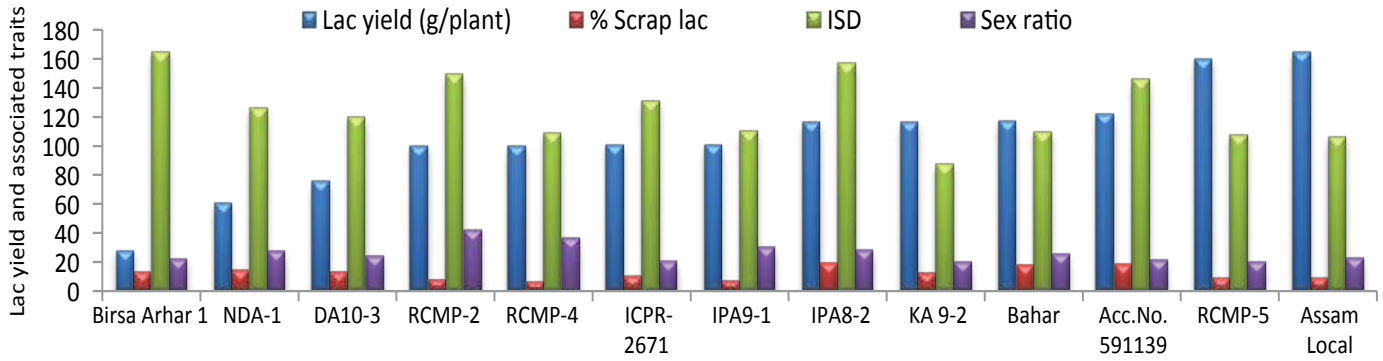


Fig. 25c. Lac attributing traits in selected pigeon pea

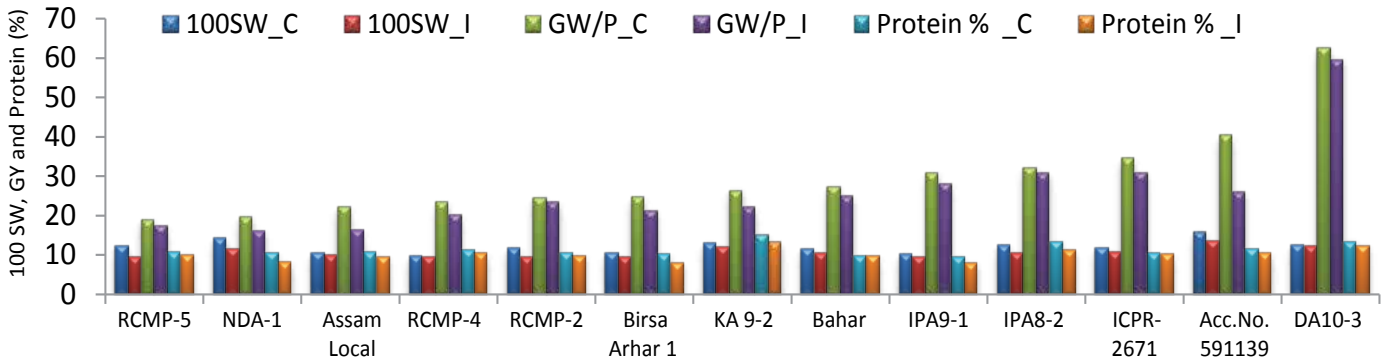


Fig. 25d. Quantitative traits of grain in pigeon pea

Table 2. Analysis of Variance for protein (%) in seeds, 100 seed weight and grain yield in lac inoculated and control conditions in pigeon pea

Source of Variation	DF	MS Protein % in seeds	MS 100 seed wt (g)	MS Grain yield (q/ha)
Varieties (A)	25	15.71**	10.80**	103.98**
Inoculation (B)	1	1.16	80.48**	37.82**
Interaction (A X B)	25	1.75**	0.92**	1.17**
Error	102	0.86	0.06	0.22
Total	155			
SE(m)				
Varieties (A)		0.38	0.14	0.27
Inoculation (B)		0.11	0.04	0.07
Interaction (A X B)		0.53	0.19	0.38
C.D.				
Varieties (A)		1.06	0.27	0.53
Inoculation (B)		N/A	0.08	0.15
Interaction (A X B)		1.50	0.39	0.75

Potential of *Swadi palas* for *kusmi* lac cultivation

Potential of *Swadi palas* was assessed for *kusmi* lac (winter crop) production at farmers' field. Broodlac (37.5 kg) was inoculated on 15 trees at Putadag, Angarha, Ranchi in July 2013. Output ratio ranged from 5 to 6.5 (Fig. 26). A very good lac encrustation was observed and 220 kg broodlac was harvested in December 2013 (Fig. 27).

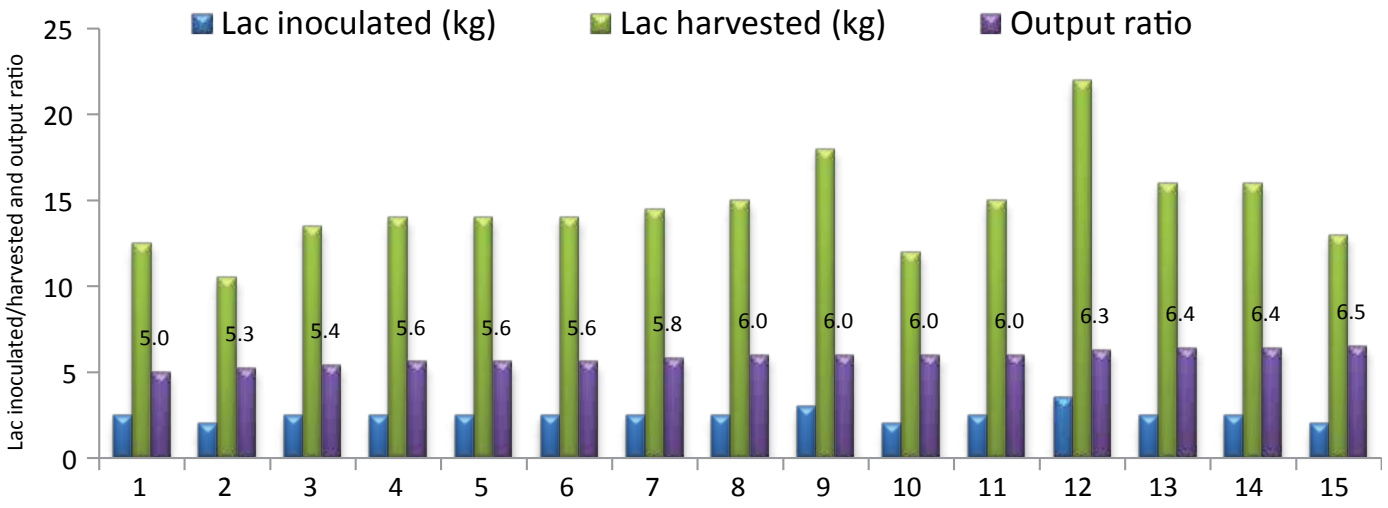


Fig. 26. *Kusmi* lac production on *swadi palas*

Fig. 27. *Kusmi* lac encrustation on *swadi palas*

2. Crop Production System Management

2.1 Lac Integrated Farming System (LIFS)

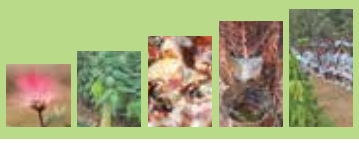
In LIFS plot, 17 kg of broodlac was inoculated on *semialata* in five rows for raising *kusmi aghani* crop in July 2012 which yielded 48 kg lac. While 13 kg of broodlac was inoculated in Feb 2013 for raising *kusmi jethwi* crop yielding 56 kg of broodlac in July 2013. 593 kg guava had been harvested from LIFS in rainy season crop in 2013.

Development of new LIFS models at Institute Research Farm (IRF)

***Semialata* + Papaya**: A new model integrating lac with papaya has been developed at IRF in an area of 50 x 42 m^2. There are 7 paired rows of *semialata* (78 plants in each row except one row) at a distance of 5m. There is one row of papaya plants in between two paired rows of *semialata*. Plant to plant distance for papaya is 2.5 m. There are 119 papaya plants in this integrated model.

***Semialata* + Vegetables**: A second model integrating *semialata* with vegetables was developed in an area of 24 m x 16 m consisting of 12 paired rows of *semialata* (28 plants in each row) at a distance of 2 m. This model has been developed to raise *kusmi jethwi* crop on *semialata* along with the integration of vegetables (ladyfinger, brinjal and tomato) in between the paired rows of *semialata*.

Replication of LIFS model : The multitier horti-lac model replicated in different villages in 2012 was provided with broodlac in July 2013 for raising *kusmi aghani* crop as follows.



Name of farmer	Village	Area (m^2)	No. of *semialata* plants inoculated	Broodlac used (kg)
Prakash Sanga	Mangoband	1500	1700	51
Neelam Singh	Mangoband	600	400	12
Jagannath Munda	Pater	1200	700	21
Sadanand Munda	Devghai	2000	700	21
Iliyazar Runda	Devghai	1800	950	30

Replication of LIFS model at new locations: LIFS model has been replicated at three new locations at farmer's field in July, 2013. The details are following:

Name of farmer	Village	Area (m^2)	Model
Manoj Ekka	Kharsidag	450	*Semialata*+ Vegetables (tomato, onion, garlic)
Madi Munda	Mangoband	2100	*Semialata*+Papaya
Bhagat Kumar	Devghai	1600	*Semialata*+ Vegetables (tomato, onion, garlic)

2.2 Development of spraying schedule of fungicides for management of sooty mold in winter *kusmi* lac crop

The lac insect, *K. lacca* secretes lac from its body. Species of *Capnodium* grow profusely making a dense fungal mat that covers the lac encrustation resulting in insect's death and causing complete or partial failure of the lac crop. The sooty mold starts growing as soon as its food, honey dew secreted by the lac insects, is made available in sufficient quantity. To optimize the use of fungicide, experiments were laid out to standardize a suitable spraying schedule for Hexaconazole (Cantaf) and Chlorothalonil (Kavach) on three lac hosts *i.e., kusum*, *ber* and *semialata* during winter *kusmi* lac crop. In earlier experiments a dose of 0.5 ml Cantaf / l water was found equally effective at higher doses in managing sooty mold and therefore, in the present experiment 0.5 ml/ l dose was used. Similarly, for Kavach, the optimum dose was standerdised as 1 g / l water in earlier experiment. Due to poor quality of broodlac settlement of lac insects on *kusum* and *semialata* were erratic and very poor and therefore abandoned. Two detailed experiments were conducted only on *ber*, one with Cantaf and another with Kavach. Eight treatments and 4 replications were undertaken in each experiment. Thirty two *ber* trees for Cantaf and 32 *ber* trees for Kavach were taken. Recommended insecticide (Dhawagold) sprays were given (at 21 day and 50 day after inoculation). Cantaf and Kavach were sprayed as per treatments.

Results indicated that two or more sprays of Cantaf starting from 60 or 90 days after lac insect inoculation can reduce sooty mold significantly but significant increase in yield was achieved only with three or more sprays started from 60 or 90 days after lac inoculation. Maximum lac yield was achieved by 3 sprays at 90, 105, 120 days after lac inoculation followed by 4 sprays at 90, 105, 120 and 130 days after lac inoculation (Table 3). Similarly, Kavach spray also significantly reduced the sooty mold with two or more sprays starting from 60 days and onwards, but the increase in yield was not significantly different from control at 5 % CD, though maximum yield was achieved by 3 sprays at 90, 105, 120 days after lac inoculation (Table 4).

Table 3. Standardization of spraying schedule of Hexaconazole (Cantaf) to manage sooty mold infestation and prevent losses of lac yield due to sooty mold in *kusmi* winter crop on *ber*

Treatments	Severity of sooty mold (%) 130 dali*	Yield (g/ m shoot length)	Increase in yield (%)
No fungicide spray	52.9	6.90	
2 sprays at 30 and 60 dali	41.4	9.01	
1 spray at 90 dali	45.4	8.88	
2 sprays at 90 and 120 dali	23.3	11.05	
2 sprays at 90 and 105 dali	28.3	9.12	
3 sprays at 60, 90 and 120 dali	32.3	15.70	127
3 sprays at 90, 105 and 120 dali	29.7	16.58	140
4 sprays at 90. 105, 120 and 130dali	21.3	16.08	133
CD 5%	19.7	5.44	
CV %	30.8	31.68	

*dali- days after lac insect inoculation

Table 4. Standardization of spraying schedule of Chlorothalonil (Kavach) to manage sooty mold infestation and prevent losses of lac yield due to sooty mold in *kusmi* winter crop on *ber*

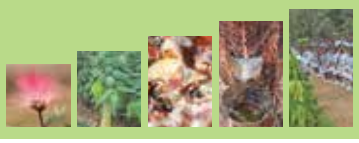
Treatments	Severity of sooty mold (%) 130 dali*	Yield (g/ m shoot length)	Increase in yield (%)
No fungicide spray	51.4	5.85	
2 sprays at 30 and 60 dali	47.5	6.05	
1 spray at 90 dali	45.0	6.64	
2 sprays at 90 and 120 dali	27.5	6.84	
2 sprays at 90 and 105 dali	31.2	10.28	
3 sprays at 60, 90 and 120 dali	18.8	13.05	123
3 sprays at 90, 105 and 120 dali	15.8	18.76	220
4 sprays at 90. 105, 120 and 130dali	17.5	13.45	129
CD 5%	18.1	NS	
CV %	38.6		

*dali- days after lac insect inoculation

2.3 Variation of lac associated fauna in relation to different host plants

Broodlac was inoculated for raising summer *kusmi* (*jethwi*) crop on *ber* (7 kg on 16 plants), *kusum* (15 kg on 6 plants) and *semialata* (10 kg on 190 plants). Highest density of settlement in /cm^2 was recorded in *kusum* (130.1) followed by *ber* (124.4) and *semialata* (110.1), whereas maximum mortality (%) was recorded in *semialata* (27.88) followed by *ber* (24.91) and *kusum* (18.75). Male percentage was recorded to be highest in *ber* (26.86) followed by *semialata* (24.84) and *kusum* (17.82). Lac insect samples (one meter length) were caged at fortnightly intervals in parasitoid emergence cages and lac associated pests were collected. Data was collected for population of associated fauna of *jethwi* crop from *ber*, *kusum* and *semialata*. Among predators only *Eublemma amabilis* was observed more in *semialata* (21). Three parasitoids namely, *Tachardiaephagus tachardiae*, *Aprostocetus purpureus* and *Parecthrodryinus clavicornis* were observed during the period. Among these *T. tachardiae* population was comparatively higher in *kusum* (38) whereas lower in *semialata* (6) and *ber* (4), whereas *A. purpureus* population was more in *kusum* (31) than *semialata* and *ber*. Only hyper-parasitoid observed was *Bracon greeni* and that too from *semialata* (4). Lac yield obtained was 6.3, 117 and 3 kg from *ber*, *kusum* and *semialata*, respectively.

Baisakhi crop inoculated during October 2012 was harvested in July 2013 yielding 19.4 kg lac from *arhar* (116 plants), 33.66 kg from *ber* (20 plants), 12.60 kg from *palas* (12 plants). Highest density of settlement in /



cm^2 was recorded in *ber* (108) followed by *arhar* (103.4) and *palas* (98.8), whereas, maximum mortality % was recorded in *ber* (19.81) and least in *arhar* (9.86). Highest male sex ratio was recorded in *ber* (35.52) and least in *palas* (25.17). Data pertaining to associated fauna of lac insect from different host plants were recorded during *baisakhi* 2012-13. During this season, *A. purpureus* was more in *palas* (279) as compared to *arhar* (126) and *ber* (40). Population of *T. tachardiae* was recorded higher in *ber* (35) in comparison to *arhar* (24) and *palas* (19). *P. clavicornis* was recorded higher in *arhar* (21) as compared to *ber* (8) and *palas* (6). Among predators, only *E. amabillis* was recorded higher in *palas* (43) as compared to *ber* (5) and *arhar* (3).

Broodlac (35 kg) was inoculated during July 2013 as *katki* crop on *arhar* (175 plants), *ber* (32 plants), *palas* (28 plants). Highest density of settlement in /cm^2 was recorded in *arhar* (68) followed by *ber* (56.1) and *palas* (52.2), whereas, maximum mortality % was recorded in *arhar* (36.61) in comparison to *ber* (25.84) and *palas* (23.94). Highest male % was recorded in *arhar* (30.47) followed by *ber* (21.26) and *palas* (19.1). Data were also collected on population of associated fauna of *katki* crop from *arhar*, *ber* and *palas*. Among predators, *E. amabillis* was observed in *arhar* (1), *ber* (13) and *palas* (21) whereas *P. pulverea* was observed in *ber* (1) and *palas* (8) but both the predators were found more in *palas. A. purpureus* population was more in *ber* (239) than *palas* (141) and *arhar* (14). *T. tachardiae* population was comparatively higher in *ber* (23) than *palas* (10) and *arhar* (2). Hyper-parasitoids namely *B. greeni*, *Elasmus claripennis*, *Apanteles sp*. were observed during the crop season. *B. greeni* was the major parasitoid and its population was more in *ber* (6) than *palas* (3) whereas other parasitoids were in very less numbers. *Katki* crop was harvested from *ber* (8 plants), *palas* (16) and *arhar* (140 plants) and about 18.9, 6.5 and 18.2 kg of lac, respectively was obtained as yield. 27 kg broodlac was inoculated in July 2013 for raising *aghani* crop on *ber* (30 plants), *kusum* (6 plants) and *semialata* (147 plants) and the crop is progressing satisfactorily.

Component analysis of honey dew

Total sugar component, total protein, HPLC analysis of the lac insect honeydew from different host plants was carried out.

Sugar content: Sugar content analysis of honey dew indicated variation amongst the host plants. The total sugar content ranged from 6.0% (*semialata*) to 29.4% (*kusum*) in *jethwi,* 3.5% (*ber*) to 41.1% (*arhar)* in *katki* and 10.10% (*semialata*) to 23.3% (*kusum*) in *aghani* crop.

Protein content: Protein content of honeydew from different hosts ranged from 43 (*kusum*) to 232 ug/g (*semialata*) of fresh weight of samples in *jethwi*, 55 (*ber*) to 275 ug/g (*palas*) of fresh weight of samples in *katki* and 62 (*kusum*) to 348 ug/g (*ber*) of fresh weight of samples in *aghani.* It has been observed that the parasitoid *A. purpureus* was attracted to the polythene bags tied around the pine trees for rosin tapping. *A. purpureus* was collected for 10-15 minutes daily (twice in a day at an interval of 2-3 hrs) for a week. An average of 14-18 parasitoids was collected every day. It was interesting to note that out of the collected parasitoids, 80-90% were males only.

2.4 Influence of macro/ micronutrients on *kusmi* lac production in comparison to standard package on *F. semialata*

Plant biomass production and lac yield during winter crop of 2013

Least plant height (155 cm) and shoot diameter (0.98 cm) was recorded due to potassium application @ 60 g/ plant. The values recorded in un-inoculated control were 175 cm and 1.32 cm. Therefore, biomass production was minimum at potassium application at higher rate (1.04 kg/ plant) due to exhaustion of plant by lac insect in previous season. Maximum biomass was produced from un-inoculated plants (1.74 kg/ plant) followed by lime treatment (1.69 kg/ plant). None of the micronutrients showed any effect on biomass production as compared to control under lac cultivation. Difference in broodlac production per plant was not significant due to different treatments.

Plant growth of *semialata* during winter crop season 2013-14

Influence of micronutrients on growth of *semialata* under different levels of liming

Four micronutrients *i.e*., zinc, copper, boron and molybdenum along with control were applied in *semialata* field (as recommended) under different levels of liming (0, 1.4, 2.8 and 4.4 t/ ha.) to visualize the effect on plant growth. Chlorophyll Content Index (CCI) values recorded in December were found to be affected significantly due to liming. It increased

steadily upto 2.8 t/ha, after which values went down significantly. However, per cent shoots with more than 9 mm diameter went on increasing up to highest level. Micronutrient application under different liming condition did not prove to be effective on any of the growth factors like CCI values, dry matter per cent, plant height etc. (Fig. 28).

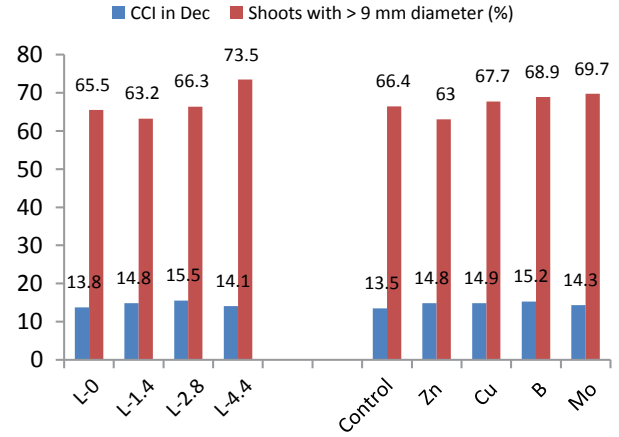


Fig. 28. Effect of liming and micronutrients on plant growth of *semialata*

Influence of macro/micronutrients and soil amendment on growth of *semialata*

CCI value was observed to be lowest in inoculated control during the months of October, December and January. Values ranged between 11 and 19 depending upon the time of observation (Table 5). No single treatment emerged to be consistent in giving higher or lower values. However, treatments like application of molybdenum, lime, potassium, nitrogen and NPK combination proved to be effective during later phase of growth *i.e.,* in December. It also visualized that lower dose of potassium (30 g) application is suitable for early stage and higher (60 g) dose in later stage of plant growth. Lower dose of potassium and NPK combination could reduce dry matter per cent of shoots significantly. All the treatments including micronutrients proved to be effective in producing thicker shoots (per cent shoots having basal diameter more than 9 mm).

Table 5. Plant growth characters affected by different macro/micronutrients

Factors	CCI October	CCI December	CCI January	Dry matter %	% shoots with > 9 mm diameter
Control (inoculated)	19.9	11.7	12.6	26.8	48.6
Zinc	23.3	14.4	15.1	25.5	69.4
Copper	24.2	12.5	13.3	24.1	72.8
Boron	22.1	12.8	13.6	27.8	75.6
Molybdenum	22.1	16.7	13.3	26.5	69.0
Liming	22.9	20.0	15.3	27.1	67.0
Potassium (30 g)	24.4	16.4	15.7	25.1	64.4
Potassium (60 g)	21.9	17.6	18.3	27.3	67.8
Nitrogen (50 g)	24.6	18.4	17.0	26.6	69.8
Nitrogen (20 g)	24.3	16.6	15.4	28.9	67.5
$N_{50}P_{25}K_{50}$	26.0	19.0	13.6	23.3	73.8
Control (uninoculated)	22.0	15.0	18.1	27.2	71.4
$CD_{(0.05)}$	2.91*	4.14*	3.65*	2.8*	12.7*

Influence of spraying of micronutrients on growth of *semialata*

Observation recorded at different time intervals indicated that spraying of boron could increase CCI values significantly during major growth phase *i.e.* in October. Twenty per cent increase in CCI value was observed due to boron spray as compared to control.

Effect of deficiency of micronutrients on *semialata* in soil less culture

Semialata seedlings were grown on coco peat filled earthen pots. Four Hoagland solutions each deficient in one micronutrients were applied to the plants as per recommended dose. Deficiency symptoms (Fig. 29a-d) appeared clearly on the upper leaves at 8-10 leaf stage of the plants.

Fig. 29a. Control

Fig. 29b. Zinc deficiency

Fig. 29c. Molybdenum deficiency

Fig. 29d. Boron deficiency

Summer *rangeeni* lac yield as affected by liming and potassium application

Rangeeni lac yield ratio as affected by liming (recommended dose) and potassium application (0, 500 and 1000 g K_2O/ tree) revealed that only liming could increase lac yield to the tune of 45 per cent over no liming. Lac yield ratio in respective treatments were 1.24 and 1.81 (Table 6). Sole effect of potassium application was not significant. However, interaction effect of liming and potassium levels revealed significant differences (Table 6, 7a & b). Under no liming condition, highest level of potassium could increase lac yield ratio up to 100 per cent. However, reverse trend was observed under liming condition.

Table 6. Summer season *rangeeni* lac yield affected by liming and potassium application

	Yield ratio	Broodlac wt/ 10 cm	Sticklac wt/ 10 cm	Sticklac wt/ 100 g broodlac
L_0	1.24	2.83	0.44	18.25
L_1	1.81	3.43	0.65	19.67
$CD_{(0.05)}$	0.38*	0.79	0.18*	5.02
K_0	1.76	2.67	0.41	16.44
K_1	1.32	3.43	0.77	21.77
K_2	1.49	3.28	0.46	18.69
$CD_{(0.05)}$	0.47	0.97	0.22*	6.14

Table 7a. Interaction of liming and potassium on yield ratio (Input: Output)

	K_0	K_1	K_2
L_0	0.9	1.1	1.8
L_1	2.6	1.6	1.2
$CD_{(0.05)}$		0.66*	

Table 7b. Interaction of liming and potassium on sticklac wt/ 100 g broodlac

	K_0	K_1	K_2
L_0	12.4	20.0	22.3
L_1	20.5	23.5	15.0
$CD_{(0.05)}$		8.7*	

Processing and Product Development

3. Processing, Storage and Quality Management

3.1 Development of dehumidified air drying methods for drying of value added lac products

Drying study of aleuritic acid in hot air tray dryer at different temperatures

Drying of aleuritic acid was carried out in hot air tray drier at 35, 40, 45 and 50^{0}C and at five different layer thicknesses (0.5, 1.0, 1.5, 2.0 and 2.5 cm) for determining drying characteristics. Aleuritic acid samples were prepared in the pilot plant of the Division. Drying trials of aleuritic acid sample prepared from 25 kg seedlac at M/s Tajna Shellac, Khunti, was carried out from centrifuged sample in hot air try drier at 35^{0}C at five different layer thickness from 0.5 cm to 2.5 cm. Drying took 6 to 25 hrs for these layer thicknesses. Drying trials were also carried out in hot air tray drier at 40^{0}C at different layer thickness which took 6 to 21 hrs (Fig. 30).

Fig. 30. Hot air tray dryer

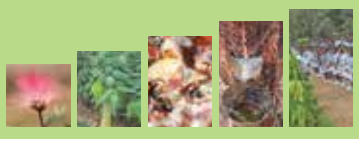
Aleuritic acid was prepared from 10 kg old *kusmi* lac (> five years) for drying trials at different temperatures. Weight of filtered aleuritic acid was 5.5 kg whereas weight of sample after centrifugation was 4.0 kg. Drying study of this aleuritic acid was done in a hot tray drier at 45^{0}C at five different layer thickness (0.5 to 2.5 cm.) from centrifuged aleuritic acid. Drying took 6 to 20 hrs. In another drying trial of aleuritic acid, prepared in institute pilot plant, from 8 kg seedlac was carried out in hot tray drier at 50^{0}C at five different layer thickness (0.5 to 2.5 cm) for determining drying characteristic. Drying for these layer thicknesses took 5 to 16 hrs.

Drying study of aleuritic acid and bleached lac in combined drying system

System for combined drying system of refrigerant and desiccant was arranged by combining chiller and desiccant drier. Trial of combined drying system performance was checked at water temperature of 25^{0}C and 5^{0}C. At water temperature of 25^{0}C, RH and temperature for desiccant system drying was 6% and 24^{0}C, whereas, these values were 5.4 % and 28.3^0 C for combined system. Lowering of water temperature to 5^{0}C resulted in increase in RH to 10.5% with temperature 15^{0}C of desiccant drying system but decrease in RH of combined drying system to 2.2 % with temperature 18^{0}C. So in combined system RH was lower compared to desiccant system (Fig. 31a & b).

Fig. 31a.Combined drying system

Fig. 31b. Drying chamber of combined system



Aleuritic acid cake was prepared from 5 kg seedlac in Pilot-plant of PD Unit and cake (2.2 kg) after centrifugation was used for drying study in combined system. Two trial of aleuritic acid drying in combined drying system was taken at chilled water temperature of 5^{0}C drying took 11 and 12 hrs, respectively. Fresh bleached lac from 500 g seedlac was also prepared and drying study in two trays in combined drying system was carried out at chilled water temperature of 5^{0}C and drying took 11 hrs for wt. to become constant. Temperature and RH in the chamber were 15-17 ^{0}C and 2.1- 2.7%, respectively.

3.2 Intrinsic chemical variability, amino acid profiling and anti-bacterial activity of Indian *Babool* gum from different agro-climatic zones

Important physico-chemical parameters of *babool* gum exudates collected from 10 Indian states covering five agro-climatic zones were determined and summarized in the Table 8.

Table 8. Physico-chemical parameters of *babool* (*Acacia nilotica*) gum samples

Parameters / Zones	Upper Gangetic plain region		Trans Gangetic plain region				Eastern plateau and hills region						Gujarat plains and hills region		Western dry region	
	BY	SR	HR	KL	RK	AR	BR	RI	BT	JR	GA	MJ	AD	BA	BI	JR
Moisture level (%)	2.44	2.21	2.97	4.84	3.01	6.33	6.27	4.52	3.40	3.17	5.75	6.27	4.60	4.26	3.45	3.31
ΔE	5.32	6.06	17.93	5.95	7.55	4.99	5.65	29.36	9.01	8.14	8.78	6.97	14.33	16.80	5.28	5.34
Yield %	78.8	80.3	76.9	76.2	70.5	78.3	84.3	65.0	78.6	80.9	81.0	66.1	66.8	65.3	73.2	69.9
C % H % N %	44.25 4.02 0.09	41.49 5.00 0.25	48.47 1.70 0.11	44.55 4.11 0.09	34.22 3.76 0.16	43.10 5.49 0.20	62.60 7.73 0.22	42.22 5.72 0.12	44.10 6.08 0.16	32.50 5.26 1.06	38.00 3.61 1.26	44.27 5.25 0.21	43.97 4.30 1.56	40.94 4.61 0.55	32.80 4.94 1.40	30.06 5.24 0.40
Ash content (%)	1.22	1.17	1.06	1.58	1.18	1.91	1.49	1.19	0.69	1.15	0.68	1.22	1.39	1.42	1.38	1.07
Specific rotation [α]	+ 53.51	+ 56.55	+ 53.13	+ 80.27	+ 84.17	+ 44.57	+ 84.17	+ 68.38	+ 56.40	+ 80.98	+ 79.32	+ 78.28	+ 86.29	+ 80.21	+ 73.77	+ 70.24

BY, Bareilly; SR, Sitapur; HR, Hisar; KL, Karnal; RK, Rohtak; AR, Amritsar; BR, Bilaspur; RI, Ranchi; BT, Balaghat; JR, Jabalpur; GA, Gondia; MJ, Mayurbhanj; AD, Anand; BA, Baroda; BI, Bundi; JR, Jaipur.

3.3 Design and development of integrated small scale lac processing unit for conversion of sticklac – seedlac

Four sets comprising of twelve number of different type of modified churning blades (Fig. 32) were fabricated to know the effect of churning mechanism for easy removal of lac dye from sticklac and efficient washing operation. Each set of modified blades was fixed to the main shaft for creating turbulence during churning/ washing operation inside the washing barrel. Different type of fabricated churning blades improved churning operation inside the washing barrel and increases the turbulence.

Rod parallel to the shaft | Rod 45^0 to the shaft | Rod perpendicular to the shaft | Flat parallel to the shaft

Fig. 32. Modified churning blades

Samples of seedlac after batch washing operation using modified churning blade was collected separately (Fig. 33). For each batch colour parameters (L, a and b) were determined using Hunter Lab Colorimeter to know the effect of modified churning mechanism / blade on quality of seedlac. The data obtained indicates that compared to traditional method, lighter colour seedlac is obtained after using modified churning method.

Fig. 33. Washed seedlac obtained after batch washing using modified churning blade

3.4 Characterization, chemical profiling and evaluation of gum ghatti (*Anogeissus latifolia* Wall.)

Gum ghatti sample Grade I (15 kg), Grade II (5 kg) and Grade III (5 kg) were procured from M/s Bahubali Udyog, Bilaspur (CG). The samples were vacuum dried in small batches and stored in air-tight containers and tested as per IS 7437: 1974 for the ash%, acid insoluble ash%, cold water solubles, pH, acidity (as HCl) % by mass and BFOM % by mass. pH of the samples (1 % solution) were found to range from 4.9 to 5.2. Viscosity of 5 % gum ghatti solutions was determined by BrookField viscometer (LV-3, 20 rpm) and was >5000 cP for Grade I, >1700 for Grade II and >800 cP for Grade III. The values obtained were within the range prescribed in BIS specification for gum ghatti. Color values of dried gum samples, were determined by Hunter Colorimeter, LabScan-SE. 'L values' measured (58 for grade I, 40 for grade II and 34 for grade III) confirmed increasing dark color from Grade I to III. Presence of tannin in gum ghatti was confirmed by Follin Ciacalteau method.

4 Value Addition, Application Development and Product Diversification

4.1 Use of natural gum / lac for conserving natural characteristics and shelf life of select fruit and seed spices through encapsulation

Farm fresh ginger was subjected to 4 coating treatments (2 kg each), using pan coating method in order to re-validate previous years' data and finalize coating protocol for ginger. Physico-chemical analysis (alcohol soluble extract, water soluble extract, moisture % and essential oil %) of ginger coated with different formulations (SHO1, SH02, SH03 and BH01) were made from 0 to 45 days of storage. Control was stored at similar condition. It was observed that all formulations were effective in controlling the moisture loss. However BH01 was most effective formulation, as compared to other formulations. The physico-chemical parameters of stored ginger as compared to control are summarised in Table 9.

Table 9. Physico chemical parameters of coated ginger *vis-à-vis* control

Treatments	Alcohol soluble extract	Water soluble extract	Per cent moisture content	Volatile oil / per 100g of sample
0 Day				
Control	28.9	36.2	86	0.3
After storage for 10 days				
SH01	27.5	20.4	75.5	0.2
SH02	27.5	20.7	78.0	0.2
SHO3	26.1	24.8	73.0	0.2
BHO1	28.0	26.0	80.5	0.2
Control	24.1	18.4	72.0	0.1
After storage for 30 days				
SH01	4.0	12.8	73.0	0.1
SH02	5.7	15.0	77.5	0.2
SHO3	4.9	14.0	72.5	0.2
BHO1	8.0	15.2	75.4	0.2
Control	5.2	14.8	70.0	0.1

After storage for 45 days				
SH01	3.9	11.5	70.0	0.1
SH02	5.6	14.8	75.0	0.1
SHO3	4.6	13.2	70.0	0.1
BHO1	6.8	13.6	75.0	0.2
Control	4.0	10.8	62.5	0.1

Based on results obtained in previous year (during preliminary trials) coriander and cumin seeds were obtained from National Research Center for Seed Spices (ICAR), Ajmer and subjected to treatment with formulations SH01B, SH02B and SH03B (1.5 kg per treatment for cumin, 1.25 kg per treatment with coriander), with pan-coating, before being sent back to NRCSS for storage studies. Their report indicated that at the conclusion of the study after 6 months, pest infestation was 21.6 (mean no of insects / 100g seed) in control and 18.6 to 19.0 in coated samples. Per cent seed damage was 9% in control, compared to 7.0 to 8.6 in treated samples. Per cent seed viability was 81.6 in control and 81.3 to 84.6 in treated samples. Essential oil content was 81.67% in control and 81.3 to 84.6% in treated samples. Color preference as per Hedonic scale was 6 (control) and 6.3 to 7.6 in treated samples. Formulation SH02B exhibited best performance in cumin. In coriander, the pest infestation was observed to the extent of 30.6%, whereas, treated samples exhibited 26.33 to 29.67%. Per cent seed damage was 20.3 to 27.6 in treated, as compared to 28.33 in control. Per cent viability was 70.3 in control and 71.0 to 75.3 in treated samples. Per cent essential oil content was 0.30 in control as compared to 0.33 to 0.37 after treatment. Color preference as per Hedonic scale was 5.3 (control) and 5.6 to 7.0 in treated samples. Formulation SH02B exhibited best performance in coriander also.

4.2 Development of natural resin/gum based sticker *bindi*

Sticker *bindi* adhesive prepared using hydrolyzed lac was studied by Differential Scanning Calorimetry (DSC). As shown in Fig. 34, the glass-transition temperature was observed to be in the range of 49.5 to 57.9^{0}C. The adhesive was analyzed using inductively coupled plasma optical emission spectroscopy (ICP-OES), which showed the presence of arsenic (As), below detection limit(BDL); lead (Pb), 0.0277mg/g; iron (Fe), 0.02538mg/g and nickel (Ni), 0.00116mg/g.

Two/three coatings of 30% solution of hydrolyzed based adhesive in isopropyl alcohol were applied by hand on base adhesive coated non-woven *bindi* sheets. After each coating the sheets were dried in oven at 80 ^{o}C or in air at room temperature. Sticker *bindi* of size 7mm and 3mm dia. was prepared by punching process.

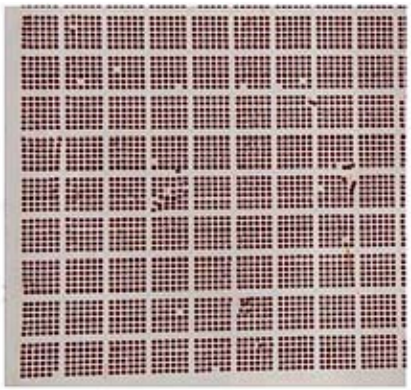


Fig. 34. Sticker *bindi* of 3mm diameter

As per feedback from Aravind Laboratories, Chennai, viscosity of 30% solution of sticker *bindi* adhesive in isopropyl alcohol was improved for screen printing using a rheology modifier. Different percentage of rheology modifier *viz.,* 2.5, 5.0 and 7.5%, respectively were blended with 30% solution of hydrolyzed lac based adhesive in isopropyl alcohol. The viscosity was determined at room temperature using Brookfield viscometer with LV3 spindle at 20rpm. As shown in Fig. 35, at 7.5% of rheology modifier, the viscosity increased to 2621cP which may be suitable for screen printing process. The bulk density of modified adhesive formulation was found to be 0.86g/cc and pH value was around 5. ICP-OES analysis of modified adhesive formulation showed the presence of arsenic (As), below detection limit (BDL); lead (Pb), 0.000323mg/g; iron (Fe), 0.00905mg/g and nickel (Ni), 0.000323mg/g.

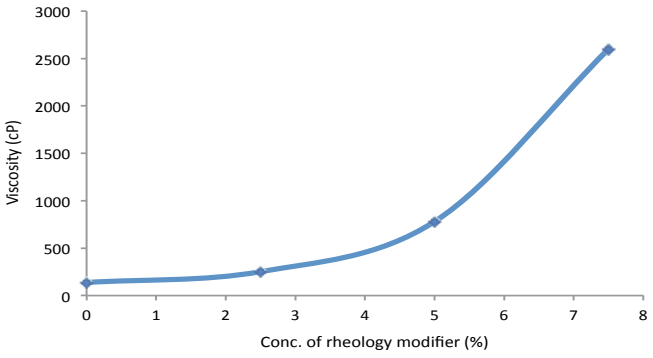


Fig. 35. Viscosity of 30% solution of sticker *bindi* adhesive in isopropyl alcohol with rheology modifier

Experiments were also carried out to prepare sticker *bindi* using commercial non-woven *bindi* sheet. The commercial *bindi* sheet was first coated with base adhesive to fill the pores and then oven dried at 80 °C for 1hr. Single coat of modified adhesive composition was applied on silicone release paper. The base coated *bindi* sheet was pasted upon it and dried in oven at 80°C for 1 hr or in air at room temperature for 24 hrs. Oven drying at 80°C was observed to decrease the adhesiveness (mean stress at maximum load 0.181MPa) compared to air-dried sample (mean stress at maximum load 0.241MPa). Thus, air drying appeared to be suitable for making sticker *bindi*.

4.3 Utilization of lac wax and lac dye for use as PGR and anti-fungal agent

Plant growth regulatory activity of lac wax

Lac wax on saponification yield policosanol. Different concentrations (100, 10, 1, 0.1, 0.01 and 0.001 ppm) of policosanol were prepared in aqueous medium using emulsification technique. The above concentrations of policosanol were tested on wheat seedlings for plant growth regulatory (PGR) activity (Table 10).

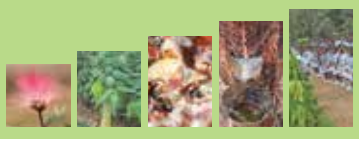
The effect of tested concentrations of policosanol on wheat seedlings revealed that plant growth promotion activity of lac policosanol is maximum at 0. 1 ppm concentration. Further the effect of policosanol in combination with saponin hydrolysate showed maximum growth in lac wax policosanol + saponin hydrolysate mixture than the individual component (Table 11).

Table 10. Effect of lac wax policosanol on germination, root and shoot length of wheat seedlings.

Treatments	Germination %	Root length (cm)	Shoot length (cm)	Root growth %	Shoot growth %
Control	83.33	11.61±1.83	9.47±2.16	NA	NA
100 ppm	85	11.76±1.19	9.64±1.15	1.29	1.80
10 ppm	82.5	11.91±0.97	10.39±0.84	2.58	9.71
1 ppm	90	12.19±1.27	11.61±1.67**	5.00	22.60
0.1 ppm	87.5	13.07±0.97**	11.2±1.44	12.58	18.27
0.01 ppm	90	12.22±1.25	10.55±1.43	5.25	11.40
0.001 ppm	85	11.85±0.99	10.1±0.87	2.07	6.65

Table 11. Effect of policosanol and their combination with saponin acidic hydrolysates on germination, dry weight, root length and shoot length of wheat seedlings.

Treatments		Germination %	Root Length (cm)	Shoot Length (cm)	Dry weight (mg)	% Root growth (over control)	% Shoot growth (over control)	% Increase in dry weight
Jadu (commercial)	10 ppm	85	10.18±1.40	12.15±1.46	32.8±2.04	0.49	17.28	5.81
	1 ppm	80	10.48±1.52	12.21±1.62	32.3±1.25	3.46	18.82	4.19
Saponin hydrolysate	10 ppm	88	11.51±2.57	16.31±2.61	-	10.67	8.66	-



Lac policosanol	10 ppm	86	10.9±1.20	12.09±1.45	32.9±2.77	7.60	16.70	6.13
	1 ppm	85	11.14±1.51	12.64±1.38*	35.6±2.46**	9.97	20.46	14.84
Lac policosanol + saponin	1 ppm	85	11.51±1.62**	13.01±1.64**	34.2±3.26	13.62	25.58	1.94
Control		80	10.13±1.1	10.36±1.27	31±3.02	NA	NA	NA

Antifungal activity of lac dye

Thin layer chromatography studies were carried out on lac dye to standardize the solvent system of TLC. Arndt-Einstert reaction was carried out to produce diazomethane for preparing methylated lac dye. Four components of methylated lac dye were separated over silica gel on TLC plate. Samples of purified lac dye and its methylated derivatives were prepared in quantity for evaluation of lac dye for antifungal activity against *Rhizoctonia solani* and *R. bataticola.*

4.4 Development of crack cream formulation based on *palas* and *moringa* gum

Purification of *palas* gum using different organic solvent systems was done. Tannin was extracted by dissolving the gum (25 g) in distilled water and filtrate was treated with brine and precipitated tannin was filtered and dried. On treatment with alcohol, it formed a solution which was treated with ether. The flesh coloured precipitate was filtered and washed with ether. Thus water-soluble and ether soluble impurities were removed. The tannin present in *palas* gum was 42% on w/w basis. Tannin present in *palas* gum were measured using Folin-Ciocalteu method and was calculated to be 412.5 mg/g. Water based cream formulation containing 2% *palas* gum tannin and 4-5% emulsifying wax and 0.01% odoriferous principles was prepared (100 g). Since the cream formulation was water based it was kept at ambient temperature to study the antibacterial properties of the prepared formulation. Coarsely powdered *moringa* gum was purified with water and extracted with methyl alcohol. The gum was filtered through muslin cloth and dried at ambient temperature. Solubility, viscosity, pH, moisture ash value and acid insoluble matter of *moringa* gum samples were determined in triplicate. The average viscosity of the 0.5% aqueous solution of *moringa* gum was 67.1 cP at 20^{0}C using spindle no. 1 at 100 rpm. Average pH of the 1% aqueous solution of *moringa* gum was 7.30 at 22^{0}C. Tannin was isolated from the *moringa* gum using solvent extraction method and estimated quantitatively through Folin-Ciocalteau method (Table 12).

