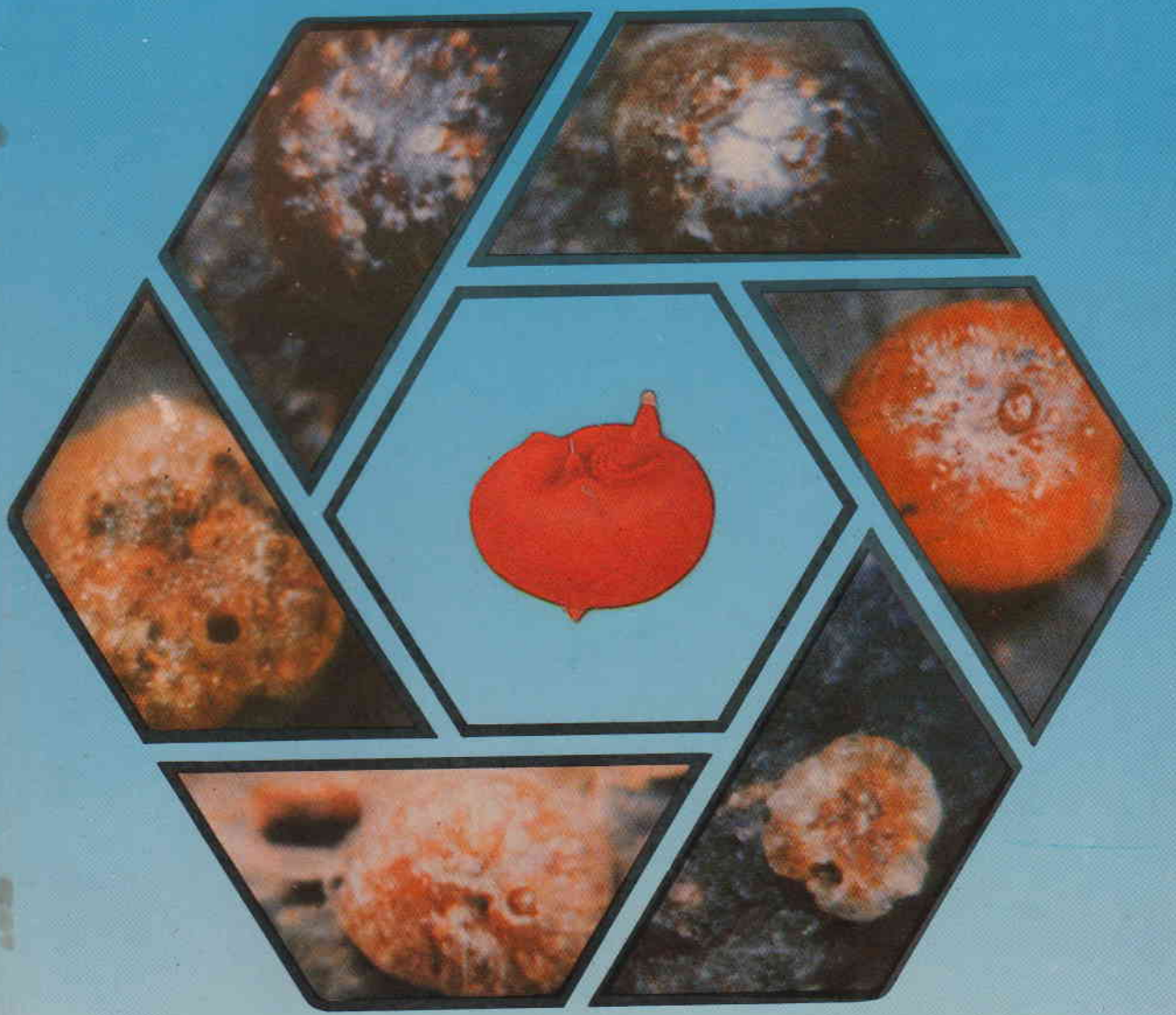
Annual Report

1987



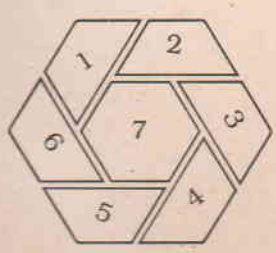
Indian Lac Research Institute

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

NAMKUM, RANCHI-834010 (Bihar)

INDIA

COLOUR FORMS OF LAC INSECTS (FEMALE CELLS)



1. Wild type *crimson*, Meghalaya
2. Wild type *crimson*, Bihar
3. Yellow (a recessive mutant)
4. *Pinkish white*
5. *Light crimson*
6. *Ruby*
7. *Normal female without cell*

INDIAN LAC RESEARCH INSTITUTE
RANCHI - 834 010
BIHAR
INDIA

ANNUAL REPORT
1987

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
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CONTENTS

1. INTRODUCTION

History and Development

The Indian Lac Research Institute came into existence in the year 1925 as a result of recommendations of an enquiry committee appointed by the Government of India to enquire into the condition of India's lac trade and suggest measures for its all round improvement. This Institute was administered in its early years by the Indian Lac Association for Research followed by Indian Lac Cess Committee. From 1966 onwards it is functioning under the Indian Council of Agricultural Research, as one of its Institute.

Since its inception, it has persistently endeavoured to boost, optimise and stabilise the production of better quality lac through evolution and dissemination of appropriate technologies. It has played a significant role in serving the lac growers belonging to tribal and other weaker sections of the society, inhabiting the important lac growing States namely, Bihar, M. P., West Bengal, Orissa, U. P. etc. by popularising improved lac cultivation technologies directly as well as through other government and voluntary agencies. The industrial aspects also received due attention and a good number of products and processes have been developed and popularised for enhancing utilisation of lac in the country. The Institute has been extending its expertise in the fields of lac cultivation and processing to the countries like USSR, Vietnam, China etc. and has attained a global recognition for its researches.

Objectives

The objectives of the Institute are

1) To carry out research towards affecting improvements in the cultivation, processing and standardisation of lac and study its constitution and modifications so as to intensify lac production and extend its utilisation.

2) To extend the results of research through publicity, maintaining liaison with and providing technical service to the growers and indigenous industries towards increased utilisation of lac and improving the quality of their products.

3) To impart training in improved methods of lac cultivation and industrial uses of lac.