Table 12. Physicochemical properties of *moringa* gum

Property	Values/observations
Solubility	Partially soluble in water, practically insoluble in EtOH, CH_3COCH_3 and $CHCl_3$
pH(1% w/v, 22 ^{0}C)	7.30
Moisture	5.2%
Ash Value	3.1%
Acid insoluble matter	2.8%
Viscosity (20 ^{0}C, 0.5% aq.soln., 100 rpm, spindle no.1)	67.1 cP

Coarsely powdered *Butea* gum was purified with water and extracted with methyl alcohol. The gum was filtered through muslin cloth and dried at ambient temperature (Table 13).

Table 13. Physicochemical properties of *palas* gum

Property	Values/observations
Solubility	Soluble in hot water, practically insoluble in EtOH, CH_3COCH_3 and $CHCl_3$
pH(1% w/v, 22 ^{0}C)	6.8
Moisture	12%
Ash Value	6.5
Acid insoluble matter	1.6%
Swelling index in distilled water	17.0

Three aqueous cream formulations have been prepared using tannin isolated from *moringa* gum and emulsifying wax. Three formulations have been prepared using tannin isolated from *palas* gum, odouriferous principle and emulsifying wax.

4.5 Modification of gummy mass for its application

Gummy mass (GM) was prepared from effluent (density - 1.1974g/ml) during aleuritic acid manufacturing to standardise the preparation process of GM. Yield of the GM was 18 to 20% on the weight of the effluent. Physico-chemical properties such as acid value, saponification value and ash content were found to be 186, 212 and 0.45% respectively. GM was also characterised with FTIR and DSC. FTIR study revealed that intensity and sharpness of carbonyl group and -CH_3 and -CH_2- frequency increased in GM as compared to lac (Fig. 36). DSC analysis of GM showed no peaks but fluidity, while shellac shows peak at 63^{0}C (Fig. 37).

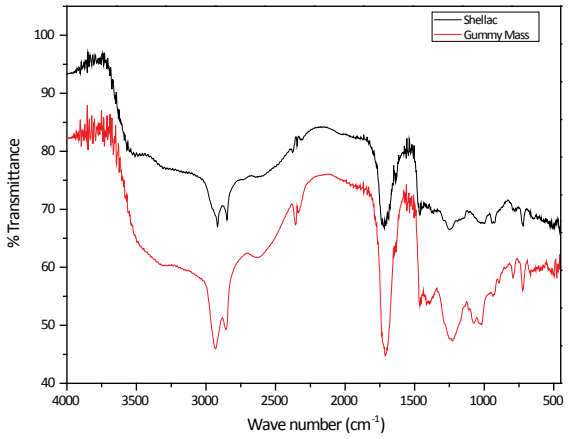


Fig. 36. FTIR spectra of lac and GM

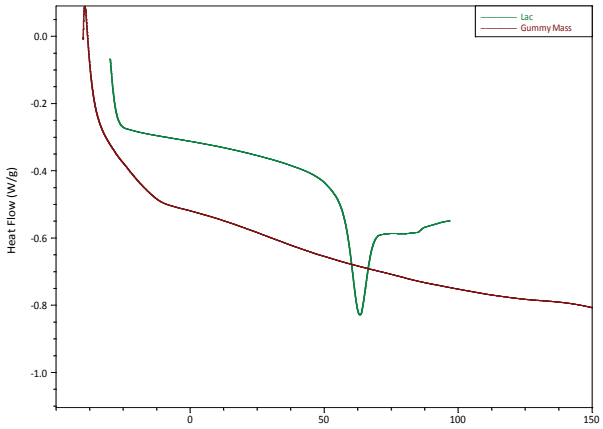


Fig. 37. DSC thermograms of lac and GM

FTIR and DSC analysis of GM mass modified with MF resin was done. FTIR spectra showed the peak frequency of carbonyl group of GM shifts to lower wavelength (Blue Shift) and intensity of the peak decreased on reaction with MF which further decreased on increasing the concentration of the MF resin. The N-H stretching vibration frequency prominently appeared at 3335 cm^{-1} on increasing the concentration of MF resin (Fig. 38a). On baking the films, intensity of –CH_3 and –CH_2- moiety increased and more broad peaks for –NH asymmetric stretching vibrations were recorded (Fig. 38b). Analysis indicated the esterification reaction between carboxyl group of GM and hydroxyl group of the MF resin.

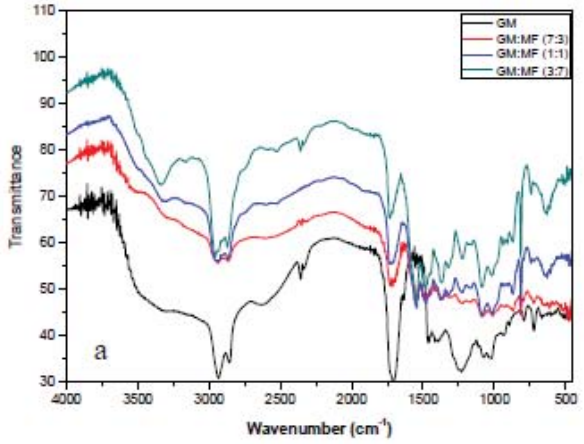


Fig. 38a. FTIR spectra of air-dried films of GM modified with MF resin baked films

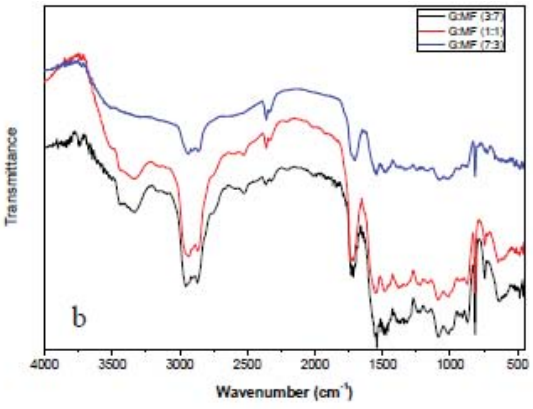


Fig. 38b. FTIR spectra of baked films of GM modified with MF resin

DSC analysis indicated decrease in softening of GM on modification with MF resin and softening in the films was observed between 40 to 100^{0}C and a broad peak was observed around 165^{0}C (Fig. 39a). Baked films of the modified products showed prominent softening at 74^{0}C (Fig. 39b), which reduced on increasing the concentration of MF resin and very little softening was recorded in GM: MF (3:7) ratio indicating the thermal stability at higher concentration of MF resin. GM mass was reacted with cardanol in different ratios at elevated temperatures for different time periods and their acid and saponification values were determined. It was found that the values of GM decreased with the increase in ratio of cardanol and reaction time.

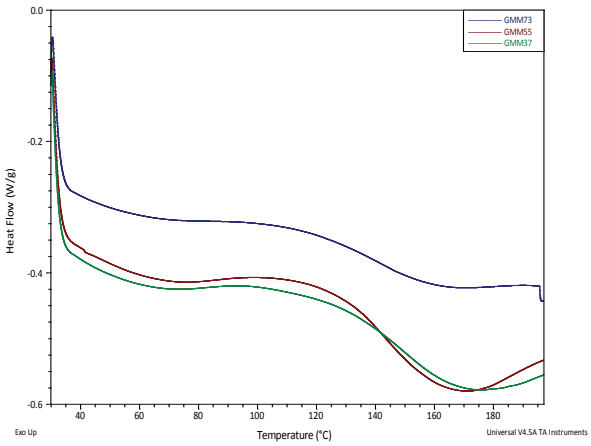


Fig. 39a. DSC thermograms of air-dried films of GM modified with MF resin

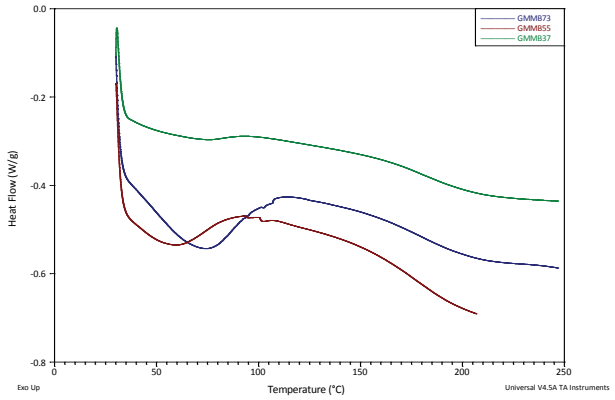


Fig. 39b. DSC thermograms of baked films of GM modified with MF resin

Films of the formulations did not dry at ambient temperature. Baked films were found to be flexible and passed the impact resistance test. Gloss of the GM improved after treatment with cardanol. GM mass was also modified with epoxy and acrylic co-polymer resins to see the possibility of the blends being used in both air drying and baking compositions. As expected, air dried films were inferior to baked films. Baking at 180^{0}C for 20 min. was most appropriate, using 3:7 ratios of synthetic resin: gummy mass (w/w).

4.6 Synthesis and evaluation of *guar* gum derivatives

Carboxymethyl derivative (anionic) of *guar* gum was synthesized by reacting the gum with sodium hydroxide and monochloroacetic acid, using semi-dry and non-aqueous method, using varying molar ratio of the reagent (*viz.* CMGG 0.4, CMGG 0.6 and CMGG0.8). The viscosity of the synthesized derivatives was measured by Brookfield viscometer using LV4 Spindle at 20 rpm speed. It was observed that the viscosity of the synthesized derivative increased with the higher molar ratio of the reagent. It was also observed that viscosity of the derivative increased with the lower alkali treatment during the reaction. The viscosity of 1% solution of carboxmethyl derivative of *guar* gum ranged from 2010 cP to 3359 cP (Fig. 40) and pH ranged from 9.69 to 7.06. The *guar* derivative synthesized with higher alkali treatment showed higher pH than the other. The derivative was characterized by FT-IR, which showed a new band at 1585 cm^{-1} confirming carboxymethylation of the hydroxyl group of *guar* gum molecule.

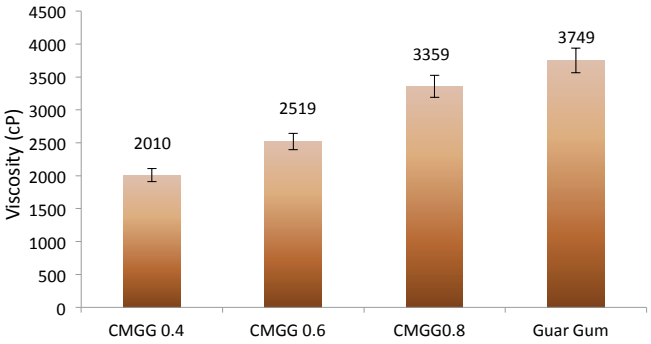


Fig. 40. Viscosity of *guar* gum and it's derivatives

Experiments were also carried out to determine the degree of substitution (Ds) of the synthesized carboxymethyl derivative of *guar* gum. Titrimetric method was followed to estimate the substitution present in the derivative. The analysis showed that the Ds of above derivative ranged from 0.012 to 0.025. The viscosity of the derivative increased with the increase in degree of substitution in the guar derivative. Differential scanning calorimetry (DSC) analysis of *guar* derivative was performed in order to understand the thermal behavior of *guar* gum and its derivative. The glass transition temperature (*Tg*) of carboxymethyl *guar* gum (84.5^{0}C) was lower than native *guar* gum (97.5^{0}C), which is attributed to the carboxymethylation process (Fig. 41).

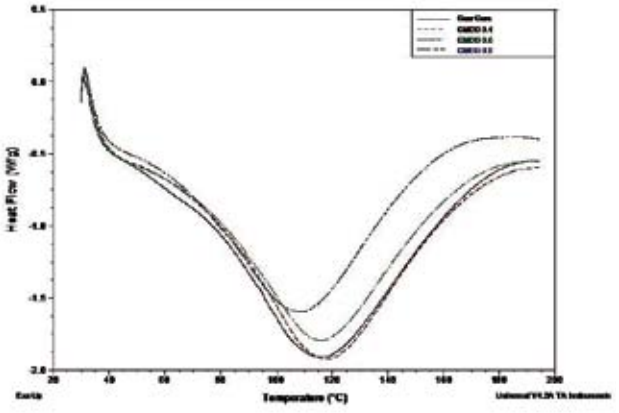


Fig. 41. DSC study of *guar* gum and it's derivatives

Transfer of Technology

5. Capacity Building of Farmers and Entrepreneurship Development

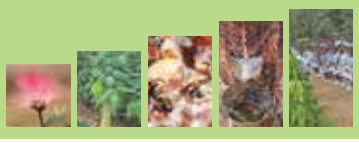
5.1 Training, demonstration, extension education and information services on lac culture, processing and product development

Farmers Training programme on Scientific lac cultivation, processing and utilization

The programme is for one week which includes lac cultivation, processing at farm level and its uses. A total of 1046 farmers from different districts of eight states *viz.*, Jharkhand, West Bengal, Maharashtra, Bihar, Madhya Pradesh, Odisha, Chhattisgarh and New Delhi participated in the programme. The details are given in Table 14.

Table 14. Farmers training programme on scientific lac cultivation, processing and utilization

Month	Sponsoring Organization	District-State	Period	No. of participants
January	JASCOLAMPF, Ranchi	Ranchi-Jharkhand	31.12.12 to 03.01.13	62
	Tribal Co-operative Marketing Development Federation India Ltd. (TRIFED), Ranchi	Purulia-West Bengal	07.01.13 to 11.01.13	32
	Self sponsored	Khunti-Jharkhand	07.01.13 to 11.01.13	01
	JASCOLAMPF, Ranchi	Simdega-Jharkhand	15.01.13 to 18.01.13	49
	Self sponsored	W. Singhbhum, Chatra-Jharkhand	21.01.13 to 25.01.13	03
February	Convergence of Agricultural Inventions in Maharashtra (CAIM), Akola	Akola-Maharashtra	28.01.13 to 02.02.13	23
	TRIFED, Ranchi	Ranchi- Jharkhand	28.01.13 to 02.02.13	26
	District Project Officer (DPO) Collectorate, Khunti	Khunti- Jharkhand	28.01.13 to 02.02.13	15
	Self sponsored	Koderma-Jharkhand	28.01.13 to 02.02.13	01
	District Industrial Centre (DIC), Murshidabad	Mursidabad-West Bengal	04.02.13 to 08.02.13	10
	Krishi Gram Vikas Kendra (KGVK), W. Singhbhum	West Singhbhum-Jharkhand	04.02.13 to 08.02.13	10
	TRIFED, Ranchi	Ranchi-Jharkhand	05.02.13 to 08.02.13	17
	Private	Rohtas-Bihar	04.02.13 to 08.02.13	01
	JASCOLAMPF, Ranchi	West Singhbhum Jharkhand	15.02.13 to 13.02.13	30
	IINRG, Ranchi	Seoni - Madhya Pradesh	15.02.13 to 13.02.13	06
	JASCOLAMPF, Ranchi	Gumla-Jharkhand	18.02.13 to 21.02.13	35



	Private	Gumla, Ranchi, Khunti, Dhanbad-Jharkhand	18.02.13 to 21.02.13	05
March	West Forest Division, Chhindwada	Chhindwara-Madhya Pradesh	25.02.13 to 02.03.13	26
	Torpa Mahila Vikas Kendra, Khunti	Khunti-Jharkhand	25.02.13 to 02.03.13	15
	Forest department, Gumla	Gumla-Jharkhand	25.02.13 to 02.03.13	07
	Private	Ranchi, W.Singhbhum-Jharkhand	25.02.13 to 02.03.13	03
	TRIFED, Ranchi	Purulia-West Bengal	05.03.13 to 08.03.13	14
	TRIFED, Ranchi	Ranchi-Jharkhand	05.03.13 to 08.03.13	13
	Self sponsored	Mandla-Madhya Pradesh	05.03.13 to 08.03.13	01
	Krishi Vigyan Kendra (KVK), Rajnandgaon	Rajnandgaon-Chhattisgarh	11.03.13 to 14.03.13	33
	TRIFED, Ranchi	Ranchi-Jharkhand	11.03.13 to 16.03.13	24
	Agricultural Technology Management Agency (ATMA), Gumla	Gumla-Jharkhand	19.03.13 to 23.03.13	21
	TRIFED, Ranchi	Purulia-W. Bengal	18.03.13 to 23.03.13	04
April	Self sponsored	W. Singhbhum, Ranchi-Jharkhand	08.04.13 to 12.04.13	06
	JASCOLAMPF, Ranchi	Khunti, Ranchi-Jharkhand	15.04.13 to 18.04.13	45
	Self sponsored	Ranchi-Jharkhand	15.04.13 to 18.04.13	01
May	JASCOLAMPF, Ranchi	Khunti, Ranchi-Jharkhand	29.04.13 to 02.05.13	28
	JASCOLAMPF, Ranchi	Latehar-Jharkhand	06.05.13 to 09.05.13	31
	JASCOLAMPF, Ranchi	Gumla-Jharkhand	06.05.13 to 09.05.13	05
	JASCOLAMPF, Ranchi	W.Singhbhum-Jharkhand	06.05.13 to 09.05.13	08
	JASCOLAMPF, Ranchi	Khunti -Jharkhand	06.05.13 to 09.05.13	07
June	JASCOLAMPF, Ranchi	Simdega, Saraikela-Kharsawan Jharkhand	04.06.13 to 07.06.13	21
	Consultants for Rural Area Development Linked Economy (CRADLE), Ranchi	Ranchi-Jharkhand	24.06.13 to 29.06.13	36
	Self sponsored	Ranchi, Gumla -Jharkhand	24.06.13 to 29.06.13	04

July	Hopman Samaj Seva Sansthan, Khunti	Khunti-Jharkhand	01.07.13 to 06.07.13	14
	Self sponsored	Ramgarh, Ranchi, Gumla, Simdega, Latehar, Khunti-Jharkhand	01.07.13 to 06.07.13	15
	Self sponsored	Purulia,West Bengal	01.07.13 to 06.07.13	01
	Self sponsored	Jashpur - Chhattisgarh	01.07.13 to 06.07.13	01
August	National Agriculture Innovation Project (NAIP-2), IINRG Ranchi	Mayurbhanj, Odisha	12.08.13 to 17.08.13	08
	NAIP- 2 IINRG, Ranchi	Bastar-Chhattisgarh	12.08.13 to 17.08.13	03
	NAIP- 2 IINRG, Ranchi	Gumla, Ranchi, W. Singhbhum, Lohardaga Khunti -Jharkhand	12.08.13 to 17.08.13	23
	PRADAN, Khunti	Khunti-Jharkhand	26.08.13 to 31.08.13	12
	NAIP-2 IINRG, Ranchi	Ranchi-Jharkhand	26.08.13 to 31.08.13	30
	Self sponsored	Simdega, W. Singhbhum, Dhanbad-Jharkhand	26.08.13 to 31.08.13	03
September	ATMA, Banka, Bihar	Banka-Bihar	02.09.13 to 07.09.13	35
	Self sponsored	Ranchi-Jharkhand	02.09.13 to 07.09.13	01
	ATMA, Latehar	Latehar-Jharkhand	09.09.13 to 14.09.13	41
October	ATMA, Latehar	Latehar-Jharkhand	07.10.13 to 11.10.13	55
	Self sponsored	Giridih-Jharkhand	07.10.13 to 11.10.13	01
	Self sponsored, JNU	New Delhi	07.10.13 to 11.10.13	01
	ATMA, Latehar	Latehar-Jharkhand	28.10.13 to 31.10.13	26
November	ATMA, Latehar	Latehar-Jharkhand	11.11.13 to 14.11.13	53
	Advasi Mahila Vikas Sansthan, Gumla	Gumla-Jharkhand	18.11.13 to 23.11.13	16
	Chotanagpur Krishi Vikas Kendra, Lohardaga	Lohardaga-Jharkhand	18.11.13 to 23.11.13	08
	Singhbhum Gramodyog Vikas Sansthan, Chaibasa	W. Sibghbhum-Jharkhand	18.11.13 to 23.11.13	04
	Singhbhum Gramodyog Vikas Sansthan, Chaibasa	W. Sibghbhum-Jharkhand	20.11.13 to 23.11.13	16
Total				**1046**

Farmers undergoing training at IINRG

Master Trainers' training programme on scientific lac production, processing and uses

Master Trainers, unemployed educated rural youth (lac facilitator), junior lac executives, managers, primary forest committee members participated and trained under Trainers' training programme on scientific lac production, processing and uses. A total of 216 participants were trained through seven different courses. The details are furnished in Table 15.

Table 15. Master trainers' programme on scientific lac production, processing and uses

Month	Sponsoring Organization	District-State	Period	No. of participants
January	Chhattisgarh State Minor Produce Federation (Trade and Development) Ltd (CGMFP), Raipur	Raipur-Chhattisgarh	21.01.13 to 25.01.13	31
April	Forest Department, Ranchi, Jharkhand	Simdega, Koderma, Latehar & Saraikela-Kharsawan-Jharkhand	08.04.13 to 12.04.13	22
	CGMFP, Raipur	Raipur-Chhattisgarh	22.04.13 to 27.04.13	09
	Ankur Rural and Tribal Development Society, Ranchi (ARTDS)	Ranchi-Jharkhand	22.04.13 to 27.04.13	12
June	KVK, Saraikela-Kharsawan	Saraikela-Kharsawan Jharkhand	27.05.13 to 01.06.13	30
September	Gramin Vikas Trust, Purulia	Purulia-W. Bengal	23.09.13 to 27.09.13	14
	Forest department, Jagdalpur	Jagdalpur -Chhattisgarh	23.09.13 to 27.09.13	13
	Collectorate, Dantewada	Dantewada-Chhattisgarh	23.09.13 to 27.09.13	11
	Self sponsored	Ranchi, Dhanbad-Jharkhand	23.09.13 to 27.09.13	04
December	ATMA, Garhwa	Garhwa-Jharkhand	02.12.13 to 07.12.13	27
	Khunti Project	Khunti-Jharkhand	02.12.13 to 07.12.13	03
	Social Initiatives Growth Networking	Ranchi-Jharkhand	09.12.13 to 13.12.13	31
	Self sponsored	Ranchi, Gumla, Sahebganj, Dhanbad-Jharkhand	09.12.13 to 13.12.13	09
Total				**216**

Educational programme on production, processing and uses of natural resins and gums (10 days)

Two agricultural educational institutions namely Sam Higginbottom Institute of Agriculture Science & Technology, Allahabad (Formerly Allahabad Agriculture Institute, Allahabad) and Institute of Agriculture Science, Banaras Hindu University, Varanasi, Uttar Pradesh nominated 44 and 29 agricultural graduate students respectively to undergo 10-days educational programme on production, processing and uses of natural resins and gums. A total of 73 students participated through the two courses under this educational programme.

Subject specific training programme

Subject specific training programmes of two days duration were organized on plantation raising and lac cultivation on *F. semialata*, *kusmi* lac cultivation on *S. oleosa* and *F. semialata* and lac cultivation on *B. monosperma*. A total of 127 persons participated through 3 different courses. The details are depicted in Table 16, 17 & 18.

Table 16. Plantation raising and lac cultivation on *F. semialata*

Month	Sponsoring Organization	State	Period	No. of Participants
April	Xavier Institute of Social Services (XISS), Ranchi	Jharkhand	15.04.13 to 16.04.13	40
June	XISS, Ranchi	Jharkhand	22.06.13 to 23.06.13	30
Total				70

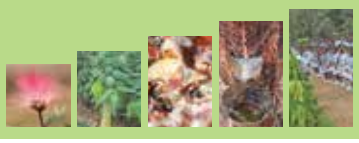
Table 17. *Kusmi* lac cultivation on *S. oleosa* and *F. semialata*

Month	Sponsoring Organization	State	Period	No. of Participants
April	CCN, Sahyog, Visakhapattanm	Andhra Pradesh	25.06.13 to 26.06.13	18

Table 18. Lac Cultivation on *B. monosperma*

Month	Sponsoring Organization	State	Period	No. of Participants
April	NAIP-3, IINRG & Birsa Ag. University, Ranchi	Jharkhand	15.07.13 to 16.07.13	39

Students participating in educational programme



On-farm training programme on scientific lac cultivation

IINRG has organized 14 on-farm training programme on lac cultivation in collaboration with various NGOs and GOs of different states. A total of 1569 farmers participated from different districts of two states *viz.*, Jharkhand and Odisha. The details are furnished in Table 19.

Table 19. On-farm training programme on scientific lac cultivation

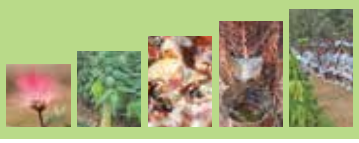
District, State	Sponsoring/ Nominating Agency	Venue (Village, Block)	Date	No. of Participants
Khunti, Jharkhand	Mahila Vikas Kendra, Torpa	Mahila Vikas Kendra Hall, Torpa	23.01.2013	119
Gumla, Jharkhand	ATMA, Gumla	Block Office Hall, Kamdara	05.02.2013	60
Gumla, Jharkhand	ATMA, Gumla	Panchayat Sthal, Kamdara	06.02.2013	60
Simdega, Jharkhand	NIDAN, Gumla	Block Office, Bano	03.03.2013	150
Baleshwar, Odisha	Kishore Chandrapur Lac Industrial Co-Operative Society Ltd. (KC Lac Ind. Co-Op. Society Ltd.)	Tartari, Neelgiri, Baleshwar	06.03.2013	100
Baleshwar, Odisha	KC Lac Ind. Co-Op. Society Ltd.	Tartari, Neelgiri, Baleshwar	07.03.2013	95
Mayurbhanj, Odisha	KC Lac Ind. Co-Op. Society Ltd.	Chakidih, Bangriposhi, Mayurbhanj	16.03.2013	100
Mayurbhanj, Odisha	KC Lac Ind. Co-Op. Society Ltd.	Chakidih, Bangriposhi, Mayurbhanj	17.03.2013	105
Baleshwar, Odisha	KC Lac Ind. Co-Op. Society Ltd.	Tartari, Neelgiri, Baleshwar	15.07.2013	100
Baleshwar, Odisha	KC Lac Ind. Co-Op. Society Ltd.	Tartari, Neelgiri, Baleshwar	16.07.2013	100
Simdega Jharkhand	Chotanagpur Vikas Nidhi, Lachragarh	Banki, Lachragarh, Jharkhand	25.07.2013	300
Gumla, Jharkhand	Adivasi Mahila Samaj Seva Kendra, Gumla	Siskari High School, Sisai	30.09.2013	100
Khunti, Jharkhand	Torpa Rural Development Society for Women, Torpa	TRDSW Centre, Torpa	06.11.2013	80
Simdega, Jharkhand	Vikas Kendra, Simdega	Konnarela Church Compound, Gangutoli	14.12.2013	100
Total				**1569**

On-farm, motivational/ supplementary training programme on lac cultivation

A total of 2217 participants attended on-farm motivational/ supplementary training programme on lac cultivation in collaboration with various NGOs and GOs of different states. The details are depicted in Table 20.

Table 20. On-farm Motivational/ Supplementary training programme on lac cultivation

District, State	Nominating Agency	Venue (Village, Block)	Date	No. of Participants
Purulia, West Bengal	Vidyasagar Abasik Balika Vidyalaya	Vidyasagar Abasik Balika Vidyalaya, Tamna	24.01.2013	150
Khunti, Jharkhand	Mahila Vikas Kendra, Torpa	Rania Block, Torpa	20.02.2013	70
Ranchi, Jharkhand	ICAR-RCER Centre, Plandu	Saraitoli, Jamchuma, Namkum, Ranchi	06.03.2013	26
Ranchi, Jharkhand	Jharkhand Tribal Development Society (JTDS), Ranchi	Mousudih, Bundu, Ranchi	20.03.2013	50
Ranchi, Jharkhand	JTDS, Ranchi	Prathmik School, Kuta Chawali, Tamar	22.03.2013	50
Ranchi, Jharkhand	JTDS, Ranchi	Utkramit Prathmik Vidyalaya, Labga, Bundu	02.04.2013	35
Ambikapur, Chhattisgarh	Ashadeep Biocare Pvt. Ltd.	Vikash Bhawan, Ambikapur	25.05.2013	503
Sundergarh, Odisha	TDCCOI, Odisha	Berghat, Luipara, Sundergarh	27.05.2013	100
Boko, Assam	Bioved & Govt. of Assam	Boko, Guwahati Kamrup, Assam	12.06.2013	350
Kohima, Nagaland	Bioved & Govt. of Nagaland	Kohima, Nagaland	14.06.2013	200
Chaibasa, Jharkhand	JTDS, Chaibasa	Panchayat Hall, Sarvada, Khuntpani	30.08.2013	70
East Singhbhum, Jharkhand	JTDS, Chaibasa	Sahyogi Mahila Training Hall Bagraisai, Rajnagar	31.08.2013	45
Ranchi, Jharkhand	Green Gold Farming Sahkari Sahyog Samiti(GGFSSS), Ranchi	Singh Palace, Radium Road, Ranchi	23.09.2013	51
Ranchi, Jharkhand	GGFSSS, Ranchi	Singh Palace, Radium Road, Ranchi	24.09.2013	21
Ranchi, Jharkhand	GGFSSS, Ranchi	Singh Palace, Radium Road, Ranchi	25.09.2013	41
Ranchi, Jharkhand	GGFSSS, Ranchi	Singh Palace, Radium Road, Ranchi	26.09.2013	38
Ranchi, Jharkhand	GGFSSS, Ranchi	Singh Palace, Radium Road, Ranchi	27.09.2013	42
Gumla, Jharkhand	Adivasi Mahila Samaj Seva Kendra, Gumla	Siskari High School, Sisai	29.09.2013	300
Khunti, Jharkhand	JTDS, Ranchi	Kochang, Arki, Khunti	03.10.2013	75
Total				**2217**



In-campus one day orientation programme on natural resins and gums

In-campus, 1-day orientation programme (86 nos.) on natural resins and gums were organized for farmers, school children, college students and extension functionaries in collaboration with GOs and NGOs of different states and 4399 persons visited the Institute for this purpose. These were nominated by various agencies mentioned in details in Table 21a, 21b, 21c & 21d.

Table 21a. In-campus one-day orientation programme on NRG for farmers

District, State	Nominating Agency	Date	No. of Participants
Ranchi, Jharkhand	GIC, Hehal, Ranchi	04.01.13	80
Ranchi, Jharkhand	Central IPM Centre, Ranchi	05.01.13	40
Palamau, Jharkhand	Zonal Research Station, Daltonganj	07.01.13	32
Ranchi, Jharkhand	ICAR-RCER Centre, Palandu	10.01.13	25
Ranchi, Jharkhand	TRIFED, Ranchi	12.01.13	25
Shivsagar, Assam	Progressive farmers	18.01.13	10
Ranchi, Jharkhand	RK Mission, Ranchi	24.01.13	61
Ranchi, Jharkhand	BAU, Kanke, Ranchi	01.02.13	18
Godda, Jharkhand	KVK, Godda	08.02.13	40
Ranchi, Jharkhand	Social Institution for Growth & Networking	13.02.13	51
Bokaro, Jharkhand	Progressive farmers	23.02.13	51
Ranchi, Jharkhand	Mile Stone Tourism, Mango	25.02.13	150
Ranchi, Jharkhand	CRADLE, Ranchi	26.02.13	50
Ranchi, Jharkhand	Mile Stone Tourism, Mango	27.02.13	118
Khunti, Jharkhand	UDYOGINI, Khunti	02.03.13	54
Ranchi, Jharkhand	RK Mission, Ranchi	05.03.13	17
Jashpur, Chhattisgarh	RE & DS, Jashpur	05.03.13	48
Gumla, Jharkhand	NIDAN, Gumla	05.03.13	45
Ranchi, Jharkhand	RK Mission, Ranchi	15.03.13	33
Hazaribag, Jharkhand	Holly Cross KVK, Hazaribag	18.03.13	53
Singhbhum, Jharkhand	Singhbhum Gramodyog Vikas Sanstha	20.03.13	44
Saraikela-Kharsawan, Jharkhand	Mahila Jagriti Samiti, Ranchi, Saraikela Unit, Chaibasa	17.04.13	30
Palamu, Jharkhand	Nav Jeevan Hospital, Satbarwa	17.04.13	23
Bokaro, Jharkhand	Jharkhand Organization & Research (JOR), Peterwar	30.04.13	50
Ranchi, Jharkhand	ICAR-RCER, Research Centre, Plandu, Ranchi	03.06.13	22
Saraikela-Kharsawan, Jharkhand	KVK, Jamshedpur	06.06. 13	27

Ranchi, Jharkhand	TRIFED, Ranchi	21.06. 13	27
Bokaro, Jharkhand	ISAP, Bokaro	22.06. 13	125
Visakhapatnam, Andhra Pradesh	CCN Sahyog, Visakhapatnam	25.06.13	18
Ranchi, Jharkhand	R.K.Mission, Ranchi	25.06. 13	33
West Singbhum, Jharkhand	JTDS, Chaibasa	29.06. 13	23
Dumka, Jharkhand	NAIP, Dumka	15.07. 13	16
Dumka, Jharkhand	NAIP, Jamtara	15.07. 13	19
Simdega, Jharkhand	Chotanagpur Vikas Nidhi, Lachragarh	26.07. 13	40
Ranchi, Jharkhand	BAU, Ranchi	08.08. 13	15
Ranchi, Jharkhand	RK Mission, Ranchi	05.09. 13	32
Khunti, Jharkhand	UDYOGINI, Khunti	09.09. 13	14
Ranchi, Jharkhand	NAIP-2 IINRG	09.09. 13	12
Khunti, Jharkhand	Torpa Rural Development Society for Women, Torpa, Khunti	27.09. 13	80
Khunti, Jharkhand	TRDSW, Torpa, Khunti	04.10. 13	84
Ranchi, Jharkhand	RK Mission, Ranchi	08.10. 13	30
Ranchi, Jharkhand	RK Mission, Ranchi	09.10. 13	30
Ranchi, Jharkhand	RK Mission, Ranchi	10.10. 13	30
Latehar, Jharkhand	ATMA, Latehar	18.10. 13	50
Ranchi, Jharkhand	RK Mission, Ranchi	24.10. 13	30
Ranchi, Jharkhand	RK Mission, Ranchi	29.10. 13	30
Khunti, Jharkhand	TRDSW, Torpa, Khunti	30.10. 13	50
Palamu, Jharkhand	ZRS, Chianki	01.11. 13	25
Ranchi, Jharkhand	XISS, Ranchi	05.11. 13	71
Ranchi, Jharkhand	RK Mission, Ranchi	06.11. 13	30
Ranchi, Jharkhand	RK Mission, Ranchi	07.11. 13	33
Ranchi, Jharkhand	RK Mission, Ranchi	12.11. 13	30
Palamau, Jharkhand	Nav Jeevan Hospital, Palamau	23.11. 13	41
Ranchi, Jharkhand	THUDA, Lowadih	25.11. 13	32
Sikkim, West Bengal	Sikkim Region, West Bengal (North)	16.12. 13	12
Khunti, Jharkhand	Vikas Kendra, Simdega	18.12. 13	110
Ranchi, Jharkhand	RK Mission, Ranchi	18.12. 13	30
Ranchi, Jharkhand	RK Mission, Ranchi	19.12. 13	24
Lohardaga, Jharkhand	PRADAN, Lohardaga	24.12. 13	49
Total			**2472**

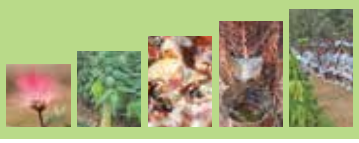


Table 21b. In-campus one-day orientation programme on NRG for school children and college students

District, State	Nominating Agency	Date	No. of Participants
Ranchi, Jharkhand	Project High School, Bargawan	13.02.13	35
Ranchi, Jharkhand	BAU, Kanke, Ranchi	04.03.13	42
Ranchi, Jharkhand	BAU, Kanke, Ranchi	13.03.13	48
Khunti, Jharkhand	Kasturba Gandhi Balika Vidyalaya, Murhu	06.04.13	51
Khunti, Jharkhand	Kasturba Gandhi Balika Vidyalaya, Murhu	06.04.13	50
Ranchi, Jharkhand	Ranchi College, Ranchi	11.04.13	09
Ranchi, Jharkhand	Sarla Birla Public School, Ranchi	18.05.13	81
Ranchi, Jharkhand	Maharani Prem Manjari Project Balika Uchcha Vidayalaya, Ratu	27.08.13	258
Ranchi, Jharkhand	Kasturba Gandhi Balika Vidyalaya, Namkum	20.09.13	115
Ranchi, Jharkhand	BWBS, Namkum	20.09.13	66
Ranchi, Jharkhand	SPP School, Sidrol, Namkum	21.09.13	117
Ranchi, Jharkhand	Kendriya Vidyalaya, Namkum	21.09.13	39
Ranchi, Jharkhand	SSP School	21.09.13	153
Ranchi, Jharkhand	Sachidanand Gyan Bharti Model School, Kusai, Ranchi	21.09.13	79
Ranchi, Jharkhand	Mazzarello Convent School, Tetri, Ranchi	21.09.13	110
Ranchi, Jharkhand	Marwari College, Ranchi	26.10.13	27
Ranchi, Jharkhand	Guru Nanak Hr. Sec. School, Ranchi	03.12.13	226
Total			**1506**

Table 21c. In-campus one-day orientation programme on NRG for extension functionaries

District, State	Nominating Agency	Date	No. of Participants
Dhanbad, Jharkhand	BAU, Kanke, Ranchi (VLWs)	22.03.13	61
Koderma, Jharkhand	BAU, Kanke, Ranchi (VLWs)	05.04.13	35
Singhbhum East, Jharkhand	BAU, Kanke, Ranchi (VLWs)	29.04.13	33
Bokaro, Jharkhand	BAU, Kanke, Ranchi (VLWs)	03.05.13	36
Gumla, Jharkhand	KVK, Gumla, Vikash Bharti (VLWs)	15.05.13	65
W. Singhbhum, Jharkhand	KVK, Jagannathpur, W. Singhbhum (VLWs)	05.06.13	24
Garhwa, Jharkhand	VLW, Trainees from Garhwa	09.12.13	64
Total			**318**

Table 21d. In-campus one-day orientation programme on NRG for executives

District, State	Nominating Agency	Date	No. of Participants
Andhra Pradesh	Andhra Pradesh Forest Academy, Hyderabad	18.02.13	38
Ranchi, Jharkhand	Administrative Training Institute, Ranchi	28.05.13	65
Total			**103**

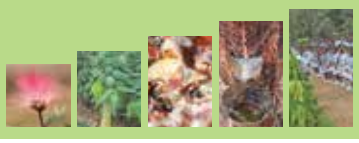
Lac based product demonstration training

Short term lac based product demonstration training was organized for self sponsored participants of different states on aleuritic acid, bleached lac, dewaxed decolorized lac and nail polish. The details are given in Table 22.

Table 22. Lac based product demonstration training

Name and Address	Sponsoring Agency	Duration	Subject
Dr. D.Raventkar, Aundh, Pune, Maharashtra	Self	11.03.13 to 19.03.13	Aleuritic Acid
Md. Imran Rokadiya, Dhamtari, Chhattisgarh	Self	13.05.13 to 22.05.13	Bleached lac
Mr. Vikrant Khandelwal, Dhamtari, Chhattisgarh	Self	27.05.13 to 01.06.13	Aleuritic Acid
Mr. Aditya Khandelwal, Dhamtari, Chhattisgarh	Self	27.05.13 to 01.06.13	Aleuritic Acid
Mr. Aditya Khandelwal, Dhamtari, Chhattisgarh	Self	27.05.13 to 01.06.13	Dewaxed decolorised lac
Mr. Hasmukh Rai Patel, Principal Scientific Officer, Mahatma Gandhi Institute for Rural Industrialization, Magunwadi, Wardha, Maharashtra	Self	29.07.13 to 13.08.13	Nail Polish

Orientation programme for school students



Other activities

Lac crop surveillance

Monitoring of lac crop, technical guidance, remedial measures for pest attack, demonstration of inoculation, spraying etc. at different locations were carried out throughout the respective seasons. The details are given in Table 23.

Table 23. Lac crop surveillance

District, State	Venue, Village (Block)	Collaborating Agency	Dated	Purpose
Surajpur, Chhattisgarh	Jamdei, Ahirpur, (Surajpur)	Ashadeep Biocare	21.01.13	*Kusmi* crop on *F. semialata*
Ranchi, Jharkhand	Saheda (Namkum)	Ashadeep Biocare	18.01.13	*Kusmi* lac crop on *ber* with pitcher irrigation
Ambikapur, Chhattisgarh	Chano, Putsura	Ashadeep Biocare	21.01.13	*Rangeeni* lac crop on *palas* tree
Purulia, West Bengal	Jabor, Kotshila, Jhalda	TRIFED, Ranchi	02.02.13	*Baisakhi* 2012-13 crop on *palas*. Spray of fipronil and fungicide recommended
Allahabad, Uttar Pradesh	Sipowa (Khajuri)	BAIF	21.02.13	*Rangeeni* lac crop on *palas* and *ber* tree
Khunti, Jharkhand	Bishnupur	Khunti Project	26.04.13	*Baisakhi* crop on *palas* and *ber*
Launipara Sundergarh, Odisha	Bandhabari and Khandadhar	TDCCOI, BBSR	27.05.13	*Jethwi* crop on *kusum* tree
Purulia, West Bengal	Balrampur	Jhalda Lac Growers and processor Co-operative Society	03.06.13	*Kusmi* lac crop on *semialata*
Sirsi, Uttar Kannada, Karnataka	Forest Range Office, Katgal Agricultural Research Station Kumta and Kumdagod Malogi Research Farm, Sirsi	College of Forestry, UAS Dharwad KVK, Sirsi, Uttara Kannada	28.06.13	Possibility of lac cultivation on *F. semialata* and other hosts
Hazaribagh, Jharkhand	Bali, Goridwar Kathadori (Churchu)	Irrigation Department	05.08.13	*Rangeeni* lac on *palas*
Khunti, Jharkhand	Torpa	Torpa Rural Development Society for Women	11.09.13	*Kusmi* lac crop on *kusum* tree
Purulia, West Bengal	Putidih, Jhalda	Jhalda Lac Growers and processor Co-operative Society	09.10.13	*Kusmi* lac crop on *ber* tree
Ramgarh, Jharkhand	Dhanbera, Ramgarh	Progressive Farmer	07.11.13	*Kusmi* lac crop on *Albizia procera*

One to one programme

New initiative has been taken to execute one to one programme in form of consultancy services to different stakeholders of NRG. The details are depicted in Tables 24 & 25.

Table 24. Number of persons interacted on different subjects in one to one programme

Subject	Jh	CG	UP	AP	Odi.	Bih.	WB	Ass.	MP	Kar.	Total (%)
Plantation raising and lac cultivation on *F. semialata*	152	8	1	2	5	8	9	1	2	1	189 (66.8)
General lac cultivation	49	7	1	1	5	2	1	4	2	0	72 (25.4)
Lac cultivation on *ber* tree	2	0	0	2	0	0	0	0	0	0	4 (1.4)
Lac cultivation on *palas* tree	1	0	0	0	0	0	0	0	0	0	1 (0.4)
Pest management	11	0	0	0	0	0	1	0	0	0	12 (4.2)
Processing of lac	2	0	0	0	0	0	0	0	0	0	2 (0.7)
Lac marketing	3	0	0	0	0	0	0	0	0	0	3 (1.1)
Total	**220**	**15**	**2**	**5**	**10**	**10**	**11**	**5**	**4**	**1**	**283**

Table 25. Potential districts of stakeholders for one to one programme

State	Districts
Jharkhand	Ranchi, Khunti, Gumla, Latehar, Lohardaga, Sahibganj, Palamu, West Singbhum, Giridih, Godda, Hazaribagh
Odisha	Sundargarh, Kalahandi, Ganjam
Chattisgarh	Surguja, Durg, Raipur, Raigarh, Balarampur, Koriya, Bastar
West Bengal	Purulia
Andhra Pradesh	Vishakhapatnam
Assam	Baksha

NRG Information Cell (NIC) and Market Oriented Technical Advisory Services (MOTAS)

Based on the information generated under market research project, a data base has been maintained in the NIC. Information related to the production, marketing, processing and export has been disseminated through verbal, written, telephonic and mails to the stakeholders. A brief description is given in Table 26.

Table 26. Details of the activities of NIC and MOTAS

State	Organization/District/Place	Category	Number
Andhra Pradesh	Rajahmundry	NGO	4
	Vishakhapatnam	Entrepreneurs	2
Bihar	NEED, Muzffarpur	NGO	1

Chhattisgarh	Mahasamund	NGO	1
	Bilaspur	Entrepreneurs	2
Delhi	IASRI and JNU, New Delhi	Research	3
	New Delhi	Entrepreneurs	3
Jharkhand	Ranchi, W. Singhbhum, Simdega, Dumka	Farmer	32
	Khunti, Gumla	NGO	2
	XISS, Ranchi	Academic	1
Maharashtra	Mumbai	Entrepreneurs	1
Odisha	Sundergarh	Traders	1
	Sundergarh	NGO	2
Rajasthan	Jaipur	Guar gum trader	1
West Bengal	Kolkata	Entrepreneurs	3
Total			**59**

Lac promotion sale counter

Lac promotion sale counter has various types of lac coated handicraft items prepared by Self Help Group of 'Bioved Lac Craft' a unit of Bioved Research Institute of Agriculture Science and Technology, Allahabad. The items include mainly paper weight, pen stands, bangle box, jewellery box, globe, bowls, plates, pen, memento etc. Besides, different types of lac varnishes are also displayed for sale as a part of promotional activity. The objective of this activity is to assess demand of lac based handicraft. The feedback of demand of items is regularly being sent to Bioved Lac Craft, Allahabad for improvement and refinement.

Diagnostic services

TOT division has also undertaken diagnostic services for forecast of larval emergence, cause of lac insect mortality, quality of broodlac, incidence of insect predators and parasitoids.

Publicity and awareness

Four free publications were distributed among farmers and other stakeholders on lac cultivation during the year 2013 (Table 27).

Sale counter for lac based handicraft

Table 27. Publication distributed to farmers and other stakeholders

Name of the Publication	States	Number
Kusum vriksha par vaigynik lakh ki kheti	Jharkhand, Bihar, West Bengal, Chattisgarh	966
Palas vriksha par vaigynik lakh ki kheti	Jharkhand, Bihar, West Bengal, Chattisgarh	1291
Ber vriksha par vaigynik lakh ki kheti	Jharkhand, Bihar, West Bengal, Chattisgarh	1691
Semialata par vaigynik lakh ki kheti	Jharkhand, Bihar, West Bengal, Chattisgarh	2516
Total		**6464**

Resources Generation

IINRG has earned Rs. 13,06,572 (Rupees thirteen lakh six thousand five hundred and seventy two) only towards training charges during the period from January to December, 2013.

6. Technology Evaluation, Refinement, Dissemination and Demonstration

6.1 Development and validation of IPM modules for the management of predators and parasitoids associated with lac insect, *Kerria lacca* (Kerr)

Evaluation of Flubendiamide for Insect-pest Management

Topical application

The result of safety evaluation with respect to topical application on *rangeeni* summer crop raised on *B. monosperma* and *F. semialata* for single spray (28-30 days after inoculation) as well as on rainy season crop raised on *B. monosperma* for one and two sprays (28-30 and 60-65 days after inoculation) indicated that mean values of lac insect survival and per cent survival due to treatment were at par with control ($P > 0.05$) (Fig. 42).

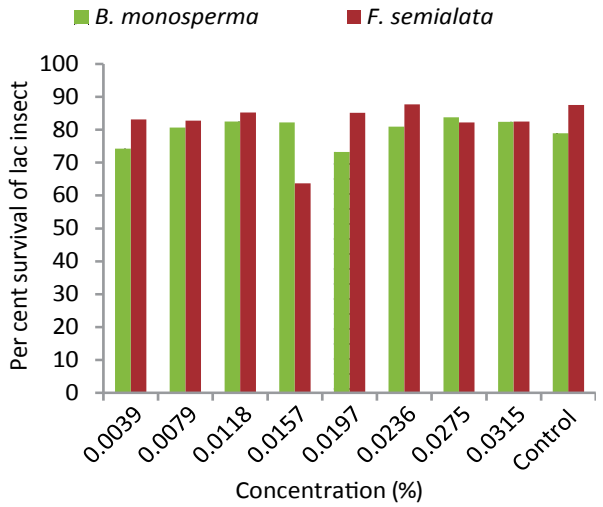


Fig. 42. Effect of flubendiamide (39.35 % m/m SC) on survival of first instars lac larvae (*rangeeni* summer season lac crop) due to topical application

Broodlac treatment

The result of survival of lac insect due to dipping of broodlac in eight concentrations (0.0039 to 0.0315 per cent) for 10 minutes and subsequent inoculation on *F. semialata* revealed that the survival of lac insect varied 65.50 to 83.71 per cent and in control the figure was 71.35 per cent. The mean values amongst the different treatment and in control was at par ($P > 0.05$). Similarly for 15 minutes dipping the mean survival varied 65.50 to 83.71 per cent due to different concentrations of the insecticide as against 71.35 per cent in control. The mean values in treatments and control was at par ($P > 0.05$) (Fig. 43).

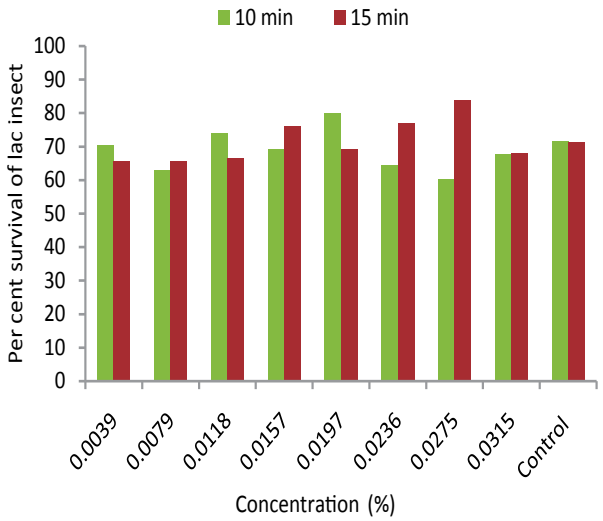
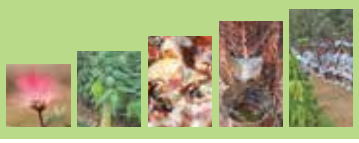


Fig. 43. Effect of flubendiamide (39.35 % m/m SC) on *rangeeni* lac insect survival due to dipping of broodlac in insecticidal formulation



Ovicidal action on eggs of *E. amabilis*

Seven concentrations of the insecticide *viz*., 0.0039, 0.0079, 0.0118, 0.0157, 0.0197, 0.0236 and 0.0275% were evaluated in laboratory for ovicidal action. The per cent of un-hatched eggs of *E. amabilis* varied 91.08 to 100 with various concentrations. The corrected per cent of un-hatched eggs have been observed to be 89.33 to 90.28 per cent. The mean values with all concentrations of pesticide was found significantly higher ($P < 0.05$) than in control (Table 28).

Effect on population of lepidopteran predators

By dipping of rangeeni broodlac derived from rainy season crop

Effect on population of *E. amabilis*

The mean population of *E. amabilis* in 50 g broodlac sample varied 0.20 to 1.70, 0.50 to 1.25 and 0.10 to 1.40 with various concentrations of insecticide for 5, 10 and 15 minutes dipping, respectively. The corresponding value in control was 3.70, 4.10 and 3.40, which was significantly higher than various concentration of insecticide evaluated ($P < 0.05$) for all the dipping time. The mean population of 5 minutes and 10 minutes dipping differ significantly ($P < 0.05$) but 10 and 15 minutes were at par ($P>0.05$) with lower concentrations (0.0039 and 0.0079%). However, with higher concentrations the mean population for all three durations were at par (Table 29).

Effect on population of *P. pulverea*

The mean population of *P. pulverea* varied 0.10 to 1.40, 0.10 to 0.90 and 0.0 to 0.60 in 50 g broodlac with 5, 10 and 15 minutes dipping time, respectively in different concentrations of treatments. Whereas in control the mean population was 4.70, 4.50 and 3.50 for 5, 10 and 15 minutes, respectively which was significantly higher ($P < 0.05$) in all treatments (Table 30).

Effect on population of insect-parasitoids

The mean population of all three parasitoids namely *T. tachardiae, A. purpureus* and *E. tachardiae* due to eight concentrations and 5, 10, 15 minute dipping showed lack of dose response relationship and thus indicated that unlike lepidopteran species the population of these parasitoids are not affected due to treatment of insecticides under this mode of treatment.

By dipping of kusmi broodlac derived from winter crop

Effect on population of *E. amabilis*

The mean population varied from 0.0 to 4.25 and 0.0 to 4.75 in 50 g broodlac dipped for 10 and 15 minutes, respectively in various concentrations of insecticide. The corresponding mean population in control was 8.0 and 6.25 for 10 and 15 minutes dipping, respectively. The mean population in various treatments was found significantly lower than the control ($P < 0.05$) for both 10 and 15 minutes dipping (Table 31).

Effect on population of *P. pulverea*

The mean population varied from 0.0 to 1.0 and 0.0 to 0.75 in 50 g broodlac dipped for 10 and 15 minutes respectively in various concentration of insecticide. The corresponding mean population is control was 6.0 and 1.75 for 10 and 15 minutes dipping respectively. The mean population was significantly lower ($P < 0.05$) in all treatments than control, for both 10 and 15 minutes. The mean population with different concentrations of insecticide for both 10 and 15 minutes are at par ($P > 0.05$) even the lowest concentration (0.0039 %) evaluated (Table 31).

Effect on population of *T. tachardiae*

The mean population varied between 4.0 to 9.75 and 4.0 to 19.00 in 50g broodlac sample for different concentrations in 10 and 15 minutes dipping respectively. The mean values were at par with control and amongst different concentrations ($P > 0.05$) (Table 31).

Residual toxicity on *A. purpureus*

Out of five concentrations evaluated, the mortality of test insect varied 31.58 to 79.46, 36.05 to 96.35 and 51.35 to 98.32 per cent during 6, 12 and 24 h of treatment, respectively. The corrected per cent of mortality within 24 h of exposure due to various concentration varied 42.49 to 98.01 per cent using Abbott's formula (Table 32).

By topical application on rangeeni rainy season crop growing on B. monosperma

Effect on *E. amabilis*

Out of eight concentrations evaluated, the mean population of *E. amabilis* showed significant reduction in population over control ($P < 0.05$). The mean population varied between 0.0 to 3.75 per cent amongst different treatments in 50 g broodlac. The reduction in population varied from 87.90 to 100 per cent (Table 33).

Effect on *P. pulverea*

In respect of *P. pulverea* the mean population varied between 0.00 to 0.75 which was significantly less than control ($P < 0.05$). The reduction in population due to different concentrations was 90.91 to 100 per cent. The mean population with all the concentration was observed to be at par ($P < 0.05$) and 100 per cent reduction has been observed with only 0.0157 % concentration (Table 33).

Effect on *T. tachardiae*

The mean population though varied between 35.75 to 115.25 but there was no difference in mean population of control and treatments with insecticide (Table 33).

Table 28. Ovicidal action of flubendiamide (480 SC) on eggs of *E. amabilis*

Conc. (%)	Mean number of eggs treated	Mean number of unhatched eggs	% of unhatched eggs	Corrected % of unhatched eggs
0.0039	87	78.75	91.08(9.60)b	89.33
0.0079	83	76.00	92.25(9.65)b	89.47
0.0118	79	74.50	93.98(9.74)bc	89.66
0.0157	67	63.75	94.62(9.77)bc	89.73
0.0197	68	64.50	95.61(9.83)bc	89.84
0.0236	60	59.25	99.59(10.03)c	90.24
0.0275	65	64.50	100.00(10.05)c	90.28
Control	74	8.00	9.72 (3.23)d	0.00
SEd ±			0.18	
Df			31	
F			354	
P			0.00	

*Figures in parentheses are transformed values to √n+1
Means marked with different letters within same column are significantly different (P<0.05)

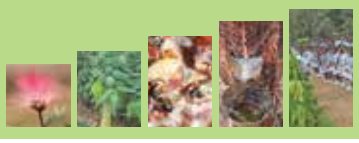


Table 29. Effect of flubendiamide (480 SC) on population of *E. amabilis* due to dipping of *rangeeni* broodlac derived from rainy season crop (July-November)

Conc. (%)	Dipping time					
	5 minutes		10 minutes		15 minutes	
	Mean number*	% reduction	Mean number*	% reduction	Mean number*	% reduction
0.0039	1.70 (1.37)d	54.05	1.25 (0.95)abc	69.51	1.40 (1.21)bcd	58.82
0.0079	1.50 (1.22)cd	59.46	1.25 (0.95) a	69.51	0.90 (1.14)abcd	73.53
0.0118	1.10 (1.19)bcd	70.27	1.20 (1.22)cd	70.73	0.50 (0.93)abc	85.29
0.0157	1.00 (1.15)abcd	72.97	1.00 (0.76)abc	75.61	0.50 (0.90)abc	85.29
0.0197	0.60 (0.99)abcd	83.78	0.90 (1.08)abcd	78.05	0.40 (0.88)abc	88.24
0.0236	0.40 (0.90)abc	89.19	0.70 (1.04)abcd	82.93	0.40 (0.91)abc	88.24
0.0275	0.30 (0.85)abc	91.89	0.80 (1.07)abcd	80.49	0.20 (0.79)ab	94.12
0.0315	0.20 (0.81)abc	94.59	0.50 (0.93)abc	87.80	0.10 (0.76)a	97.06
Control	3.70 (1.93)e	0.00	4.10 (1.99)e	0.00	3.40 (1.79)e	0.00
SEd ±	0.21		0.21		0.21	
Df	269		269		269	
F	4.83		4.83		4.83	
P	0.00		0.00		0.00	

*Mean number in 50 g broodlac. Figures in parentheses are transformed values to √n+0.5
Means marked with different letters within a coloumn are significantly different (P<0.05)

Table 30. Effect of flubendiamide (480 SC) on population of *P. pulverea* due to dipping of *rangeeni* broodlac derived from rainy season crop (July-November)

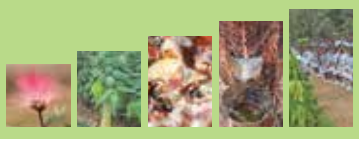
Conc (%)	Dipping Time					
	5 minutes		10 minutes		15 minutes	
	Mean	% reduction	Mean	% reduction	Mean	% reduction
0.0039	1.40 (1.28)abc	70.21	0.90 (1.07)bc	80.00	0.60 (1.00)abc	82.86
0.0079	0.50 (0.97)ab	89.36	0.20 (0.81)ab	95.56	0.50 (0.91)ab	85.71
0.0118	0.40 (0.90)ab	91.49	0.30 (0.86)ab	93.33	0.30 (0.85)ab	91.43

0.0157	0.30 (0.85)ab	93.62	0.10 (0.76)ab	97.78	0.20 (0.81)ab	94.29
0.0197	0.20 (0.81)ab	95.74	0.10 (0.76)ab	97.78	0.20 (0.81)ab	94.29
0.0236	0.10 (0.76)ab	97.87	0.10 (0.76)ab	97.78	0.10 (0.76)ab	97.14
0.0275	0.10 (0.76)ab	97.87	0.30 (0.86)ab	93.33	0.10 (0.76)ab	97.14
0.0315	0.10 (0.76)ab	97.87	0.10 (0.76)ab	97.78	0.00 (0.71)a	100.00
Control	4.70 (2.12)d	0.00	4.50 (2.13)d	0.00	3.50 (1.87)d	0.00
SEd ±	0.16		0.16		0.16	
Df	269		269		269	
F	11.99		11.99		11.99	
P	0.32		0.32		0.32	

*Figures in parentheses are transformed values to √n+0.5
Means marked with different letters for5, 10 and 15 minutes dipping time are significantly different (P<0.05)

Table 31. Effect of flubendiamide (480 SC) on population of lepidopteran predators and insect parasitoids of lac insect due to dipping of *kusmi* broodlac derived from winter season crop (July-January)

Conc. (%)	*E. amabilis*				*P. pulverea*				*T. tachardiae*	
	10 minutes		15 minutes		10 minutes		15 minutes		10 minutes	15 minutes
	Mean number	% reduction	Mean number	% reduction	Mean number	% reduction	Mean number	% reduction	Mean number	Mean number
0.0039	4.25 (1.97)^{a}	46.88	4.75 (1.89)^{ab}	24.00	1.00 (1.13)^{ab}	83.33	0.75 (1.0)^{ab}	57.14	5.33 (1.74)	4.00 (1.34)
0.0079	1.25 (1.22)^{a}	84.38	1.75 (1.41)^{abc}	72.00	0.75 (1.06)^{ab}	87.50	0.75 (1.0)^{a}	57.14	4.00 (1.34)	5.00 (2.23)
0.0118	1.00 (1.14)^{abc}	87.50	1.50 (1.39)^{abc}	76.00	0.75 (1.00)^{ab}	87.50	0.25 (0.84)^{a}	85.71	4.67 (1.73)	11.33 (2.50)
0.0157	0.75 (1.00)^{a}	90.63	1.25 (1.27)^{abc}	80.00	0.50 (0.93)^{a}	91.67	0.25 (0.84)^{a}	85.71	4.25 (2.01)	12.50 (3.37)
0.0197	0.50 (0.93)^{abc}	93.75	1.00 (1.13)^{a}	84.00	0.50 (0.93)^{a}	91.67	0.00 (0.71)^{ab}	100	5.50 (2.34)	13.25 (3.42)
0.0236	0.50 (0.97)^{a}	93.75	0.75 (1.06)^{a}	88.00	0.25 (0.84)^{ab}	95.83	0.00 (0.71)^{a}	100	6.67 (2.14)	13.00 (3.16)
0.0275	0.25 (0.84)^{a}	96.88	0.25 (0.84)^{abc}	96.00	0.00 (0.71)^{ab}	100	0.00 (0.71)^{a}	100	6.67 (2.11)	15.33 (2.97)
0.0315	0.00 (0.71)^{cd}	100	0.00 (0.71)^{bcd}	100	0.00 (0.71)^{a}	100	0.00 (0.71)^{a}	100	9.75 (2.79)	19.00 (4.10)



Control	8.00 (2.85)[e]	0.00	6.25 (2.33) [de]	0.00	6.00 (2.47)[c]	0.00	1.75 (1.41)[b]	0.00	17.75 (4.17)	38.00 (2.08)
SEd ±	0.42		0.42		0.27		0.27		0.97	0.97
Df	71		71		71		71		71	71
F	3.87		3.87		4.88		4.88		1.42	1.42
P	0.00		0.00		0.00		0.00		0.166	0.166

*Figures in parentheses are transformed values to √n+0.5
Means marked with different letters within same column are significantly different (P<0.05)

Table 32. Residual toxicity of flubendiamide (480 SC) on *A. purpureus*, a parasitoid of lac insect

Conc. (%)	No. of parasitoids released	Mortality within 1 h of exposure	Mortality within 6 h of exposure	Mortality within 12 h of exposure	Mortality within 24 h of exposure	Corrected % mortality within 24 h of exposure over control
0.0039	124	2 (5.71)	13 (31.58)c	17 (36.05)c	49 (51.35)ab	42.49
0.0079	171	13 (10.32)	53 (43.60)bc	99 (59.76)b	131 (73.27)a	68.41
0.0118	237	9 (12.50)	157 (49.05)bc	195 (69.11)ab	207 (85.82)a	83.24
0.0157	113	2 (2.56)	55 (62.09)ab	75 (80.06)ab	85 (86.16)a	83.65
0.0197	124	7 (4.49)	102 (79.46)a	120 (96.35)a	122 (98.32)bc	98.01
Control	113	0 (0.00)	0 (0.00)d	3 (2.88)d	19 (15.40)c	0.0
SEd ±		0.75	1.22	1.08	1.51	
Df		35	35	35	35	
F		1.25	10.11	15.29	6.26	
P		0.316	0.00	0.00	0.001	

Figures in parentheses are per cent mortality
Means marked with different letters within same column are significantly different (P<0.05)

Table 33. Effect of flubendiamide (480 SC) on insect predators and parasitoids due topical application on rainy season crop growing on *Butea monosperma*

Conc. (%)	*E. amabilis*		*P. pulverea*		*T. tachardiae*
	Mean number*	% reduction	Mean number*	% reduction	Mean Number*
0.0039	3.75 (1.99)b	87.90	0.75 (1.10)a	90.91	68.25 (7.91)
0.0079	3.25 (1.85)ab	89.52	0.25 (0.84)a	96.97	35.75 (5.94)
0.0118	3.50 (1.94)b	88.71	0.25 (0.84)a	96.97	51.25 (7.12)

0.0157	2.25 (1.55)ab	92.74	0.00 (0.71)a	100.00	68.75 (8.10)
0.0197	1.00 (1.22)ab	96.77	0.00 (0.71)a	100.00	115.25 (10.68)
0.0236	0.50 (0.97)ab	98.39	0.00 (0.71)a	100.00	110.25 (10.43)
0.0275	0.00 (0.71)a	100.00	0.00 (0.71)a	100.00	103.75 (10.17)
0.0315	0.00 (0.71)a	100.00	0.00 (0.71)a	100.00	27.50 (5.15)
Control	31.00 (5.38)c		8.25 (2.94)b		97.50 (8.36)
SEd ±	0.55		0.18		1.95
Df	35		35		35
F	13.28		33.82		2.02
P	0.00		0.00		0.088

*Figures in parentheses are transformed values to √n+0.5
Means marked with different letters within same column are significantly different (P<0.05)

6.2 Demonstration of lac cultivation technologies under farmer's field condition

The project is being carried out for demonstration of the proven lac cultivation technologies in the field through participation of the farmers, GOs and NGOs. The details are depicted in Table 34 & 35.

Table 34. Demonstration of lac cultivation technologies in different States and districts

State	District	Technologies demonstrated	Crop	Linkages/Agencies
Jharkhand	Latehar (Lalli)	*Kusmi* lac on *ber*	Winter season	Progressive farmers
	Latehar (Nadbelwa)	*Rangeeni* lac on *palas*	Rainy season	
	Bokaro (Peterwar)	*Kusmi* lac on *semialata*	Winter season	KVK, Bokaro
		Rangeeni lac on *palas*	Summer season	
	Saraikela-Kharsawan	*Kusmi* lac on *ber*	Winter season	KVK, Saraikela-Kharsawan
		Kusmi lac on *semialata*		
Maharashtra	Gondia	*Kusmi* lac on *semialata*	Winter season	NGO (BAIF)
		Kusmi lac on *kusum*	Summer season	
		Rangeeni lac on *palas*	Summer season	Lac Industrialist
Bihar	Patna	*Kusmi* lac on *semialata*	Winter season	ICAR- RCER, Patna
Uttar Pradesh	Allahabad	*Kusmi* lac on *semialata*	Winter season	NGO- BIOVED

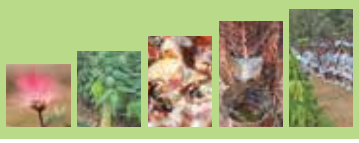


Table 35. Details of crop output (broodlac yield)

Place	Lac host utilized	Crop	Yield Ratio
Bokaro	*F. semialata*	*Kusmi* lac crop (winter season)	3.8
Allahabad	*F. semialata*	*Kusmi* lac crop (winter season)	4.7
Saraikela- Kharsawan	*Z. mauritiana*	*Kusmi* lac crop (winter season)	6.7
Latehar	*B. monosperma* and *Z. mauritiana*	*Rangeeni* lac crop (rainy season)	5.0

Winter season *kusmi* broodlac was inoculated on *ber* and *semialata* at Saraikela and Bokaro (Jharkhand), Patna (Bihar), Gondia (Maharashtra) and Allahabad (U.P.). Rainy season *rangeeni* lac crop was also inoculated on *palas* tree at Saraikela and Latehar. Harvesting of *kusmi* winter season crop on *ber* and *semialata* was done with good results at Saraikela, Allahabad and Bokaro. While complete crop mortality was observed in Patna, Gondia and Latehar for winter season *kusmi* lac crop. Two sites *viz.*, Lalli and Nadbelwa (Dist. Latehar) in Jharkhand and one at Allahabad in U. P. were dropped after two years of completion of the activities. Two sites namely Sitapur (U.P.) and Rangamati, Purulia (W.B.) have been added to the list.

6.3 Market research for production and marketing of natural resins and gums

Natural resins and gums related data on production, price and export were collected from the 307 stakeholders including 62 traders, 61 manufacturers and 184 Govt. officials and key informants across 33 districts of 11 states. Secondary data on NRGs about export, import and production from various websites were collected. On the basis of survey in the markets and processing centres of different lac producing states, the estimated national production of sticklac during 2012-13 was approximately 19,577 tons (Fig. 44). Jharkhand ranks 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal. These five states contribute around 96 % to the national lac production. At national level, the production of lac was observed around 9.36 % more than the previous year.

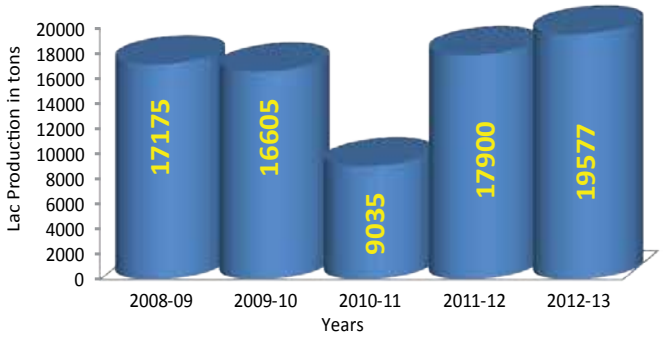


Fig. 44. Lac production in India during previous five years

The data on prices of *rangeeni* and *kusmi* sticklac and seedlac have been collected from the lac markets on bi-monthly basis. Price of *rangeeni* and *kusmi* sticklac has shown decreasing trend from Jan. to Dec. 2013. Prices declined sharply during the period. It was due to the surplus supply of sticklac in the market and poor demand from the industry as the previous year carry over with them. Export data of current year 2012-13 was compared with the last year and it indicated that current year export was comparatively lower than last year (2011-12). However, in value terms it is higher than previous year. A decline in export was observed but the export value of lac based value added products were higher than previous year (Table 36). *Guar* gum production level increased due to its export demand. Rajasthan contributed more than 80% of *guar* gum production in the country. Overall, NRG production level during 2012-13 is estimated to be comparatively higher than the previous year.

Table 36. Total NRG production, export and import during 2012-2013

Particulars	Production (tons)	Export		Import	
		Quantity (tons)	Value (Rs. Lakh)	Quantity (tons)	Value (Rs. Lakh)
Guar gum	807541.68	331497.58	2114672.40	460.35	2573.72
Lac	19575.00	4361.30	48027.58	NA	NA
Karaya gum (Indian Tragacanth)	212.35	576.40	2220.80	71.92	197.86
Other NRGs*	10251.78	3949.48	11197.83	89214.06	75763.32
Total	**837580.78**	**340384.76**	**2176118.61**	**89746.33**	**78534.90**

**Production figure includes only gums and pine resins*

6.4 Evaluation of lac mud as organic manure

The project was initiated with an objective to evaluate the suitability of lac mud in vegetable crops. It is well established fact that many industrial wastes, creating pollution problem in the country are known to contain plant nutrients and many have been explored for use in agriculture as organic source of plant nutrition for saving a part of chemical fertilizers without affecting the yield potential. Lac mud produced in our country is mostly dumped which may create pollution hazards. In long run it is not suitable for sustainability of lac industry and in turn lac production system. Keeping this in view, the field experiment was conducted taking 8 different lac mud based treatments (100% N through lac mud, 75% N through lac mud + 25% N through inorganic source, 50% N through lac mud + 50% N through inorganic source, 25% N through lac mud + 75% N through inorganic source, 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source, 12.5% N through lac mud + 12.5% N through vermicompost + 75% N through inorganic source, 100% N through inorganic source and control *i.e.*, no manure and fertilizers) in brinjal.

Effect on plant growth: Integration of different sources of nutrients i.e., lac mud, vermicompost and inorganic fertilizer recorded higher plant height, stem girth, number of primary branches and number of leaves per plant at 25, 50 and 75 days after transplanting. Application of 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source proved better followed by 50% N through lac mud + 50% N through inorganic source, 12.5% N through lac mud + 12.5% N through vermicompost + 75% N through inorganic source and 25% N through lac mud + 75% N through inorganic source.

Effect on flowering and harvesting time: Days to flowering and first harvesting were reduced by application of different lac mud based treatments. Application of 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source reduced the days taken in flowering and first harvesting by 5 and 10 days, respectively, as compared to 100% N through inorganic source.

Effect on yield and its attributes: Nitrogen substituted through 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source recorded the highest number of fruits per plant, average fruit weight, fruit weight per plant and fruit yield per hectare (Table 37). Fruit yield per hectare with application of 25% N through lac mud + 25% N through vermicompost + 50% N through inorganic source, 50% N through lac mud + 50% N through inorganic source, 12.5% N through lac mud + 12.5% N through vermi compost + 75% N through inorganic source, 25% N through lac mud + 75% N through inorganic source was 10.46, 8.78, 2.44 and 1.04% higher over 100% N through inorganic source.

Table 37. Effect of lac mud based on fruit yield and its attributes of brinjal

	No. of fruits/ plant	Fruit weight (g)	Fruit yield (q/ha)
100% N through lac mud	5.01	205.0	305.78
75% N through lac mud + 25% N through inorganic source	5.01	205.0	315.14
50% N through lac mud + 50% N through inorganic source	8.02	226.2	347.62
25% N through lac mud + 75% N through inorganic source	7.02	215.1	322.88
25% N through lac mud + 25% N through vermi-compost + 50% N through inorganic source	8.03	230.2	352.99
12.5% N through lac mud + 12.5% N through vermicompost + 75% N through inorganic source	7.02	217.1	327.36
100% N through inorganic source	6.01	207.1	319.55
Control (No manure and fertilizers)	4.00	122.9	150.41
S. Ed.	0.55	17.28	19.01
CD (P= 0.05)	1.18	37.08	40.79

6.5 Impact assessment of technological interventions and constraints analysis of lac cultivation

A complete list of farmers trained during last five years was prepared and a cluster of villages across the blocks of five districts were identified. Finally, to conduct the study a total of 150 households were selected randomly.

Interaction with the trained lac farmers in Mandla district of Madhya Pradesh

Other Projects (Sponsoring Agency)

7. Network project

7.1 Network project on harvesting, processing and value addition of natural resins and gums (ICAR)

Network Project on Gum Arabic at CAZRI, Jodhpur

Gum production from important arid plant species

Twenty trees of each gum yielding species *viz., Acacia tortolis*, *Anogeissus rotundifolia*, *Anogeissus pendula*, *Acacia senegal* and *Prosopis juliflora* were selected and treated with CAZRI gum inducer at CAZRI, Kailana afforestration experimental area. The terrian of the said area is undulating and rocky- gravelly in structure. In the same manner ten trees of each lesser known gum yielding species *viz.*, *Balanities aegyptiaca* and *Cordia myxa* were also selected and treated with CAZRI gum inducer. Tree structure traits *viz.*, collar diameter, canopy size, treatment date, gum collection date and yield were recorded (Table 38). Gum production per tree was maximum from *A. rotundifolia* (519 g/tree) and minimum from *A. pendula* (120 g/tree).

Table 38. Tree structural traits and gum yield at Kailana afforestration area of CAZRI from different trees species.

Trees Species		Mean			Date of Treatment	Date of Gum collection	Average Yield (g/ tree)
		Tree Height (m)	CD (cm)	Canopy (m)			
known popular gum yield species	*Acacia senegal*	4.62	65.80	2.45	13.3.13	27.3.13	135.50
	Acacia tortolis	4.34	38.40	2.45	16.3.13	27.3.13	240.00
	Anogeissus pendula	5.65	25.50	5.20	16.3.13	27.3.13	120.00
	Anogeissus rotundifolia	7.55	88.50	5.80	16.3.13	27.3.13	519.30
	Prosopis juliflora	3.00	18.90	2.78	30.3.13	10.4.13	220.00
Lesser known gum yielding species	*Balanities aegyptiaca*	4.95	43.10	2.45	14.3.13	27.3.13	217.00
	Cordia myxa	6.77	61.28	4.47	30.3.13	10.4.13	148.00

CD= Collar diameter/ coefficient of deviation

Gum production from *B. monosperma* in semi arid area

B. monosperma is a small to medium-sized deciduous tree, 5-15 (max. 20) m tall, up to 43 cm diameter at breast height (DBH); trunk usually crooked and tortuous, with rough greyish-brown, fibrous bark showing reddish exudates; branchlets densely pubescent. Species is widely distributed throughout India, Burma and Ceylon, popularly known as '*dhak*' or '*palas*', commonly known as 'flame of forest'. The trials were conducted in Sagatpuria, Birdhol and Mansa villages of Kotari block of Bhilwara district of Rajasthan. Gum obtained from *B. monosperma* is also known as *Kamarkas,* which has medicinal properties for treatment of back and knee pain, diarrhea and dysentery, infusion or decoction of the gum, anemia, etc. The gum of *B. monosperma*, is also used in many food dishes.

Drilling of the tree trunk was attempted during February, 2013 (Fig. 45). Gum exudation start 4-5 days after treatment and continues up to another 4-6 days. It appears that the dose being applied is not suitable for *B. monosperma*, therefore to standardize the dose of gum inducer as well as time, further studies are required so that optimum gum can be harvested from this species. The average yield of gum obtained was 137.3g/tree (Table 39).

Fig. 45. Step by step process of treating *B. monosperma* trees for gum exudation

Table 39. *B. monosperma* tree structural traits and gum yield at different villages of Bhilwara District

Villages	Mean			Date of Treatment	Date of Gum picking	Average Yield (g/ tree)
	Tree Height (m)	CD (cm)	Canopy (m)			
Sagatpuriya	8.13	86.8	4.9	4.2.13	8.2.13	137
Birdhol	7.83	79.8	4.2	4.2.13	9.2.13	149
Mansa	8.95	91.2	5.1	4.2.13	8.2.13	126

CD= Collar diameter/ coefficient of deviation

Effect of management practices and gum inducer on gum production of *Acacia senegal* in rocky and semi-rocky lands

Experimentation continued during the year 2012-13 at Bhopalgarh experimental area of CAZRI, Jodhpur. Treatments comprised of 2 factors. Factor one consisted of 3 levels of management practices *viz.*, irrigation, manuring and irrigation + manuring with an absolute control. Factor 2 consisted of two concentrations of gum inducer *viz.*, half concentration of normal dose and normal dose with an absolute control. Normal dose contains 195 mg ethephon/ml of solution. The results of three years experimentation are presented in Table 40. In case of control (conventional practice by making blazes on tree trunk) the gum production was more or less negligible. However, fortnightly two irrigations before treatment during 2012-13 resulted in production of gum to the tune of 22 g/tree in case of half concentration of the normal dose treatment and 56 g/tree in case of normal dose treatment.

Manuring of the trees resulted in production of 29 and 61 g gum/tree respectively in half concentration of normal dose treatment and normal dose treatment (Table 40). When manuring was done with irrigation during the year it was found that gum production was 32 g/tree when half concentration of normal dose was applied, which was higher than even normal dose treatment. This clearly indicates that with slight tree management in form of manuring and watering the concentration of gum inducer can be reduced to half (97.5 mg ethephon/ml of solution) of normal strength. This indicated that in rocky and semi-rocky areas where *A. senegal* grows in abundance, tree management practices coupled with gum inducer application can be effective for gum Arabic exudation. About 23,520 sq km area in arid western Rajasthan is rocky and semi-rocky and *A. senegal* is the main tree constituent of such land formation. Such land forms can enhance the farmers' income by way of gum production through use of management practices and gum inducer. In case of 150 trees/ha, such unproductive land form can produce 3 kg gum/ha which can provide an additional income of Rs. 3000/- to the farmers. Besides, Rs. 3,000 to 5,000 can be earned by sale of *A. senegal* seed from the same plantation.

Table 40. Effect of management practices (P) and different concentrations (C) of gum inducer on gum production of *A. senegal* in semi-rocky area of Bhopalgarh, Jodhpur

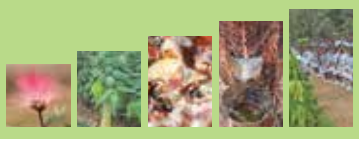
Treatments	2010-11			2011-12			2012-13		
	Control	Half conc.	Full conc.	Control	Half conc.	Full conc.	Control	Half conc.	Full conc.
Control	0.0	8.5	31.7	2.3	10.4	37.4	3.5	17.5	15.17
Irrigation	0.0	20.0	46.3	1.0	25.9	52.0	4	21.5	55.67
Manuring	0.0	28.7	34.3	0.8	32.7	40.5	3	28.7	60.83
I + M	3.3	60.3	21.3	7.0	71.4	27.3	3.3	31.8	64.33
SEm±	Between mean of P	Between mean of C	Between Interaction P x C	Between mean of P	Between mean of C	Between Interaction P x C	Between mean of P	Between mean of C	Between Interaction P x C
	1.74	1.5	3.01	1.91	1.65	3.3	10.68	9.25	18.4
CD (P=0.05)	5.09	4.41	8.81	5.59	4.84	9.68		27.12	

Seeds of *A. senegal* are valuable commodity as they are used as vegetable in western Rajasthan. Seed production in *A. senegal* trees under different management practices in rocky and semi-rocky lands were investigated during 2012 (September to December. 2012). Seeds in five trees in each replication were removed from the pods and weighed. The process continued till the seed formation was completed.

Details of seed production in the experiment are presented in (Table 41). Three years data indicated that trees which were treated with half concentration of gum inducer together with manuring produced maximum quantity of seeds per tree. The treatment of only half conc. of gum inducer resulted in poor seed setting. Irrigation + manuring + half concentration of gum inducer were second best treatment as far as seed production after treatments was concerned.

Table 41. Seed production in *A. senegal* on rocky and semi rocky lands at Bhopalgarh, district Jodhpur as affected by management practices for gum exudation

Treatments	Seed Yield (g/tree/yr)			Average
	Year-2011	Year-2012	Year-2013	Yield (g/tree/yr)
Control (No irrigation, No Manuring, No dose of gum inducer)	145.00	153.33	204.50	167.61
Half conc. of gum inducer	110.00	123.33	229.50	154.28
Full conc. of gum inducer	142.00	151.67	299.50	197.72
Irrigation	130.00	135.00	202.50	155.83
Irrigation and Half conc. of gum inducer	128.00	136.67	160.00	141.56
Irrigation and Full conc. of gum inducer	148.00	158.33	140.00	148.78
Manuring	126.00	133.33	142.50	133.94
Manuring and Half conc. of gum inducer	190.00	276.67	368.00	278.22
Manuring and Full conc. of gum inducer	135.00	145.00	195.00	158.33
Irrigation + Manuring	171.00	186.67	264.00	207.22
Irrigation + Manuring and Half conc. of gum inducer	185.00	191.67	299.00	225.22
Irrigation + Manuring and Full conc. of gum inducer	130.00	143.33	190.50	154.61
Average yield (g/tree/ Year)	**145.00**	**161.25**	**224.58**	**176.94**



Plantation establishment of high gum yielding plant type of *A. senegal*

A stand of high gum yielding plant type of *A. senegal* (Nigerian origin) was established in the farm of CAZRI during monsoon season of 2010. The survival percentage after 3 years was more than 96%. The row to row and plant to plant distance is 3 x 3 m. On an average the plants attain a height of 225 cm and collar diameter (CD) 17.7 cm.

Extension and adoption of gum inducing technique

The farmers from over 45 villages of Chauhatan and Baytu tehsils of Barmer district; Shergarh and Phalodi tehsils of Jodhpur district; some villages of Nagaur and Pali districts have adopted the gum inducing technology in large scale. Total number of trees treated with gum inducer reached up to 30,000 during 2012-13, resulting in production of 12 t of gum Arabic. During the year average rate of gum Arabic was Rs. 700/- per kg in local market. The farmers earned a revenue of Rs. 84,00,000/. As the gum exudation technology is being adopted by large number of farmers and every year the population of treated trees of *A. senegal* is increasing substantially. Besides *A. senegal* other gum yielding trees like *A. tortilis, A. nilotica, A. leucopholea, P. cineraria, P. juliflora, A. rontundifolia* etc. are also being treated by villagers by using this technique effectively for gum production.

Training/Workshop organized

Subject	Venue	Duration	Remarks
One day field training	Village, Bhramsar, District Jaisalmer	16 March 2013	About 70 farmers participated. Two hundred doses of gum inducer was distributed free of cost to farmers for livelihood improvement programme.
Farmers' workshop on request of India Bull Foundation	Village, Karnu and Tehsil-Khimsar, District –Nagaur	23 March 2013	More than 100 farmers participated in the workshop. One thousand doses of CAZRI gum inducer were distributed to farmers to spread technology in larger parts of Nagaur District, where large number of scattered pockets of *A. senegal* are found in abundance.
One day off-campus training-cum-workshop on request of Gharmin Vikas Trust	Village, Rohina and Dheari, Distrct- Nagaur	26 March 2013	Two hundred doses of CAZRI gum inducer was distributed free of cost to farmers of both villages to spread technology for livelihood improvement.
One day field training	Village, Kharesh, District Nagaur	3 June 2013	About 100 farmers participated. Two hundred doses of gum inducer was distributed free of cost to farmers for livelihood improvement programme.

Network Project Centre at NRC Agro-Forestry, Jhansi

Development of agroforestry models including gum and resin yielding trees for livelihood security and horizontal dissemination of technologies.

On NRCAF Research farm

In agri-horti-silviculture model, maximum survival was recorded in *Aegle marmelos* and plant height in *A. senegal* (Table 42). The minimum survival and growth was observed in *Carrisa carandus*. In horti-silviculture-I model, *A. senegal* planted in rows show lesser survival (27%) than on boundary (90%). In term of plant height and other growth parameters, row plantation attained better growth than boundary. *Terminalia arjuna* has shown 100% survival. In horti-silviculture-II model, *A. nilotica* has shown maximum growth. In both horti-silviculture models, fruit yielding species *viz., Citrus limon* and *Psidium guajava* could not survive. Survival of *A. senegal* block plantation on rocky site was 100% and plants attained mean height of 194 cm with collar dia. of 2.5 cm. In general, survival and growth of *A. nilotica* was better than *A. senegal*.