Major Missions

1) Evolving lac production technologies for improving productivity and quality of sticklac and broodlac.

2) Improving lac host plants and their management practices for increased lac production.

3) Development and upscaling of technologies for processing and diversified utilisation of lac and its by-products.

4) Dissemination of information on improved technologies in respect of lac culture, processing and utilisation to the lac growers and the end users.

Organisational Set-up

The Institute consists of six Divisions namely, Entomology, Plant Sciences, Chemistry, Technology, Insect Genetics & Breeding and Extension. Each Division has its own independent working set up. In order to support the research and extension activities the Institute also maintains a number of sectional units namely Administrative, Audit & Accounts, Library, Maintenance and Workshop, Technical & Monitoring Cell, Plantation & Land scaping, Art-cum-Photography, Medical, Security, Estate Maintenance and Central Stores etc. In addition, an operational research project is being implemented in six backward tribal villages in the Ranchi district.

Research on regional problems of lac cultivation are being carried out at Regional Field Research Station at Dharamjaigarh (Raigarh) M. P.

The detailed organisational set-up is given ont page no. 3.

Staff & Budget

The Institute has a sanctioned strength of 60 Scientists, 86 Technicians, 49 Administrative, 14 Auxillary and 136 Supporting staff.

The budget of the Institute for the financial year 1987-88 was Rs. 79.58 lakh for non-plan and Rs. 30.00 lakh for plan scheme. The actual expenditure during the year was Rs.83.74 and Rs. 20.84 lakhs under non-plan and plan respectively.

Research Achievements

Management of lac predators : Trials with new insecticides indicated that *trichlorfon* (Dipterex) can replace the *endosulfan* for the control of lac predators thus possibilities of these predators developing resistence to *endosulfan* can be obviated.

New Colour forms of lac insects : Inbreeding of a *rangeeni* stock of lac insects has led to the discovery of new colour forms. Some of these insects secreted extremely light coloured resin retaining the body colour. Possibility of evolving the strains producing the much desired lighter coloured lac resin is being examined.

Modified lac wax : Lac wax (melting point 77-88°C and penetration value 5) has been modified using sodium bisulphite to produce a wax with high melting point (84-85°C) and better hardness (penetration value 2).

Coal-blocks : Water and impact resistant blocks suitable as domestic fuel have been developed using inferior quality coal dust and *kiri*, a by product of the lac industry. Such a coal-block (500 g) costing 60 paise only produces enough energy to cook normal food for a small family.

Extension Highlights

In addition to the regular extension activities of the Institute a *Radio Krishi Pathshala* (Farm School on Air) covering various aspects of lac cultivation was organised and 13 talks were transmitted through A. I. R., Ranchi at weekly interval for the benefit of a large number of lac cultivators of adjoining areas of Bihar and West Bengal.

Ten training camps in 7 villages of Ranchi were organised and on the spot training/guidance was provided to 856 farmers.

Four industrial nominees from Andhara Pradesh, Bihar, Delhi & Maharashtra, were given special demonstration-cum-short term training in the testing and preparation of lac based products.

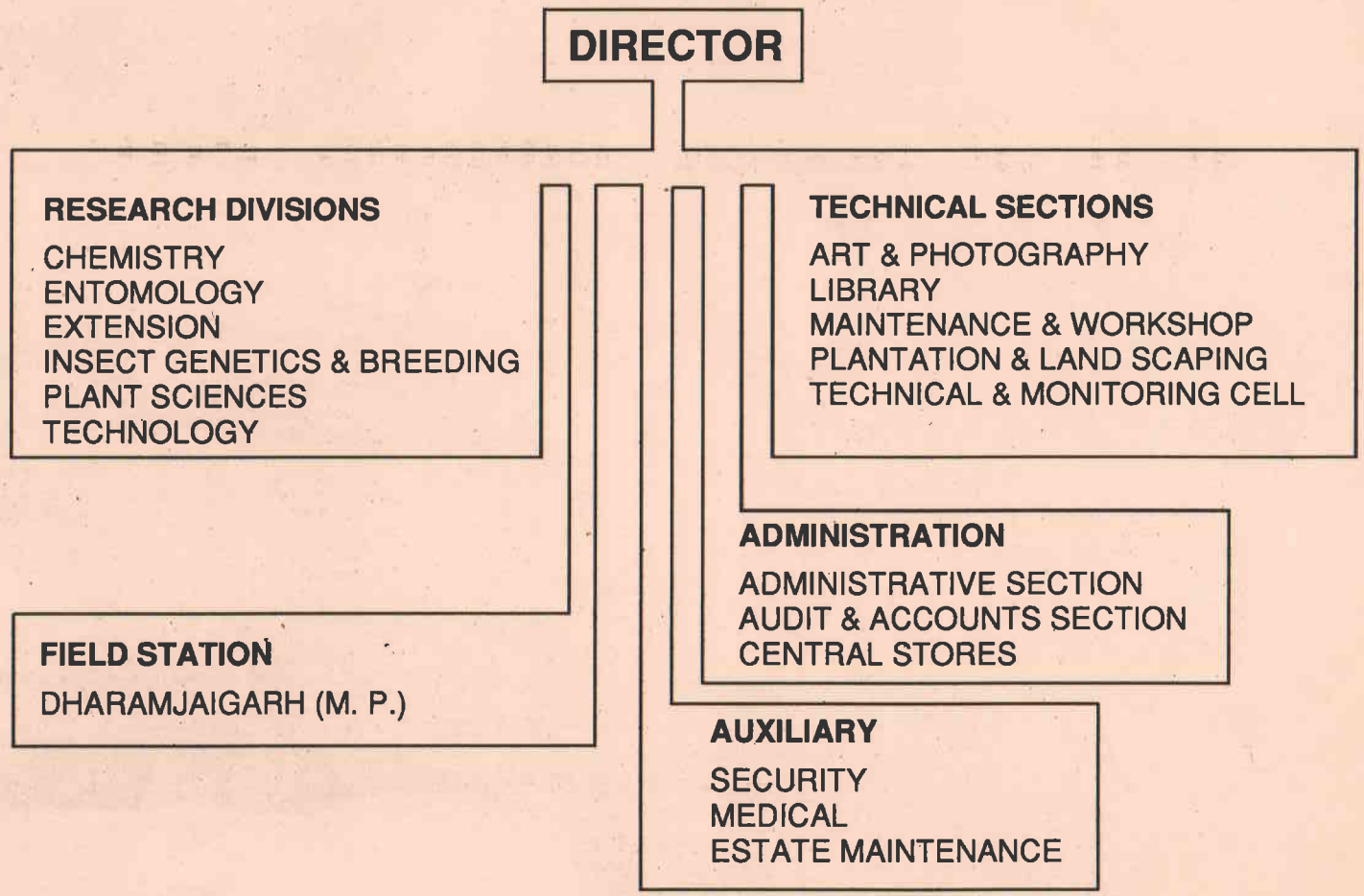
Training of F. A. O. Nominees

Training on various aspects of lac cultivation, processing and utilisation was organised for 8 F. A. O. nominees from Vietnam, in two batches. Study tours were also organised for them.