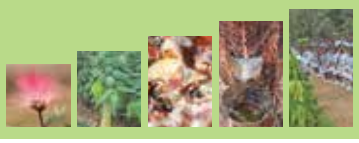
Table 42. Growth and survival of trees in the agroforestry models at NRCAF farm (42 MAP)

Agroforestry Models	Collar diameter (cm)	Height (cm)	Canopy (m^2)	Survival (%)
Agri-horti-silviculture(Field No. 25)				
Acacia senegal (Kumat)	9.19	389.17	10.85	82
Citrus limon (Lemon)	4.88	240.95	4.56	91
Aegle marmelos (Beal)	8.11	305.00	4.98	96
Carrissa carandus (Karonda)	0.65	74.41	0.095	75
Horti-Silviculture I (Field No. 20)				
A. senegal	9.09	379.44	15.17	27
Terminalia arjuna (Arjun)	4.87	155.4	1.65	100
A. senegal (boundary)	6.49	268.6	5.92	90
Horti-Silviculture II (Field No. 20)				
Acacia nilotica (Babul)	41.56	621.60	35.04	100
Terminalia arjuna (Arjun)	4.83	167.80	2.63	100
A. senegal (boundary)	5.39	209.80	3.81	90
Block plantation				
A. senegal	2.49	194.03	1.12	100

During the rabi season in agri-horti-silviculture model, mustard (*var. varuna*) was sown on 31 Oct. 2012 and the recommended package of practices were followed. The crop was harvested on 21 March, 2013. Plant growth and yield attributes were measured at different distances *viz.*, 0.5, 2.5 and 4.5m distances from each tree line (*A. senegal*, *Aegle marmelos* and *C. limon*) and control. Growth and yield data of mustard grown in agri-horti-silvi model is given in Table 43. Different tree species had significantly reduced grain yield up to 0.5m distance from tree trunk while yield at 2.5m and 4.5 m distance was not affected. More plant population was observed under *A. marmelos* (24 plants/m^2) than under *A. senegal* (16 plants/m^2) among the trees, while the control (33 plants/m^2) recorded maximum plant population. Similar trend was observed for total biomass and grain yield. Maximum grain yield was obtained from the control plot (108.63 g/m^2) followed by *A. marmelos* (70.80 g/m^2) while minimum under *A. senegal* (45.29 g/m^2). Lesser values for all the parameters were recorded nearer to the tree line compared to farthest distance.

Table 43. Growth and yield attributes of Mustard (var. varuna) under agroforestry model including gum and resin yielding trees (2012-13)

Growth parameters	Distance from tree line (m)	Tree species				
		A. senegal	***C. limon***	***A. marmelos***	**Control**	**Mean**
Plant population/ m^2 (no.)	0.5	8	9	12	33	15
	2.5	20	26	28	33	27
	4.5	22	26	32	33	28
	Mean	**16**	**20**	**24**	**33**	



Plant height (m)	0.5	154.2	167.2	168.4	204.5	173.6
	2.5	174.5	189.4	195.1	204.5	190.9
	4.5	187.0	198.4	204.7	204.5	198.6
	Mean	**171.9**	**184.9**	**189.4**	**204.5**	
Total biomass (g / m^2)	0.5	79.95	127.07	152.17	473.98	208.29
	2.5	247.18	358.77	415.11	473.98	373.76
	4.5	275.66	415.29	438.06	473.98	400.75
	Mean	**200.93**	**300.38**	**335.11**	**473.98**	
Grain yield (g / m^2)	0.5	10.87	12.78	17.07	108.63	37.34
	2.5	59.56	71.13	93.98	108.63	83.32
	4.5	65.44	90.58	101.36	108.63	91.50
	Mean	**45.29**	**58.16**	**70.80**	**108.63**	

On farmers field

Data on survival and growth of various species planted in different agroforestry model at farmers' field in GKD watershed and Ambabai village is presented in Table 44.

Table 44. Growth parameters of trees in the agroforestry models at GKD Watershed (42 MAP)

Plantation	Collar diameter (cm)	Height (cm)	Canopy (m^2)	Survival (%)
Sri Thakur Das				
A. nilotica	37.67	237.50	1.96	53
Psidium guajava (Guava)	2.28	117.36	0.72	98
Carrissa carandus (Karonda)	0.6	73.00	0.11	12
Sri Himmat				
A. senegal	6.43	258.33	6.63	78
Emblica officinalis (Anola)	10.31	377.29	10.85	54
C. carandus	0.63	48.00	0.08	18
Sri Mani Ram				
A. senegal	3.14	161.36	2.76	41

After 42 months of planting, *A. senegal* recorded more survival (78%) than *A. nilotica* (53%) in GKD watershed. Out of planted horti-cultural species, guava had shown maximum survival (98%) while, karonda the least (18%). In terms of plant height *A. senegal* was better than *A. nilotica* whereas, reverse was true in case of collar dia. Newly planted *A. senegal* recorded 70 to 96% survival in GKD watershed. In Ambabai village after 18 months of planting, survival of *A. senegal* was 41% with plant height of 161 cm and collar dia 3.14 cm (Table 45).

Table 45. Survival of boundary plantation of gum yielding tree, *A. senegal* planted at Farmers' field in GKD watershed in 2012

Farmer's Name	No. of trees planted	Spacing (m apart)	Survival (%)
Sri Lakhan	50	2.5	84
Sri Shambhu	50	2.5	88

Sri Gangadhar	50	2.5	80
Sri Soni Pal	50	2.5	90
Sri Saligram	10	4	80
Sri Ghanshyam	50	2.5	96
Sri Ram Swarup	20	3	80
Sri Sumer	20	3	70
Sri Manoj	10	4	70
	310		

Effect of lac production on gum yield and *vice versa*

To assess effect of inoculation of lac insect on gum yield of *B. monosperma* trees, a trial was conducted at naturally occurring 15-20 year old trees of *B. monosperma*. Lac insect was inoculated in the month of November 2012 and lac was harvested in July 2013. For exudation of gum, knotching was done in the month of December on both lac inoculated and un-inoculated trees. It revealed that inoculation of lac insect increased gum exudation in *B. monosperma* trees (Fig. 46). Trees inoculated with lac insect yielded more gum (76.0 g/m^2) than un-inoculated trees.

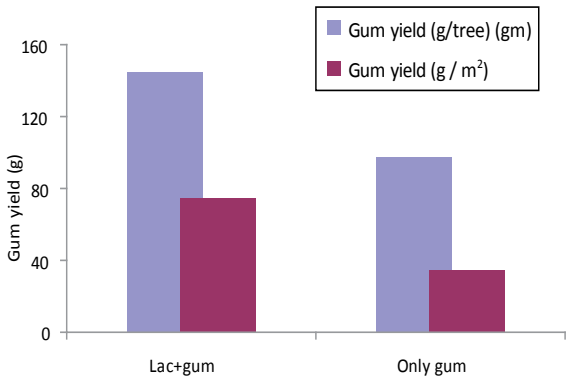


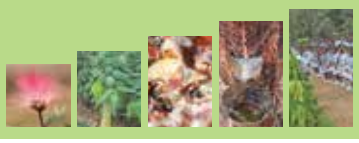
Fig. 46. Effect of lac production on gum yield and vice versa in *B. monosperma*

Effect of Ethephon on yield of *B. monosperma* gum

A trial conducted on naturally occurring 15-20 years old trees of *B. monosperma* at NRCAF farm to assess effect of gum inducer (ethephon) on yield of *B. monosperma* gum. Trial consisted of four treatments *viz.,* control, spray of ethephon on tree surface before knotching, spray of ethephon after knotching and injection of ethephon at base of tree before knotching; and three doses *viz.* 4 ml of 10%, 4 ml of 20% and 4 ml of 30% ethephon. The finding revealed that yield of gum was significantly influenced by application of ethephon, however, doses did not affect the yield. Maximum gum was obtained when ethephon was sprayed on tree surface before knotching (Table 46).

Table 46. Effect of Ethephon application on gum yield (g/m^2) from *B. monosperma*

Method of Ethephon application	**Dose of Ethephon and respective gum yield (g/tree)**			
	4 ml of 10%	**4 ml of 20%**	**4 ml of 30%**	**Mean**
Control	38.4	22.5	45.4	35.4
Spray of ethephon on tree surface before knotching	369.6	272.7	269.1	303.8
Spray of ethephon on tree surface after knotching	89.5	46.0	47.9	61.1
Injection of ethephon at the base of tree trunk+ knotching	10.0	15.7	16.9	14.2
Mean	**126.8**	**89.2**	**94.8**	
Level of significance (P-value) for samples methods				9.96E-07
Level of significance (P-value) for ethephon dose				0.0553
Level of significance (P-value) for interaction				0.0936



Network Project on *guar* gum at MAU, Parbhani

Viscosity profile (mpa.s) of 1% gum solution of *guar* genotypes of different locations

The *guar* gum was isolated and purified from endosperm splits using wet processing method. The viscosity profile of 1 per cent gum solution was carried out at 37±1^{0}C by using Haake's Rotoviscometer (RV-20). The result on viscosity profile of aqueous 1% guar gum solution of various *guar* genotypes exhibited a good thickening capacity. The viscosity of genotypes found to vary from 3050 to 6164 mpa.s (Table 47). Genotype HGS-563 showed maximum mean viscosity of 5765 mpa.s followed by CAZG-11-3 (5679 mpa.s) and RGr-11-2 (5675 mpa.s). Location wise, gum sample from Jodhpur ranked 1st in viscosity of 5336 mpa.s followed by Durgapura (5321 mpa.s).

Table 47. Viscosity profile (mpa s) of 1% gum solution of *guar* genotypes of different locations.

Genotypes	Durgapura	Jodhpur	Parbhani	S K Nagar	Mean	Rank
HGS-3-52	4350	3548	3050	4120	3767	11
RGC-1038	5110	4675	5010	4825	4905	9
RGr-11-3	5548	5962	5978	5202	5673	4
HGS 26-5-1	5060	5535	5810	5641	5512	5
RGr-11-1	5230	5200	4239	5113	4946	8
CAZG-11-2	5020	5417	4025	5524	4997	7
GAUG-825	4105	4546	5131	4647	4607	10
CAZG-11-1	6013	6121	5831	4013	5495	6
CAZG-11-3	6135	5539	5919	5122	5679	2
RGr-11-2	5985	6164	4524	6025	5675	3
HGS-563	5970	5993	4973	6122	5765	1
Mean	5321	5336	4954	5123		
Rank	2	1	4	3		

Flow properties of variety RGC-936 *guar* gum solution with respect to concentration of gum

The results presented in Table 48 on viscosity profile as a function of concentration of *guar* gum revealed that they exhibited pseudoplastic/non-newtonian behaviour at relatively higher concentrations. It was observed that viscosity of *guar* gum solution increased from 3490.14 to 51652.43 mpa.s at lower shear rate (4.51s^{-1}) as the concentration increased from 1 to 3%. The apparent viscosity of *guar* gum solution decreased from 3490.14 to 498.18 mpa.s as the shear rate increased from 4.51 to 451 s^{-1} at the concentration level of 1%.

Table 48. Flow properties of variety RGC-936 *guar* gum solution with respect to concentration of gum

Concentration of gum (%)	Apparent viscosities (mpa.s)[a]					
	Shear rate (sec^{-1})[b]					
	4.51	**12.63**	**34.73**	**97.42**	**270.15**	**451.00**
1.0	3490.14	2840.45	2095.40	1499.16	1235.77	498.18
1.5	5750.20	2898.38	1900.18	1680.96	1440.85	990.20

2.0	32000.26	16274.10	21700.27	11168.38	7629.32	3258.53
2.5	48979.08	32400.18	25315.25	15959.68	10152.30	6397.26
3.0	51652.43	40590.78	33997.17	26138.10	12278.37	7389.17

a - Each value represents the average of three determinations
b - Unless otherwise stated, the readings were recorded from shear rates 4.51 to 451 s^{-1} (total 10 determinations)

Effect of temperature on flow properties of variety RGC-936 1.0 % *guar* gum solution

The data on effect of temperature on flow behavior of *guar* gum solutions at 1% concentration at different shear rate are presented in Table 49. It was observed that viscosity of 1% solution decreased considerably when the temperature of solution increased from (40 to 80^{0}C). The viscosity of 1% solution at 40^{0}C was 3193.17 mpa.s at 4.51 s^{-1}, but it was drastically reduced (1816.77 mpa.s) at 80^{0}C at the same share rate.

Table 49. Effect of temperature on flow properties of variety RGC-936 1.0 % *guar* gum solution

Temperature (^{o}C)	Apparent viscosities (mpa.s)[a]					
	Shear rate (sec^{-1})[b]					
	4.51	12.63	34.73	97.42	270.15	451.00
40	3193.17	2280.11	1690.14	1221.75	953.15	453.48
50	2665.47	2120.32	1322.55	1082.13	868.17	408.53
60	2610.16	2036.19	1302.81	936.14	695.90	310.18
70	2243.76	1876.08	1128.11	630.56	463.12	252.19
80	1816.77	1398.59	1065.64	520.90	393.33	147.68

a - Each value represents the average of three determinations.
b - Unless otherwise stated, the readings were recorded from shear rates 4.51 to 451 s-1 (total 10 determinations)

Network Project on Rosin at Dr. YSPUH&F, Solan

Progeny experiment at main campus, Solan

The study area is within the natural range of *Pinus roxburghii* Sargent. Investigating trees were located in the campus area of Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, near Oachghat at an altitude of 1200-1225 m above mean sea level and located at 30° 51' N latitude and 76° 11' E longitude. This represents a transitional zone between subtropical and temperate region of the state of Himachal Pradesh. Experiment has been laid out on resin tapping potential of chir pine progenies of superior trees raised at main campus and data collected for oleoresin yield. The trees of progenies having more than 30 cm diameter at breast height (dbh) were segregated for oleoresin tapping experiment (Fig. 47). In total, 22 out of 60 progenies had minimum one tree above 30 cm dbh in at least two replications, and were selected for oleoresin tapping. The method employed for oleoresin collection was borehole method. Three boreholes at different times (March- October, April-October and May-October) were drilled in each tree. The collection of oleoresin was made from 44 trees. The oleoresin collected from each tree was weighed and recorded in the end of season.

Fig. 47. Progeny trial of chir pine

Oleoresin yield

The average value of oleoresin yield was recorded to be 865 g. The maximum value of oleoresin yield was noted in Kopra-P5 (1182 g/season) followed by statistically at par values for Jubble-PT-Green Centre(1160 g/season), Bagthan-PT-Black Centre (1080 g/season), Leda-P10 (1100 g/season), Kaldoo-P1 (1100 g/season). The lowest oleoresin yield was found in Chretmansoo-P4 (411 g/season), which was statistically similar to Kaldoo-P5 (414g/season), Bagthan-PT-Black Base (495g/season), Dibkon-P3 (483.33g/season), Rakni-P8 (548g/season).

Anatomical parameters

Number of stomatal rows on round surface

The data on number of stomatal rows on round surface exhibited significant variation in different progenies. The photographs of needle sections showing stomatal rows on round surface are shown in Fig. 48 & 49. The maximum number of stomatal rows on round surface (6.5) were noticed in Leda-P5 and Dibkon-P3, which showed statistical similar values with Kora-P5 (6.0), Kaldoo-P3, Rakni-P8, Banethi-PT-Black Base, Sandrohal-P5 and Bagthan-PT-Black Top (5.5). The minimum value (3.0) was recorded in Kaldoo-P10, which was statistically at par with Leda-P10, Dhami Shimla Yellow Base, Bagthan-PT-Black Centre, Jainagar-PT-Yellow Base (3.5) and Kaldoo-P9 (4.0) progenies.

Number of stomatal rows on flat surfaces

The photographs of needle sections showing number of stomatal rows on flat surfaces are shown in Fig 48 and 50**.** The effect of all treatments on number of stomatal rows on flat surfaces were found to be non-significant, however, the maximum number was found in Kaldoo-P1 and minimum in Kather-PT-Black Centre, Leda-P5 and Rakni-P8.

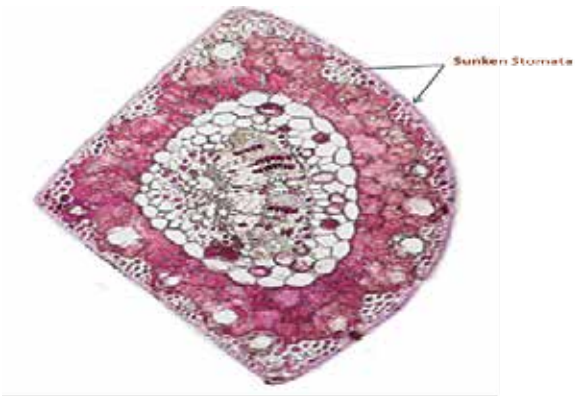


Fig. 48 Typical cross section of a chir pine needle

Number of stomata per mm of a row

Perusal of data revealed that the range of number of stomata per mm of a row with in progenies was found to be 6.5 to 12. Bagthan-PT-Black attained maximum value of 12.0, followed by statistically par values in Kaldoo-P8, Kaldoo-P9, Leda-P5 and Kopra-P5 (11.5). The lowest value of 6.5 for number of stomata per mm of a row was recorded in Kaldoo-P10, preceded by statistically similar values in Rakni-P8 (7.0) and Kather-PT-Black Centre (7.5). The photographs of needle sections showing number of stomatal rows on flat surfaces are depicted in Fig. 49 & 50.

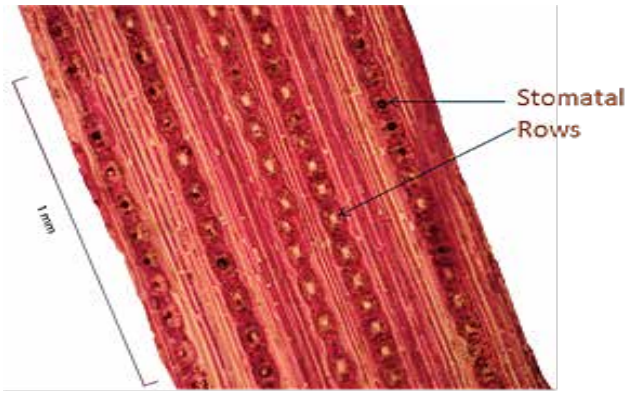


Fig. 49 Tangential longitudinal peeling from round surface

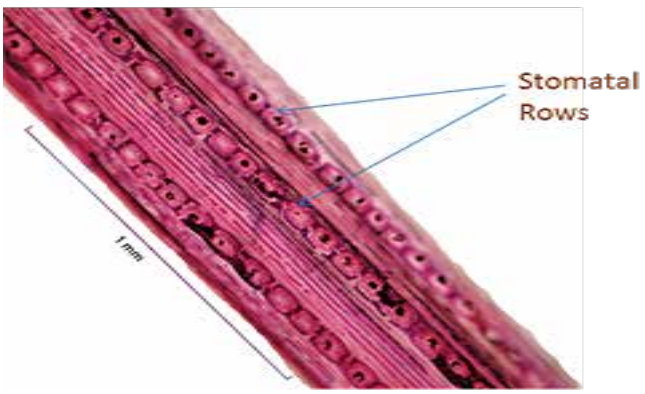


Fig. 50 Tangential longitudinal peeling from flat surface

Regression studies

To estimate the oleoresin yield, multiple linear regression equation was fitted with 5 different characters (Table 50). The regression model was developed by considering oleoresin yield as dependent variable and bark thickness, needle length, needle thickness, number of stomatal rows on round surface and number of stomata per mm of a row as independent variables. The coefficient of multiple determination (R^2) was 0.518; hence, 51.8 per cent of total variation in

oleoresin yield (g) was explained by these 5 characters. The character bark thickness (cm), number of stomatal rows on round surface had non-significant effect on the estimation of oleoresin yield (g) and thus not included in the prediction equation. While, needle length (cm), needle thickness (mm) and number of stomata per mm of a row had positive effect on the estimation of resin yield and can be used in prediction of oleo resin yield in *P. roxburghii.*

Thus, the prediction model for the oleoresin yield (g) is: Oleoresin yield (X_1) = X_1=-1695.41 +61.569 X_3 +763.274 X_4 +72.002 X_6

Table 50. Functional relationship (multiple regression) between morphological parameters and oleoresin yield

Oleoresin yield (g) (X_1)	Bark thickness (cm) (X_2)	Needle length (cm) (X_3)	Needle thickness (mm) (X_4)	No. of stomatal rows on round surface (X_5)	No. of stomata per mm of row (X_6)	R^2
-1695.41 (679.061)	98.231 (102.966)	61.569 (26.625)	763.274 (904.065)	-23.164 (56.537)	72.002 (31.731)	0.518
X_1=-1695.41 +61.569 X_3 +763.274 X_4 +72.002 X_6						

*Significant at 5% level of significant, Values in parenthesis are standard error

Natural stand experiment at main campus, Solan

Trees were located as natural stand in the university campus, which were marked and numbered. In this experiment diameter at breast height (DBH) was measured and all the trees were classified into five diameter classes *viz.*, 30-35cm, 35-40cm, 40-45cm, 45-50cm, 50-55cm and 55-60cm. Three boreholes at different times (March-October, April-October and May-October) were drilled in each tree.

Effect of tree diameter and number of boreholes on oleoresin yield at main campus

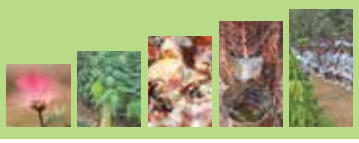
The data pertaining to the oleoresin yield as affected by the tree diameter at breast height (DBH) revealed that the oleoresin yield was significantly affected by the DBH and number of boreholes. The maximum oleoresin yield of 935.9 g/hole was recorded in 40-45 cm diameter class. The minimum oleoresin yield of 362.6 g/hole was observed in 30-35 cm diameter class which was statistically at par with 35-40 diameter class (430.9 g/hole). The analysis of variance reflected significant differences among number of bore holes for oleoresin yield. The highest oleoresin yield of 771.27g/hole/tree was obtained from second bore hole. The lowest oleoresin yield of 409.00 g/hole/tree was recorded from third bore hole. The interaction between DBH and bore holes was also observed to be significant at 5 per cent level of significance. The maximum oleoresin yield of 1120 g/hole/tree was obtained from second bore hole with 45-50 cm diameter class. The minimum oleoresin yield of 293.7g/hole was recorded in third bore hole with 30-45 cm diameter class.

Experiment at Bhota (Hamirpur)

The resin tapping experiment at Forest Division Hamirpur (HP) was initiated in April, 2011. Five diameter classes were formed *i.e.*, 35-40, 40-45, 45-50, 50-55, 55-60 and 60-65 cm depending upon the availability of trees and 18, 20, 19, 20, 10 and 15 trees were tapped under six diameter classes, respectively. The tapping procedure and methodology followed was same as in the experiment A and B. The main objective of this experiment was to know the resin yielding potential of chir pine trees. The identification of high resin yielding trees will also be done for improvement of future plantations. The oleoresin was collected from high resin and low resin yielders and evaluated for turpentine, rosin content and melting point of rosin.

Effect of DBH on oleoresin yield

The analysis of variance reflected significant differences among various diameter classes for oleoresin yield and revealed that maximum oleoresin yield of 2.667 kg/tree was recorded in 40-45 cm diameter class which was statistically at par with 45-50 cm (2.20 kg/tree).



Minimum oleoresin yield of 1.063 kg/tree was recorded in 30-35 cm diameter class which was statistically at par with 35-40 cm (1.093 kg/tree) diameter class. Severe fire in the month of April-May in the tapping area of chir pine forest resulted in lesser yield.

Evaluation of oleoresin of high and low resin yielders for turpentine, rosin content and melting point of rosin

Turpentine content

The turpentine content of oleoresin ranged from 20.50 to 26.00 per cent among high resin yielders. Among the low resin yielders the turpentine content ranged from 19.30 per cent to 20.10 per cent.

Rosin content

Among the high resin yielders the highest rosin content of 78.65 per cent was obtained. Lowest rosin content of 72.00 per cent was recorded in high resin yielder. Among low resin yielders the rosin content ranged from 76.00 to 80.00 per cent.

Melting point of rosin

Among the high resin yielders the melting point of rosin ranged from 60 to 67^{0}C, whereas among the low resin yielders the melting point of rosin varied from 75 to 80^{0}C.

Network Project on Karaya Gum at IGKVV, Raipur

Identification of *Sterculia* species

Survey was done in the month of March 2013 in the sites where gum tapping experiment were carried out in Koria and Gariyaband districts of Chhattisgarh. During survey, it was observed that these regions are hilly and rocky. Besides, *Sterculia urens* another species was observed in hilly and rocky region, which has different characteristics/features than *S. urens*. Plants are very limited (2-3 plants) and comparatively smaller in size and girth. The stem and bark colour was pure white and was locally known as '*Gudal*' whereas *S. urens* called '*Gindol*'. The bark of '*Gudal*' tree is used mainly for making rope. Tree is not used for gum tapping. Leaves of these trees are three lobed and its bark thickness (1.2-1.5 cm) was less than *S. urens*. The colour of bark was white instead of dark brick red coloured in *S. urens*.

Mass propagation of *S. urens*

The flowering and fruiting season for the species *S. urens* is between January to April. The fruit ripening and seed harvesting takes place between last week of April to end of May. Seeds are collected and dried in the month of May. For raising seedlings, seeds are sown in shaded area in polybags with 5 kg soil vertisol and sand (1:1). Three plants were raised in each poly-bag and after 3 weeks only single healthy plant was kept after thinning. After 4th day of sowing sprouting was observed in *S. urens* species. Radicle emergence was noticed within five days and plumule emergence was noticed within 6-7 days. 80-90% survival of the seedling was observed. The *S. urens* seedlings do not tolerate water logging condition. 12-16 weeks old seedlings can withstand drought condition. Water logging condition during initial period of seed development cause damage to seedlings and plants finally die after loss of leaves. The plants become ready for plantation within one year.

Vegetative propagation of *S. urens*

For vegetative propagation of *S. urens*, stumps were collected from high yielding gum trees from Koria District in the month of July and from Amba Choki in the month of August. Stumps were collected from ethephon treated and untreated trees for propagation as well as to find out the ill effect of ethephon treatment on plant health. The stumps were planted in the nursery in shaded area. Stumps 45 cm long and 3-6 cm girth (diameter) were treated with IAA, IBA and NAA at two levels @ 250 and 500 ppm for 3 hours before planting and compared with control (without treatment). The stumps rejuvenated after 15-20 days. NAA @ 500 ppm was found significantly effective for successful rejuvenation as compared to other treatments in treated and untreated trees equally. There was no significant difference in rejuvenation between treated and untreated stumps.

In another experiment for testing ill effect of chemical treatment (ethephon) on plant health, seeds from treated (ethephon) and untreated trees were collected and sown for germination and seed vigour tested. There was no dormancy in seed and germination was up 90-95% in the seed collected in the months of May and sown in the month of July-August.

Network project on guggul at JNKVV, Jabalpur

Study on gum-resin tapping from *guggul* plant (*Commiphora wightii*)

The tapper has no control on the length of incision especially on *guggul*. The location of the *guggul* plants is rarely on plain and in isolation. Karrel, cactus and other thorny companion plants are always associated with *guggul* plant in the ravines. The topography rarely gives the tapper a comfortable standing posture to perform the tapping ideally. Unlike other gum yielding plants, which stand vertical to the ground, most of the *guggul* plants in the ravines are slanting and horizontal to the ground.

This makes tapping difficult due to accessibility problems. Length of the incisions depends on the circumference of the target branches. Comparatively, *guggul* branches have smaller circumference as compared to other gum plants. Thus, incisions are usually smaller and irregular. In the study, two incisions on each of the two branches and two tertiary branches of the *guggul* plant were made. The tertiary branches of the two selected secondary branches were not tapped. Similarly, the secondary branches of the two tertiary branches were also not tapped. During each tapping period the plants remained the same, but new incisions were made. It also gave an opportunity to observe the healing process of the earlier incisions and oozing if any. The lengths of incision on the secondary branches were in the range of 28.36 to 36.14 mm/branch and 17.07 to 24.71 mm/branch on the tertiary branches. In most of the cases, oozing occured immediately after the incision. The oozing was collected in a small air-tight measurable plastic container with a lid of capacity 1.5 ml. After collection of the fresh gum-resin, the container was sealed and marked for the plant, branches and date of incision. During the tapping period, oozing occurs for longer duration after incision. The mean of overall oozing from the secondary branches ranged from highest (1.20 ml) to lowest (0.36 ml). The mean highest overall oozing from the tertiary branches were 0.52 ml and lowest 0.06 ml. The reason for the death of most of the guggul plants is due to tapping from main stem and deeper incision. Selection of secondary or tertiary branches (as the case) will save the plants as these branches grow faster than primary stem.

Study on the exudation of *guggul* in relation to the soil factors

Soil Nutrient

Soil samples were collected during all the seven tapping period from the respective plant base. The samples were analysed in the Soil Testing Laboratory of JNKVV, Jabalpur. The purpose was to find the soil factors affecting the oozing. The soil nutrient status EC, Nitrogen, Phosphorous, Potassium and Organic carbon remained almost the same from the first tapping schedule 28.09.2012 to 22.02.2013. This was probably due to the reason the *guggul* plant in Morena (Chambal ravines) remain leafless from first week of September to second week of June.

Soil Moisture

The soil moisture of the plant site was measured by the Digital soil moisture meter during each of the seven tapping from 28.09.2012 to the last tapping 22.02.2013. It was found that the soil moisture of all the *guggul* plants varied. Its variation was dependent on the location of the plant in the ravine. The plants on the flat surface and in the valley of ravines had comparatively higher soil moisture than those along the ridges of the ravines. The soil moisture is found to affect the oozing of the gum in *guggul*. Oozing increases after a period of low soil moisture and similarly there is an increase in density (mg/ml) of the gum at low soil moisture. The soil moisture was lowest during January, 2013 and it varied from 5 to 9 per cent. The oozing of the gum varied in different *guggul* plants and it was negatively co-related with soil moisture.

8. Externally Funded Projects

8.1 To understand the nature of diversity in lac insects of *Kerria spp.* in India and the nature of insect × host interaction (NAIP: Component-4)

Survey of Kerala for lac insect and lac host plants

Surveys were carried out in Malappuram, Wayanad, Kozhikode and Thrissur districts of Kerala during 15th to 23rd July, 2013. *A. auriculiformis, A. lebbek, C. surinamensis, Ficus sp* and *M. penduliflorus* were observed but no lac insect was found. Lac insect

collected from *Amherstia nobilis* from state Museum and Zoo, Thrissur during 2011 died due to unfavorable conditions. An attempt was made again for collecting the lac insect from the site but tree branches were found pruned along with live lac insect. Five plants of *A. nobilis* from Kerala Forest Research Institute (KFRI) nursery, Peechi were procured and planted at IRF.

Survey of Assam, Nagaland and Meghalaya for lac insect and lac host plants

Exhaustive survey was carried out in ten different districts in Assam, Nagaland and Meghalaya during 18th to 29th October, 2013. Lac host plants *viz., A. auriculiformis, A. lebbek, A. lucida, A. saman, Butea monosperma, Cajanus cajan, Ficus sp, M. penduliflorus* and *Z. mauritiana* were found in surveyed areas. Lac insects (immature and mature) were collected on *Litchi* at Jarnapani (Fig. 51a), Ber (*Bokeri*) at Lio Wokha Old, Wokha District, Nagaland (Fig. 51b), *Ficus spp* (*Arhat* tree), at Doloigaon, Kharbiolong Districts, Assam (Fig. 51c) and *Ficus sp* (*Dingjri/ Pipal*) at Sornithan, Ri-bhoi district, Meghalaya (Fig. 51d). As per farmers knowledge, new lac host plants, *viz., Tokho*, *Tsolong* and *Sohtharnu* were recorded. Samples (leaf,cuttings, seeds) of the these plants were collected for further study. In addition, lac insect (live and settled) was also observed on *A. saman* at Central Park, Salt Lake, Kolkata. Lac insect collected from Nagaland, Assam and Meghalaya have been inoculated on *F. macrophylla* at NATLIGEC.

Fig. 51a. Lac insect on *litchi* at ICAR NEHR RC, Jarnapani, Nagaland

Fig. 51b. Lac insect on *ber* at at Lio Wokha Old, Wokha, Nagaland

Fig. 51c Lac insect on Ficus spp, Doloigaon, Kharbiolong, Assam

Fig. 51d Lac insect on Sornithan, Ri-bhoi, Meghalaya

New species of lac insect described under NAIP-LID project

Three recently collected stocks from Manipur, Thrissur and Madurai were reported as new species, *viz., Kerria manipurensis*, *K. maduraiensis* and *K. thrissurensis* and three already collected and conserved stocks from Orissa, Bangalore and Punjab were described as new species, viz., *Kerria pennyae*, *Kerria dubeyi* and *Kerria varshneyi*, respectively.

Molecular characterization

Twenty-four primers flanking dinucleotide, trinucleotide and tetranucleotide repeats were chosen for labeling

with a 5'fluorescent dye. PCR was carried out in 48 lac insect lines using fluorescently labeled primers and the products were run on a capillary DNA analyzer. Allele fragment lengths were quantified using Gene mapper software V4 (ABI). Polymorphism was observed between *K. lacca* and *K. chinensis* lines. The primer MST-1 gave peaks of 112 and 115 in *K. lacca* lines; however *K. chinensis* from Thailand and Meghalaya gave a peak of 94 and 91, 94 respectively. Similarly in case of MST-2, *K. lacca* lines gave peaks of 92 and 95. However, peaks at 104 and 125 were observed in *K. chinensis* of Thailand and peaks of 96 and 99 in *K. chinensis* from Meghalaya. A SNP based genotyping screening was done in selected SNP domain using LIK001, LIK002, LIK003, LIK004, LIK011, LIK017, LIK018, LIK023 lac insect lines. Study was carried out in different coding proteins including NADPH subunit 4 and 5 protein, e3 ubiquitin, transposable unit TL3, phenyl alanine t-RNA synthase etc. SNPs were found in the genes *viz*., N-methyltransferase, guanylate cyclase, e3 ubiquitin-protein, mitochondrial bc1 complex, transport protein. *K. chinensis* line (LIK023) showed insertion of 50 bases in trehalose transporter gene and an insertion of 146 bases in mitochondrial malate dehydrogenase gene

8.2 A Value Chain on Lac and Lac based Products for Domestic and Export Markets (NAIP: Component-2)

Promotion of *kusmi* lac cultivation on *ber / Kusum*

Nine hundred and fifteen (915) kg *kusmi* broodlac was distributed among 147 farmers of 26 villages in Ranchi and Khunti districts during June-July, 2013 for inoculation of 1087 *ber* host trees through five NGOs associated in the project. Additional 85 kg broodlac was distributed among 6 farmers to inoculate the plants of *F. semialata* established under the project. An yield ratio (output : input) of 5.4 was obtained from *kusum* trees during June-July 2013.

Raising of new plantation of *Semialata* and *ber* for lac cultivation on plantation basis

Seedlings of *F. semialata* (16100) and *ber* (3715) were distributed among 41 farmers of 30 villages to raise plantation and further propagate lac cultivation on plantation basis under the project during June- July, 2013. About 3000 plants of *F. semialata* have been inoculated with 85 kg broodlac during June- July 2013. The plantation has been established under the project (Fig. 52).

Fig. 52. Lac crop on *F. semialata*

Imparting training on primary lac processing to rural entrepreneurs/ lac grower

Technology of small scale lac processing unit (capacity-100 kg sticklac/day) has been licenced to two firms M/s National Enterprises, Tupudana, Hatia and Small Industries Service Organisation (SISO), Nagpur and these firms have sold nearly 50 units in Chhattisgarh, M.P, Maharastra, U.P etc.

Commercial trial of aleuritic acid with improved yield

Three commercial trials of aleuritic acid were carried out successfully with 25kg seedlac/batch and 10 days hydrolysis at the processing units of the Consortium partners of the project namely, M/s Tajna Shellac, Khunti (1 trial in January - February, 2013). M/s Gupta Brothers, Bundu (2 trials, one with lab grade alkali and another with commercial alkali in August, 2013). Yield in these trials were above 18% by seedlac weight.

A second trial for bleached lac with improved bleaching agent was also carried by M/s Gupta Brothers (Shellac), Bundu in December 2013-January 2014, with 20 Kg seedlac to further confirm the technology on commercial scale which was already demonstrated at M/s Tajna Shellac Pvt. Ltd, Khunti (Fig. 53).

Fig. 53. Commercial trial of making aleuritic acid at M/s Gupta Brother's (Shellac) Bundu

Recovery and purification of the by-product of lac industry (lac dye from wash water)

Work on improvement in washing of crushed sticklac for making seedlac was carried out for improved recovery of lac dye with use of minimum quantity of wash water. A total of 12 nos. of washing trials in repeated batch washing (5-6 batches) with fixed quantity of water (5, 10 and 15 l) in each batch with varying duration of pre-soaking for 15 and 30 minutes. Dye samples were recovered separately for each batch of trials. Preliminary results from some of the starting batches indicated that most of the lac dye came in first batch of wash water. Wash water from at the most two batches of repeated washing with 5-6 times wash water requirement by weight of seedlac may be taken for maximum recovery of lac dye. Rest batches do not contain significant quantity of lac dye. The water requirement in batch washing is less compared to traditional washing with continuous addition of water which requires more than 10-12 l of water by wt. of seedlac for making seedlac free from lac dye (Fig. 54a & 54b).

Fig. 54a: Filtered lac dye

Fig. 54b. Filtered dyes from different wash

Standardization of measures to enhance shelf life of bleached lac

Storage study has been carried out for bleached lac in different packaging materials. Sixty samples of fresh bleached lac were stored in 7 different packaging materials (LDPE, HDPE, PP, paper bag and aluminium coated polythene) in open storage (ambient for control) and refrigerated condition (14-15^{0}C) and tested from QEL, IINRG after 3 month intervals.

Initial moisture content %	Flow (mm)	Life (min.)
5.5	55	10

Flow and life was lowest in case of open storage condition for both ambient and refrigerated (Flow and life: Nil and 3 min for ambient, 22 mm and 6 min for refrigerated) whereas these parameters were highest in aluminium coated polythene (Flow and life: 10 mm and 5 min for ambient, 35 mm and 10 min for refrigerated) which was mainly due to higher moisture retaining capacity in aluminium coated polythene bag (4.12 and 5.5%) compared to 1.01 and 1.23% moisture in open condition after 3 months of storage.

On Farm Training / Field and exposure visit on Scientific Method of Lac Cultivation

Four "On Farm Trainings" were organized for lac growers in different villages of Ranchi and Khunti districts. Fifty eight lady farmers visited IINRG for exposure and attended lecture on scientific cultivation from Durgra & Nihaldih (Khunti) villages through Udyogini. Besides following field visits were undertaken.

Date	Village (s)	Purpose of visit
11.01.2013	Getalsud, Angarha, Ranchi	Observation of standing lac crop on *F. semialata*
27.01.2013	Getalsud Farm, Angarha, Ranchi	To select the place for establishing small scale lac processing unit
18.02.2013	Getalsud Farm, Angarha, Ranchi	For exploring the reason of mortality of *F. semialata*
19.06.2013	Getalsud Farm, Angarha, Ranchi	Observation of standing lac crop on *F. semialata*
23.09.2013	Getalsud Farm, Angarha, Ranchi	Observation of standing lac crop on *F. semialata*
05.11.2013	Chete, Sithio, Ranchi; Dand Toli, Kudri, Khunti and Tangerkela, Rania, Ranchi	Observation on plantation and crop on *F. semialata*

Training on Handicraft making

Twenty three Master trainers have been trained and subsequently they have trained 240 beneficiaries during April, 2013. Another 10-days training programme was organized at BRIAT, Allahabad. Beneficiaries from seven villages (Digri, Palotoli, Jaipur, Besenpur, Baghia, Tutikhel,Semartoli) of Khunti district participated in the training.

8.3 Developing sustainable farming system models for prioritized micro watersheds in rainfed areas of Jharkhand (NAIP: Component-3)

The Institute is a consortium partner and Birsa Agriculture University, Ranchi is the lead centre. The project was concluded in March 2012 but revived again in November 2012.

Performance and output from *rangeeni* summer crop

Data have been collected from farmers who raised *rangeeni* lac crop on *B. monosperma.* A total of 10 household of Jamtara and nine from Dumka districts had produced 143 and 107 kg *rangeeni* broodlac, respectively during July 2013. In addition, 36 kg of sticklac was also produced during November 2013. Two sprays of fipronil were carried out on lac culture as per schedule of spray. Around 88 mandays generated by intervention of this activity in the adopted villages (Table 51).

Performance and output from *rangeeni* rainy season crop

A total of 242 and 296 kg *rangeeni* broodlac was produced from Jamtara and Dumka, districts respectively from *rangeeni* rainy season crop harvested during November 2013. In addition, 184 kg of scraped lac was also produced during this period. Two sprays of fipronil and carbendazim were carried out on the rainy season crop. Around 233 mandays generated by intervention of this activity in the adopted villages (Table 51).

Field visit/ Demonstration/ Training to farmers

Twenty five field visits were undertaken for interaction with farmers and monitoring of lac crop time to time in adopted villages of Jamtara and Dumka districts; A total of seven demonstrations were carried out for *rangeeni* lac cultivation on *B. monosperma* tree, one in each village namely Karmatand and Nawadih villages of Jamatara district*;* Jiyathar, Sagbehari, Guhijori (block: Dumka), Sarepahari and Maghi Santhali village of Dumka districts; A total 39 farmers from Jamtara and Dumka districts have successfully completed two days training on "Scientific Lac cultivation on *palas* tree" at IINRG, Ranchi during 15th and 16th July 2013.

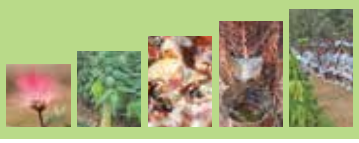


Table 51 : Employment and Income generation from lac production during 2013

Block	Village	No. of farm families	Production of brood lac in July (kg)	Production of scrap lac in July (kg)	No. of families	Production of brood lac in November (kg)	Production of scrap lac in November (kg)	Highest income by the individual farmer	Name of the lead farmer
Dumka	Sagbehri	6	85	12	9	218	72	9,300	Ram Hansda
	Jiyathar	3	22	9	2	78	24	8,600	Isahak Hembram
Subtotal	2	9	107	21	11	296	96		
Jamtara	Karmatand	6	76	8	6	156	55	7,800	Baldev Marandi
	Jhilimtand	1	12.5	3	1	22	12	5,100	Ram Murmu
	Nawadih	3	54.5	4	2	64	21	5,400	Shivlal Tudu
Subtotal	3	10	143	15	9	242	88		
Grand total	**5**	**19**	**250**	**36**	**20**	**561**	**184**		
Employment generated (mandays)			75	13		168	65		

8.4. Climate change and lac crop performance (NICRA-ICAR)

Lac production scenario and weather parameters

National lac production trends in India during 1980-81 to 2012-13 have showed an inconsistence and fluctuating production. Lac production of the country is the summation of four crops, contributed by two crops each of *rangeeni* and *kusmi* strains annually. The contribution of *rangeeni* strain has shown a sharp decline in total production (151.5 tons) whereas *kusmi* strain has shown the increasing production (214.5 tons) trend during the same period. About 25-30 years back the major contribution in country lac production come from *rangeeni* strain (80-85%) and only 15-20% by *kusmi* strain, but in recent years, the relative contribution of *kusmi* crops (52%) has been significantly increased in total lac production of the country. This change could be attributed to promoting *kusmi* lac production, especially on *ber* during winter (*aghani*) crop and drastic decline in the production of summer *rangeeni* lac crop, which used to be the major lac crop. The performance of national production of both crops of *rangeeni* strain was analyzed which reveals, sharp decline in total production of *baisakhi* crop (180 tons), which was earlier contributing about 50-55% alone in total lac production, whereas rainy season (*katki*) crop showed the increasing trend in production (28.6 tons). Further, analysis of relative contribution of *rangeeni* and *kusmi* crops in total lac production of the country and three states (Jharkhand, Madhya Pradesh and West Bengal) during last 25 years (1988-89 to 2012-13) revealed that the *rangeeni* crops contributed more than 80% upto 1997-98 in national production which decreased sharply and now contributes only about 48% (2008-09 to 2012-13), whereas, in Jharkhand the contribution of *rangeeni* was about 82-88% in total lac production during 1988-89 to 1997-98 which is about 18-20% during 2008-09 to 2012-13, clearly indicating Jharkhand as the worst affected state in *rangeeni* lac cultivation in recent years. Therefore, the performance of the *rangeeni* strain of lac insect, especially in Ranchi, Jharkhand in relation to changes in temperature (maximum and minimum) and rainfall was analyzed. Analysis of weather data reveals that the winter months (December and January) have become colder and pre and post (November and February) winter months warmer. Monsoon and winter rainfall spells and magnitude also found to be associated

with lac crop performance. These changes in climatic parameters have implication in lac cultivation as it is a critical period of lac insect development (pre-sexual maturity) during the summer season crop. The decline in summer (*baisakhi*) crop production and improvement in that of rainy (*katki*) season crop has been shown to be associated with concomitant changes in certain weather parameters during critical growth period of lac insects.

Analysis of weather data of Ranchi, Jharkhand

Weather parameters *viz.,* temperature, relative humidity and rain fall were analyzed for the period 1984-2012 of Ranchi, Jharkhand which reveals that mean temperature (0.23^{0}C) has been increased at Ranchi. February to July months has become hotter while December and January has become colder during this period. Difference between Minimum and Maximum temperature has widened during January to May while not much difference was observed during the rest of the period except for November, wherein, the gap is reduced. Mean relative humidity (6.2%) and rain fall (64.6 mm) have been decreased at Ranchi. The month of January to June has become more dry during the period (decrease in RH over 28 years during January - June: 11.6%) and January to June has got more rain than normal while July-December has got less rain than normal (Fig. 55).

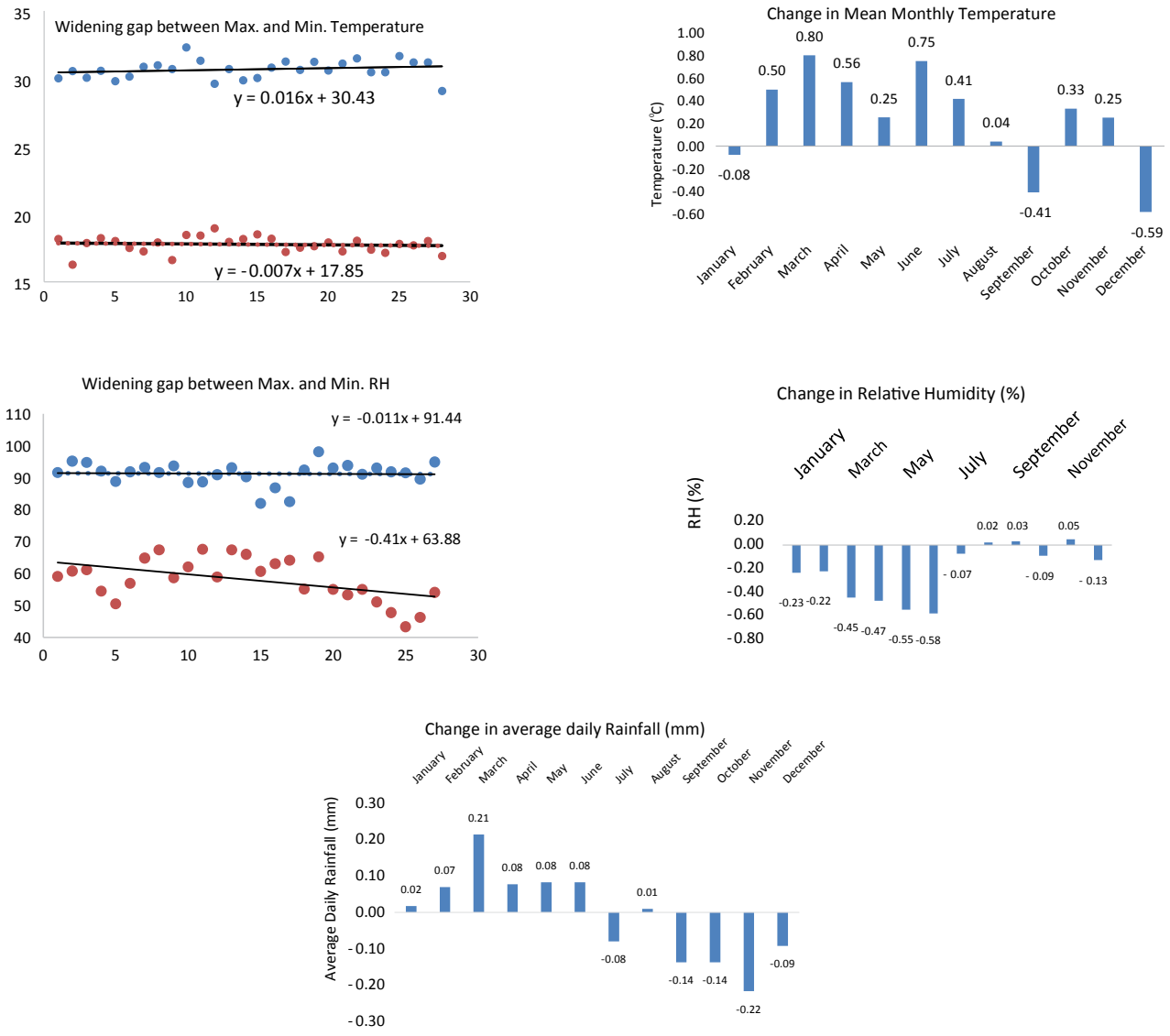


Fig 55: Change in weather parameters at Ranchi during 1984-2012

Analysis of lac production data Vs weather parameters

Effects of abiotic factors (temperature, rain fall and relative humidity) were correlated with lac production of *rangeeni* crop during 2006-07 to 2011-12. It was observed that the role of RH in a positively significant manner with respect to lac production during critical crop period of summer crop (*baisakhi*). The vulnerability level of lac insect is high during and prior to sexual maturity stage which is normally in February-March (summer crop) and August-September (rainy crop). Thus, post-winter and mid monsoon are critical periods for lac insect survival and any adverse climatic condition can lead the productivity (Table 52).

Table 52. Effect of abiotic factors on production of summer crop during 2006-07 to 2011-12

Crop/Month (Production)	Temperature (^{0}C)		Total Rainfall (mm)	Relative Humidity (%)	
	Maximum	Minimum		Max.	Min.
Baisakhi (Summer) crop	-0.690 (30.0)	-0.582 (14.0)	0.929** (184.0)	0.949** (65.0)	0.867* (47.0)
December	-0.500 (25.6)	-0.310 (7.6)	0.470 (5.4)	0.911* (69.6)	0.526 (50.2)
January	-0.254 (23.6)	-0.508 (7.2)	-0.923** (6.7)	-0.949** (67.2)	0.024 (43.6)
February	-0.254 (28.2)	0.724 (11.4)	0.412 (12.2)	0.529 (64.3)	0.490 (47.0)
March	-0.910* (32.9)	-0.197 (16.1)	0.488 (21.2)	0.858* (54.1)	0.881* (39.2)
April	-0.836* (37.5)	-0.578 (20.6)	0.729 (17.0)	0.892* (49.6)	0.836* (36.1)
May	-0.578 (38.2)	0.501 (22.2)	0.517 (77.7)	0.870* (60.3)	0.669 (44.4)

*Figure in parenthesis is mean value of the period

Impact of abiotic factors on insect pest of lac insect (indirect effect)

Among the number of parasitoids and predators associated with lac insect, *A. purpureus,* an endoparasitoid (Fig. 56), was found abundant and most serious problem for summer *rangeeni* crop. Emerging population of *A. purpureus* during critical crop growth period and weather parameters *viz.,* temperature, relative humidity and rain fall were correlated during *baisakhi* 2011-12 and 2012-13. Significant positive correlation with temperature and negative correlation with relative humidity was found in *baisakhi* (2011-12) during the months of January-March 2012 and in *baisakhi* (2012-13) in the months of February-April 2013 (Table 53), which indicates that the summer crop is vulnerable to weather parameters.

Symptom of parasitization with different stages of *A. purpureus* | *A. purpureus* female and male

Fig 56. Symptoms and various stages of *A. purpureus*

Table 53. Correlation between abiotic factors and population of *A. purpureus* during summer season (*baisakhi*) crops (2011-12 and 2012-13) at Ranchi

Crop/Months	Host plant	Temperature (°C)		Relative humidity (%)		Total rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
Summer (*baisakhi*) crop 2011-12						
January 2012 - March 2012	*Ber*	0.240*	0.129	-0.291**	-0.226*	-0.041
Palas		0.412**	0.297**	-0.276**	-0.202	-0.090
Summer (*baisakhi*) crop 2012-13						
February 2013- April 2013	*Ber*	0.178	0.225*	-0.206	-0.205	0.026
	Palas	0.110	0.189	-0.139	-0.134	-0.018

Population dynamics of parasitoid and predators associated with *rangeeni* strain of lac insect

Relative abundance and emergence profile of parasitoids and predators associated with lac insect were recorded at two climatically distinct locations (Institute Research Farm), Namkum, Ranchi, Jharkhand and Putidih, Jhalda, West Bengal. Relative abundance and emergence profile of parasitoids and predators associated with lac insect during *rangeeni* 2012-13 revealed that three parasitoids (*A. purpureus*, *T. tachardiae* and *P. clavicornis*) and two predators (*E. amabilis* and *P. pulverea*) were in plenty. *A. purpureus* and *P. clavicornis* population were more in the month of March-April, whereas *T. tachardiae* was more in June –July, during *baisakhi*, 2012-13. In *katki* 2013, *A. purpureus* and *P. clavicornis* population were more in the month of September-October, whereas *T. tachardiae* was more in October-November (Fig. 57a-c). Predator population *viz., E. amabilis* and *P. pulverea* were maximum during crop maturity period in both crops (Fig. 58a & b). Population variation was observed between the location, host and crop season. Caging of lac samples for recording population and emergence profile of parasitoids and predators revealed that summer crop were more vulnerable to *A. purpureus* and most of the parasitization took place before sexual maturity stage thus killing lac insect invariably as compared to rainy crop (Parasitization at crop maturity stage). This result is in confirmatory with last year findings.

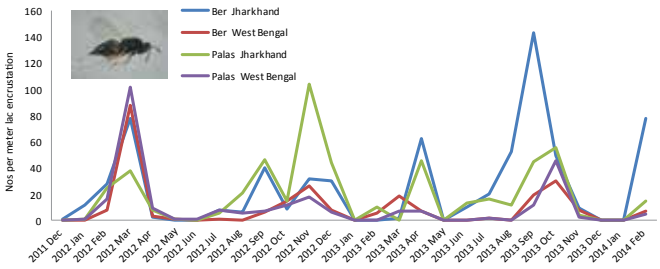


Fig. 57a. Emergence profile of *A. purpureus* from *rangeeni crops* (2011- 2014)

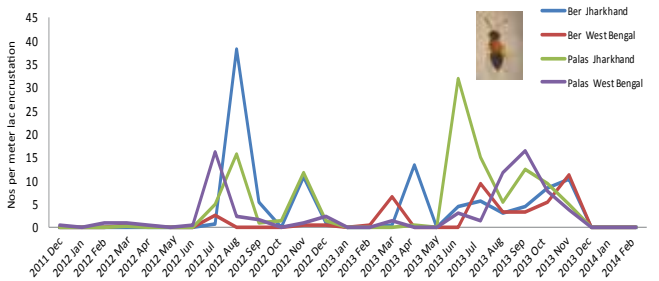


Fig. 57b. Emergence profile of *T. tachardiae* from *rangeeni crops* (2011- 2014)

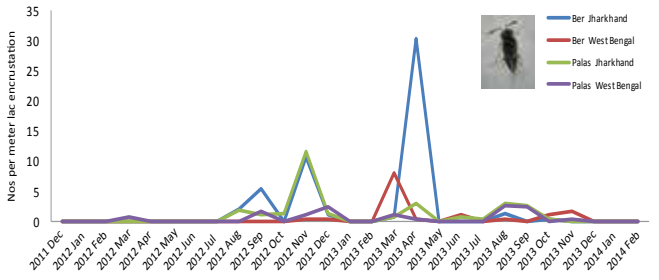


Fig. 57c. Emergence profile of *P. clavicornis* from *rangeeni crops* (2011- 2014)

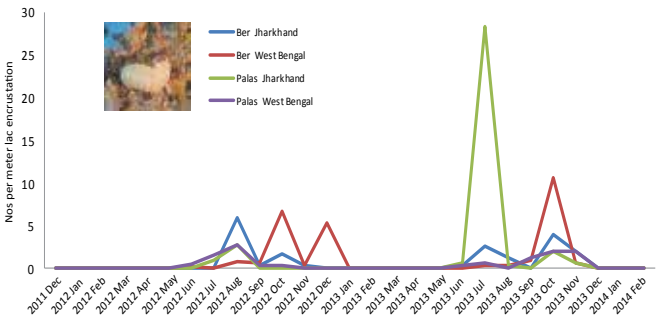


Fig. 58a. Emergence profile of *E. amabilis* from *rangeeni crops* (2011- 2014)

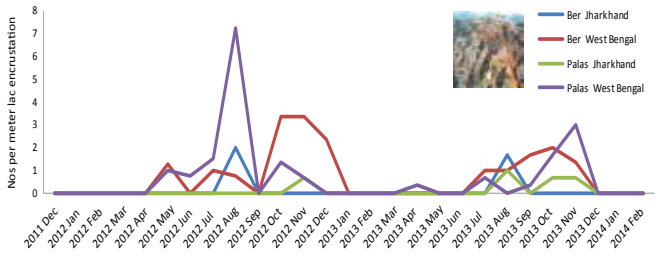


Fig. 58b. Emergence profile of *P. pulverea* from *rangeeni crops* (2011- 2014)

New records of lac associated fauna

New lac associated parasitoids (10 nos) *viz., Pachyneuron aphidis* (Pteromalidae), *Pachyneuron stom* (Pteromalidae), *Pachyneuron ahlannse* (Pteromalidae), *Pteromalus pupareum* (Pteromalidae), *Necremnus leccarthros* (Eulophidae), *Pseudotorymus sp.,* (Torymidae) *Plutarchia indefensa* (Eurytomidae), *Sphecodes sp* (Halticidae), *Diplazon lactatorius* (Ichneumonidae) and *Cotesia sp.,* (Braconidae), Syrphids (4 nos), *Episyrphus viridaureus*, *Episyrphus sp., Sphaerophoria sp.,* and *Eupeodes sp.,* (Syrphidae) and one fruit fly *Bactrocera tau* (Tephritidae) were collected from Jammu center and two new lac associated parasitoids *viz., Mischotetrastichus sp.* (Eulophidae), *Dolichogenidea sp* (Braconidae) and one predator *viz., Oryzaephilus surinamensis* (Silvanidae) from IINRG, Ranchi under NICRA project and identified from IARI, New Delhi.

Life cycle and productivity linked attributes of *rangeeni* lac crops

Variation in pre sexual maturity and total life cycle period was observed between host and locations in *rangeeni* (2012-13) crop. Difference in pre sexual maturity period in Jharkhand and West Bengal were 23, 19 and 8, 10 days on *palas* and *ber* during *baisakhi* 2012-13 and *katki* 2013, respectively, whereas, in total life cycle period difference was 1, 12 and 8, 6 days on *palas* and *ber* during *baisakhi* 2012-13 and *katki* 2013, respectively. No difference was observed in duration of male emergence during both hosts and seasons. Productivity linked attributes of *rangeeni* lac insect raised on *ber* and *palas* tress at both locations revealed significant differences in pre harvest (initial density settlement, initial mortality, sex ratio and survival at maturity) parameters and post harvest (fecundity and resin weight) parameters. The minimum and maximum values of various productivity linked parameters *viz*., Initial density of settlement (83.07 to 133.59/cm^2), initial mortality (9.07 to 58.06%), sex ratio (7.87 to 42.98 % male), survival at maturity (7.15 to 22.37/cm^2), fecundity (261.57 to 445.03 nos.) and resin weight (11.66 to 17.03 mg) showed very high range (Table 54).

Table 54: Productivity linked attributes of *rangeeni* lac insect, *K. lacca* (2012-13)

Productivity linked attributes	Summer (*baisakhi*) crop [2012 - 13]				Rainy (*katki*) crop [2013]			
	Jharkhand		West Bengal		Jharkhand		West Bengal	
	Palas	*Ber*	*Palas*	*Ber*	*Palas*	*Ber*	*Palas*	*Ber*
Initial settlement density (No./cm^2)	132.44	132.00	133.59	112.81	83.07	179.07	111.26	101.37
Initial mortality (%)	20.66	14.84	9.07	10.40	58.06	26.62	25.04	21.74
Sex ratio (% male)	38.86	30.91	42.98	28.69	7.87	20.03	7.87	20.70
Survival at maturity (No./cm^2)	7.15	8.22	8.41	15.19	12.04	8.52	19.37	22.37
Fecundity (Nos.)	402.17	368.23	445.03	332.07	331.83	261.57	369.07	345.87
Resin weight (mg)	17.03	14.80	13.76	11.66	11.98	15.38	11.66	12.47
Brood lac ratio (output/input)	3.39	2.08	2.64	2.45	0.78	5.2	8.33	3.06

Influence of climate on biochemical profile of lac host trees

Key biochemical stress indicators of two lac insect host trees (*ber* and *palas*) were studied at different periods at two locations to understand the impact of climate *vis-à-vis* lac insect survival. Malone dialdehyde (MD) content, an indicator of oxidative stress, behaved differently with respect to host trees tested as well as locations. More oxidative stress was observed during the winter period in both host trees. The lac inoculated *ber* trees showed significant difference with respect to locations (West Bengal showed maximum MD while Jharkhand showed the minimum). Protein content at both locations showed increased level in un-inoculated than inoculated in both the hosts which showed that both the hosts under the cultivation were under nutritional stress during both crops (summer and rainy crop seasons). Significant increase in proline content was observed in lac inoculated *ber* trees during *baisakhi* (summer) crop, indicating the stress of the plant due to inoculation. Whereas, in *palas* the significant increase in proline content was observed only during Feb-May *baisakhi* crop. The proline content, an indicator of water stress was found to have negative correlation with Relative humidity (r = -0.59) and positive correlation with mean daily temperature (r = 0.28) during December to May. The inoculation of lac insect along with the water loss due to low RH has got significant role in imparting stress to the plant indicated by high R^2 values 0.96 and 0.95 in inoculated plants during *baisakhi* 2011-12 and 2012-13, respectively.

8.5 Lac Cultivation and processing Unit Establishment (Sponsored by Jharkhand Govt.)

This project was started in public private partnership mode in Khunti area. District Planning Office, Khunti has taken the initiatives and three institutions namely (DPO, TRDS and BIOVED) came forward to work together in collaboration with IINRG, Ranchi under the project. The following activities were performed during the year (Fig. 59 & Table 55).

Fig. 59. *Kusmi* lac on *Z. maurtiana* in Torpa, Khunti, Jharkhand

Table 55 : Activities performed under the project in Khunti area

Activity	Observation/beneficiaries
Capacity building programme	A total of 33 farmers of Khunti including 4 CWD officials were benefited through one week training and master training programs for better understanding of scientific methods of lac cultivation. SHG member also got training at TRDS, Torpa by BIOVED, Allahabad.
Monitoring and advisory services	Seven visits by the officials of IINRG were conducted for the monitoring of lac cultivation activities at farmer's field. During visits technical guidance about the proper method of inoculation, pest management and marketing of the produce was provided. Samples of various crops at different stages were also collected for evaluation. Site for establishment of small scale lac processing unit was finalized.
Plantation of host plants	A total of 31,490 seedlings of *kusum* (490), *ber* (5000) and *F. semialata* (26000) were supplied to the beneficiaries across the identified villages in Torpa and Rania block of Khunti.
Exposure visit	A total of 366 farmers from Torpa and Rania block of Khunti including 4 CWD officials visited IRF for better understanding of scientific methods of lac cultivation.
Benchmark survey	Eight villages in Khunti were surveyed for impact assessment. A total of 100 beneficiaries and 50 non-beneficiaries were interviewed.

8.6 National Action Plan (NAP) for sustainable income generation of tribals through cultivation and processing of lac (TRIFED)

The project is sponsored by Tribal Co-operative Marketing Development Federation (TRIFED) of India Ltd, Ministry of Tribal Affairs, Government of India, New Delhi with a budgetary provision of Rs 4.05 crores. The project is located in six selected districts of six states *viz.,* Jharkhand, West Bengal, Odisha, Madhya Pradesh, Chhattisgarh and Andhra Pradesh in which 666 SHGs comprising 6600 nos tribal members were covered.

Training of Trainers (TOT) Programmes on Scientific Lac cultivation

In-campus Training of Trainers (TOT) programmes on scientific lac cultivation of one week duration was organized for the trainers of Jharkhand and West Bengal states. In this programme six camps were organized for 130 beneficiaries.

Crop monitoring and technical guidance

Visit was under taken by the experts of the institute to assess the progress of the lac crop in different adopted lac growing areas of West Bengal state along with representatives of Ranchi Regional Office of TRIFED. Necessary suggestions were given to farmers for the effective management of lac crop (Table 56).

Table 56 . Visit undertaken for crop monitoring and technical guidance

District - State	Village–Block	Observation / Remarks
Purulia, West Bengal	Village Jabar of Kotshila Block	Summer season (*baisakhi*) *rangeeni* lac crop raised on *B. monosperma* was very good in all the adopted areas. Farmers were advised for additional spraying of fipronil @ 1.5 ml/l was advised along with fungicide immediately to contain the menace of pest and fungal attack. Forecasting of lac samples for lac crawlers emergence, pest incidence in lac samples, quality of broodlac and other querries were also addressed as and when required. Meetings for purchase of broodlac and other tool kits were also attended from time to time as per proposal received from regional office of TRIFED.

Extension activities undertaken

Technical Guidance and Advisory Services

Nine technical guidance and advisory of various institutions for various purposes has been given below

Stakeholders	Nature of Guidance/Advisory	Dated
Kishore Chandrapur Lac Industrial Co-operative Society Ltd. Natapada district Balasore, Odisha	Project formulation and estimate for *kusmi* lac cultivation	22.01.2013
Odisha Livelihoods Mission, Mayurbhanj	Prospect of crop on *palas* tree	08.02.2013
Bioved Research Institute of Agriculture and Technology, Allahabad, U.P	*Rangeeni* lac crop on *palas* tree	20.02.2013
Mr. Nandesh Sinha, Koyalnagar, Dhanbad	Lac production on *F. semialata*	02.03.2013
Mr Ashish Kumar Rout	Prospects of lac cultivation in Nayagarh district of Odisha	02.03.2013
Dhandadhar Horti- Agricultural & Forest produces Development Co-operative Ltd.	Prospect of lac cultivation in Sundergarh district	16.03.2013
Directorate of Micro and small scale Enterprises Purulia.	Cost of development of nursery of *F. semialata*	09.05.2013

Tribal Development Co-operative corporation of Odisha Ltd. Bhubneshwar	*Kusmi* lac production on *kusum* tree in Sundergarh district	27.05.2013
Guru Ghashi Das Vishwavidyalaya, Koni, Bilaspur (C.G.), Central University	About lac cultivation	15.05.2013

8.7 Jute based bio-composites for Industry (NFBSFARA)

Shellac was treated with urea, thiourea and maleic anhydride in aqueous and alcoholic media and their films were developed. FT-IR, DSC and TGA studies of air-dried and baked films of the treated samples were carried out. Improvement in thermal properties of lac was observed on treatment with the cross-linking agents as observed in DSC studies. Different samples of jute biocomposite boards were prepared using the modified compositions. Jute based bio-composite boards (6" x 6") were also prepared using tamarind kernel powder (TKP), shellac and blend of both in different combinations. Solutions of TKP and shellac were prepared in suitable solvents and mixed thoroughly in the ratios, TKP: Shellac 100:0, 60:40, 40:60 and 20:80 using four layer jute sheets. The boards were prepared in Carver press (hydraulic) at 150°C and 5 tons hydraulic pressure. The boards prepared were good in strength and with significant fibre load (55- 63%). Density of the boards were calculated and found to be in the range of 0.82 – 0.91 g/cm^3. Prepared boards were sent to NIRJAFT, Kolkata for testing maximum flexural load, flexure extension, flexure strain, maximum stress & strain, flexural modulus, flexure strength and inter-laminar shear stress etc. Small, cross section pieces of the boards were cut and dried for scanning electron microscopic (SEM) study.

SEM micrograph of Jute-lac based bio-composite made from lac (30%) shows smooth surface structure with no gap between lac matrix and jute reinforcement. This conclude good wet ability and bonding between matrix and reinforcement of bio-composites (Fig. 60).

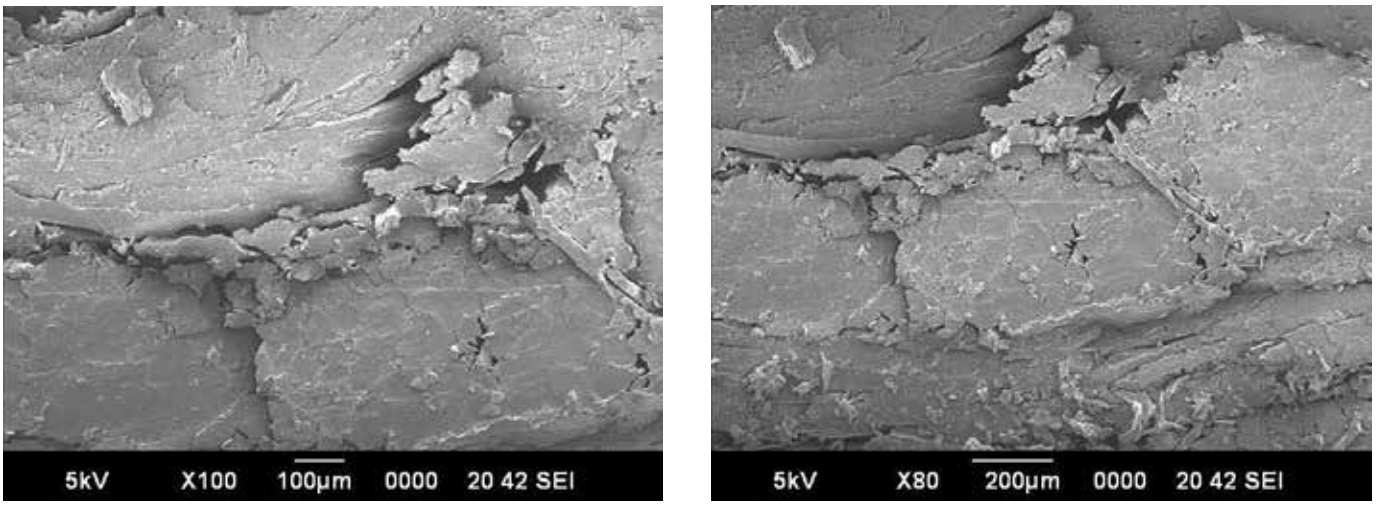
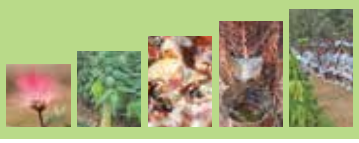


Fig 60. SEM micrograph(X80 & X100) of lac based bio-composites

8.8 Use of natural resins and gums for preservation and value addition of fishery products (Ministry of Food Processing)

A new research project of 2 years duration, to be jointly operated by IINRG, Ranchi and CIFT, Kochi, was sanctioned in the last quarter of 2013, by the Ministry of Food Processing, Govt. of India. Accordingly, appointment of SRFs at both centers was completed and preliminary work was initiated; Formulations of lac, gum, lac-gum and lac-oil emulsions were provided to CIFT for evaluation on dried fish for preventing fungal and bacterial infestation, decrease odor and improving cosmetic appearance.



9. Collaborative Projects (Partners)

9.1 Studies on lac-based coating formulations for extending shelf life of pomegranate (NRCP, Solapur and MPKV, Rahuri, MS)

The results were found to be encouraging, as per final reports obtained from both collaborative centers. NRCP reported that lac formulations developed at IINRG, Ranchi were found to be useful in reducing the physiological loss in weight, shrinkage and increasing the gloss of the fruits of pomegranate cv. *Bhagwa* through postharvest dip. The post harvest dip was found to be effective in maintaining the fruit quality during the storage period and improving the shelf-life by 6-7 days over control. Among the different lac formulations, SH02 was the best for maintaining the quality of the fruits of pomegranate cv. *Bhagwa* compared to SH03 and SH01. MPKV, Rahuri, also working on *Bhagwa*, additionally reported that in cold storage conditions, the shelf life was extended upto 61 days when treated with SH03B formulation. 5 l formulations was sent to MPKV, Rahuri for further research trials during 2014; 5 l formulation was also sent to M/s Marine Chemicals, Kochi, for commercial trials as per request received from them.

9.2 Termite, borer and fungal resistance of shellac-based varnishes (IIWST, Bengaluru)

Four shellac-based varnishes *viz*., V1, V2, V3 and V4 were tested for their termite resistance, borer resistance and fungal resistance at Institute of Wood Science & Technology (IWST), Bengaluru. Stakes / blocks of different sizes of rubber wood (*Hevea brasiliensis*), completely free from knots, moulds and stains, were air seasoned and weighed. They were treated with varnishes adopting three types of treatment methods i.e. spraying, dipping for 24 hrs. and pressure impregnation (50 Lbs/hour & vacuum for 15 minutes). Out of three treatment methods, pressure impregnation was found to be most effective. The wood stakes / blocks were weighed after treatment with varnishes. The treated stakes / blocks did not show much change in the color. These were air-dried for four weeks and weighed again. The untreated ones served as control. All the tests were carried out following BIS testing standards. Out of the four varnishes, V4 was 100% termite resistant up to six months. The damage was 1.43, 2.85, 4.29 and 16.42%, after 9, 12, 15 and 18 months respectively. After 21 months, the percent damage in case of V4 was 18.57 %, whereas it was 74.28% in case of control. Therefore, V4 can be used as an anti-termite wood protectant but it is less efficient than the plant products like 'cashew nut shell oil' and synthetic insecticide like 'bifenthrin', which are 100% termite resistant for more than a year. With respect to the effectiveness in protection against borers, they were better than control. All the varnishes protected the wood samples completely. As regards, fungal resistance, none of the varnishes was significantly effective in bringing down the decay. However, V1 was slightly better (10-20%) compared to others.

9.3 Development of seri-lac culture model for income augmentation (CSRTI, Mysore)

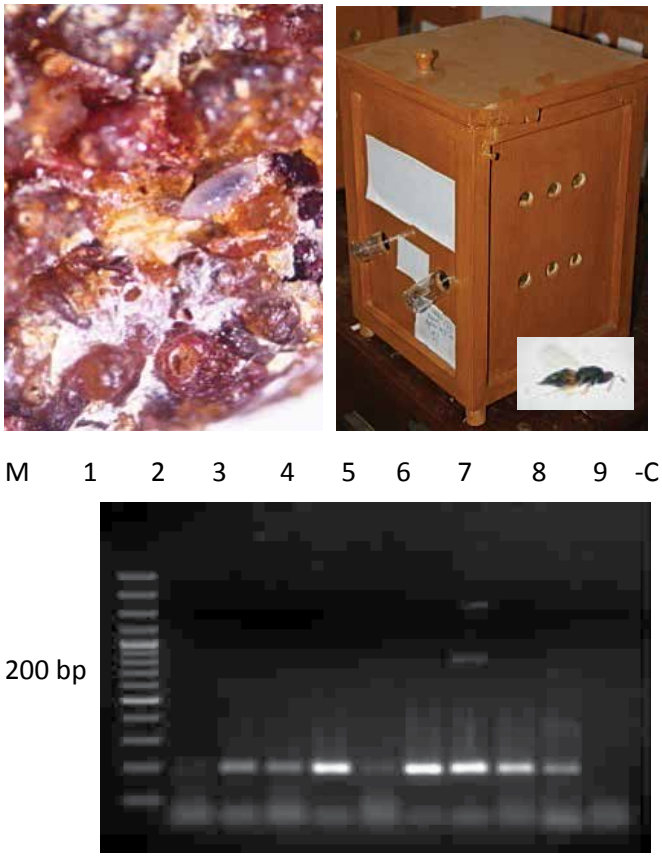
The genus *Flemingia* which belongs to the family of Leguminosae comprises over forty species in the world. In India, this genus is represented by fifteen species. Several plants of this genus have been used in folk medicine on the other hand *Flemingia* is also exploited as host plants for lac production. *Flemingia* being a leguminous plant can resist and survive in long dry spells and have capacity to fix the atmospheric nitrogen. Root nodulation takes place very freely with native rhizobia and helps in Biological Nitrogen Fixation (BNF). Considering the advantages associated with the perennial nature of shrub, attempt has been made to grow *Flemingia* as an intercrop with mulberry at Regional Sericulture Research Station (RSRS), Chamarajanagar (2012-2013) with an objective to work out the additional income of lac culture and its economics in relation to mulberry leaf production, assess the soil fertility, study cross infectivity if any from mulberry to lac host plant and *vice versa* and to study the carbon sequestration rate and crop productivity. One experiment was initiated at RSRS, FARM with existing mulberry tree plantation in wider spacing (8' X 8'). Twenty days old seedlings of *Flemingia* seedlings were raised in nursery beds/ polythene packets were transplanted in between mulberry tree plantation with spacing

of 8' X 3'. Regular cultural operations like weeding, manuring and irrigation (once in three days) carried out for better establishment. About 450 seedlings were transplanted and assessed for its growth and biomass production after eight months of transplantation. The survival percentage was recorded around 55 per cent. The biomass production per plant ranged from 0.450 to 0.670 kg (including shoot + leaves) with the shoot length of 80 – 110 cm. Study indicated that temperature crossed more than 35°C followed by dry weather during the growth period coupled with high soil pH (> 8.6%) had the adverse effect on the growth of plants. Since, age of the mulberry tree plantation is more than eight years with well established root system, it was feared that it may not be able to support the growth of *Flemingia* plants. However, the plants attained normal growth with care and ready for the inoculation of lac insects at FARM. Soil pH is showing decreasing trend from pH 8.6 to 8.01 in *Flemingia* transplanted plot. Soil acidification caused by this legume cultivation and microbial activities reduces the soil pH in alkali conditions is a clear indication to use it as one of the important bio-resource.

10. Exploratory study

10.1 Early detection of *Aprostocetus purpureus* in *jethwi* and *katki* crop

Early detection of *A. purpureus* through incidence (microscopic observation), abundance (adult emergence) and molecular technique (PCR based) during *jethwi* and *katki* crops during 2013 on *ber* was studied. Lac insect samples were taken one week after inoculation for molecular analysis and one month after inoculation for microscopic observation, followed by caging at weekly interval. Incidence of *A. purpureus* was observed 44 days after inoculation (DAI) through PCR technique, whereas, microscopic observation and caging revealed the incidence 57 and 64 DAI, respectively during *jethwi* 2013. In *katki* 2013, first incidence of *A. purpureus* was observed 7 DAI through PCR technique. However, microscopic observation revealed the incidence 30 DAI and adult emergence through caging was recorded 53 DAI. Detection using molecular approach required lesser sample and time (Fig. 61).



M- marker, 1 to 9:PCR product of lac insect samples collected in weekly interval from one month after inoculation, -C: negative control

Fig. 61. Early detection of *A. purpureus* through (a) microscopy, (b) caging and (c) PCR in lac insect samples

10.2 Alternate hosts for *A. purpureus*

A. purpureus is a dreaded parasitoid of lac insect and was hitherto considered exclusive to the lac ecosystem. However, *A. purpureus* was recorded from scale insect samples collected from various crops *viz*., *Aonla* (4, 7), *Hibiscus* (1, 5) and Mango (2, 10) at 15 days interval during April - May, 2013 from *Aonla* scale, *Hibiscus* mealy bug, Mango scale during April and May. It is evident that, *A. purpureus* is not exclusive to the lac ecosystem. New pest management strategies would need to be evolved in the light of finding.

10.3 Modification of tamarind kernel powder

The carboxymethylation procedure for tamarind kernel powder (TKP) was standardized and carboxymethyl derivative of TKP was synthesized by reacting TKP with monochloro acetic acid at 65°C for 4-5 hours. The

reaction product was confirmed by FTIR analysis. Color values of dried TKP, raw and purified, were determined by Hunter Colorimeter, Lab Scan-SE. Purified TKP sample showed significantly lower 'a' and 'b' values, denoting decreased yellow and red colored impurities which are washed out during purification. Hydrogels were synthesized from raw TKP with different concentrations (2, 4, 8, 10, 20 and 30%) of borax as a cross-linker. Swelling in distilled water at room temperature was studied and it was found that 10% borax hydrogel gives maximum water holding capacity; 1 g gel could hold 13.6 g water. The absorption/ swelling trends of different gels are shown in Fig. 62.

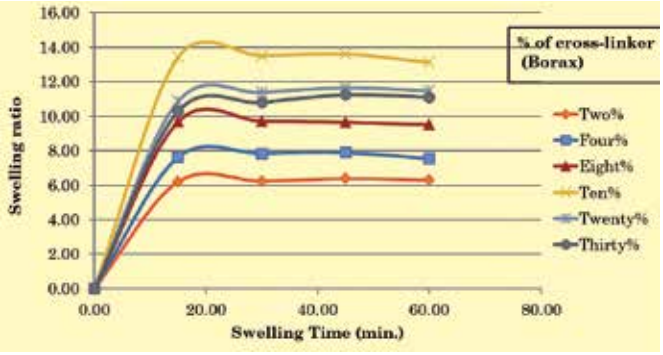


Fig. 62. Effect of borax % on water holding capacity of TKP hydrogel

10.4 Improvement in natural *alta* formulation

In order to improve natural alta formulation, four different metal chlorides and seven different chemical mordants were added in separate experiments to study their effect on colour and fastness of the natural alta, out of which two mordants had desirable effect. The mordants giving no colour improvement or imparting dark brown colour were rejected; also selected mordants were tested for their solution stability. Colour values for different formulations (metal complexes) of natural alta were taken in terms of L, a and b by Hunter's Colorimeter, it was observed that aluminum metal complex was found superior to others.

Certain skin caring components are also mixed into it, so as to make it not only safe but also have medicinal value for the skin. Alta after application could be removed by thorough washing with soap or detergent. Based on various experiments carried out, two Lac Dye Alta (LDA) formulations named as IINRG-LDA-91 (orange color) and IINRG-LDA-94 (deep red color) were finalized for commercialization (Fig. 63).

Fig. 63. Lac dye based natural alta applied in combination

10.5 Study on growth of lac production in India during XI plan period

Analysis of year wise lac production data in India during XI Plan (2007-2008 to 2011-2012) indicated average production by the country to the tune of 16.246 thousand tonnes. Jharkhand state registered highest average annual production (6.306 thousand tonnes), sharing 38.82 per cent of total lac produced in the country. This is followed by Chhattisgarh (30.21%), Madhya Pradesh (13.66 %), West Bengal (6.97%), Maharashtra (4.96%), Odisha (2.27%), Uttar Pradesh (1.94 %), Assam (0.52%), Andhra Pradesh & Gujarat (0.30% each) and Meghalaya (0.06 %). In respect of state wise growth rate in lac production, the country registered negative growth rate to the tune of 8.38 per cent per annum. Amongst the major lac producing states, Jharkhand and West Bengal recorded positive growth of 12.19 and 9.94 per cent per annum respectively, during this period. Amongst the declining trend state, Madhya Pradesh recorded highest negative growth (-32.41 %) followed by Uttar Pradesh(-29.37%), Chhattisgarh(-26.76%), Maharashtra (-10.62%) and Odisha (-9.92%). The other minor lac producing states namely Assam, Gujarat, Meghalaya also registered declining trend during the period. Strain wise analysis of production data for various states was also carried out in an attempt to identify which type of lac suffered most during this period. In Jharkhand, *kusmi* lac production (75.45% share) recorded positive growth of 21.56 per cent and *rangeeni* (24.55% share) negative growth of 16.60 per cent per annum. Both summer and winter crop of *kusmi* registered positive growth of 27.5 and 15.7 per cent per annum respectively. However, for *rangeeni*, it is rainy season crop which suffered most (-32.75%).The production of *rangeeni* summer crop

remained more of less static (-0.71%). In Chhattisgarh both *rangeeni* (55% share) and *kusmi* lac (45% share) recorded negative growth rate to the extent of 34.33 and 17.55 per cent per annum. The *rangeeni* summer and rainy crop recorded negative trend of 32.92 and 37.30 per cent per annum. Whereas *kusmi* summer and winter crop also recorded declining trend of 15.46 and 19.86 per cent per annum during plan period. In Madhya Pradesh also, *rangeeni* and *kusmi* lac showed declining trend and recorded negative growth rate to the tune of 34.93 and 45.64 per cent per annum respectively. Both summer and rainy season crop of *rangeeni* also registered negative growth of 31.30 and 29.10 per cent per annum, respectively. Similarly, *kusmi*-summer and winter recorded negative growth of 43.55 and 39.60 per cent per annum respectively. In Odisha also, both *rangeeni* and *kusmi* lac production recorded negative growth of 12.23 and 8.52 per cent per annum, respectively. Both summer and winter of *kusmi* as well as summer and rainy season crop of *rangeeni* showed declining trend. *Rangeeni* summer recorded highest negative growth of 16.91 per cent per annum. In West Bengal, the overall growth rate of both *rangeeni* and *kusmi* lac recorded positive to the tune of 10.65 and 4.07 per cent per annum. Though, *rangeeni*-rainy season crop registered declining trend of 16.48 per cent per annum. District wise growth rate in various states of India have been also carried out for all lac growing states.

10.6 Trial for lac cultivation on *Litchi*

Under the collaborative programme with Regional Centre Eastern Region- Ranchi Centre, *kusmi* broodlac was inoculated on 22genotypes of *litchi* as summer crop at the farm of Regional Centre for Eastern Region -Ranchi centre, to screen suitable *litchi* genotype for lac cultivation. The productivity (Output to input ratio) of broodlac indicated that five genotypes have productivity more than five. These are L4/36 (12.0), Surguja selection- 1 (6.59), Late Bedana (5.70), CHES-2 (5.55) and CHES-2-1 (5.0). Five genotypes which recorded very low productivity (< 1.0) include Rose Scented (0.31), Ajholi (0.50), Shahi (0.7), Laugia (0.83) and Trikoha (0.9). It was also observed that thin and tender shoots are suitable for better survival of lac insect.

11. Industrial Problems

11.1 Development of tackifier

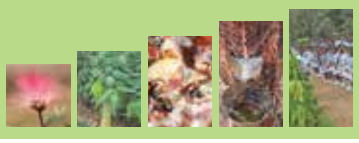
In continuation to the development of tackifier, peel adhesion test (Zero Peel and Peel at 180°) of three samples of tackifier developed were carried out. Adhesive strength at zero peel was higher for all the samples than peel at 180°. The highest adhesive strength (stress at max. load) was recorded for the sample TF-91 at Zero peel was 0.661 MPa.