Honours & Awards

Sri M. Mukherjee, Scientist S-1 was awarded the degree of Doctor of Philosophy by the Ranchi University for his thesis entitled *"Lac Esters and Their Utilisation"* .

ORGANISATIONAL SET-UP OF I.L.R.I. NAMKUM, RANCHI



2. PROGRESS OF RESEARCH

A. DIVISION OF ENTOMOLOGY

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES IN PROGRESS

Impovement in Lac Cultivation Techniques

1.1.9 To evolve suitable management practices for brood and sticklac production in the light of recent findings

Based on the recent findings of crop and pest management technologies this project was taken up in order to evolve improved management practices for sustained production of quality broodlac and to maximise the yeid of sticklac on three conventional hosts namely, *Schleichera oleosa (kusum), Butea monosperma (palas) and Ziziphus mauritiana (ber).* Development of precise method for estimation of broodlac requirement and expected yield was also aimed.

1.1.9.1 Technique for *kusum*

An experiment was laid out on a total number of 128 trees consisting of the following 8 treatments with 4 replications on 4 trees each.

KA Four coupe system using 10g broodlac per metre of shoot length and application of schedule-I for pest control.

KB Four coupe system using 20g broodlac per metre of shoot length and application of Schedul- I for pest control.

KC Four coupe system using 20g broodlac per metre of shoot length (No pest control)

KD Four coupe system using 10g broodlac per metre of shoot length and application of schedule II for pest control.

KE Four coupe system using 20g broodlac per metre of shoot length and application of schedule II for pest contnrol.

KF Two coupe system involving inoculation of 12 month old shoots during January - February using 10g broodlac per metre of shoot length, partial harvesting and self inoculation during June-July, and application of schedule II for pest control.

KG As above, using 20g broodlac per metre shoot length.

KH Two coupe system involving inoculation of 12 month old shoots during June - July using 10g broodlac per metre shoot length, self inoculation during January - February (no partial harvesting) and application of schedule II for pest control.

Following two schedules for pest control were included in various cropping patterns (treatments) described above.

Pest control schedule I : Spraying of a mixture of 0.05 percent *endosulfan* (Thiodan 35 E. C.) and .05 per cent BHC (50 per cent W. P.) 5 weeks after inoculation, followed by another spray after 8 weeks of inoculation, if considered necessary.

Pest control schedule II : In addition to spray as described above an additional spray of 0.05 per cent *endosulfan* alone during the last week of October/first week of November for *aghani* crop and second week of June for *jethwi* crop.

Considering initial shoot coverage and the density of lac larvae settled on the shoots the crop performance will

be assessed in relation to the yeild of brood and sticklac per metre shoot length, per pruned point and finally per tree.

The trees under first five treatments (KA to KE) were pruned during July and the response of trees to pruning was satisfactory.

Another experiment was laid out on 80 *kusum* trees to find out correlation between the total available shoot length and the yield obtained (broodlac as well as sticklac) with the stem girth, height, canopy spread, area & number of pruned points.

Preliminary study was made on 12 trees each, pruned in July 1986, January 1987 and July 1987. Shoot length was recorded just before pruning and 6, 12 & 18 months after pruning. In case of trees pruned in July 1986 significant increase in the shoot length was recorded only up to 12 months after pruning. The results indicated positive correlation between the area of canopy, number of pruned points and total shoot length.

1.1.9.2 Technique for *palas*

Experiments were laid out at Kundri lac farm (Palamau district) for comparing the technologies as described below :-

Trap-cropping : :The available trees were divided into 2 sets in the ratio of 3:2 and the larger set was inoculated lightly using 10g broodlac/metre shoot length for broodlac production. The trees under second set were inoculated heavily using 40g broodlac/metre shoot length for trapping predatory larvae *(Eublemma amabilis* and *Holcocera pulverea)* and eliminating them by harvesting the crop *ari* (immature), (*A. Rep.* 1979-80).

Mechanical exclusion : The broodlac was enclosed in 60 mesh synthetic net bags (33 x 10 cm) and used for inoculation in order to prevent the pest carryover from broodlac to the next crop.

Chemical control : Application of one or two sprays of 0.05 percent *endosulfan*. First spray within 5 weeks of settlement, of lac larvae in July-August and the second one a month before broodlac harvesting i.e. in September.

The experiment was laid out on 2100 trees in RBD with the following 3 treatments and 7 replications each consisting of 50 trees (two coupe of 1050 trees each).

P. H. A. : Trap cropping with 30 and 20 trees in first and second sets respectively, use of synthetic netting bags for crop inoculation and one spray of *endosulfan* in July-August on the trees of first set only.

P. H. B. : As in P. H. A. but with an additional spray of 0.05 per cent *endosulfan* one month prior to crop maturily.

P. H. C. : No treatment (control)

Trees were pruned during April and inoculated in November. Samples were collected at the time of *phunki* removal for assessment of pest population

Another experiment was laid out on 150 trees for studying the correlation between plant and crop parameters in order to develop a precise method for estimation of broodlac requirement and expected yield.

The trees were divided into 2 equal coupes and the first coupe consisting of 75 trees was pruned in April. Plant parameters like stem girth, height of the trees and canopy measurements were recorded prior to pruning and the shoot length was recorded at the time of inoculation. The pruned trees were classified according to the shoot length developed by them and grouped in 6 sets ranging from 15 to 32.5 metre shoots with a class interval of 2.5 metre. They were inoculated with brood rates ranging from 5 to 30g per metre shoot length accordingly.