11.2 Standardization of nail polish formulation and technology transfer

Nail polish samples were developed in different concentrations and shades. Properties of the nail polishes were studied. Technology of the Nail Polish was transferred to Mahatma Gandhi Institute for Rural Industrialization (MSME), Wardha, (Maharashtra) during 29-31 August 2013. Training for preparation of the Nail Polish (process know-how of the technology) was demonstrated to the representative of the Institute.

11.3 Confectionary coating

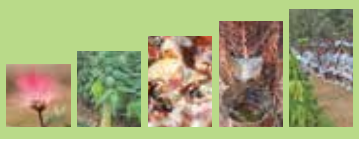
The work was initiated as per request received from M/s Mala Food Products, Panchgani (MS), for providing a suitable protocol for reducing the stickiness of pectin jelly beans being manufactured by them. Several approaches were adopted for pre-coating and glazing the jelly beans, using a wide range of edible materials, including lac, various gums, corn starch, zein protein and edible oil. The work had to be carried out in controlled conditions, below 50% RH, failing which the jelly beans, which are extremely hygroscopic, absorbed atmospheric water vapour and clumped together. The problem was finally solved, and 500 g of glazed jelly beans were dispatched to the firm for evaluation at their end.



Approved on-going Research Projects

Sl.No.	Project Title	Principal Investigator
Productivity and Quality Improvement		
1.	Host plant evaluation and improvement for lac productivity and summer sustainability	Dr J Ghosh
2.	Potentiality trials of *Kerria chinensis* on new lac host plants	Dr A Mohanasundaram
3.	Collection, conservation, characterization and documentation of lac insect and host plant bio-diversity	Dr V D Lohot
Crop Production System Management		
4.	Lac Integrated Farming System	Dr Vibha Singhal
5.	Development of spraying schedule of fungicides for management of sooty mold in winter *kusmi* lac crop	Dr A K Singh
6.	Study of variation of lac associated fauna in relation to different host plants	Sri S C Meena
7.	Influence of macro / micronutrients on *kusmi* lac production in comparison to standard package on *Flemingia semialata*	Dr S Ghosal
Processing, Storage and Quality Management		
8.	A comparative study of different drying methods on drying kinetics and quality of gum *karaya*	Er M Prasad
9.	Development of dehumidified air drying methods/ systems for drying of value added lac products	Er S K Pandey
10.	Intrinsic chemical variability, amino acid profiling and anti bacterial activity of Indian *babool* gum from different agro-climatic zones	Dr M Z Siddiqui
11.	Design and development of integrated small scale lac processing unit for conversion of sticklac – seedlac	Dr S C Sharma
12.	Characterization, chemical profiling and evaluation of gum ghatti (*Anogeissus latifolia* Wall.)	Sri N K Thombare
Value Addition, Application Development and Product Diversification		
13.	Use of natural gum/ lac for conserving natural characteristics and shelf life of select fruit and seed spices, through encapsulation	Dr P C Sarkar
14.	Development of natural resin/ gum based sticker *bindi*	Dr K P Sao
15.	Utilization of lac wax and lac dye for use as PGR and anti fungal agent	Dr S Srivastava
16.	Development of crack cream formulation based on *palas* and *moringa* gum	Dr S K S Yadav
17.	Modification of gummy mass for its application	Dr M F Ansari
18.	Synthesis and evaluation of *guar* gum derivatives	Dr A Roy Chowdhury
Capacity Building of Farmers and Entrepreneurship Development		
19.	Learning, capacity building, extension education and information service on Natural Resin and Gums	Dr A K Jaiswal
Technology Evaluation, Refinement, Dissemination and Demonstration		
20.	Development and validation of IPM modules for the management of predators and parasitoids associated with lac insect, *Kerria lacca* (Kerr)	Dr A K Jaiswal
21.	Demonstration of lac cultivation technologies under farmer's field condition	Dr A K Singh
22.	Market research for production and marketing of natural resins and gums	Dr R K Yogi
23.	Evaluation of lac mud as organic manure	Dr A K Singh
24.	Impact assessment of technological interventions and constraints analysis of lac cultivation	Dr R K Yogi

NAIP Projects		
25.	To understand the nature of diversity in lac insects of *Kerria spp.* in India and the nature of insect x host interaction (NAIP- Component -4)	Dr K K Sharma
26.	A value chain on lac and lac based products for domestic and export markets (NAIP-Component-2)	Dr N Prasad
27.	Developing sustainable farming system models for prioritized micro watersheds in rainfed areas of Jharkhand with BAU, Ranchi (NAIP Component–3)	Dr A K Jaiswal
Externally - Funded Projects		
28.	Production of summer *kusmi* broodlac on *kusum* for promotion of lac cultivation in Gujarat with farmer's participation (Forest Department, Silva Division, Gujarat)	Dr Md Monobrullah
29.	Climate change and lac crop performance (NICRA - ICAR)	Dr Md Monobrullah
30.	Lac cultivation and processing unit establishment	Dr J P Singh
31.	National Action Plan (NAP) for sustainable income generation of tribals through cultivation and processing of lac (TRIFED)	Dr J P Singh
32.	Jute based bio-composites for industry (NFBSFARA)	Er S K Pandey
33.	Use of natural resins and gums for preservation and value addition of fishery products (Ministry of Food Processing, Govt. of India)	Dr P C Sarkar
34.	Multidimensional investigation on *Aprostocetus purpureus,* a resurgent parasitoid of Indian lac insect, *Kerria lacca* (Kerr.) for devising lac crop management strategies (DBT)	Dr Archana Saini
ICAR Network Project		
35.	Network project on harvesting, processing and value addition of natural resin and gums (ICAR)	Dr N Prasad
Collaborative Projects		
36.	Lac based agro-forestry in Bundelkhand region: Introduction and evaluation (NRC Agroforestry, Jhansi)	Dr S Ghosal
37.	Studies on lac-based coating formulations for extending shelf life of pomegranate (NRCP, Solapur and MPKV, Rahuri, MS)	Dr P C Sarkar
38.	Termite borer and fungal resistance of shellac based varnishes (IIWS &T, Bangalore)	Dr M Z Siddique
39.	Development of seri-lac culture model for income augmentation (CSRTI, Mysore)	Dr A Mohanasundaram
Exploratory Studies		
40.	Early detection of *Aprostocetus purpureus* in *jethwi* and *katki* crop	Dr Thamilarasi K
41.	Alternate hosts for *Aprostocetus purpureus*	Dr A Mohanasundaram
42.	Modification of Tamarind Kernel Powder (TKP)	Sri N Thombare
43.	Improvement in Natural Alta formulation	Sri N Thombare
44.	Study on growth of lac production in India during XI plan period	Dr R K Yogi
45.	Trial for lac cultivation on *Litchi*	Dr A K Jaiswal
Industrial Problems		
46.	Development of tackifier	Dr M F Ansari
47.	Standardization of nail polish formulation and technology transfer	Dr M F Ansari
48.	Confectionary coating	Dr P C Sarkar



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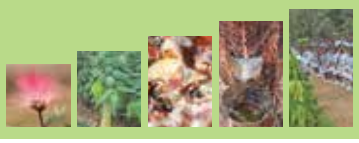

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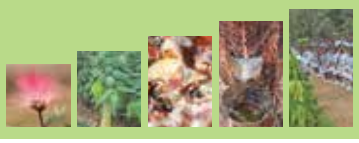

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- महताब ज़ाकरा सिद्दीक़ी (2013). भारतीय महिलाएं की कृषि एवं पशुपालन में भूमिका। लाक्षा, भारतीय प्राकृतिक राल एवं गोंद संस्थान, राँची (झारखण्ड), पृष्ठ 22–23।
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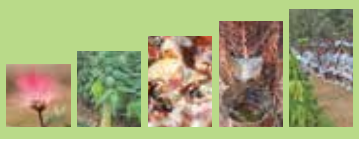
- Monobrullah Md (2013*). Jalvayu privartan aur Bhartiya Krishi* (in *Hindi), LAKSHA, pp 38-41.*
- Ramani R (2013). *Guar* and lac production show positive trends. In: IINRG Newsletter, Apr-June 2013.
- Ramani R (2013). Mega Initiative for total partnership: from lac to handicraft. In: IINRG Newsletter, Jan-Mar 2013.
- Ramani R (2013). Need for consolidation of *guar* and lac sectors. In: IINRG Newsletter, July-Sept. 2013.
- Sharma SC, Prasad N and Pandey SK (2013). *Gond ewam raal yukt gond ka vaigyanik utpadan, Kheti*, **12**: 21-24.

Institute Publications

- Year planner cum publicity brochure-2013 - 28 pp.
- Aleuritic Acid-book- 96 pp.
- लाक्षा–2012–राजभाषा पत्रिका, पुस्तिका – 82 पृष्ठ
- कैसे करें सेमियालता पर लाख की वैज्ञानिक खेती – पुस्तिका – 40 पृष्ठ
- QRT Report-Book - 96 pp.
- Lac host plants- potential uses, booklet - 52 pp.
- Natural Resins and Gums-IINRG Newsletter, 16(4), 8 pp (Oct-Dec 2012)
- Insect pest of lac crop and their management, booklet, 48 pp.
- Good manufacturing practices for bleached lac, Mannual, booklet, 16 pp.
- Raising of lac host plantation (*ber* & *semialata*) and modern technique of lac cultivation, Folder, 6 pp.
- वार्षिक प्रतिवेदन–2011–12 –पृष्ठों की संख्या–100
- Natural Resins and Gums-IINRG Newsletter, 17(1), (Jan-Mar 2013) 8 pp.
- Annual Report 2012-13, 108 pp.
- Natural Resins and Gums-IINRG Newsletter, 17(2), (April-June2013) 8 pp.
- लाख फसल के शत्रु कीट एवं प्रबंधनए पुस्तिका– पृष्ठों की संख्या–46



- DNA Bar coding of Indian *Kerria* species/races, booklet, 68 pp.
- लाक्षा–2013–राजभाषा पत्रिका, पुस्तक– पृष्ठों की संख्या–84
- Aqueous lac varnish for earthenware and bamboo articles, Folder, 4 pp.
- Ms. Dorothy Norris third memorial lecture-2013, 8 pp.
- Recovery of lac dye: A by product of lac industry, Folder, 4 pp.
- IINRG Vision 2050, booklet, 24 pp.
- Natural Resin and Gums-IINRG Newsletter, 17(3)-(July-Sept 2014) 8 pp.
- Lac, Natural Resins and Gums Statistics- At a glance-2012, 33 pp.
- Recent advances in beneficial insects-National Symposium, Book of Souvenir, 128 pp.

Publicity

Kisan Melas, Exhibitions, Institute – Industry Interface Meetings

The experts from IINRG participated and depicted technologies developed by Institute at various places *viz.,* R.K. Mission, Getalsud, Angarha, Ranchi, Annual *Kisan Mela*; OUAT, Bhubaneswar (Xth Agric. Science Congress Exhibition); BAU, Kanke, Ranchi (Agrotech-cum-Agril Fair); IARI, Pusa Campus, New Delhi; KVK, Katihar, Agril Fair; Department of Agriculture & ATMA, Latehar, Exhibition-cum-Kisan Gosthi; Patna, Bihar, Eastern Region Agricultural Technology Showcasing Meet-2013 cum *Kisan Mela*. Besides this experts from IINRG also participated in 12 *Kisan Gosthi* organized in different districts of Jharkhand and West Bengal wherein 3986 farmers and traders were benefitted in the field of natural resins and gums.

Tours / Visits

- Pandey SK, Sc. participated in India Innovation Growth Programme on 14 February 2013 organised by FICCI and Lockheed-Martin at Green Horizon, Ranchi.
- Pandey SK, Sc. participated in Annual Workshop of NAIP project on Lac Value Chain held during 11-12 March, 2013 at NASC Complex, New Delhi.
- Pandey SK, Sc. participated in one day Agribusiness Camp on 18 March 2013 organised at BCCI, Bhawan Kolkata by ZTMC-BPD, NIRJAFT, Kolkata.
- Sao KP, Pr. Sc. and Chowdhury AR, Sc. visited Aravind Laboratories, Chennai, during 19-23 March 2013 for preparation of sticker bindi using hydrolyzed lac based adhesive.
- Pandey SK, Sc. participated in one day Lac Network Workshop on Lac collection, processing and marketing on 17 April 2013 at Seoni, MP.
- Nandkishore T, Sc. visited NIRJAFT, Kolkata during 13-14 June 2013 to discuss the progress and future working plan regarding NFBSFARA Project - Jute based Biocomposites for Industry.
- Nandkishore T, Sc. visited BIS, Manak Bhavan, New Delhi for purchase and procurement of BIS standards required for gum testing on 23 July 2013.
- Sarkar PC, Sr. Sc. attended the meeting of ITMC on 16 August 2013 to discuss the formalities of technology transfer of coating formulation for pomegranate to M/s Marine Chemicals, Kochi.
- Monobrullah Md, Pr. Sc. visited KVK, Petarwar (Bokaro), Nauyakhap, Bedia tola and Katarbera areas of Chargi village on 14 August 2013 for monitoring of *kusmi* lac crop raised on semialata and *kusum* trees under FLD programme.
- Srivastava S, Pr. Sc. attended the meeting of ITMC on 16 August 2013 to review the license given on fruit coating formulation for *kinnow* to M/s Gupta Brothers, Bundu.
- Srivastava S, Pr. Sc. visited FSSAI, Ministry of Health and Family Welfare at New Delhi on 22 August 2013 to obtain the receipt of the draft of Rs 25,000/- from the office of FSSAI. He also met with Director (Product Approval), FSSAI and requested to expedite the process for final approval.
- Nandkishore T, Sc. visited Bilaspur, Katghora, Korba (Chhattisgarh) and Gumla during 29-31 August 2013 to collect gum samples and also to see gum and lac processing industries. He also imparted demonstration-cum-on farm training to 50 farmers on scientific gum inducing technology in *babool* tree at Kalmitar village, Bilaspur on 31 August 2013.
- Monobrullah Md, Pr. Sc. visited ICAR-RCER, Patna and KVK, Buxar during 29-30 August 2013 to

monitor *kusmi* lac crop raised on *F. semialata* under OFT programme.

- Monobrullah Md, Pr. Sc. visited SKUAST-J, Jammu during 10-13 September 2013 for monitoring of *rangeeni* lac crop (*katki* 2013) inoculated on *ber* trees under NICRA Project and to conduct Viva-voce examination of two M.Sc. Entomology students of SKUAST-J, Jammu.
- Srivastava S, Pr. Sc. visited Kolkata on 7-9 October 2013 to attend OFC and VISA interview as pre-departure formalities which are to be completed for attending International training in School of Packaging, MSU, East Lansing, Michigan, USA.
- Monobrullah Md, Pr. Sc. visited ICAR-RCER, Patna on 10 December 2013 for monitoring *kusmi* lac crop raised on *F. semialata* under OFT programme.
- Monobrullah Md, Pr. Sc. attended regional consultation workshop on state action plan on climate change for Jharkhand organized by JAPCC on 13 December 2013 at Hotel BNR Chanakya, Ranchi.
- Dr. S. Ghosal, Sr. Sc. made more than 15 field visits in different villages to provide technical know- how to the lac growers and for crop monitoring.
- Srivastava S, Pr. Sc. visited JASCOLAMF plant, Sidrol, Ranchi, to ascertain the working of movable parts of the plant, power supply and manpower deployed for running the Aleuritic Acid plant.

Radio / TV Talks

Name of Scientists	Topic of Radio talk	Date of broadcast
Dr. A K Jaiswal, PS & Head	*Lakh Keet Sancharan evam Fasal Suraksha* (Akashwani)	13.07.2013
Dr S Ghosal, Sr. Sci.	Scientific methods of lac cultivation (DD1 and ETV Bihar)	5.08.2013 6.08.2013
Dr J P Singh, Sr. Sci.	*Lakh Kheti ki Samasyaein evam Samadhan* (Akashwani)	16.08.2013
Dr S Ghosal, Sr. Sci.	Nutritional management of lac hosts for winter season *kusmi* lac production in particular reference to *ber* (Akashwani)	7.12.2013
Dr A K Jaiswal, PS & Head	*Jharkhand Mein IINRG, Ki yojnayein* (Doordarshan)	19.12.13

Database

- Shamim G, Ramani R, Pandey DM, Ranjan SK, Kandasamy T and Sharma KK. Fatty acids, terpenes and pigment biosyntheses in Indian lac insect, *Kerria lacca* (Kerr.) Accession nos. KF463149 - KF463155 (7 sequences).
- Ranjan SK, Shamim G, Kandasamy T, Sharma KK, Mohanasundaram A, Kaprakkaden A and Ramani R. Diversity analysis of *Kerria* sp (Hemiptera: Coccoidea: Tachardiidae) through sequence variation of housekeeping genes (18S rRNA). Accession nos. KF537579 - KF537619 (41 sequences).
- Ranjan SK, Shamim G, Kandasamy T, Sharma KK, Mohanasundaram A, Kaprakkaden A and Ramani R. Diversity analysis of *Kerria* sp (Hemiptera: Coccoidea: Tachardiidae) through sequence variation of housekeeping genes (Elongation factor alpha). Accession nos. KF554253 - KF554298 (46 sequences).
- Shamim G, Ramani R, Ranjan SK, Kandasamy T and Sharma KK. Isolation of bacterial flora associated with *Kerria lacca* (Kerr). Accession nos. KF717499 - KF717527 (29 sequences).
- Shamim G, Ranjan SK, Kandasamy T, Mohanasundaram A, Kaprakkaden A, Sharma KK and Ramani R. Diversity analysis of *Kerria* spp. (Hemiptera: Coccoidea: Tachardiidae) through EPIC-PCR. Accession nos. KF886192 - KF886238 (41 sequences).
- Shamim G, Pandey DM, Sharma KK and Ramani R. Fatty acids, terpenoids and pigment biosyntheses in *Kerria lacca* (Kerr). Accession nos. KJ210844 - KJ2108452 (9 sequences).

Patents

- Ranjan SK, Vidyarthi AS and Ramani R. 2013. Group-specific primers for identification of *Kerria* species. Appn. No. 580/KOL/2011A; 22/02/2013.
- Patent on "Novel Molecular Method to Differentiate Infra-Subspecific Forms, *Kusmi* and *Rangeeni*, of Indian Lac Insect, Kerria lacca" (S K Ranjan, G Shamim, Thamilarasi K, A Vidyarthi, K K Sharma and R Ramani) was filed on 26.11.13. The patent application no. 1333/KOL/2013.
- Patent on 'Inhibition of growth in human malignant cell lines using lac dye' (Shamim, Gulsaz; Ranjan, Sanjeev Kumar; Pandey, D. M.; Sharma, K. K. and Ramani, Rangnathan). Patent application number - 1435/KOL/2013. Date of filing – 19.12.2013.

Success stories

Upliftment of socio-economic status through integration of Horticultural crops in lac cultivation

Lac integrated farming system model was replicated in the field of Mr Prakash Sanga in Mangobandh village during July 2012 in an area of 1500 m^2. This model is a Horti-lac system consisting of *semialata* and papaya plants. There were 27 paired rows of *semialata* having 2 m distance between each paired row. There was a row of papaya plants in between two paired rows of *semialata* alternately. This model comprised of 2000 *semialata* and 140 papaya plants.

The alternate rows of *semialata* where papaya was not raised in between, integration of vegetables (tomato, brinjal, lady finger and chilli) was done. 90 kg of chilli, 60 kg lady finger, 670 kg brinjal and 2639 kg tomato was harvested in 2012-13. As the *semialata* plants grew very healthy in six months only, therefore in five rows, 20 kg of broodlac was inoculated on 270 plants in Feb 2013 for raising *jethwi (kusmi)* crop in first year of plantation. 68 kg broodlac + 4 kg rejected sticklac was obtained for summer crop. Papaya plants started yielding an average of 30-40 kg fruits per plant after one year. So far, farmer has sold 13 quintals of papaya. In this way, the farmer is earning year round income through diversified produce by adopting lac integrated farming system approach. His success and economic upliftment is motivating other farmers also to adopt LIFS technology.

Enhancing income through lac cultivation- Story of a small tea vendor

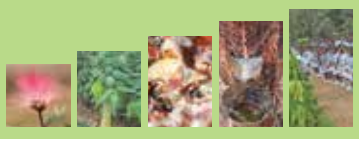
Mr Yogendra Ahir

Mr. Yogendra Ahir, aged 57 years living in Banta village of Silli block in Ranchi district (Jharkhand). He was running a small tea stall from which he earned around Rs 3000 per month which was insufficient to support the family requirements. He is the father of four daughters (three married) and one son, aged 12 years. He owned around 60 decimal lands for paddy cultivation under rainfed condition. He does not have any lac host tree but is aware of potential of lac cultivation. He met Shri Ramesh Chandra, an ex-trainee of Indian Institute of Natural Resins and Gums (IINRG), Ranchi who motivated Shri Ahir to initiate lac cultivation. He acquired three trees of *Z. mauritiana* from his fellow farmer and inoculated 3 kg of *kusmi* broodlac (worth Rs 1500) in July 2011 with the pre-condition that production will be shared. The tree was pruned during February 2011 on advice of Shri Ramesh Chandra. After six months of inoculation, he harvested 30 kg broodlac worth Rs 15,000 during January 2012. Out of this, he retained 13 kg for his own purpose and rest 17 kg given to owner of tree. In order to fulfil the broodlac requirement every year in July for inoculation on *ber* trees, he searched for *S. oleosa* tree in other areas and involved one of his relative (Village: Bundiaru, Block: Rahe, Dist Ranchi) to take summer crop by giving him broodlac. Thus 13 kg broodlac was inoculated on one *S. oleosa* tree during January 2012. After six months, his relative harvested 100 kg broodlac from single *kusum* tree. Shri Ahir has taken back 20 kg broodlac from his relative during July 2012 and re-inoculated *ber* trees with 15 kg broodlac

in his own village (on share basis). Rest 5 kg broodlac, was given to another relative (Village: Chirgaldih, Block: Sonahatu, Ranchi) who inoculated on 10 *ber* trees. When lac crop matured after six months in January 2013, he harvested 65 kg *kusmi* broodlac worth Rs 32,500 during January 2013 from 15 kg inoculated by him. Out of 65 kg produced, he sold 30 kg @ Rs 500 per kg and earned cash income of Rs 15,000. Rest 35kg was given to another relative with the condition that he will return twice the quantity given to him after six months when crop will mature as he required broodlac every year in July to inoculate *ber* trees. He gets back 70 kg broodlac in July 2013 which was marketed with cash income of Rs 28,000. Shri Ahir inoculated 20 *ber* trees during July 2013 with 40 kg broodlac which was given to him in lieu of broodlac he had given to his first relative during July 2012. He added an income of Rs 8,000 from *phunki* scraped of Rs 40 kg. The standing crop on *ber* tree is developing well. He adopted all the scientific methods of lac cultivation including pruning of trees for availability of tender shoots and crop protection measures recommended by IINRG, Ranchi. Mr. Ahir is basically doing commercial broodlac production on *ber* trees. A apart of his production, he is giving to other farmers every season but takes back broodlac from fellow farmers every year in order to fulfil his own requirement to inoculate *ber* trees and also to market and earn cash money every six months. Year by year his income enhanced as he has adopted more farmers. Basically this is how a resource poor farmer arranged lac host trees (*ber*) from other farmers, became self-reliance for broodlac and enhanced his income to Rs 36,000 per season in two years by a meagre investment of Rs 1,500 only. The technology of lac cultivation is also being transferred from farmers to farmers. Encouraged from this, he raised 150 numbers of *Flemingia semialata*, a quick growing bushy lac host plant with tomato as intercropping. The lac crop on *F. semialata* is growing well. Now Shri Ahir is supporting his family very well. Thanks to Shri Ramesh Chandra for motivating and supporting Shri Ahir at initial stage. (Shri Yogendra Ahir, Mobile: 8809915993).

Income generation through *kusmi* lac cultivation

Smt. Albina Marki was the member of Self Help Group (DEEPAK) came into the contact with the Centre for Women Development (CWD), Torpa, Khunti (under DPO sponsored project on lac cultivation and processing unit) in 2011-12. Her husband Sri Phillip Marki was inspired to join the occupation of lac cultivation with scientific interventions during various exposure visits by the officials from IINRG, Namkum, Ranchi and CWD, Torpa. He was identified from SHG group as direct beneficiary under this project. He came to the institute for training and visited the Institute Research Farm where scientific cultivation of lac was demonstrated by experts. He was trying lac cultivation on *kusum* and *ber* but could not succeed due to poor quality broodlac. His efforts were directed towards scientific lac cultivation and experts from IINRG demonstrated the technology at the Baghiya village and inputs were supplied by CWD, Torpa. Now, he has adopted scientific lac cultivation and is well aware about time of pruning, selection of good quality broodlac, bundling of broodlac and inoculation, *phunki* removal, spraying of recommended pesticides etc. Family of Smt. Albina has got good quality *kusmi* broodlac from the project (7 kg) and also purchased good quality *kusmi* broodlac (10 kg) and inoculated on 15 *kusum* trees in Feb, 2013. They also arranged about 20 kg broodlac for inoculation. Thus, a total of 37 kg broodlac was inoculated. Marki family got a total of 270 kg *kusmi* lac production. In September 2013, they earned Rs.1.15 lakh by the sale of first harvest of the *kusmi* crop. This produce (brood lac) was again inoculated for next crop by their family and other farmers in the locality. Broodlac was purchased by CWD, Torpa and distributed to the other interested member of SHGs in identified lac growing areas. This improved the standard of living of the farmers in his locality also. Moreover, with the initiative of all the partners including District Planning Office, Khunti, IINRG, Ranchi and CWD, Torpa beneficiaries from three different SHG from Rania block were honoured on 12 September 2013 on the occasion of Foundation Day Celebration of the Khunti District. Hon'ble Chief Minister, Jharkhand, Shri Hemant Soren handed over a cheque of Rs. 4 lakh. Broodlac was purchased from these beneficiaries for distributing further. Besides this, lac worth of Rs. 5.00 lakh was sold by the beneficiaries in the open market with good price during the year by the members of SHGs. This achievement has brought in a lot of interest towards lac cultivation in this area.



Participation of Scientists in Conferences/ Meetings/ Seminars / Symposia / Workshops / Trainings

Conferences / Meetings / Seminars etc.

By Director

- Presented RFD of the Institute on January 11, 2013 and responded to comments, noted points of action.
- Attented NARAKAS meeting at CIP, Kanke, Ranchi on January 29, 2013.
- Chaired 14th Regional RAC meeting of RSRS, Nagri (Central Silk Board) on February 6, 2013.
- Chaired RRAC meeting of Regional Sericultural Research Station, Ranchi on March 6, 2013.
- Attended the meeting of HoDs and Directors with DG of CS Division on March 11, 2013.
- Attended the RAC meeting of NBAII at Bengaluru as member on March 12-13, 2013.
- Attended the meeting of HoDs and Directors with DG of Agric. Engg. Division on March 14, 2013.
- Attented Directors' Conference at New Delhi on March 19-20, 2013.
- Attented workshop MDP Programme on "Strategic Perspectives of Dark Side of Leadership" at IIM Indore on 4-5 March 2013.
- Attended three ASRB selection Committee meetings for the posts of Principal Scientist on 29th April and 2nd May, 2013.
- Attended Annual Day function at Kendriya Vidyalaya and addressed the students on May 5, 2013.
- Attended the Workshop on lac handicraft making by Jhascolampf in Ranchi and delivered talk on May 14, 2013.
- Attended as Chief Guest, inaugural event of Summer school on Horticulture-based crop diversification option for livelihood security in tribal areas on May 21, 2013.
- Participated in the XXII Biocontrol Workers' Group Meeting on Biological Control of Crop Pests at NBAII, Bengaluru on the second and concluding day in various deliberations. Chaired Session VI on Institute-Industry Partnership and presented the recommendations in the plenary session on May 25, 2013.
- Attended Selection Committee meeting for the post of Sr Sc (Extn) in ASRB on June 6, 2013.
- Organized the IIAB Expert Consultation on IIAB at Conference Hall, NASC Complex on 10th June in which a total 30 experts from various Institutions participated. Made a presentation on the Institute on June 10, 2013.
- Attended the Expert Consultation on NIBSM at NASC Complex, New Delhi on June 11, 2013.
- Attended inaugural ceremony of NICRA II Annual meeting in BP Pal Stadium, New Delhi June 17, 2013.
- Attended and addressed two interaction meetings on the initiative of of Hon. MP, Shri Anantkumar Hedge, with senior officials of district administration; VC of UAS, Dharwad (at Sirsi); officials from KVKs; officials from Forest Dept.; officials from NABARD; interested farmers from the area during June 26-27, 2013.
- Attended 36th RAC Meeting of the CTR&TI, Ranchi as member during July 10-11, 2013.
- Attended the SMD-level consultation organized by PDFSR, Modipuram to develop linkages with various ICAR Institutes. Also attended the SMD-level consultation organized by PDFSR, Modipuram to develop linkages with various ICAR Institutes on July 15, 2013.
- Attended ICAR Foundation Day award functions and the the Directors' Conference on July 16, 2013.
- Attended the selection committee meeting in MPAUT, Udaipur on August 23, 2013.
- Attended a meeting organized by Jharkhand Council of Sci. and Tech. for establishment of patent facilitation center at Ranchi on August 26, 2013.
- Attended as Chief guest, Anita Sen Memorial Award Programme organized by Udyogini at Bundu and gave away the awards on September 5, 2013.
- Attended the 5th CCM of the network project HPVA-NRG and chaired the proceedings to review the work done during October 8-9, 2013.
- Attended the national conference on Recent Advances in Modern Biology and Sericulture for Women Empowerment and Rural Development as a guest of eminence and delivered lead lecture on October 25, 2013.

- Attended as member, the First RAC meeting of IIAB, Ranchi at NASC Complex, New Delhi on November 7, 2013.
- Attended the Brainstorming Session on "Choosing Leaders in Agric. Research, Methods of Scientists' Recruitment and Talent Search in Agri-teaching, Research and Extension," organized under the aegis of NAAS on November 11, 2013.
- Attended the ASRB selection committee meeting (Agronomy) under CAS at ASRB, New Delhi on December 18, 2013.
- Attended the ASRB selection committee meeting (Org. Chem) under CAS at ASRB, New Delhi on December 23, 2013.
- Attended 7th EFC and 8th SFC meeting to finalize the SFC document of the Institute and network projects at Krishi Bhavan, New Delhi on December 30, 2013.

Interactive meetings with overseas stakeholders

- Mr Robert Rae, Shines, Australia on June 19, 2013.
- Mr Thomas E Kohlberg, Kane International, USA, on October 18, 2013.
- Discussed with European representatives of lac industry, Mr Penning and Mr Hall, regarding generation of fresh data on safety of shellac, as per international protocols on December 17, 2013.

Deputation abroad

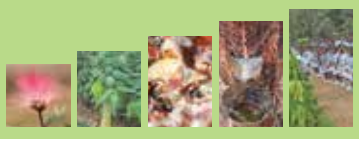
Participated in the Expert Consultation on Promotion of Medicinal and Aromatic Plants in the Asia-Pacific Region during 2-3 Dec 2013 at Bangkok

Talks delivered

- Delivered lecture on "Role of lac production in farming system in Eastern Plateau region." In the summer school (21st May to 10th June) on "Horticulture Based Diversification options for Livelihood Security in Tribal Areas" at ICAR-RCER Res. Centre, Plandu on June 4, 2013.
- Delivered talk on "Climate Change and Agriculture." at Administrative Staff College, Ranchi University on September 23, 2013.
- Made presentation on "Lac Cultivation for Rural Livelihood Enhancement." In National Conference on Recent Advances in Modern Biology & Sericulture for Women Empowerment and Rural Development on October 25, 2013 at KSSRDI, Bengaluru.
- Delivered talk on "Opportunities in lac as a product, IINRG, its research on lac and potential for revival and promotion of lac." In Workshop on "Creating partnerships for Tribal Women's Enterprise-based Livelihoods on Lac" by Udyogini, Ranchi on October 18, 2013.
- Made a presentation of my views on choosing Leaders in Agri. Research, Methods of Scientists Recruitment and Talent Search in Agri-Teaching, Research and Extension - my suggestions. In the brainstorming session organized by NAAS on November 11, 2013.
- Delivered lead lecture: "Lac insect: A journey through time." In the national symposium on "Recent Advances in Beneficial Insects." November 27-29, 2013 at IINRG, Ranchi.

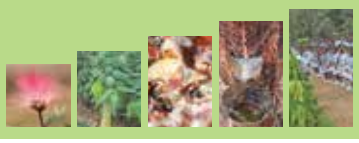
By Others

- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division attended as RFD Nodal Officer of the Institute, the presentation meeting of RFD 2013-14 at IASRI, New Delhi on January 11, 2013.
- Dr. Md Monobrullah, Pr. Sc. visited CRIDA, Hyderabad to attend and present Research Progress Review meeting of NICRA Project held at CRIDA, Hyderabad during January12-13, 2013.
- Dr. Srivastava S, Pr. Sc., Dr. Siddique MZ, Sr. Sc., Dr. Sarkar, PC, Sr. Sc., Dr. Ansari MF, Sr. Sc., Shri, SKS Yadav, Sc. and Dr. Chowdhury AR, Sc. attended ICAR Chemists Conclave organized by Division of Agricultural Chemicals, IARI, on January 14-15, 2013, at IARI, New Delhi.
- Dr. AK Jaiswal, Pr. Sc. and Head TOT Division participated in a workshop on Lac production and processing at Sheesh Mahal, Chandil in Saraikela-Kharsawan district organized by KVK Saraikela-Kharswan, Jharkhand on January 24, 2013.
- Monobrullah Md, Pr. Sc. visited New Delhi to attend and present a paper in International conference on "Agriculture and climate change (ICACC)" organized by TERI, Delhi at IHC, Lodhi Road, New Delhi during 28-31 January 2013.



- Dr. Srivastava, S, Pr. Sc. and Er. Pandey, SK, Sc. attended DST-Lockheed Martin India Innovation Growth Programme at Hotel Green Horizon, Station Road at Ranchi on February 14, 2013.
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division, Monobrullah Md, Pr. Sc., Dr. JP Singh, Sr. Sc., Dr. Thamilarasi K, Sc. and Dr. Mohanasundaram A Sc. participated in International Conference on Insect Science on New Horizon in Insect Science. Organized by University of Agricultural Science, GKVK, Bangalore and Indian Society for Advancement of Insect Science, PAU, Ludhiana at Bangalore during February 14-17, 2013.
- Dr. AK Jaiswal, Pr. Sc. and Head TOT Division participated in 15th Indian Agricultural Scientists and Farmers' Congress on Agriculture and Global climate change on February 22-24, 2013 and delivered a key note address on "Climate change and Agriculture".
- Monobrullah Md, Pr. Sc. visited Allahabad during 21- 24 February 2013 to attend and present a paper in 15th Indian Agricultural Scientists and Farmers' Congress on Agriculture and Climate Change organized by Bioved, Allahabad at during 22-24 February 2013.
- Dr. RK Yogi, Sc. attended 15th Indian Agricultural Scientist and Farmer's Congress on Agriculture and Global Climate Change organized by Bioved Research Institute of Agricultural and Technology, Allahabad during February 22-24, 2013.
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division attended the brainstorming session on breeding strategies for vanya silkworms organized by Central Tasar Research and Training Institute, Ranchi on February 28, 2013.
- Dr. Ansari MF, Sr. Sc. attended "National Workshop on Foresight and Future Pathways of Agricultural Research through involvement of Youth in India" during March 1-2, 2013, at NASC Complex, New Delhi.
- Er. Pandey, SK, Sc. participated in Annual Workshop of NAIP project on lac value chain held on March 11-12, 2013 at NAAS Complex, New Delhi and presented the progress of project.
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division attended a one day meeting of HoDs and Project Coordinators of the Institutes of Engg. Division with the DG on March 14, 2013 at Krishi Bhavan, New Delhi. Action Taken Report on the proceedings of the last meeting, the annual achievements of the LP Division and research activities contemplated during the XII Plan were presented orally in the meeting.
- Er. Pandey, SK, Sc. participated in "One day Agribusiness camp" on March 18, 2013 organised at BCCI, Bhawan Kolkata by ZTMC-BPD, NIRJAFT, and Kolkata.
- Dr. RK Yogi, Sc. attended National Seminar on Agribusiness potential of Rajasthan, organized by Institute of Agribusiness Management, SKRAU, Bikaner, Rajasthan and Indian Society of Agricultural Marketing, Nagpur during March 19-20, 2013.
- Dr. Ansari MF, Sr. Sc. attended a seminar on 'Climate change and its results' at IINRG Ranchi on March 22, 2013
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division attended the annual workshop of NAIP, Component-4 at New Delhi on March 25-26, 2013 and presented the progress of the project.
- Dr. A K Jaiswal Pr. Sc. and CCPI, NAIP-3 attended CAC Meeting at Birsa Agricultural University, Ranchi on April 01, 2013 chaired by the Chairman Dr Kirti Singh and Dr A P Srivastava National Coordinator, Component-3.
- Shri. SKS Yadav, Sc. attended and participated in the Group meeting of proposed Network Project on High Value Compounds and Phytochemicals on April 02, 2013 organized at IISR, Calicut.
- Dr. KK Sharma, Pr. Sc. and Head, LP Division attended the Agri Summit 2013 organized by ICAR-RCER at Patna on April 8-9, 2013 and presented a paper on plantations for lac cultivation – a potential remunerative venture especially for north eastern states.
- Dr Vaibhav D Lohot, Sc. attended a one day brainstorming session on of Seed Platform on April 8, 2013 at Division of Seed Science & Technology, IARI, New Delhi conducted by Directorate of Seed Research, Mau.

- Dr. A K Jaiswal Pr. Sc. and Head, TOT Division attended a meeting with Director, Jharkhand Tribal development of Society, Ranchi on April 12, 2013 for promotion of lac production on the State.
- Dr. KK Sharma, Pr. Sc. and Head, LP Division attended the Farm Innovators Meet organized by ZPD at Kolkata on April 14, 2013 and the inauguration function of the new building of ZPD, Kolkata. Also, handed over the documents related to KVK Khunti to ZPD, Kolkata.
- Dr. AK Jaiswal, Pr. Sc. and Head, TOT Division and Er. Pandey, SK, Sc. participated in workshop on "lac production and processing in Madhya Pradesh" organized by M.P. State Minor Forest Produce Fed. Ltd. Bhopal at Seoni district in M.P. on April 17, 2013.
- Dr. KK Sharma, Pr. Sc. and Head, LP Division attended the *Rajbhasha Sammelan* and award distribution function at Indian Museum Campus, Kolkata on April 18, 2013, and received the first prize given to the institute for doing good work in implementation of Hindi.
- Dr. AK Jaiswal Pr. Sc. and Head, TOT Division attended "Scientific Advisory Committee" Meeting at Divyayan *Krishi Viyan Kendra*, Ram Krishan Mission, Ranchi on June 04, 2013.
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division participated in the one day Expert Consultation meeting of IIAB, Ranchi organized by IINRG, Ranchi on June 10, 2013 at NASC Complex, New Delhi to discuss the way forward for IIAB. Also participated in the Expert Consultation meeting of NIBSM, Raipur on June 11, 2013 at NASC Complex, New Delhi.
- Dr. Md Monobrullah, Pr. Sc. visited IARI New Delhi to attend and present progress report of NICRA project in Second Annual Workshop Meeting held at IARI, New Delhi during June 17-19, 2013.
- Dr. Ansari MF, Sr. Sc. attended a seminar on "Advance Separation and Detection Techniques" organized by Agilent Technologies, on July 05, 2013, in Ranchi.
- Dr. A. Bhattacharya, Pr. Sc. and Dr. RK Yogi, Sc. participated in a regional seminar on Natural Resins and Gums organized by Govt. of Assam, in collaboration with RFRI, Jorhat (Assam), IINRG, Ranchi (Jharkhand) and BIOVED, Allahabad (Uttar Pradesh) at Boko, Kamrup, Assam on July 11, 2013.
- Dr. A. Bhattacharya, Pr. Sc. and Dr. RK Yogi, Sc. attended in a regional seminar on Natural Resins and Gums organized by Confederation of Naga Farmers' Union (CONFU), Kohima, Nagaland in collaboration with IINRG, Ranchi (Jharkhand) and BIOVED, Allahabad (Uttar Pradesh) at Kohima, Nagaland on July 13, 2013.
- Dr, RK Yogi, Sc. participated as a nodal officer in high level SMD meeting on performance indicators on July 15, 2013 at NCAP, New Delhi.
- Shri. Nandkishore T, Sc. attended the Third Annual Review Workshop of the National Fund for Basic, Strategic and Frontier Application Research in agriculture (NFBSFARA), at NASC Complex on July 22-23, 2013.
- Dr. RK Yogi, Sc. attended an interaction meeting for renovation of lac processing unit on August 12, 2013 with Principal Secretary, Department of Cooperative, Govt. of Jharkhand at Project Bhavan, Dhurwa, Ranchi.
- Dr. KK Sharma, Pr. Sc. and Head, LP Division participated in Seminar-cum-Workshop on Geographical Indications and GI Products of Jharkhand organized by Geographical Indication Registry, Chennai and JHARCRAFT, Ranchi at Ranchi on August 16, 2013.
- Dr. Vaibhav D Lohot, Sc. attended "Awareness Building and Sensitization Workshop" on National Fund for Basic, Strategic and Frontier Application in Agriculture (NFBSFARA) at NIRJAFT, Kolkata during August 23 -24, 2013.
- Dr. AK Jaiswal Pr. Sc. and CCPI, NAIP-3 attended CAC Meeting of NAIP-3 at Birsa Agriculture University, Ranchi Chaired by Vice Chancellor on September 06, 2013.
- Dr. AK Jaiswal Pr. Sc. and Head, TOT Division attended a meeting at R K Mission Ranchi for holding National Seminar on September 07, 2013.
- Dr. Srivastava S, Pr. Sc. attended the 6th CAC meeting of NAIP sub-project on LVC and Lac based products for Domestic and Export market held on September 09-10, 2013 at IINRG, Ranchi.
- Dr. Ansari MF, Sr. Sc. participated as Lac expert in 'Karigar Science Congress–2013', organized by



Madhya Pradesh Council of Science and Technology (MPCOST), at Bhopal (M.P.) during September 17-18, 2013. Presented a general introduction of lac to all the Karigars and a special interaction session was conducted for lac Karigars only.

- Dr. AK Jaiswal, Pr. Sc. and Head, TOT Division participated and delivered lecture on Lac production for livelihood in Dumka district under NAIP-3 on September 24, 2013.
- Dr. RK Yogi, Sc. attended MDP workshop on Supply Chain Management in Agriculture held at National Academy of Agricultural Research Management, Hyderabad during October 8-10, 2013.
- Dr. Sarkar PC Sr. Sc. and Nandkishore T, Sc. attended a workshop, "The Millennium Alliance" under India-US Innovation Partnership for global development, organized by FICCI & USAID on October 31, 2013 at Hotel Green Horizon, Ranchi.
- Er. Pandey, SK, Sc. and Dr. SKS Yadav, Sc. participated in ICAR-Industry Meet at ICAR-RCER, Plandu, on November 16, 2013.
- Dr. AK Jaiswal, Pr. Sc., Dr. A.K. Singh, Sr. Sc., Dr. Alok Kumar, Sr. Sc., Shri. S K S Yadav, Sc. and Dr. R. K. Yogi, Sc. attended interaction meeting with Dr. Gurbachan Singh, Chairman ASRB, New Delhi and Dr. Satya Priya, NPC (L&WP), FAO, New Delhi on November 26, 2013 at IINRG, Ranchi.
- Dr. KK Sharma, Pr. Sc. and Head, LPD and Dr. Md Monobrullah, Pr. Sc. attended regional consultation workshop on state action plan on climate change for Jharkhand organized by JAPCC on December 13, 2013 at Hotel BNR Chanakya, Ranchi.
- Dr. KK Sharma, Pr. Sc. and Head, Lac Production Division represented the Institute in the TRIFED meetings to recommend MSP for NTFPs including lac and *Karaya* gum held on December 20, 2013 at New Delhi.

Human Resource Development

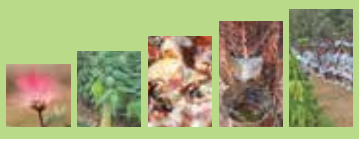
- Shri Sheeraz Saleem Bhat, Shri. Kishor Uttamrao Tribhuvan, Shri. Mate CJ and Ms. Rajna S Sc., underwent three months "Foundation Course for Agricultural Research Services (FOCARS)" training from 1st January to 1st April 2013 at National Academy of Agricultural Research Management, Hyderabad, Andhra Pradesh.
- Dr. Srivastava S, Pr. Sc. Dr. Siddiqui MZ, Sr. Sc. Dr. Sarkar PC, Sr. Sc. Dr. Ansari, MF, Sr. Sc., Dr. Vaibhav D Lohot, Sc., Shri. SC Meena Sc. and Dr. Chowdhury AR, Sc. participated in a Workshop on 'Sophisticated Analytical Instruments' at IINRG organized in collaboration with BIT, Mesra and ICAR-RCER, Plandu, during February 18-23, 2013.
- Dr. Siddiqui MZ, Sr. Sc. attended National Training Programme on "Entrepreneurship Development & Management for Women Scientists & Technologists working with Government Sector" at Entrepreneurship Development Institute of India, Ahmedabad (Gujarat) from March 18-22, 2013.
- Shri. Kishor Uttamrao Tribhuvan and Shri. Sheeraz Saleem Bhat, Sc. completed one month "Orientation Training Program" from May 13, 2013 at Indian Institute of Natural Resins and Gums (IINRG),Namkum.
- Dr R K Yogi Sc. and Shri. Nandkishore T, Sc. attended two days workshop on Skill development by Central Labour Education Board, Ministry of Labour and Planning, GOI during May 20-21, 2013 at IINRG, Ranchi.
- Shri. Kishor Uttamrao Tribhuvan, Sc. underwent three months professional attachment training at National Research Centre on Plant Biotechnology from 12th June to 12th September, 2013 on "Assembly and annotation of NGS data".
- Shri. Sheeraz Saleem Bhat, Sc. underwent three months professional attachment training at Centre for Sustainable Technologies, Indian Institute of Science, Bangalore from 13th June to 13th September, 2013 on "Carbon sequestration under different land use systems".
- Ms. Rajna S, Sc. completed one month "Orientation training programme" at the Institute from July 6, 2013.
- Shri. Mate CJ, successfully completed 3 months attachment training at Forest Research Institute Dehradun, from August 2 - November 7, 2013.
- Ms. Rajna S, Scientist has undergone three months professional attachment training at Biology and Biotechnology Division, Indian Institute of Chemical Technology (IICT), Hyderabad from 12th August to 11th November 2013 on "Chemical ecology- Insect host plant interactions".

- Dr. Chowdhury AR, Sc. attended Awareness Building and Sensitization Workshop on National Fund for Basic, Strategic and Frontier Application in Agriculture (NFBSFARA) at NIRJAFT, Kolkata during August 23-24, 2013.
- Dr. KK Sharma, Pr. Sc. and Head, LPD participated in Management Development Programme on Leadership Development (Pre-RMP Cadre) at National Academy of Agricultural Research Management, Hyderabad from 26th August to 6th September, 2013.
- Dr. Siddiqui MZ, Sr. Sc. attended DST, GOI, New Delhi sponsored training programme on "Knowledge Management & Knowledge Sharing in Organization for Scientists and Technologists" at Indian Institute of Public Administration, New Delhi from September 9-13, 2013.
- Dr. Srivastava S, Pr. Sc. and Er. Pandey SK, Sc., attended International training on 'Flexible Packaging Techniques' under NAIP on Lac Value Chain (Component-II) at Centre for Packaging Innovation and Sustainability, Michigan State Univ, East Lansing, MI, USA, during October 16 - 25, 2013.
- Dr. K Thamilarasi, Sc. attended winter school on "Frontier technologies in the area of biotechnology, on gene isolation, characterization and breeding with reference to abiotic stress related genes" from December 10- 30, 2013 at NRCPB, New Delhi

Honors, Awards and Recognitions

- Dr. Ramani R acted as Chairman, Lac, Lac Products and Polishes Sectional Committee, CHD 23, Bureau of Indian Standards, New Delhi
- Dr. Ramani R acted as Chairman, RAC (2011-14), Regional Sericultural Research Station, Ranchi
- Dr. Ramani R acted as Member, RAC, Central Tasar Research &Training Institute, Nagri.
- Dr. Ramani R reviewed research articles for *African J. Biotech*., *Indian Forester* and Proceedings of National *Acad. Sci* (B).
- Dr. KK Sharma, Pr. Sc. and Head, LPD chaired the Session on Molecular entomology and nanotechnology and co-chaired the Session on Urban, medical and veterinary entomology in 4th International Conference on Insect Science (ICIS), Bangalore on February 15, 2013.
- Dr. Md Monobrullah, Pr. Sc. chaired one session on February 16, 2013 in 4th International Conference on Insect Science organized by University of Agricultural Science, GKVK, Bangalore and Indian Society for advancement of Insect Science, PAU, Ludhiana at Bangalore.
- Dr A K Jaiswal Pr. Sc. and Head, TOT conferred first "Dr Bangali Baboo Medal 2013" in the field of Agricultural Entomology at 15th Indian Agriculture Scientists and farmers congress held at Allahabad, U.P. on February 22-24, 2013.
- Dr. Monobrullah Md, Pr. Sc. received best paper presentation award by Bioved Research Society, Allahabad on 23 February, 2013 for presenting paper on "Abundance and incidence of major parasitoids and predators of *Kerria lacca* (Kerr) in present climatic scenario" during 15th Indian Agricultural Scientists & Farmers' Congress on Agriculture and Global Climate Change, organized by Bioved Research Institute of Agriculture & Technology, Allahabad during 22-24 February 2013.
- Dr. Vaibhav D Lohot, Sc. received a 3rd best research work award on "Biochemical Evaluation of lac host plant." in oral presentation in seminar on Interdisciplinary Advances in Bio-Technology organized by Department of Biotechnology, Ranchi Women's College, Ranchi on March 22, 2013.
- Dr. Ansari MF, Sr. Sc. was awarded Ph.D. degree on his thesis entitled "Development of surface coating compositions based on shellac-synthetic resin/ polymer blends" by BIT Mesra, Ranchi, in July 29, 2013.
- Dr. Ansari MF, Sr. Sc. received 'Distinguished Worker Award - 2013' from IINRG Ranchi on September 20, 2013.
- Dr. Ansari MF, Sr. Sc. participated in Hindi competitions and won 2nd Prize in 'Format Writing' on September 30, 2013.
- Dr. Ansari MF, Sr. Sc. received 'Best Article Award-2013' for the article "Uses of Exudate Gums" (in Hindi) published in *LAKSHA* on September 30, 2013.

Awards recieved by various scientists and research scholars in National Symposium on Recent Advances in Beneficial Insects (Apiculture, Lac culture, Sericulture



and Insect Pollinators) organized by SANRAG and IINRG, Ranchi, at IINRG during November 27-29, 2013.

- Dr. Sarkar PC, Sr. Sc. received Best Paper Award, for his paper, "Organic Coatings: New Paradigm in Spice Processing",
- Dr. Mohanasundaram A, Sc. received best oral paper presentation award for the paper entitled "Abundance and emergence profile of lac associated fauna in *rangeeni* crop under different climatic conditions"
- Best poster award for "Why do syrphids get attracted to lac infested host, *Flemingia semialata*?" (Gupta RK, Monobrullah Md, Mohanasundaram A, Sharma KK and Bali K)
- Second best poster award for **"**Comparative study on the contribution of lac in the annual household income of farmers in three prominent rice base production systems in Barghat Block of Seoni district, Madhya Pradesh". (Namved Brajesh, Shah Tahir Hussain, Kurmi Anil, Bhaty Mukesh Kumar, Bave Jainendra, Moni Thomas and Monobrullah Md)
- Third best poster award for "Impact of lac inoculation on host plant biochemistry of *ber* and *palas* during summer season crop (*baisakhi*)". (Anees K, Verma Sweta and Monobrullah Md)
- Appreciation award for "Review of sex determination mechanism in lac insect". (Sweta Verma, Parnav Kumar, Mohanasundaram A, Monobrullah Md, Sachan A, Sharma KK and Ramani R).
- Dr. Thamilarasi K , Sc. received special appreciation award for the poster entitled "Novel method for identification of infra-sub-specific forms (*kusmi* and *rangeeni*) of *Kerria lacca* and other races/species of *Kerria*" (Ranjan SK, Shamim G, Thamilarasi K, Sharma KK, Vidyarthi AS and Ramani R).
- Dr. Md. Monobrullah, Pr. Sc. continued as reviewer for various NAAS-indexed national and international journals.
- Dr. Siddiqui MZ, Sr. Sc. was recognized as a reviewer of the research paper entitled, "Ecological niche modeling of geographic distribution of *Commiphora wightii* (Arnt.) Bhandari in arid western Rajasthan, India" for the NAAS-indexed Journal, *Arid land research and management.*
- Dr. Sarkar PC, Sr. Sc. continued as reviewer for various NAAS-indexed journals published by Agicultural Research Communications Center, Karnal.
- Dr. Ansari MF, Sr. Sc. was recognized as Reviewer of the research paper entitled "Hydroxypropyl methylcellulose as a polymeric corrosion inhibitor for aluminium" for the International Journal *Pigment & Resin Technology*, U.K.
- Shri. Sheeraz Saleem Bhat, Sc. has been selected as member of Editorial Team of Journal of Agricultural Science, Canadian Centre for Science and Education, Toronto, Canada.

Capacity Building

- Dr. Srivastava S, Pr. Sc. delivered a lecture on 'Quality parameters of gum *karaya* and its role in marketing' to farmers and NGOs from Simdega, Jharkhand, on January 22, 2013.
- Dr. Siddiqui MZ, Sr. Sc. delivered a lecture on "Physico-chemical properties of *karaya* gum" under the training programme on *karaya* gum for beneficiaries of TRIFED, Jharkhand, at TOT Division, IINRG, Ranchi, on January 22, 2013.

Lectures delivered by various scientists to participants in workshop on 'Sophisticated Analytical Instruments', organized at IINRG in collaboration with BIT, Mesra and ICAR-RCER, Plandu, Ranchi, during February 18-23, 2013

- Dr. Srivastava S, Pr. Sc. delivered lectures on CHNS Analyzer and UV-Vis spectrophotometry and their practical demonstration.
- Dr. Siddiqui MZ, Sr. Sc. delivered a lecture on Viscometry and its practical demonstration.
- Dr. Sarkar PC, Sr. Sc. delivered a lecture on FTIR (with hands-on practical session).
- Dr. Ansari MF, Sr. Sc. delivered lectures and demonstrations on GC-MS and DSC.
- Dr. Chowdhury AR, Sc. delivered a lecture on HPLC and its practical demonstration.
- Er. Pandey SK, Sc. imparted training on aleuritic acid to Shri. DD Ravetkar, entrepreneur from Mumbai, March 11-19, 2013.
- Dr Vaibhav D Lohot, Sc. and Dr. Mohanasundaram A, Sc. delivered lectures on Biodiversity of Lac hosts

with particular reference to *Palas* (*B. monosperma*) and identification of lac associated fauna and their management and visit of institute museum, respectively in ten days training programme on Recent Advances in Lac Cultivation with particular reference to *F. semialata*" conducted by LPD, IINRG, Ranchi from March 11-20, 2013.

- Er. Pandey SK, Sc. imparted training on bleached lac to Shri Imran Rokariya, entrepreneur from Dhamtari, Chattisgarh, May 13-22, 2013.
- Dr. Srivastava S, Pr. Sc. delivered a lecture on 'Industrial aspects of quality control for Natural Resins and Gums, to B.Sc. (Ag) students from Institute of Agriculture Sciences, BHU Varanasi, on May 18, 2013.
- Dr. Md Monobrullah, Pr. Sc. delivered a lecture on "*Jalvayu Parivartan aur Bhartiya krishi*" in 1-day Hindi symposium on *Jalvayu privartan avm uske parinam*" organized by IINRG, Ranchi under NICRA Project on March 22, 2013.
- Er. Pandey SK, Sc. imparted training on aleuritic acid to two entrepreneurs, Shri Dinesh Khandewal, Arbind Shellac and Shri Aditya Khandewal, Thakuria Shellac factory, Dhamtari, Chattisgarh, May 27 - June 05, 2013.
- Dr. Srivastava S, Pr. Sc. delivered a lecture on 'Industrial aspects of quality control for Natural Resins and Gums' to B.Sc. (Ag & Technology) students from Sam Higginbottom Institute of Science Ag. and Technology, Allahabad and Master Trainer, Chhattisgarh, on June 15, 2013.
- Dr. Md Monobrullah, Pr. Sc. delivered lecture on "Effect of climate change on Indian lac production" during training programme on "Rural livelihood promotion through scientific lac cultivation and management" on 26 June 2013 organized by Institute of Forest Productivity (IFP) Lalgutwa, Ranchi.
- Dr. Sarkar PC, Sr. Sc. delivered invited lecture on "Lac Processing, Products and Uses" on June 26, 2013, to the participants of training program on "Rural Livelihood Promotion through Scientific Lac Cultivation and Management" at Institute of Forest Productivity(ICFRE), Ranchi.
- Dr Thamilarasi K, Sc. gave 6 months training for 3 M.Sc students and 1 B.Sc student (3 months)
- Dr Vaibhav D Lohot, Sc. gave 3 months training to two B.Sc. Students from Department of Biotechnology, Ranchi Women's College, Ranchi on "Biochemical evaluation of two *Calliandra sp".*

Technology Fortnight 2013

Transfer of Technology Division organised 2nd 'Technology Fortnight' during January 15-29, 2013 on 'Advanced Production and Processing Technologies of Natural Resins and Gums'. During the fortnight ten different trainings and educational programmes were organized in which one-week training for the farmers of Simdega (Jharkhand); one-week Master Trainer's Training; one-day 'Workshop on *kusmi* lac cultivation on *Flemingia semialata*' in Ambikapur (Chattishgarh); *Kisan Gosthi* in Saraikela-Kharsawan (Jharkhand); Educational programme for school children in Purulia (West Bengal); training and demonstration of 'Scientific tapping and collection of *karaya* gum from *Sterculia urens*' tree in Simdega and two Field-day programmes in Balarampur and Ahirpur area of Surajpur district (Chhattisgarh) were conducted. Off-campus training on scientific cultivation, processing and uses of lac was also conducted in collaboration with Torpa Rural Development Society for Women at Torpa (Khunti). These programmes were sponsored by JASCOLAMPF, Ranchi; State Forest Department; TRIFED, Ranchi; *Krishi Vigyan Kendra*, Saraikela-Kharsawan; Vidyasagar Group of Schools, Purulia and Ashadeep Biocare Pvt. Ltd., Ambikapur. More than 1200 farmers, entrepreneurs and school children participated and benefited from these programmes.

Inaugural session of 2nd Technology Fortnight

Annual *Kisan Mela*-2013

Annual *Kisan Mela*-cum-Exhibition was organized on 13th February 2013 by Transfer of Technology Division. More than 1000 farmers from Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal and Maharashtra participated in the Mela. Hon'ble Union Minister of State for Agriculture & Food Processing Industries, Government of India, Shri Tariq Anwar, Member of Rajya Sabha from Jharkhand Shri Parimal Nathawani, Principal Secretary (Agriculture) Government of Jharkhand Shri A. K. Singh, Dr. N.P.S. Sirohi, ADG (Engg.) ICAR were prominent dignitaries to attend the Mela besides several other dignitaries from the state, lac industrialists and entrepreneurs. While inaugurating the Mela-cum-Exhibition, Shri Anwar appreciated the institute's efforts for transfer of technology programme. Five farmers from Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal have been awarded for "Excellent Lac Farmers' Award". Besides, Shri V. Srinivasa Rao, IFS, Conservator of Forest (Jagdalpur Circle, Chhattisgarh) was awarded "Excellent lac executive Award" for his contribution towards promotion of lac in Chhattisgarh. A total of 22 stalls related to agriculture, horticulture, lac culture, natural gums and resins were put up by various government institutes and private organizations. The farmers have been shown the lac museum and institute plantation. A *Kisan Gosthi* was also organized on this occasion where more than 75 questions were answered by the experts.

Hon'ble Union Minister Shri Tariq Anwar visiting stalls during *Kisan Mela* 2013

Workshop on *Kusmi* lac production on *Flemingia semialata*

A workshop on "*Kusmi* lac production on *Flemingia semialata*" was jointly organized by Transfer of Technology Division, IINRG, Namkum, Ranchi and Ashadeep Biocare Pvt. Ltd. (ABPL) in Ambikapur district of Chhattisgarh state on 20th February 2013. Around 700 farmers from Garhwa, Surajpur and Ambikapur attended the workshop. Ashadeep Biocare Pvt. Ltd. (ABPL) is promoting lac cultivation on *F. semialata* under "*Kisan* Business Concept" where 500 plants of *F. semialata* has been given to each farm family on payment basis and planted by the farmers in their homestead. Broodlac

was also made available to farmers on payment. Market support in ensured by ABPL. Lectures on scope and merits of lac production, raising of plantation, scientific method of lac cultivation on this host, pest management of lac crop, harvesting and marketing were delivered by experts of IINRG, Ranchi. A question-answer session was also organized where clarifications were given to farmers in respect of profit from this intervention. The workshop was followed by a visit to field area in Surajpur district on the next day (21st February). Visit of field area indicated excellent growth performance of this species in view of fertile soil and water availability. Many plants have 4-5 tillers suitable for crop inoculation. At the current price of Rs. 600 per kg, profit of Rs. 40-50 thousand can be made per year from 500 plants of this species. These areas have plenty of water, required for lac cultivation on this species. Around 300 farm families have already raised 500 plants in their homestead in this district and more families are joining them in lac cultivation.

Training on 'Recent Advances in Lac Cultivation with particular reference to *F. semialata*

A ten days training on 'Recent Advances in Lac Cultivation with particular reference to *F. semialata*' was organized by the Lac Production Division for two participants from Annamalai University during 11.3.2013 to 20.3.2013. Dr. KK Sharma, Head, LPD was the Convener and Dr. Md. Monobrullah Sr. Sc. and Dr. S Ghosal, Sr. Sc. were the Co-conveners.

Seminar in Hindi on *Jalvayu privartan avum uske parinam*

A one day seminar in Hindi on '*Jalvayu parivartan avum uske parinam*' was organized by IINRG, Ranchi on March 22, 2013.

Dr. Anand Bhusan, Chairman, JAC addressing inaugural function

Ninety two delegates including 32 from 18 Central Govt. offices of Ranchi participated in the seminar. Dr. Anand Bhusan, Chairman, Jharkhand Academic Council (JAC), Ranchi inaugrated the workshop. Dr. S. Haque, Director, Central Institute of Psychiatry chaired the first session and also delivered the Key note lecture on 'Climate change and its impact on mental health of human beings'. The second session was chaired by Dr. S. Kumar, PS & Head, ICAR-RCER-RC, Ranchi. Eight presentations were made on different aspects of climate change. Dr. K.K. Sharma, PS & Head, LP Division was the convener and Dr. Md. Monobrullah Co-convener. This programme was sponsored under National Initiative on Climate Resilience Agriculture (NICRA-ICAR) project.

Summer student Workshop 2013 on NRG

Second summer students workshop on NRG was organized by Transfer of Technology Division. It was inaugurated by Hon'ble Member of Parliament Sri A K Hegde on 13th May 2013. A total of 29 undergraduate students from College of Agriculture, Banaras Hindu University participated in this workshop. While inaugurating the workshop, Sri Hegde suggested the students to give priority for social career rather than personal career. This will bring satisfaction in their life. He also stated that future of Indian Agriculture lies in such commodity as lac because it can withstand shortage of water, low input cost and labour requirement. He said, unawareness about lac is the main cause which limits its production in a few states despite availability of resources in many parts of the country. In order to create awareness and bring this in the mainstream of agriculture; it is desirable to convene a meeting of Vice Chancellors in this institute. He also suggested to include lac production, processing and uses in curriculum of undergraduate agriculture course for better dissemination of knowledge.

Students participating in Summer student workshop 2013

A technical bulletin entitled "Pests of lac crops and their management" was also released on this occasion by him. Dr. R. Ramani, Director of the institute briefed about institute activity and achievements as well future plans. Dr A K Jaiswal, Head TOT Division briefed about objective of the workshop and number of training programmes executed by the institute during XI plan period.

Visit of Hon'ble Member of Parliament Sri A K Hegde at IINRG, Namkum, Ranchi

Sri A K Hegde, Member of Parliament, Uttara Kannada (Karnataka) and Member of Parliamentary Committee on Agriculture visited Indian Institute of Natural Resins and Gums on 12-13 May, 2013. The main objective of his visit was to understand the process of lac production and explore the possibility of introducing the same in forest dominated areas of Karnataka for livelihood support of farmers. He visited lac insect and host plant gene bank, lac crop on *B. monosperma, S. oleosa, F. semialata* in the Institute Research Farm. Besides, the different stages of lac insect, life cycle and crop cycle was also explained. A model lac village Mangubandh was also visited by him where all the 35 families are involved in lac production activities on *S. oleosa, Z. mauritiana and F. semialata*. He interacted with lac growers to understand the socio-economic impact of adopting lac cultivation in the village. He also visited institute library, surface coating laboratory and product demonstration unit of the institute. He appreciated the efforts of the institute for technology development on lac production, processing and value addition besides its dissemination to farmers. While visiting institute lac museum, he was surprised to know the use of lac in diversified sectors from handicraft to fine chemicals. During a brief meeting with Director of the institute Dr R. Ramani, he suggested a visit to North Kannada district by the Director and other experts for developing an action plan to introduce lac cultivation as hosts like *S. oleosa* and *B. monosperma* are available in several patches. He has shown keen interest in introducing bushy host *F. semialata* in selected districts of Karnataka.

Consortium Advisory Committee (CAC) Meeting

Sixth Consortium Advisory Committee Meeting was organized during September 09-10, 2013 at IINRG, Ranchi. Dr. NSL Srivastava, Chairman, CAC and members reviewed the progress. The meeting was also attended by Dr. R Ramani, Director, IINRG, Ranchi, CPI, CCPIs and progressive lac growers associated with the project. During the meeting two publications on good manufacturing practices for Lac dye and Aleuritic Acid were released. On Sept. 9, 2013 Chairman, CAC along with CPI & Dr. S. Ghosal, CCPI visited demonstration sites of *kusmi* lac cultivation on *ber* (Village – Mangubandh, Namkum, Ranchi), raising *ber* plantation and lac cultivation on *ber* after four years of its planting, *F. semialata* plantation and lac cultivation on this host on plantation basis and integration of *F. semialata* with papaya, maize and tomato for lac integrated farming at village Mangubandh and Kochbong, respectively. Growth of lac insects on these hosts was very good. Chairman, CAC interacted with the lac growers who are associated in demonstration activities and expressed his satisfaction on the performance of the project work in the field. On September 10, 2013 a visit to Training-cum-Production Centre for making lac based handicrafts established at Ketaribagan, Ranchi was organized for the CAC, Chairman.

Sixth CAC meeting of NAIP – LVCP at IINRG, Ranchi

3rd Dorothy Norris Memorial Lecture on 90th Foundation Day

Indian Institute of Natural Resins and Gums celebrated its 90th Foundation Day on September 20, 2013. The 3rd Dorothy Norris memorial lecture on modeling molecules, materials and organisms was delivered by Dr. G Narahari Sastry, In-Charge, Center for Molecular Modeling, IICT, Hyderabad in honour of Founder Director of the erstwhile Indian Lac Research Institute Ms. Dorothy Norris on September 19, 2013. While welcoming the Chief Guest, Director of the Institute Dr. R Ramani dwelt upon the achievements of the institute during the past

one year. He informed that Ms. D Norris was the longest serving Director of the institute and played a very vital and dynamic role in establishment of the institute. She was instrumental in creating a sound infrastructure for the institute, including the chemical and entomological laboratories and the research farm. Dr. Sastry in his lecture, deliberated on the application of molecular modeling in various spheres of scientific arena for human welfare. Dr. NS Rathore, DDG (Engg.), ICAR, New Delhi presided over the function. Dignitaries and a large number of distinguished scientists from Birla Institute of Technology, Mesra; Central Tasar Research and Training Institute, Regional center of ICAR-RCER, Regional Station of NBPGR and other scientific organizations participated in the programme. Two folders on 'Recovery of lac dye:a bye product of lac industry' and 'Aqueous lac varnishes for earthenware and bamboo articles' were released by Dr. NS Rathore on this occasion. Dr. KK Sharma, Head, LPD and Convener proposed vote of thanks.

IINRG Celebrates 90th Foundation Day

On 20th September 2013, Indian Institute of Natural Resins & Gums, Namkum, Ranchi celebrated its 90th Foundation day at the newly built conference Hall i.e. "*Palash Sabhagriha*". The programme started with the lighting of lamp by the distinguished guests namely, Dr. S. Ayyappan, Secretary, DARE & DG, ICAR, Prof. D.T. Khating, Vice Chancellor, Central University, Jharkhand, Sri V. K. Chaubey, Deputy Commissioner, Ranchi, Dr. R. Ramani, Director, IINRG & Dr. A.K. Jaiswal, Head, TOT & Convener. Dr. R. Ramani, Director, IINRG welcomed the distinguished guests & highlighted the achievements of the Institute with future plan of action. On this occasion Chief Guest, Sri V. K. Choubey, Deputy Commissioner, Ranchi praised the contributions of Institute in lac production, processing and capacity building and also ensured the cooperation of district administration for the development of tribals through lac based livelihood. In the presidential address Prof. D.T. Khating, Vice Chancellor, Central University, Jharkhand entrusted the historical achievements of IINRG and requested the Institute to provide their expertise in the development of Central University, Jharkhand and also offered to run integrated research projects in collaborations of University and Institute. Dr. S. Ayyappan, Secretary, DARE & DG, ICAR focused on Farmers First, Innovation, Partnership, Vision, Skill Based Agriculture and youth participation in Agriculture and allied activities specially resins & gums for the development of nation and states. Distinguished guests also conferred Best worker award to different categories of the institute staff. Seven farmers from Ranchi district were felicitated for their excellent contribution in the field of lac cultivation, Pig & Goat keeping, pisciculture etc. under agriculture project of ICAR-RCER. Four publications namely 'DNA Barcoding of Indian *Kerria* species / races', 'IINRG Vision 2050', 'Natural Resource Management for Horticultural Development', '*Lakh Phasal Ke Shatru Keet'* were also released. On this occasion, distinguished workers of the institute *viz*. Dr. Md. Fahim Ansari, Scientist, Shri PA Ansari and Dr. Anjesh Kumar, Technical Officers, Shri P Singh, AAO, Shri Baijnath Mahato and Shri Poulus Ekka, Supporting Staff were awarded with certificates and trophies for their commendable contribution in their sphere of work.

Dr. S. Ayyappan, Secretary, DARE & DG, ICAR inaugurated Conference Hall i.e. *Palash Sabhagriha* on the occasion of Institute foundation day 2013

Earlier, Foundation Day was declared as an "Open day for school children" was also organized where around 850 school children visited the Institute. The children were shown the film on lac, lac host plantation, lac culture and museum. A cultural function organized in the evening for the participants and the employees of the institute culminated the celebrations.

5th Coordination Committee Meeting of Network Project on HPVA of NRG

The 5th Coordination Committee Meeting of Network Project on Harvesting, Processing & Value Addition of Natural Resins and Gums was held at the Directorate of Research Services, Jawaharlal *Krishi Vishwa*

Vidyalaya, Jabalpur, during October 8-9, 2013. The meeting was chaired by Dr. V S Tomar, Vice Chancellor of JNKVV, Jabalpur and attended by Prof. KNS Yadav, Vice Chancellor, Rani Durgawati Vishwa Vidyalaya, Jabalpur; Dr. U Prakasham, Director, TFRI, Jabalpur; Dr. R. Ramani, Director, IINRG, Ranchi; Dr. Anupam Mishra, Project Director, ZPD, Jabalpur; Deans and Directors of JNKVV, Jabalpur; Project Coordinator of Network Project on HPVA of NRG; PIs, CoPIs and RAs of Network Project Centres. Technical Programme for 2013-14 of Network Project Centers was finalized. The final recommendations of the meeting was presented by the Project Coordinator.

Fifth Coordination Committee Meeting of Network Project on HPVA of NRG at Jabalpur

IINRG organizes National Symposium on Recent Advances in Beneficial Insects

The National Symposium on Recent Advances in Beneficial Insects – honeybees and pollinators, lac insects and silk insects from 27-29 November, 2013, organized jointly by Society for Advancement of Natural Resins and Gums (SANRAG) and Indian Institute of Natural Resins and Gums (IINRG, Ranchi) was a maiden attempt to bring the beneficial insects (BI) at one platform and discuss on common and specific problems relevant to emerging scenario. Central Tasar Research and Training Institute, Ranchi and All India Coordinated Research Project on Honeybees and Pollinators were the event partners. Dr. KK Sharma was the Convener of the Symposium and Dr. Md. Monobrullah and Dr. A Mohanasundaram, the Co-Conveners. The event was inaugurated by Dr Gurbachan Singh, Chairman, ASRB and key-note addresses delivered by Dr Peter A Kenmore (FAO Representative in India), Dr VP Singh (Regional Representative for South Asia, ICRAF, New Delhi). Dr. AK Malhotra, PCCF, Jharkhand presented the role of forestry in this context. Souvenir - cum - Book of Abstracts was also released during the inaugural session.

Inauguration of the Symposium by the Chief Guest

The three-day symposium was divided into five sessions - Production System Management; Ecology & Population Dynamics; Systematics, Biochemistry & Biotechnology; Sustainable Utilization & Livelihood Opportunity and Processing & Application of Beneficial Insect Products. Different aspects on beneficial insects from production to policy issues including stakeholders, ecosystem approaches in pest management, integrated farming and productivity were also deliberated in the session. Ninety one delegates participated and highlighted their research findings and issues through, 4 key-note addresses, 10 lead lectures, 47 oral and 22 poster presentations. Recommendations of all the five sessions were discussed and finalized in the plenary session which was chaired by Dr MP Pandey, Vice Chancellor, Birsa Agricultural University, Ranchi and Co-chaired by Dr. TP Rajendran, Ex ADG (PP) and OSD, NIBSM, Raipur in the presence of Dr RS Singh, Director, Forensic Science Laboratories, Jharkhand.

Evaluation of the Posters by expert committee members

The need for harnessing the potential of BIs to supplement farmers' agricultural income in enhancing their livelihood was emphasized; BIs are also highly amenable for incorporation in integrated farming systems. It was pointed out that economic benefit of honey bees through crop productivity was much higher than their products and they should be viewed as an input especially for the cross-pollinated crops. It was also felt that there was a need for (i) strong industrial liaison for in appropriate segments of BIs, (ii) production of post-independent compendium in the line of "Fauna of British India," which continues to be an authentic reference book and (iii) Journal of Beneficial Insects, in view of limited publication avenue in some of these sectors. Some of the major recommendations that emerged are:

- Creation of South and SE Asian Network for Natural Resins and Gums, similar to the Network for Natural Gums and Resins in Africa (NGARA), Nairobi, Kenya, with linkage with the latter and the lac producing countries of the world.
- National Mission for Pollinators and natural enemies of pests: To develop a mission-mode programme to integrate pollinators in the agriculture practices, using a system approach. It would also lead to development of a National Policy Paper on Pollinators.
- Support system development in the beneficial insect sector like input supply, credit and marketing support, insurance, etc. Institutionalization of culture components.
- A module on BI may be developed by all the related organizations for use in the educational system of the country: General and Agriculture; this will include course materials suitable for inclusion at different levels (school- and college-levels).

Delebration of final recommendations of National Symposium

Institute Research Committee (IRC)

The Institute Research Committee (IRC) meeting for the year 2013-14 was held on 1st, 2nd & 5th June, 2013 under the Chairmanship of Dr. R Ramani, Director, IINRG in the Institute Conference Hall. Dr. R Ramani, Chairman welcomed the HoDs, Member Secretary, Scientists and Technical personnel of PME Cell in the meeting. In his opening remarks, Dr R Ramani, Director and Chairman, IRC informed that the meeting has been convened to review the progress of ongoing institutional and externally funded research projects, presentation of completed projects and new project proposals and finalization of research projects for 2013-14. He opined that the recommendations of the QRT/ RAC have to be taken into consideration while proposing new projects. The Chairman, IRC presented the draft of Vision 2050. Several inputs were provided by the House for its further improvement.

The following general remarks were given by the Chairman for future guidance and compliance:

- When the project period is coming to an end and the PI seeks extension for the project, the PI has to submit a proposal giving the progress made against the objectives, along with justification for its extension.
- All the projects should normally conclude in the month of March of the current year.
- All the PIs of externally funded projects will be having complete power similar to PIs of NAIP projects, as decided by ICAR recently. A circular to this effect is to be issued shortly.
- It was briefed that Head of Divisions should submit complete information regarding the requirement of the contractual support mentioning the nature of jobs and the quantum of work required. There should be uniformity in the proposals. Chairman of the said committee was directed to initiate necessary action at the earliest.
- The Director desired that the Scientists should write more of popular articles, contribute more number of research papers and its publication in high impact journals. The Scientists were urged to propose inclusion of journals relevant to this Institute, for NAAS rating.
- The technologies developed may be finalized at the earliest and steps initiated for their commercialization.
- All the Divisions will prepare list of technologies developed during the year with brief background and write-up and provide it to TOT Division annually, preferably during January. The list will be finalized after discussion in meeting of HoDs and I/C PME Cell.
- In his concluding remarks the Chairman opined that the overall progress presented by the PIs was satisfactory.
- The Chairman stressed upon for the improvement with respect to publications in high impact journals. Necessary initiatives may be taken by all concerned.

Research Advisory Committee (RAC)

The XXth meeting of the RAC was held on 20-21 June 2013 at IINRG. Following members were present:

Dr N Krishnamurti - Chairman

Dr N P S Sirohi, ADG (Ag. Engg.) ICAR – Member

Dr Vineet Kumar, Scientist E, FRI, Dehradun – Member

Shri Subhash Jayaswal, Proprietor, Indian Shellac Industries, Dhamtari, Chhattisgarh – Member

Dr R Ramani, Director, IINRG, Ranchi – Member

Dr A K Jaiswal, Principal Scientist, IINRG, Ranchi - Member Secretary

Invited members

Dr K K Sharma, Head LP Division

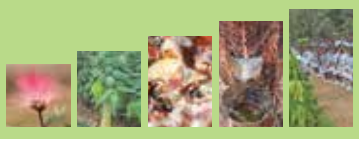
Dr N Prasad, Head PPD Division

Dr A Bhattacharya, I/c PME Cell

Twentieth meeting of the RAC held at IINRG

The major recommendations given by the RAC are as follows

- Interaction with industry should be strengthened. Scientists associated with process refinement/ development should visit the processing industries of NRG regularly to identify and address specific problems.
- There is need for automation of lac processing industry in view of increasing shortage of manpower. Cleaning of lac after washing is labour-intensive and effective method need to be developed.
- Educational video films on NRGs should be made, which can be used as teaching tool as well as for education through mass media.
- The institute should develop a display of all the natural gums and resins produced in the country including the minor ones in the Museum.
- Potential of new lac insect host plant and their combination need to be explored more vigorously.
- Efforts need to be made to develop more models of lac integrated farming system and conduct trials in the farmers' field.
- Conservation and characterization of lac insect and host plant biodiversity need to be taken on priority at national level.



Distinguished Visitors

Date	Name and Address
15/01/2013	Shri K K Sone, Director, Agriculture, Govt. of Jharkhand
23/01/2013	Mr Robert Rae, 7 Whiting St., Australia
04/02/2013	Mr Jacob Smith, Chicago, USA
13/02/2013	Shri Tariq Anwar, Hon'ble Minister of State for Agriculture, Govt. of India
13/02/2013	Shri Parimal Nathwani, Member of Parliament, Rajya Sabha, New Delhi
13/02/2013	Shri S K Choudhary, Chief Secretary, Govt. of Jharkhand
13/02/2013	Shri A K Singh, Principal Secretary, Agril. & Sugarcane Development, Govt. of Jharkhand
13/02/2013	Shri N P S Sirohi, ADG (Engg.), ICAR, New Delhi
22/02/2013	Dr Anand Bhusan, Chairman, Jharkhand Academic Council, Ranchi
22/02/2013	Dr S Haque, Ex- Director, CIP, Kanke, Ranchi
12/05/2013	Shri Anant Kr. Hegde, Member of Parliament, Uttara Kannada, Karnataka
19/09/2013	Dr G N Shastry, CSIR,IICT, Hyderabad, Andhra Pradesh
19/09/2013	Dr N S Rathore, DDG(Engg.), ICAR, New Delhi
20/09/2013	Prof D T Khathing, Vice-Chancellor, Central University of Jharkhand, Ranchi
20/09/2013	Dr S Ayyappan, Secretary, DARE & DG, ICAR, New Delhi
20/09/2013	Shri V K Chaubey, DC, Ranchi
03/10/2013	Mr Stephen Hall, London Shellac Trade Association
23/11/2013	Shri R S Sharma, Chief Secretary, Govt. of Jharkhand
26/11/2013	Dr Gurbachan Singh, Chairman, ASRB, ICAR, New Delhi
27/11/2013	Dr Peter A Kenmore, FAO representative in India
27/11/2013	Dr V P Singh, Regional representative for South Asia, ICRAF, New Delhi
27/11/2013	Dr A K Malhotra, PCCF, Jharkhand
28/11/2013	Dr Abraham Verghese, Director, NBAII, Bangalore
28/11/2013	Dr T P Rajendran, Ex- ADG, Plant Protection & OSD, NIBSM, Raipur
29/11/2013	Dr M P Pandey, Vice-Chancellor, BAU, Ranchi
21/12/2013	Dr N K Krishna Kumar, DDG (Hort.), ICAR, New Delhi

Institute Research Farm

Infrastructure Development

- Desiltation of the *Kacha* pond (Northern side) for an area measuring approx. 40m x 30m up to 0.5m depth and the bund cutting in the eastern side of the pond for the area 100m x 2m to increase the storage capacity completed.
- Strengthening and widening of the bund on the western side of the *Kacha* pond for about 100 m running length to protect the boundary wall was completed.
- Two pits 19' x 12' x 5' and 18' x 12' x 5' were prepared for making of compost.
- 60 cm height was increased in 190 m boundary wall near *kacha* pond.

Nursery management

- The seedlings of different lac host were raised namely - *Semialata* - 75000 Nos, *Ber* -35,000 Nos, *Kusum* – 2500 Nos, *Galwang* -250 Nos.
- 1044 seedlings of *F. semialata* were transplanted for gap filling at seed production plot.

Lac culture & Seed production

- 548 kg broodlac of Kulajanga, Gumla, Nawadih, Bandgaon stocks and *ber* was inoculated on 527 *ber* trees under RFS plots.
- 755 kg *kusmi* broodlac and 5kg *rangeeni* broodlac were sold.
- The seed of *semialata* -20 kg, *kusum* – 5 kg, *galwang* 15 kg were collected for nursery and sale purposes.

Pisci-culture

- 2000 finger lings of *Rohu, Katla* and *Mrigal* were stocked in *Kacha* pond.

Soil Amendment

- 50 kg *Dhaicha* and 50 kg *Sanai* were sown for green manuring in *kusum* plot nos. 40 - 46.

Maintenance:

- Weeding, cleaning and lime pasting with Biflex TC around 1700 *kusum*, 2500 *ber*, 2500 *palas*, 950 *galwang*, 90 *ghont*, 750 *khair*, 18 *sandan* and 1000 other trees were carried out.

Miscellaneous

- Agricultural crop – 50 kg wheat (variety: *Sonalika*) has been sown in 1 ha of land for utilization of vacant plot and resource generation.

Resource generation

Broodlac/ Sticklac (Rs)	Other Farm Produce (Rs)	Fuel Wood (Rs)	Water + Fuel (Desel) Charges (Rs)	**Total (Rs)**
381950	313314	27639	40150	**7,63,053**

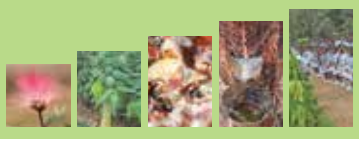
Quality Evaluation Laboratory

- Two internal audit meetings of QEL were conducted on 24.01. 2013 and 08.07.2013.
- Two management review meetings of QEL were conducted on 26. 02. 2013 and 26.07.2013.
- Scientific information and related support was provided to BIS official in conducting surveillance audit of QEL on 30th September 2013.
- A total 237 samples of lac and lac based products received from Govt. organizations/ private industries/ Divisions of IINRG and 752 tests of above samples were carried out.
- A sum of ₹1,49,745/- (One lakh forty nine thousand and seven hundred forty-five rupees only) was earned through the testing of 237 samples of lac and lac based products.
- One entrepreneur has been trained for determination of Bleach Index.

Prioritization, Monitoring and Evaluation (PME Cell)

The activities performed by Prioritization, Monitoring and Evaluation Cell (PMEC) during the report period were

- Correspondences and sending important and time bound reports to the Council.
- Compilation and preparation of various reports for the Council *viz*., Monthly report for Cabinet Secretariat (12), Quarterly progress report (04), Quarterly Achievement report for DG (04), Quarterly performance report (04), Half Yearly



Progress Report (HYPR) (02), Information on targets for next quarter and progress of current quarter (04), Annual Plan and Outcome budget report (01), DARE report (01), information related to SMD meeting etc.

- Coordination for HRD programmes of scientists and other staff members of the institute - International training- (2 Scientists); National Training – (12 Scientists).
- Processing for publication of Research Papers in journals (14).
- Maintenance of research project files- Institute projects (24); Externally funded projects (10).
- Coordination for participation of Scientists in Conference / Workshop etc. (21).
- Coordination for conduction of SOC meeting (04), IRC meeting (01), Monthly/Bi-monthly review meeting of Scientists and Technical (05), RAC meeting (01).
- Processing of papers for Honours/Awards for institute staff (09).
- Providing LAN and internet connectivity to the Divisions and Sections of the institute.
- Providing e-mail services to the scientists.
- Annual maintenance of computer system & Local Area Networking (LAN) of the institute.
- Power point presentations during meetings and seminars.
- Maintenance of Conference Hall.
- Maintenance of database for personnel information management System Network (PERMISNET) and Intelligent Reporting System.
- Processing of requests under Right to information (RTI).
- Maintenance of database for project information management system (PIMS Net-ICAR) a web based software.
- Regular updating of institute website (general information, events, tenders, walk in interviews) from time to time.
- Development of application software for record keeping of institute publications and HRD.
- To coordinate and synthesize the recommendations of meetings *viz*. QRT, RAC, IRC, Director's conference, Regional Committee.
- The PMEC coordinated for organizing the one day Workshop on Sensitization of system Implementation and Data digitization under MIS and FMS in ICAR in collaboration with IASRI, New Delhi and CRIJAF, Barrackpore on 31st October, 2013. The Workshop was attended by 57 participants from ICAR Institutes of Eastern region (Kolkata, Bhubaneshwar, Cuttack, Patna, Ranchi).