From the data obtained so far, positive correlation was observed between the girth or canopy volume with shoot length developed and colonised by the lac insects.

(Y. D. Misra, S. G. Choudhary & M. L. Bhagat).

Physiology of Lac Insect and Associated Insects

1.2.5 Analysis of physico-physiological factors causing lac insect preference for host plants.

On account of very high mortality of lac insects developing on potted *Moghania macrophylla (bhalia)* plants, especially during the months of April-May no definite trend in the effect of NPK application in respect of survival and settlement of lac insects was observed. The experiment was, therefore, planned *de novo* under field conditions. A plantation of 1,000 *bhalia* and 300 *Albizzia lucida (galwang)* plants was initiated for this purpose.

(A.H. Naqvi)

1.2.6 Biochemical studies on lac insects to ascertain strain differences

Attempts were made to estimate the concentration of sodium in the lac insects. Dry and resin free bodies of mature lac females of *Jethwi* 1987 crop season *(Kusmi* strain) were converted into ash. The ash was taken in double distilled water and filtered. The filterate was tested in flame photometer. The results indicated the presence of sodium in approximately 10 µ/g concentration.

(A.K. Sen)

1.2.9 Determination of physical and biochemical bases of lac insect host preference

The project was taken up to find out the basis of selection of suitable host plants for better performance of lac insects.

The study is to be conducted on different lac hosts namely, *kusum, ber, palas, Ziziphus xylopyra (ghont), Acacia catechu (khair)* and *Croton oblogifolius (putri)* for assessment of performance of the lac insect in relation to both physical as well as physiological characteristics of these host species. Observations on the texture, colour, girth and moisture content of shoots of the mentioned host plants will be taken. The desity of larval settlement, initial and subsequent mortalities, sex ratio, size of the mature females and weight of the resin produced in respect of the lac colonies developing on such shoots will be recorded in order to study the correlation.

During *baisakhi* 1987-88 crop season, 50 shoots each from pruned *palas, ber, putri, ghont* and *bhalia* were selected randomly and inculated during October.

From the observations made so far no correlation between the plant characteristics and either the larval settlement or the initial larval mortality could be detected.

(A.H. Naqvi & A.K. Sen)

1.2.10 Studies on the factors influencing growth and development in the sexually reproducing female lac insect

The project was taken up with a view to find out the factors responsible for the differences in resin secretion efficiency of the mated and virgin females and also to identify the triggering factors responsible for growth and resin production in the mated females.

The study involves raising of lac insect culture on potted *bhalia* plants covered with synthetic net in order to completely eliminate the males from one set of the colony for for allowing parthenogenetic development of the females. In the other set of experiment the mating was allowed. Comparative study of the mated and virgin females will be made with respect to the growth and rate of resin secretion at 3 different intervals upto crop maturity. Histochemical studies of the virgin and mated female lac insects will also be carried out.

Two hundred *bhalia* plants were raised in pots for use during the four different lac crop seasons. The plants will be inoculated after attaining suitable age.

(A.K. Sen, A.H. Naqvi & Y.D. Misra)

Ecology of Lac Insect and Associated Insects

1.3.5 Ecological studies taken up at Dharamjaigarh, (M. P.)

The Regional Field Research Station at Dharamjaigarh continued to carry out the following investigations.

1.3.5.1 To study the relative performance of kusum broodlac from different sources (states) at Khadgaon

The study was continued in *aghani* 1986-87, *jethwi* 1987 and *aghani* 1987-88 crop seasons on the same lines as reported earlier.

Aghani 1986-87 crop in general was not satisfactory. The crop data (Table 1) indicated that in the first generation the performance of broodlac obtained from M. P. was significantly superior in respect of total sticklac production, followed by that from Bihar and West Bengal.

In the second generation, M. P. broodlac performed better in respect of broodlac production, followed by Bihar, West Bengal & Orissa.

In case of first generation *jethwi* 1987 crop, the performance of M. P. broodlac was significantly superior in respect of broodlac yield followed by Orissa, West Bengal & Bihar. However, in respect of total sticklac production, Orissa broodlac performed best followed by M. P., Bihar & West Bengal.

1.3.5.2 To study the relative abundance of parasites and predators in different regions of M. P. in different crops of kusum

Samples of lac twigs weighing 4 kg each were collected from different localities of M. P. as mentioned earlier and caged. Emergence of insects was recorded daily for the next two months from the date of caging. The samples collected and caged from *aghani* 1986-87 crop were observed till February, 1987.

Total number of species isolated from different *kusmi* crops was 5 inimical parasites, 7 beneficial parasites and 3 predators. *Tetrastichus purpureus* and *Apanteles tachardiae* were the most abundant inimical and beneficial

Table - 1
Performance of Kusum broodlac from different sources

	Aghani 1986-87				***Jethwi*** 1987			
	First generation		Second generation		First generation		Second generation	
Source of broodlac	Broodlac used to broodlac obtained	Broodlac used to total stick-lac yield	Broodlac used to broodlac obtained	Broodlac used to total stick-lac yield	Broodlac used to broodlac obtained	Broodlac used to total stick-lac yield	Broodlac used to broodlac obtained	Broodlac used to total stick-lac yield
Madhya Pradesh	1:0.83	1:0.80*	1:0.40*	1:0.32	1:5.13*	1:2.56**	1:5.18	1:1.80
Bihar	1:0.15	1:0.05	1:0.16	1:0.37	1:0.12	1:0.57	No	No
Orissa	-	-	1:0.05	1:0.26	1:3.21	1:5.09**	No	No
West Bengal	1:0.02	1:0.37	1:0.13	1:0.18	1:0.47	1:0.34	No	No
* C.D. at 5 per cent	1:0.43	1:0.14	N.S		1:4.62	1:1.35		
**.C.D. at 1 per cent	1:0.63	1:20	N.S.		1:6.47	1:1.89		

parasites respectively at all places during both the crop seasons. Among the predators, *H.pulverea* was the most abundant at all the places and during both the crop seasons except in Bastar and Hoshangabad districts where *E.amabilis* was more abundant during *aghani* 1986-87 crop. All the three categories of insects were more abundant during *aghani* crop than in the *jethwi* crop. Abundance of beneficial parasites at Hoshangabad district during *aghani* 1986-87 crop. Inimical parasite and predators were most abundant in Bastar district and beneficial parasites in Hushangabad district during *jethwi* 1987 crop season.