The PME Cell presently maintains three servers namely, proxy server for providing internet connectivity to various Division/Section, Mail server for providing e-mail facilities and Apache web server for hosting website.

Library and documentation center

The library of the Institute is playing an important role in meeting the information needs of its user. Library of the Institute is a repository of scientific and technical information on natural resins and gums. Besides catering to the needs of institute scientists it also renders services to other researchers, academicians, technologists and students as well as lac/gums/resins industrialists from other parts of the country.

The library maintained adequate linkage with leading reference libraries for strengthening the information resources. This library also supplies photocopies of rare research articles to NISCAIR, New Delhi from time to time against payment.

Advance/Full Text/Abstracts access of more than 3400 journals from several publishers has been made available online through Consortium for e-Resources in Agriculture (CeRA) to our scientists during the year.

Revenue of ₹14,779.00 generated from the sale of publications and reprographic services during the year. The library also continued for exchange of institute publications with scientific institutions in and outside the country.

Services provided by the Library to its users

E-journals access, C.D. searches, document delivery services, reprographic services, bibliographic services, current awareness services, inter library loan services for resource sharing and sale & distribution of institute publications.

Journals & periodicals subscribed/ received

Foreign Periodicals (Subscribed)	-	08
Foreign Periodicals (Gratis/exchange)	-	04
Indian Periodicals (Subscribed)	-	33
Indian Periodicals (Gratis/exchange)	-	14

Library holdings (as on 31/12/2013)

Documents	Additions	Total Holdings
Books	37	7901
Bound Journals	32	21574
Annual Report	82	5030
CD- Rom	-	123
IS-Specification	-	184
Maps	-	37
Patents (Foreign)	-	327
Patents (Indian)	-	15
Thesis	1	12

Estate section

The Estate sections is an important section catering to the essential services, *viz.*, security of institute premises, water and power supply, infrastructure development, engineering works, civil & electrical maintenance and general maintenance & upkeep of divisions, sections and residential quarters.

Electrical work

About 820 electrical jobs completed

Completion of work through C.P.W.D

- Electrical renovation of canteen building
- Electrical installation of new conference hall

Work carried out departmentally

- Maintenance of street lights in serviceable condition throughout the year
- Maintenance of electrical installation of residential quarters and division/ section throughout the year
- Maintenance of genset and associated panels, transformer, overhead LT lines throughout the year
- Providing of UPS power supply from *kusumi* conference hall to PME cell through surface wiring
- Construction of 02 No of GI earth pit for surface coating lab
- Electrical wiring of old AC room of PPD division
- Installation of new CFL in main campus and AC in *kusmi* conference hall (3), Director office (2) and SAO office (3)

Civil & Water supply

The plumbing related jobs (460) were completed

Completion of work through C.P.W.D

- Roof treatment was completed at various places *viz.*, dispensary, estate section, administrative building and Qtr Type-III (1-9 &11)
- New conference hall and stair case in Type-III (22-29) & Type-II (25-36) were constructed
- Boundary wall height was raised in main campus & PDU campus
- AR & MO was carried out at various sections and divisions *viz.*, PPD division, canteen, bungalow No.2 and dispensary

Work in progress through CPWD

- External painting & water proofing of terrace of pilot plant building
- Roof treatment of *Samaj sadan*
- Raising of boundary wall at IRF.
- Internal painting of Director Office

Work carried out departmentally

- Reconstruction of boundary wall near rear gate
- Rewinding of 10 HP and 20 HP monoblock pump of pump house

Carpentry Work

Carpentry jobs (231) were completed

- Window (16 Nos), solar drier (02 nos) for PDUnit. Memento (46 nos) for TOT Division and window (13 nos) and net door (1 no) for residential quarter were prepared

Turning and welding jobs

Turning jobs (476) and welding jobs (274) were completed

General maintenance & upkeep of institute premises

- The work of general maintenance and upkeep of institute premises has been monitored and verified as per the scope of work ordered throughput the year

- Works of various tradesmen of estate section were monitored and verified at monthly basis
- Various works of cleaning, beautification and maintenance of institute premises from Director's office to Guest House- LPD Division - Type- V- 2- Library- Estate section - Administrative building were carried out during Phase-1.

Facelifting in front of Library

- Different cleaning works namely, lime wash of 200 trees trunk, cutting of weeds and grasses surrounding the river bed pump house & PDU pump house, behind TOT division and in front of newly constructed conference hall, between boundary wall and metal road from main guard room to transformer room of main campus, between boundary wall to metal road from guard room to Type –II Quarter on right side of main gate in PDU campus, between backside of newly constructed conference hall and right side of TOT division were carried out on occasion of the Foundation Day, 2013

Overview of PDU campus after cleaning

Health services

The institute is running its own dispensary in the campus. Lady Doctor AMA Dr. (Mrs.) Richa Katiyar and AMA Dr. N. P. Sinha are working as part time Medical Officers on contractual basis on alternate days. In the mean time before the joining of AMA, Dr. N. P. Sinha; AMA Dr. Mukul Kumar has also served the institute dispensary for a period of eight months from the 1st February 2013. Most of the cases were handled in the dispensary itself except the complicated cases which were referred to authorized hospitals in the city for expertise treatment. The dispensary is well equipped with all instrument/accessories to handle the cases of general/minor dressing, first aid, physical examination of the gents/lady patients and determining B.P, Pulse, Height, Weight, Blood Sugar etc. The Dispensary has been equipped with computer so that the patient monitoring with respect to issue of medicine, date of receiving, unregistered patient etc. near date of expiry of medicines, short supply by the supplier (stock) can be done easily and early report placed before the doctor for better decision during prescribing medicines. OPD Medical Booklet has also been issued to the chronic patients with their Unique Identification Code (UIC) mentioned on it so that better treatment can be provided to them. During this period around 5970 patients were attended in the IINRG dispensary. Most of the medicines prescribed by AMAs were made available to the patients from dispensary itself. Apart from regular employees, pensioners and contractual staff of projects of our institute are also looked after.

IPR / ITMU

- Extension material was prepared for participation in Agribusiness camp at NRC, Pig on February 13, 2013, organised by NIRJAFT, Kolkata.
- Monthly reports (RFD) were sent to ZTMC, NIRJAFT, Kolkata, on commercialization of institute technologies.
- One meeting of ITMC, IINRG was organized on August 19, 2013, for technology transfer of fruit coating formulation for pomegranate to M/s Marine Chemicals, Kochi and review of license of fruit coating formulation for *kinnow* given to M/s Gupta Brothers, Bundu.
- Draft MoU for technology transfer of fruit coating formulation for pomegranate to M/s Marine Chemicals, Kochi was prepared, in consultation with concerned scientist.
- Participated in ICAR-Industry Meet, organized by ICAR-RCER, Plandu, in association with IINRG and BAU, Ranchi on November 16, 2013 at Plandu in which

demonstration of Institute technologies was done through display of samples and extension materials.

- Two meetings of ITMC were organised on December 6, 2013, for commercial production of biopesticide and on December 11, 2013 for transfer of alta technology.

Agrometeorology

Agro-meteorology Unit of the Institute is situated at 23^{0}23' N latitude, 85^{0}23'E longitude and 650 m altitude. During the year 2013, different weather parameters on monthly basis recorded by the unit are presented in Table 57. Rainfall recorded on weekly basis has been depicted in Fig. 64.

Monsoon rain started on 10th June and continued upto October (post monsoon months). Total rainfall received during this year was 1447.8 mm. The heaviest rainfall of the season (74.6 mm) in a day during monsoon months was recorded on 27th July 2013 but heaviest rainfall (99.40 mm) of the year recorded on 2nd October (post monsoon months). Agromet unit of the Institute witnessed the effect of cyclonic storm Phailin, resulted strong winds and incessant rainfall during the month of October. During the year every month, excepting January, November and December, witnessed rainfall.

The highest mean maximum temperature (38.2^{0}C) was observed in the month of May and the lowest mean minimum temperature (6.0^{0}C) during January. 24th May and 9th January were recorded as the hottest and coldest day of the year with a temperature of 42.2 ^{0} C and 1.2^0 C, respectively. Mean maximum RH (89.3%) was recorded in August whereas mean minimum RH (42.9%) recorded during March.

Table 57. Meteorological data recorded at Agro-Met Unit of the Institute during 2013

Month	Mean Temperature (^{0} C)		Mean Relative Humidity (%)			Total Rainfall
	Maximum	Minimum	Maximum	Minimum	Mean	(mm)
January	22.9	6.0	69.1	55.6	62.4	0.0
February	26.4	10.0	69.1	60.1	64.6	24.8
March	32.2	14.0	50.3	42.9	46.6	21.1
April	34.7	17.9	51.0	48.0	49.3	21.7
May	38.2	22.2	60.1	52.7	56.4	79.6
June	31.2	21.9	82.9	76.0	79.5	277.9
July	29.4	21.7	87.0	80.9	84.0	250.9
August	29.5	21.1	89.3	83.9	86.6	213.6
September	30.3	20.9	86.6	81.4	84.0	157.0
October	26.8	18.7	85.5	80.1	82.8	401.2
November	26.5	9.9	72.1	60.4	66.3	0.0
December	24.0	6.6	86.8	71.6	79.2	0.0
				Total Rainfall (mm)		**1447.8**

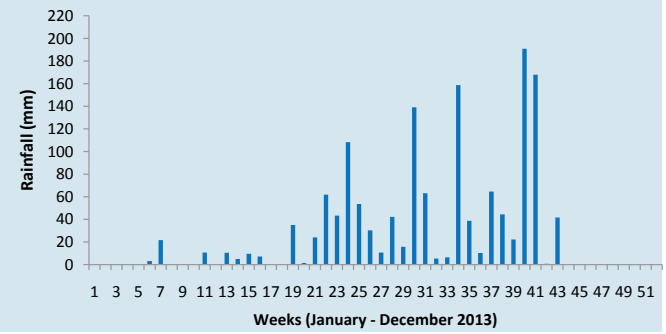
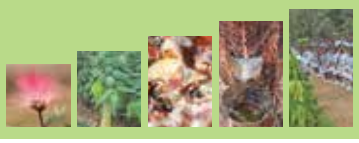


Fig. 64. Weekly rainfall (mm) during 2013



संस्थान के राजभाषा प्रकोष्ठ की गतिविधियां

भारत सरकार के राजभाषा विभाग (गृह मंत्रालय) द्वारा तैयार किए गए वार्षिक कार्यक्रम एवं राजभाषा अधिनियम व नियमों के संबंध में भारतीय कृषि अनुसंधान परिषद, नई दिल्ली से समय–समय पर प्राप्त निर्देशों पर अनुवर्ती कार्रवाई तथा सरकारी कार्य में हिन्दी के प्रयोग को और गति प्रदान करने के लिए संस्थान में राजभाषा प्रकोष्ठ की स्थापना की गई है। इसमें एक तकनीकी अधिकारी (रा. भा.), एक अंशकालीन तकनीकी सहायक, एक अंशकालीन टंकक तथा एक अंशकालीन पदचर कार्यरत हैं। संस्थान में राजभाषा संबंधी क्रियाकलापों की समीक्षा के लिए संस्थान के निदेशक की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति गठित की गई है, जिसमें विभागों/अनुभागों के अध्यक्ष, सदस्य के रुप में शामिल हैं तथा तकनीकी अधिकारी (रा.भा.) सदस्य सचिव हैं।

संस्थान 'क' क्षेत्र में है, इसे राजभाषा अधिनियम की धारा 10(4) के अर्न्तगत केन्द्रीय गजट में अधिसूचित किया जा चुका है। संस्थान के पाँच अनुभागों को शत–प्रतिशत कार्य हिन्दी में करने हेतु विनिर्दिष्ट किया गया है एवं प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को अपना–अपना कार्य हिन्दी में करने हेतु व्यक्तिशः आदेश दिये गये हैं। राजभाषा नियम के प्रावधानों के अनुपालन एवं दैनिक कार्य में हिन्दी के प्रयोग में प्रगति लाने तथा इसे सर्वग्राह्य बनाने के लिए **राजभाषा प्रकोष्ठ** द्वारा निम्नलिखित कार्य सम्पादित होते हैं:–

संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी तथा बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई। वार्षिक रिपोर्ट के हिन्दी संस्करण का प्रकाशन, राजभाषा की वार्षिक पत्रिका **लाक्षा** का प्रकाशन, कार्यालय आदेश, परिपत्र, ज्ञापन, निविदा इत्यादि एवं पत्राचार हेतु विभिन्न सामग्रियों का आवश्यकतानुसार अनुवाद। हिन्दीतर अधिकारियों और कर्मचारियों को हिन्दी शिक्षण योजना द्वारा आयोजित प्रशिक्षण एवं नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों द्वारा आयोजित विभिन्न हिन्दी प्रतियोगिताओं एवं कार्यशालाओं में सहभागिता हेतु प्रेरित करना ।

संस्थान के दैनिक कार्य में हिन्दी के प्रयोग में प्रगति एवं इसे सरल बनाने के लिए राजभाषा प्रकोष्ठ द्वारा निम्नलिखित कार्य सम्पादित होते हैं:

- संस्थान राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन, कार्यसूची एवं कार्यवृत की तैयारी एवं बैठकों में लिए गये निर्णयों पर अनुवर्ती कार्रवाई ।
- वार्षिक रिपोर्ट के हिन्दी संस्करण एवं वार्षिक राजभाषा पत्रिका लाक्षा का प्रकाशन, भा.प्रा.रा.गों.सं. समाचार पत्रिका, कार्यालय आदेश, परिपत्र, ज्ञापन, निविदा, सूचना एवं पत्राचार हेतु विभिन्न सामग्रियों का अनुवाद।
- हिन्दीतर अधिकारियों और कर्मचारियों को हिन्दी शिक्षण योजना द्वारा आयोजित प्रशिक्षण एवं नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों द्वारा आयोजित विभिन्न हिन्दी प्रतियोगिताओं एवं कार्यशालाओं में सहभागिता हेतु प्रेरित करना ।
- हिन्दी दिवस, हिन्दी चेतना मास एवं योजनानुसार नगर स्तरीय राजभाषा संबंधी प्रतियोगिता, संगोष्ठी एवं कार्यशाला का आयोजन करना ।
- संदर्भ साहित्य, हिन्दी पत्रिका, शब्दकोष, एवं तकनीकी शब्दावली के उपार्जन हेतु कार्य
- द्विभाषी मुहरों, नामपट्ट, पत्रशीर्ष (लेटरहेड) के निर्माण अथवा सक्रिय सहयोग करना।
- प्रचार सामग्रियों के हिन्दी रूपान्तर एवं समारोहों के समाचार संकलन एवं प्रेस प्रबंधन का कार्य
- विभागीय विषय पर तकनीकी शब्दावली का निर्माण
- हिन्दी में वैज्ञानिक गोष्ठी के साथ साथ प्रशासनिक तथा तकनीकी वर्ग के लिए कार्यशाला का आयोजन ।
- निदेशक महोदय की अध्यक्षता में वर्ष 2012 में संस्थान राजभाषा कार्यान्वयन समिति की चारो तिमाही बैठकों का आयोजन निम्नलिखित तिथियों को किया गया तथा प्रगति की समीक्षा की गई। तिमाही रिपोर्ट एवं कार्यवृत परिषद सहित अन्य संबंधित कार्यालयों में प्रेषित की गई :

(क) दिनांक 20.02.2013 (ख) दिनांक 14.05.2013

(ग) दिनांक 16.08.2013 एवं (घ) दिनांक 06.12.2013

जिसके अर्न्तगत निम्नलिखित प्रमुख चर्चायें हुई तथा सर्वसम्मति से निर्णय लिए गए :–

- संस्थान में हिन्दी में मूल रूप से पत्राचार बढ़ाने के लिए नकद पुरस्कार योजना का अनुपालन।
- वार्षिक कार्यक्रम 2012–13 एवं 2013–14 के निर्देशों पर चर्चा ।
- नगर स्तरीय हिन्दी संगोष्ठी का आयोजन।
- गृह पत्रिका लाक्षा–2013 का प्रकाशन ।

- वर्ष–2013–14 के लिए नकद पुरस्कार योजना लागू करना एवं वर्ष–2012–13 के प्रतिभागियों के लिए पुरस्कार का निर्धारण।
- नगर स्तरीय हिन्दी कार्यशाला का आयोजन
- तकनीकी विषय पर हिन्दी कार्यशाला का आयोजन।
- प्रशासनिक विषय पर हिन्दी कार्यशाला का आयोजन।
- द्विभाषी मुहरों का निर्माण।
- द्विभाषी नामपट्ट की व्यवस्था।
- लाक्षा 2012 के सर्वश्रेष्ठ आलेख का चयन एवं पुरस्कार
- हिन्दी दिवस/हिन्दी प्रतियोगिताओं का आयोजन।
- प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को व्यक्तिशः आदेश जारी करना
- सभी कम्प्यूटरों में यूनिकोड या गुगल हिन्दी सॉफ्टवेयर की ब्यवस्था
- अनुवाद के लिए आउटसोर्सिंग
- हिन्दी पुस्तकों का उपार्जन
- जाँच–विन्दु का निर्धारण।

राजभाषा प्रकोष्ठ की उपलब्धियां–2013

- दिनांक– 22.03.2013 को ''जलवायु परिवर्तन एवं उसके परिणाम'' विषय पर हिन्दी में नगर स्तरीय संगोष्ठी का आयोजन किया गया।
- 20–21 मई 2013 को ''कौशल विकास'' विषय पर दो दिवसीय हिन्दी प्रशिक्षण कार्यशाला का आयोजन किया गया।
- "प्राकृतिक राल एवं गोंद–भा.प्रा.रा.गों.सं. समाचार पत्रिका" का सम्पूर्ण अनुवाद तथा आउटसोर्सिंग द्वारा सम्पूर्ण वार्षिक रिपोर्ट का अनुवाद कराया गया।
- संस्थान की वार्षिक हिन्दी पत्रिका **लाक्षा–2013** का प्रकाशन किया गया ।
- संस्थान के आगत–निर्गत पत्रों का विस्तृत (अनुभाग/विभाग व क्षेत्रवार) विवरण तैयार कर विहित प्रपत्र में तिमाही रिपोर्ट तैयार की गयी तथा परिषद् समेत सभी संबंधित कार्यालयों को प्रेषित की गयी ।
- वैज्ञानिक उपकरणों से जुड़े कम्प्यूटरों को छोड़कर संस्थान के कुछ अन्य कम्प्यूटरों में हिन्दी फॉन्ट लगा दिये गयें हैं तथा ज्यादातर कम्प्यूटरों में युनीकोड/गुगल हिन्दी सॉफ्टवेयर डाला गया है।
- वर्ष 2013 में राजभाषा प्रकोष्ठ की पहल पर विज्ञान एवं साहित्य से जुड़े कुछ हिन्दी पुस्तकों का उपार्जन किया गया।
- समय–समय पर हिन्दी के प्रयोग को प्रोत्साहित करने के लिए विभिन्न प्रकार की हिन्दी प्रतियोगिताओं का आयोजन किया गया
- हिन्दी में श्रुतिलेखन (डिक्टेशन) के लिए पुरस्कार योजना संस्थान में लागू की गई है।
- लाक्षा–2012 के सर्वश्रेष्ठ आलेख के चयन के लिए कमिटी गठित कराई गई तथा सर्वश्रेष्ठ आलेख का चयन कर लेखकों को पुरस्कार प्रदान किया गया।
- सरकारी काम–काज मूल रूप से हिन्दी में करने हेतु संस्थान में नकद पुरस्कार योजना लागू की गई, इसमें वैज्ञानिक, तकनीकी एवं प्रशासकीय वर्ग के कुल 05 अधिकारियों/कर्मचारियों ने भाग लिया विगत वर्ष के विजेताओं को पुरस्कार प्रदान किए गए।

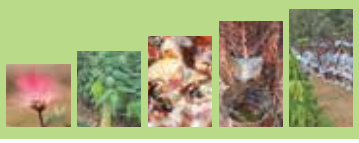
कार्यक्रम

हिन्दी चेतना मास/हिन्दी दिवस समारोह–2013

संस्थान में सितम्बर 2013 की अवधि में **हिन्दी चेतना मास** का पालन तथा दिनांक–30.09.2013 को अपराह्न 01.15 बजे **हिन्दी दिवस समारोह** का आयोजन किया गया।

हिन्दी दिवस समारोह के अवसर पर मुख्य अतिथि श्री मधुकर, सलाहकार सम्पादक, खबर मंत्रा, राँची ने **दृश्य मिडिया एवं हिन्दी पत्रकारिता** विषय पर व्याख्यान दिया। श्री मधुकर ने कहा कि हिन्दी की प्रगति में इलेक्ट्रोनिक मीडिया व पत्रकारिता का अहम योगदान रहा है। हिन्दी के पिछड़ेपन के लिए हमारी मानसिकता दोषी है। चीन, रुस, जापान जैसे देशों में इंजिनियरिंग तथा मेडिकल की पढ़ाई स्थानीय भाषाओं में होती है, परंतु हमारे देश में आजादी के 66 वर्षो बाद भी ऐसा संभव नहीं हो सका है।

इस अवसर पर विशिष्ट अतिथि के रुप में डॉ (श्रीमती) यशोधरा राठौर, सहायक प्राध्यापक, हिन्दी विभाग, राँची महाविद्यालय ने **वैश्वीकरण की दिशा में हिन्दी की स्थिति** विषय पर बोलते हुए कहा कि हिन्दी की प्रगति के लिए शिक्षण, पत्रकारिता, प्रशासन, विधि कार्यो को हिन्दी में करने की आवश्यकता है।



संस्थान के निदेशक, डॉ रंगनातन रमणि ने अपने स्वागत भाषण में कहा कि संस्थान के कार्यालय कार्य के साथ–साथ वैज्ञानिक साहित्य में भी हिन्दी का अच्छा प्रयोग हो रहा है। संस्थान द्वारा नियमित अंतराल पर हिन्दी/द्विभाषी पुस्तिकाएं, पत्रिकाएं पत्रक इत्यादि प्रकाशित होते रहते हैं।

इस अवसर पर अतिथियों द्वारा संस्थान की राजभाषा पत्रिका **लाक्षा–2013** का लोकार्पण किया गया।

हिन्दी चेतना मास की अवधि में हिन्दी टिप्पण, प्रारूप लेखन, निबंध, अंताक्षरी, पर्याय, व्याख्यान इत्यादि प्रतियोगिताओं का आयोजन किया गया एवं विजेताओं को पुरस्कार प्रदान किये गए इसके साथ ही लाक्षा–2012 में उत्कृष्ट आलेख का पुरस्कार डॉ मो फहीम अन्सारी, श्री एस के एस यादव को प्रदान किया गया।

समारोह का संचालन डॉ अंजेश कुमार एवं धन्यवाद ज्ञापन डॉ (कु) महताब जाकरा सिद्दीकी, अध्यक्ष, हिन्दी दिवस समारोह आयोजन समिति ने किया।

संस्थान के हिन्दी/द्विभाषी प्रकाशनों की सूची

- कैसे करें सेमियालता पर लाख की खेती, पुस्तिका. पृष्ठों की संख्या–40
- लघु लाख प्रसंस्करण इकाई– फोल्डर– पृष्ठों की संख्या–06
- प्राकृतिक राल एवं गोंद–भा.प्रा.रा.गों.सं. समाचार पत्रिका (द्विभाषी) अंकों की संख्या–04, पृष्ठों की संख्या–32
- ईयर प्लानर सह प्रचार पत्रक (द्विभाषी), पृष्ठों की संख्या–28

संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकों मे लिए गए निर्णय एवं की गई कार्रवाई

लिए गए निर्णय	अनुपालन/की गई कार्रवाई
नगर स्तरीय हिन्दी संगोष्ठी का आयोजन	मार्च 2013 में ''जलवायु परिवर्तन एवं उसके परिणाम'' विषय पर हिन्दी में नगर स्तरीय संगोष्ठी का आयोजन किया गया।
द्विभाषी मुहरों का निर्माण	मांग–पत्र के अनुरुप द्विभाषी मुहरों का निर्माण किया गया है।
सभी कम्प्यूटरों में हिन्दी सॉफ्टवेयर लगाना	वैज्ञानिक उपकरणों से जुड़े कम्प्यूटरों को छोड़कर संस्थान के कुछ अन्य कम्प्यूटरों में हिन्दी फॉन्ट लगा दिये गयें हैं ।
संस्थान की हिन्दी पत्रिका **लाक्षा** का प्रकाशन	संस्थान की हिन्दी पत्रिका **लाक्षा–2013** का प्रकाशन सितम्बर 2013 में कर लिया गया है।
हिन्दी प्रतियोगिताओं का आयोजन	संस्थान में टिप्पण, प्रारुप लेखन, निबंध, श्रुतिलेख, अंताक्षरी इत्यादि हिन्दी प्रतियोगिताओं का आयोजन किया गया।
हिन्दी चेतना मास एवं हिन्दी दिवस का आयोजन	हिन्दी चेतना मास एवं हिन्दी दिवस का आयोजन किया गया।
हिन्दी संगोष्ठी का आयोजन	वैज्ञानिक विषय पर संगोष्ठी का आयोजन किया गया।
नकद पुरस्कार योजना लागू करना	हिन्दी में मूल पत्राचार को बढ़ावा देने के लिए नकद पुरस्कार योजना लागू की गई है तथा इसके अन्तर्गत विजेताओं को पुरस्कार प्रदान किए गए हैं।
जाँच–बिन्दु का निर्धारण	राजभाषा अधिनियम के प्रावधानों के अनुरुप जाँच–बिन्दु का निर्धारण किया गया है।
व्यक्तिशः आदेश लागू करना	संस्थान के प्रवीणता प्राप्त सभी अधिकारियों/कर्मचारियों को अधिकतम कार्य हिन्दी में करने के लिए निदेशक महोदय के हस्ताक्षर से व्यक्तिशः आदेश जारी कर दिए गए हैं।
लाक्षा–2012 के लिए सर्वश्रेष्ठ आलेख का चयन	लाक्षा–2012 के लिए सर्वश्रेष्ठ आलेख के चयन के लिए गठित मूल्यांकन समिति के द्वारा निर्धारित एक आलेख के दो लेखकों को पुरस्कार प्रदान किया गया।
तकनीकी विषय पर हिन्दी कार्यशाला का आयोजन	20–21 मई 2013 को ''कौशल विकास'' विषय पर दो दिवसीय हिन्दी प्रशिक्षण–सह–कार्यशाला का आयोजन किया गया।

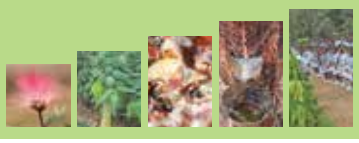
अन्य गतिविधियां

- भारतीय प्राकृतिक राल एवं गोंद संस्थान नामकुम, राँची को पूर्वी भारत के ''क'' क्षेत्र के केन्द्र सरकार के कार्यालय वर्ग में राजभाषा के सर्वश्रेष्ठ कार्यान्वयन के लिए प्रथम् पुरस्कार प्रदान किया गया है। राजभाषा विभाग, गृह मंत्रालय द्वारा 18 अप्रैल 2013 को कोलकाता में आयोजित पूर्वी क्षेत्र

पुरस्कार ग्रहण करते हुए प्रभारी निदेशक, डॉ. केवल कृष्ण शर्मा

एवं पूर्वोत्तर क्षेत्र राजभाषा सम्मेलन में संस्थान के प्रभारी निदेशक, डॉ केवल कृष्ण शर्मा को विश्व भारती शांति निकेतन के कुलपति आचार्य शुशांत दत्त गुप्ता एवं राजभाषा विभाग, भारत सरकार के सचिव श्री अरुण कुमार जैन ने ट्राफी देकर सम्मानित किया। संस्थान के तकनीकी अधिकारी (राजभाषा) डॉ अंजेश कुमार को कार्यान्वयन में उत्कृष्ट कार्य के लिए प्रथम पुरस्कार के रुप में प्रशस्ति पत्र देकर सम्मानित किया गया।

- केन्द्रीय मनश्चिकित्सा संस्थान, कांके में दिनांक – 29.01.2013 एवं दिनांक – 26.08.2013 को आयोजित राँची नगर राजभाषा कार्यान्वयन समिति की बैठकों में संस्थान का प्रतिनिधित्व डॉ रंगनातन रमणि, निदेशक, श्री सुजीत कुमार सिंह, वरिष्ठ प्रशासनिक अधिकारी एवं डॉ अंजेश कुमार, त.अ. ने किया तथा बैठकों में संस्थान की गतिविधियों की जानकारी दी और अध्यक्ष नराकास के अनुरोध पर उपरोक्त दोनों कार्यक्रमों का संचालन व समन्वय का कार्य डॉ अंजेश कुमार ने किया।
- केन्द्रीय मनश्चिकित्सा संस्थान, कांके में दिनांक – 08.08.2013 को नराकास की राजभाषा पत्रिका ''राजभाषा जोहार'' के संपादक मंडल की बैठक आयोजित की गई जिसमें सदस्य के रुप में डॉ अंजेश कुमार, त.अ. ने भाग लिया तथा पत्रिका की सामग्री को अन्तिम रुप दिया गया। साथ ही पत्रिका के मुद्रण के लिए प्रेस जा कर कार्य किया गया तथा प्रकाशन किया गया।
- सतर्कता जागरुकता सप्ताह के समापन समारोह एवं कौमी एकता सप्ताह के आयोजन में सहयोग किया गया।



Budget

Budget allocation and utilization during 2013-14

(Rupees in lakhs)

	Non-Plan		Plan	
GRANT IN AID CAPITAL	**R.E**	**Expenditure**	**R.E**	**Expenditure**
Equipments	3.00	2.98	3.20	3.19
Library Books & Journals	0.00	0.00	36.00	35.99
Furniture & Fixtures	2.00	2.00	0.80	0.80
Total grant in aid capital	**5.00**	**4.98**	**40.00**	**39.98**
GRANT IN AID SALARIES (REVENUE)				
Establishment Expenses (Salaries)				
i. Establishment charges	1097.70	954.48	0.00	0.00
ii. Over Time Allowance	0.30	0.30	0.00	0.00
Total Estt. expenses (grant in aid-salaries)	**1098.00**	**954.78**	**0.00**	**0.00**
GRANT IN AID GENERAL (REVENUE)				
Pension & Other Retirement Benefits	160.00	152.85	0.00	0.00
Travelling Allowances	9.60	9.57	10.00	9.97
Research & Operational Expenses	28.82	28.78	40.00	39.99
Administrative Expenses	139.36	139.12	45.00	44.92
Miscellaneous Expenses	21.91	21.82	11.00	10.53
Total grant in aid- general	**359.69**	**352.14**	**106.00**	**105.41**
GRAND TOTAL(Capital + Revenue)	**1462.69**	**1311.90**	**146.00**	**145.39**
Loans & Advances	7.00	6.97	0.00	0.00
Plan Schemes AICRP & Net Work Projects				
i. Network Project on H & PHP & VANR&G			46.00	45.89
ii. NICRA			15.00	14.93
iii. I.P.R.			8.60	6.08
iv. NFBSFARA			13.03	8.82
v. KVK KHUNTI			3.50*	0.50
	Target	**Achievement**		
Revenue General Target	**47.50**	**46.12**		

*Rs. 3.0 lakhs under revolving fund

Personnel

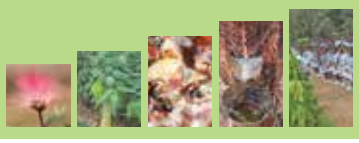
Details of scientific, Technical, Administrative and Supporting staff as on December 31, 2013

Scientific	Sanctioned Strength
R.M.P.	01
Principal Sc.	06
Senior Sc.	14
Sc.	26
Total	47
Technical	
Category-I	41
Category-II	20
Total	**61**
Administrative	
Sr. A.O.	01
F.& A.O.	01
A.A.O.	02
A.D.(O.L.)	0
P.S.	01
Security Officer	01
P.A.	02
Assistant	10
Sr.Clerk	05
Jr.Clerk	06
Steno Gr.III	01
J.A.O.	01
Total	**31**
Skilled Support Staff	
S.S.S.	82
Total	**82**

Cadre	Sanctioned	In-Position
Scientific	47*	34*
Technical	61	50
Administrative	31	24
Supporting	82	54
Total	**221**	**162**

* Including one RMP (Director)

Dr. R. Ramani	**Director**
Division of Lac Production	
Dr. K. K. Sharma, Pr. Sc. & Head, LPD	Agril. Entomology
Dr. A. K. Singh, Pr. Sc.	Plant Pathology
Dr. Md. Monobrullah, Pr. Sc.	Agril. Entomology
Dr. S. Ghosal, Sr. Sc.	Agronomy
Dr. Vibha Singhal, Sr. Sc.	Agro. Forestry
Dr. Jyotirmoy Ghosh, Sr. Sc.	Gen. Plant Breeding
Dr. Vaibhav D.Lohot, Sc.	Plant Physiology
Sri Anees K., Sc. (on study leave)	Plant Biochemistry
Dr. Mrs. Thamilarashi K., Sc.	Agril. Biotech.
Sri S. C. Meena, Sc.	Agril. Entomology
Dr. A. Mohana Sundaram, Sc.	Agril. Entomology
Sri K. U. Tribhuvan, Sc.	Agril. Biotech.
Sri S. S. Bhatt, Sc.	Agro-forestry
Ms. Rajna S., Sc.	Agril. Entomology
Sri P. A. Ansari, T.O.	F/F Tech.
Sri Binod Kumar, T.O.	F/F Tech.
Sri S. K. Tripathi, Tech. Asstt.	F/F Tech.
Sri Bhupal Kumar, Sr. Technician	Lab. Tech.
Division of Processing and Product Development	
Dr. N. Prasad, Pr. Sc. & Head, PPD	A.S. & P.E.
Sri Murari Prasad, Pr. Sc.	Chemical Engg.
Dr. K. P. Sao, Pr. Sc.	A.S. & P.E.
Dr. S. K. Tyagi, Pr. Sc.	Agril. Chemical
Dr. Sanjay Srivastava, Pr. Sc.	Agril. Chemical
Dr. P. C. Sarkar, Sr. Sc.	Agril. Chemical
Dr. M. Z. Siddique, Sr. Sc.	Agril. Chemical
Sri S. K. Pandey, Sc.	Mech. Engg.
Dr. Md. Fahim Ansari, Sr.Sc.	Agril. Chemical
Dr. S. C. Sharma, Sc.	F. M. & Power
Dr. Arnab Roy Choudhary, Sc.	Agril. Chemical
Sri N. K. Thombare, Sc.	Agril. Chemistry
Sri C. J. Mate, Sc.	Agril. Chemical



Sri D. D. Singh, C.T.O.	Lab. Tech.
Sri K. K. Prasad, A.C.T.O.	Lab. Tech.
Sri T. K. Saha, Sr.T.O.	Lab. Tech.
Sri Bhola Ram, T.O.	Lab. Tech.
Sri S. K. Tirkey, Tech.Asstt.	Lab. Tech.
Sri Ajay Kumar, Tech.Asstt.	Lab. Tech.
Sri R. K. Rai, Tech.Asstt.	Lab. Tech.
Sri Anup Kumar, Tech.Asstt.	Lab. Tech.
Sri Binod Kumar, Tech.Asstt.	Lab. Tech.
Division of Transfer of Technology	
Dr. A. K. Jaiswal, Pr. Sc. & Head	Agril. Entomology
Dr. A. Bhattacharya, Pr. Sc.	Agril. Entomology
Dr. Alok Kumar, Sr. Sc.	Agril. Extension
Dr. A. K. Singh, Sr. Sc.	Agronomy
Dr. R. K. Yogi, Sc.	Agri. Economics
Sri S. K. S. Yadav, Sc.	Agril. Chemical
Sri R. P. Srivastava, T.O.	Photography Staff
Sri D. K. Singh, T.O.	F/F Tech.
Sri A. K. Sinha, T.O.	F/F Tech.
Sri S. B. Azad, T.O.	F/F Tech.
Smt. Ratna Sen, T.O.	Lab. Tech.
Sri P. Patamajhi, T.O.	F/F Tech.
Sri Madan Mohan, Tech.Asstt.	F/F Tech.
P.M.E. Cell	
Dr. A. Bhattacharya, Pr. Sc.	I/c PME Cell
Ms. P. R. Ghatak, ACTO	Lab. Tech.
Sri D. Ganguly, Sr. T.O.	Lab. Tech.
Sri Sunil Kumar, Sr. T.O.	Lab. Tech.
Administrative Section	
Sri Sujit Kumar Singh	Sr. Admn. Officer
Admin. I	
Sri Amrendra Kishore	AAO
Sri Thibu Minz	Asstt.
Sri S. C. Lal	Asstt.
Sri R. N. Mahto	Asstt.
Sri Krishna Murari Kumar	Sr. Clerk
Sri Bandhu Mahto	Jr. Clerk
Admin.II	
Sri Binod Kumar, T.O.	D.D.O.
Sri Anant Pandey	Asstt.
Sri Arjun Gope	Asstt.
Sri R. K. Toppo	Asstt.
Sri Samal Kumar	Sr. Clerk(Cashier)
Admin. III	
Sri Prahlad Singh	AAO
Sri Ravishanker	Asstt.
Sri Arun Kumar Tripathi	Asstt.
Sri K. K. Deonath	Sr. Clerk
Steno	
Sri Arjun Kr.Sinha	Private Secretary
Sri S. K. Yadav	P.A.
Sri Hari Vilas	Steno. Gr. III
Audit & Accounts Section	
Sri G. C. Joshi	Finance & Accounts Officer
Sri K. Oraon	Asstt.
Sri Bihari Sahu	Asstt.
Sri K. P. Kashi	Sr.Clerk
Sri Ashwani Kumar	Sr. Clerk
Institute Research Farm	
Sri L. C. N. Shahdeo, C.T.O.	F/F Tech.
Sri M. Surin, T.O.	W. & Engg.
Sri Satish Kumar, Sr. Tech. Asstt.	F/F Tech.
Sri S. K. Mukherjee, Tech. Asstt.	F/F Tech.
Sri Jhirga Oraon, Technician	W. & Engg.

Estate	
Sri A. K. Yadav, Security Officer	I/c Estate
Sri H. L. Bhakta, T.O.	W. & Engg.
Sri Binoy Kumar, Sr. Tech. Asstt.	W. & Engg.
Sri Arjun Sharma, Tech. Asstt.	W. & Engg.
Sri R. K. Ravi, Tech. Asstt.	W. & Engg.
Sri K. Tirkey, Tech. Asstt.	W. & Engg.
Sri B. S. Choudhary, Tech. Asstt.	W. & Engg.
Sri P. V. D. Tirkey, Tech. Asstt.	W. & Engg.
Sri Rama Kant Singh, Sr. Tech.	W. & Engg.
Sri Anil Kr. Sharma, Sr. Technician	W. & Engg.
Sri Mahavir Mahto, Technician	W. & Engg.
Sri Sukra Oraon, Technician	W. & Engg.
Library	
Sri V. K. Singh, C.T.O.	Lib. Inf. & Doc.
Sri Binod Kumar, T.O.	Lib.Inf. & Doc.
Hindi Cell	
Dr. Anjesh Kumar, T.O.	Press & Editorial
Quality Evaluation Lab. (Under P. & P.D.Div.)	
Dr. Sanjay Srivastava, Pr. Sc.	I/c Q.E.L.
Sri B. K. Singh, Tech.Asstt.	Lab. Tech.
Dispensary	
Dr. Sanjay Srivastava, Pr. Sc.	I/c Dispensary
Dr. N. P. Sinha	Medical Doctor (Part time)
Dr. Richa Katiyar	Medical Doctor (Part time)
Sri C. K. Singh, Sr. Tech. Asstt.	Medical & Paramedical Pharmacist

Transport	
Sri Arbind Kumar, Sr. Tech. Asstt.	Driver
Sri J. Tewari, Tech. Asstt.	Driver
Sri M. Singh, Tech.Asstt.	Driver
Sri R. K. Yadav, Tech. Asstt.	Driver
Sri Bandi Oraon, Technician	Driver

Recruitments and Transfers

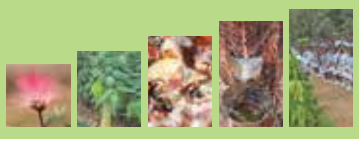
(a) Joining

1. Sri C.J.Mate joined the Institute as Sc.(Agrl. Chemical) on 09.04.2013
2. Sri K.U. Tribhuvan joined the Institute as Sc. (Agrl. Biotechnology) on 12.04.2013
3. Sri S.S.Bhatt joined the Institute as Sc.(Agro-Forestry) on 12.04.2013
4. Smt. Rajna S. joined the Institute as Sc.(Agril. Entomology) on 10.06.2013
5. Smt. P.R.Ghatak joined the Institute as A.C.T.O. on 22.07.2013 after relieving from NIRJAFT, Kolkata.
6. Dr. Alok Kumar joined the Institute as Sr. Sc.(Agril. Extension) on 02.09.2013

(b) Promotion:

Scientific

1. Dr. S.K.Giri, Sc.(SS) promoted to the post of Sr. Sc. w.e.f. 15.11.2008 (already transferred to CIAE, Bhopal).
2. Dr. Dipnarayan Saha, Sc.(SS) promoted to the post of Sr. Sc. w.e.f. 20.11.2008 (already transferred to NBPGR, New Delhi).
3. Er. S.K.Pandey, Sc.(SS) recommended for next higher Research Grade Pay w.e.f. 07.01.2009.
4. Md. Fahim Ansari, Sc.(SS) recommended for next higher Research Grade Pay w.e.f. 01.06.2010.
5. Dr. Govind Pal, Sc.(SS) promoted to the post of Sr. Sci. w.e.f. 13.09.2010 (already transferred to DSR, Mau)
6. Dr. Monobrullah, Sr. Sc. selected to the post of Principal Sci. on 24.05.2013
7. Dr. Sanjay Srivastva, Sr. Sc. seleted to the post of Principal Sci. on 24.05.2013



Technical

1. Sri Dipak Ghosh, Ex-Asstt. Chief Tech. Officer promoted to the post of Ex-Chief Tech. Officer(Lab. Tech.Group) on 03.02.2012.
2. Sri D.D.Singh, Assst. Chief Tech. Officer promoted to the post of Chief Tech. Officer(Lab.Tech.Group) on 03.02.2012.
3. Sri L.C.C.N.Shahdeo, Asstt. Chief Tech. Officer promoted to the post of Chief Tech. Officer (Field/ Farm Tech.Group) on 03.02.2012.
4. Sri V.K.Singh, Asstt. Chief Tech. Officer promoted to the post of Chief Tech. Officer (Library Information & Documentation Group) w.e.f. 03.02.2012.

Administration

1. Sri K.M.Kumar, L.D.C. promoted to the post of U.D.C. w.e.f. 28.06.2013(A/N)
2. Sri Ashwini Kumar, L.D.C. promoted to the post of U.D.C. w.e.f. 28.06.2013(A/N)

(c) Transfer

1. Dr. R.K.Singh, Sc. (SS) transferred from IINRG, Ranchi to CAZRI, Jodhpur after selection as Sr. Sc.
2. Dr. J.P.Singh, Sr. Sc. transferred from IINRG, Ranchi to IARI, New Delhi on 30.10.2013.

(d) Retirement

1. Smt. Prabha Devi, Technical Officer (Lab.Tech.) retired on 31.07.2013
2. Sri B.P.Kujur, SSS retired on 31.08.2013.

(e) Death

1. Sri Mahabir Mahto, Ex-SSS expired on 12.02.2013
2. Sri Nayeem Ansari, Ex-SSS expired on 29.04.2013