1.3.5.3 To study the relative abundance of parasites and predators in different regions of M. P. in different crops on palas

Samples of lac twigs weighing 2 kg each were collected from different localities of M. P. Samples were caged and emergence of insects was recorded daily for two months from the date of caging.

Total number of species isolated in different *rangeeni* crops was 4 inimical parasites, 7 beneficial parasites and 3 predators. *T. purpureus* was the most abundant inimical parasite at all the places and both the crop seasons. *A. tachardiae* was the most abundant beneficial parasite at all the places during *baisakhi* crop except at Umaria in Sahdol district, where *Pristomerus sulci* was more abundant during *katki* crop. Amongst the predators, *H. pulverea* was most abundant at all the places and both the crop seasons except at Bilaspur district where *E.amabilis* was more abundant in *katki* 1987 crop. All the three categories of insects were more abundant in *katki* than in *baisakhi* crop season.

Abundance of inimical parasites, beneficial parasites and predators was highest at Raipur, Sahdol and Bilaspur districts respectively during *baisakhi* crop season and at Mandla, Bilaspur and Baster districts during *katki* crop season.

(B. N. Sah)

1.3.6 Population dynamics of kusmi strain of lac insect to ascertain the causes of kusmi crop failures (First Phase)

The study was continued during the *aghani* 1986-87, *jethwi* 1987 and *aghani* 1987-88 crop seasons.

Aghani 1986-87 : From the surviving population of 19.7 percent reported last year, only 10 per cent reached maturity stage.

***Jethwi* 1987** : The average number of lac larvae settled was 79.5±12 per cm shoot length out of which 8.4± 2 and 9.7± 3 died due to starvation and other causes respectively during the first month after inoculation. At the second sampling stage i.e. after a fortnight the mortality increased to 49. 2 per cent of the original population. Finally at the time of crop maturity, only 9.8 per cent of the original population was observed surviving. During *jethwi* 1987 crop season the density of lac larvae per unit area in the basal and middle segments of the shoots was at par with the apical segment.

***Aghani* 1987-88**: The average settlement of lac larvae was 75.0±13 per cm of shoot length of which 1.2±1 and 17.9±4 died due to starvation and other causes respectively. The average mortality recorded one month after inoculation was 25.5 per cent of the initial population which increased to 79.5 per cent a fortnight later. No significant difference in the population of lac larvae settled per unit area in different quadrants and canopy strata was observed.

The density of lac larvae per unit area was highest in the middle followed by basal and apical segments of the shoot.

(B. N. Sah & M. L. Bhagat)

Control of Enemies of Lac Insect

1.4.3 Effect of insecticides on the lac insect *Kerria lacca* (Kerr) and associated fauna

1.4.3.1 Screening of insecticides for their safety to the lac insects and toxicity to the lac predators

The experiment was continued to study the effect of three insecticides namely *trichlorfon* (Dipterex), *thiocylam* (Evisect) and *endosulfan* (Thiodan 36 E. C.) on the lac insect at 0.025 and 0.05 per cent concentrations. Population of the living lac insect was counted before the insecticidal treatment and after two days, one week, two weeks and four weeks of the application.

No adverse effect of these insecticides on the lac insects was observed at 40-45 and 65-70 days stage with any of the above concentrations.

In other set of experiment two concentrations (0.025 and 0.05 per cent) of the above mentioned 3 insecticides were tried in the field on the predators (*E. amabilis* and *H. pulverea*) developing on *katki* 1987 crop at 40 days stage. The performance of *trichlorfon* and *endosulfan* was observed to be at par with each other and was significantly superior to *thiocylam*. Results confirmed the findings of the last year.

1.4.3.7 Treatment of broodlac with selective insecticides

The experiments were repeated with broodlac obtained from *aghani* 1986-87, *jethwi* 1987 and *katki* 1987 crop seasons after slight modification of the programme reported last year. In addition to *endosulfan*, BHC was also tried during the last two crop seasons.

For *aghani* 1986-87 broodlac all the three reduced concentrations (0.025, 0.05, 0.1 per cent) with all the four dipping durations (2, 4, 6 & 10 minutes) tried were found highly effective in controlling the emergence of predators without any adverse effect on the emergence of lac larvae as compared to the control.

For *jethwi* and *katki* 1987 broodlac, *endosulfan* as well as BHC at 0.025 per cent concentration exhibited no adverse effect on the emergence of lac larvae even when dipped up to 30 minutes.

(S. G. Chaudhary, A. Bhattacharya, Y. D. Misra, B. N. Sah and A. K. Sen)

1.4.9 Studies on the application of harmones and pheromones for the control of major lac predators

Studies on the effect of *diflubenzuron* (Dimilin) on the eggs and larrae of predators namely *E. amabilis* and *H. pulverea* and the lac insect were continued.

1.4.9.1 Effect of *diflubenzuron* on the eggs of *E. amabilis*

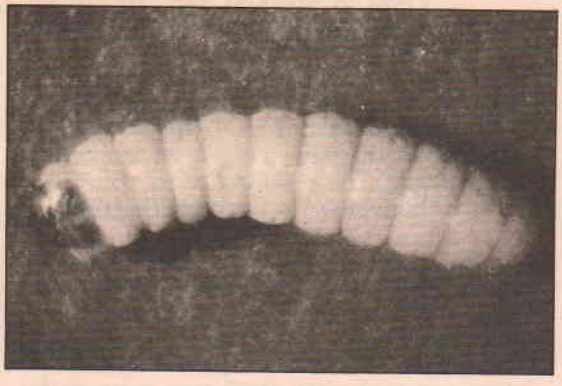
Eggs of *E. amabilis* of different age groups, ranging from 24 to 96 hours, were treated with 5 serial concentrations of diflubenzuron starting from 0.2 per cent. Results confirmed the earlier findings (*A. Rep.* 1986) i.e. the effect of *diflubenzuron* in all concentrations tried was highly effective in reducing the hatching of the eggs of *E. amabilis*.

1.4.9.2 Effect of diflubenzuron on the larvae of E. amabilis and H. pulverea

Lac colonies were raised on *bhalia* and ready to hatch eggs of *E. amabilis* were tagged on the lac bearing shoots after spraying with 5 serial concentrations of *diflubenzuron* starting from 0.2 per cent. All the concentrations resulted in hundred per cent mortality of *E. amabilis* larvae (I stage) 5 weeks after the treatment.

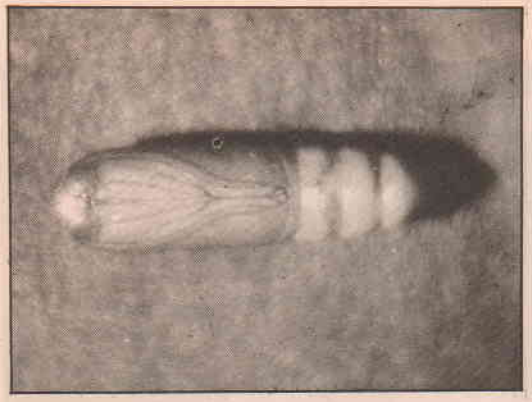
In case of *H. pulverea*, advanced stage field collected larvae were fed on *suji* mixed with 0. 2, 0.1 and 0.05 per cent concentrations of *diflubenzuron*. The

Treatment of broodlac with selective insecticides



Normal Larva of *E.amabilis*

Malformed Larva of *E.amabilis* after oral application of diflubenzuron



Normal pupa of *E. amabilis*

Malformed pupa of *E. amabilis* after oral application of diflubenzuron

above mentioned three concentration were recorded to cause 90.0, 78.9 and 66.5 per cent mortality, respectively.

1.4.9.3 Effect of diflubenzuron on lac insect

Five serial concentrations of *diflubenzuron* starting from 0. 2 per cent were sprayed on 3 weeks old lac colonies, during *katki* 1987 and *aghani* 1987-88 crops. No adverse effect on the survival and sex ratio was observed.

Efect of *diflubenzuron* on the emergence of lac larvae by dipping mature lac females in the above five concentration for 30,60 and 120 seconds during *baisakhi* 1986-87 and *katki* 1987 crop seasons was studied. No adverse effect of dipping was observed with any of the above concentration and dipping durations.

1.4.9.4 Small scale field trial of diflubenzuron against lac predators

Field trials were carried out on lac crop raised on *bhalia* plants during *katki* 1987 and *aghani* 1987-88 crop seasons with four treatments and 5 replications in RBD. *Diflubenzuron* was sprayed three weeks after inoculation.

Significant reduction in the predator population in all the treatments, resulting in yield increases, was observed during *katki* 1987 crop season (Table 2 & 3).

(A. Bhattacharya)

1.4.13 Studies on the economic threshold level of *E. amabilis* and *H. pulverea* infesting lac crops

Trials were continued on *baisakhi* 1986-87 and *jethui* 1987 crop seasons at three stages (1-30, 30-60 and more than 60 days) with varying levels of artificially created predator densities (2,4,6,8 and 10 per 30 cm lac encrustation).

Yield of sticklac per 30 cm lac encrustation obtained from various treatments was compared with control (no infestation). It was observed that 10 per cent damage was caused by 4, 6 and 8 larvae per 30 cm in 1-30, 30-60 and more than 60 days stages of lac crops, respectively. The results are in conformity with the last years findings (Figure I).

Another trial was also conducted in the field to determine the economic threshold level during *aghani* 1987-88 and *Katki* 1987 crop seasons on *kusum* and *bhalia* bushes respectively. Crops were sprayed with 0.05 per cent *endosulphan* prior to commencement of economic injury level i.e. beyond 4, predator larvae per 30 cm lac encrustation.

Table-2

Effect of diflubenzuron spray on the predator population

Concentration (per cent)	Average predator population/metre encrustation	
	Katki 1987	*Aghani* 1987-88
0.0125	2.05 (3.04)*	1.95 (3.22)**
0.05	1.81 (2.43)**	1.72 (2.35)**
0.2	1.22 (0.52)**	1.48 (1.46)**
control	2.86 (7.89)	4.59 (20.76)
S.E. ±	0.29	0.45
CD at 5%	0.61	0.98
CD at 1%	0.85	1.37

Date subjected to treatment : n+1
Figures in parentheses indicate original value

* Significant at 5 per cent level.
** Significant at 1 per cent level.

Table-3

Effect of diflubenzuron spray on lac yield during *katki* 1987 crop

Concentration (per cent)	Average yield of scraped lac/metre encrustation (g)	per cent increase over control
0.0125	8.45	15.59
0.05	10.51	43.77
0.2	8.74	19.56.
Control	7.31	-
CD	N.S.	

Under this trial, details pertaining to cost of input during spraying operations including the materials as well as the resultant yield are being recorded.

(S. G. Chaudhary)

Studies on Germplasm of Lac Insect

1.5.8 Studies on germplasm collection, conservation and characterisation of indigenous/exotic lac insects

Economic attributes in respect of 14 stocks were reported last year. This year economic attributes of 3 new stocks were studied (Table 4). Out of these 17 stocks 10 stocks were further studied for various industrial parameters i.e. life, flow, wax content, acid value & melting point etc. Assam stock was found to posses lowest wax content (3.92 per cent) whereas highest melting point (81°C) was observed in Dharamjaigarh stock .

(S. K. Jaipuriar, R. P. Kapil & S. K. Saha)

1.5.11 Studies on chromosomal behaviour of lac insect strains

Cytological studies on three stocks of lac insect namely, Ludhiana, Orissa crimson and Orissa yellow revealed that in males of all the stocks one haploid set of chromosomes was hetrochromatized during early embryogeny, whereas in the females both the sets of chromozomes were found to be euchromatic. Chromosome number eighteen (2n =18) was observed in both the sexes of these stocks, as found in *Kerria lacca* (Kerr).

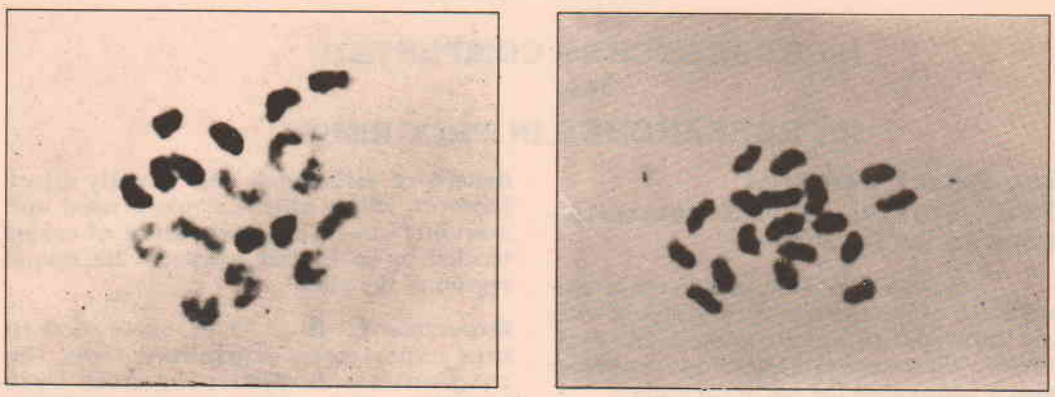
(S. K. Jaipuriar)

Table-4

Economic attributes of lac insects

Stock	Rearing season	Life period (days)	Number of larvae produced/ female	Resin secreted/ female (mg)	Relative resin dye level (optical density) at 450 nm.
Local Yellow	*Baisakhi*, 1986-87	248	400	13.7	85
	Katki, 1987	116	233	6.5	71
Orissa Yellow	*Jethwi*, 1987	195	324	13	76
	Aghani, 1987-887	154	298	19.8	76
Meghalaya	*Baisakhi*, 1986-87	192	128	8	82
	Katki, 1987	170	353	16	69

Mitotic chromosomes of lac insect *Kerria lacca* (Kerr)

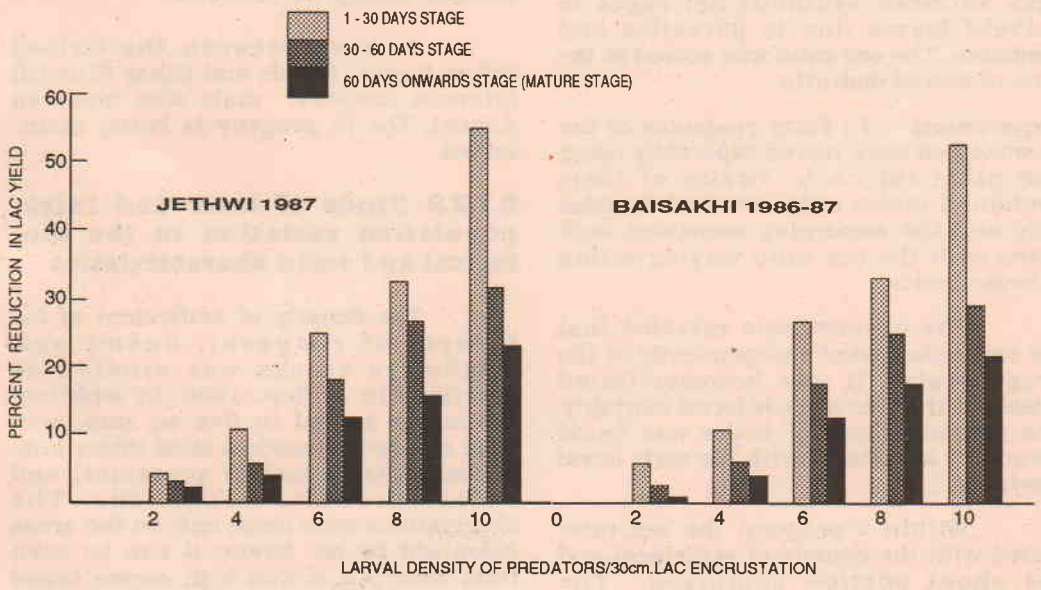


A. Male set showing heterochromatic and euchromatic chromosomes

B. Female set having only euchromatic chromosomes

Figure - I

Effect of density of lac predators (larvae) on the yield of lac crops



B. DIVISION OF INSECT GENETICS & BREEDING

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES IN PROGRESS

Lac Insect Genetics

6.1.1 Studies on sex-determination in lac insects

It was reported earlier that the sex ratio of lac insects varied widely with the host plant species used (*A. Rep.* 1986). The experiment was repeated which confirmed the earlier results.

The nature of sex ratio variability was further studied in relation to progeny size, larval mortality, density of settlement and portion of shoot colonised.

The insects used in these experiments originated from *kusmi* (Ranchi) and *rangeeni* (Kundri, Palamau) stock of lac insects. The progenies were reared on 20 cm shoot portions of *bhalia* potted plants and the test insects were covered with 80 mesh synthetic-net cages to prevent losses due to parasites and predators. The sex ratio was scored at the time of sexual maturity.

Experiment - I : Forty progenies of the *kusmi* stock were reared separately using one plant for each. Twelve of them contained males only, two had females only and the remaining consisted both sexes with the sex ratio varying within extreme limits.

The observations revealed that the sex ratio varied independently of the progeny size. It was however found related to the rate of early larval mortality. The preponderance of males was found invariably associated with the early larval mortality.

Within a progeny, the sex ratio varied with the density of settlement and the shoot portion colonised. The proportion of females was significantly higher in the sparsely settled larvae which decreased with the increase in the density of settlement. This density effect, however, varied with the plant used and mortality rate. The proporation of males tended to be higher towards the apical region of the shoot.

Experiment - II : The insect used in this experiment originated from the *rangeeni* stock. Five progenies were reared together, using one plant with ten replications. The sex ratio varied with the mortality rate, density of settlement, shoot portion colonised and plant used as was observed in the individual progenies of the *kusmi* stock.

(N. S. Chauhan)

6.1.2 Survey of genetic variation in lac insects

6.1.2.1 Study of crosses

A cross between the Orissa yellow *kusmi* female and Bihar (Kundri) crimson *rangeeni* male was made in August. The F_1 progeny is being maintained.

6.1.2.2 Study of inter and intra-population variation in the biological and resin characteristics

The density of settlement of lac insects of *rangeeni*, *kusmi* and Meghalaya stocks was studied as described in *A. Rep.*, 1986. In addition, the larvae settled in five sq. mm. area were counted at random sites under sub-optimal (Single-mother progenies) and excess broodlac conditions. The observations were made only on the areas colonised by lac larvae. It can be seen from table 5 & 6 that with excess brood rate, the Meghalaya insects showed the highest density of settlement followed by the *kusmi* & *rangeeni* insects.

Table-5

Density of settlement of first instar larvae on potted *bhalia* plants under excess brood conditions

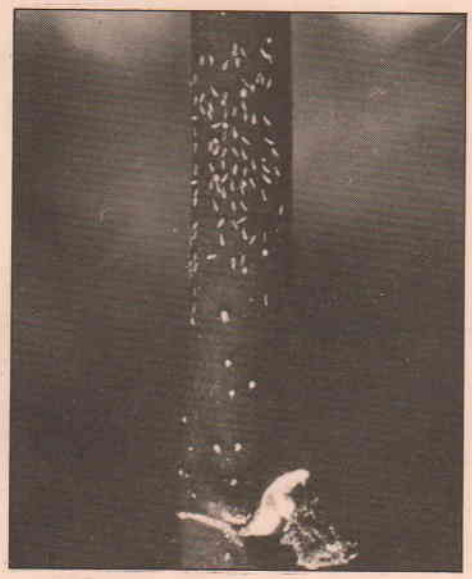
Stock	Crop season	No. of plants	No. of samples	No. of larvae/sq-cm Mean± S.E.
Bihar (Kundri) *rangeeni*	*Katki* 1987	4	20	168.9 ± 7.6
	Baisakhi 1987-88	5	25	191.8 ± 6.3
Orissa-yellow	*Aghani* 1987	5	15	217.3 ± 12.4
Bihar (Ranchi) *kusmi*	*Aghani* 1987-88	5	25	224.6 ± 8.9
Meghalaya (Nangpoh)	May-October 1987	5	15	264.0 ± 11.2

Table-6

Density of settlement of first instar larvae on potted *bhalia* plants under sub-optimal brood conditions

Stock	Crop season	No. of plants	No. of samples	No. of larvae/5 Mean ± S.E.	Mean No. of larvae sq.cm
Bihar (Kundri) *rangeeni*	*Katki* 1987	3	45	5.49 ± 0.33	110.8
	Baisakhi 1987-88	48	720	3.94 ± 0.08	79.5
Bihar (Ranchi) *kusmi*	*Aghani* 1987-88	3	45	11.11 + 0.26	224.2

Settlement pattern of single mother progenies of lac insect



A. *Rangeeni*

B. *Kusmi*

The melting point (m.p.) of lac produced by the fully mature female lac insects of a few stocks was studied using the ILRI method with minor modification (Handbook of Shellac Analysis, 1952). The data obtained (Table 7) showed that the mean m.p. was practically same in the *rangeeni* and the two *kusmi* stocks for comparable seasons. In *rangeeni* strain, *baisakhi* crop showed a higher m.p. than the *katki*. The m.p. varied very narrowly within the stocks. The m.p. of lac of the Meghalaya stock was not as high as reported last year for the same season.

(R. Ramani & K. Krishan Sharma)

Lac Insect Breeding

6.2.1 Mutation studies on lac insects

It was reported earlier that four new colour forms of lac insects were picked up from the inbred progenies of Kundri *rangeeni* stock. Two of these showed extremely light colour of insect body as well as the resin secreted by them. The other two forms showed normal body colour but produced lighter coloured resin. The lines derived from these colour forms are being maintained.

(N. S. Chauhan)

Table -7

Melting point of lac produced by the female lac insects

Stock	Crop Season	No. of samples	Melting point of lac (°C) Mean ± S. E.
Bihar (Kundri) *rangeeni*	*Katki* 1986	30	79.9 ± 0.23
	Baisakhi 1986 - 87	30	83.1 ± 0.18
Orissa-yellow	*Aghani* 1986 - 87	30	79.4 ± 0.16
Bihar (Ranchi) *kusmi*	*Aghani* 1986 - 87	30	77.6 ± 0.23
Meghalaya (Nangpoh)	November 1986 to May 1987	30	83.8 ± 0.23

C. DIVISION OF PLANT SCIENCES

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES IN PROGRESS

Propagation and Management of Lac Host Plants

2.1.2 Management of *bhalia* for lac cultivation

2.1.2.3 To find out a suitable method for raising *bhalia* seedlings

An experiment was laid out in RBD with 8 treatments and three replications under nursery bed (3.4 x 1.2 m) condition, a similar experiment was also laid out in RCBD with 25x10 cm and 25x15 cm polythene bags filled with soil, F.Y.M.and sand in the ratio of 2:1:1. Seeds were sown at weekly intervals starting from first week of April to the end of May.

Observations were recorded on plant height, number of leaflets per seedling, leaflet area and dry matter accumulation per seedling at 60 DAS (Days After Sowing) and 105 DAS. The data shown in table - 8 indicated that the differences due to time of sowing on the above mentioned plant growth attributes at 60 DAS were statistically significant. At 105 DAS, however, no marked difference was observed in nursury bed.

Plant growth attributes in general, were found to be better under nersery bed condition than polythene bags.

(B. P. Singh)

2.1.3 Integration of lac cultivation with general agriculture under dry farming conditions

2.1.3.2 Raising of tuber, corm and rhizome crops in the mixed plantation of *bhalia* and *galwang*

The experiment was continued as per lay out reported earlier (*A. Rep.* 1978). Marked increase in the lac yield and plant growth attributes were recorded from the

Sweet potato and turmeric growing as intercrops in a mixed plantation of *bhalia* and *galwang*

treatments where intercrops were grown apparently due to fertilizer application and cultural operations given to the intercrops. Combined sticklac yield from the two hosts was highest in the treatment *Kachu (Colocasia esculenta* Linn.) + turmeric *(curcuma domestica Valet)* where gross return of Rs. 7637/ha was recorded (Table 9).

(B. P. Singh & S. C. Srivastava)

2.1.6 Agricultural utilization of lac mud as organic manure

The project was kept in abeyance since 1983 and was revived after merging the experiment numbers 1 and 2 (*A. Rep.* 1981-82). Effect of lac mud, farm yard manure alone and in combination with NPK on rice-wheat sequence was studied.

The experiment was laid out in RBD with eleven treatments and three

Table - 8

Effect of time of Swoing on plant growth attributes of *bhalia*

Period of sowing (weeks)	60 days after sowing				105 days after sowing			
	Average plant height (cm)	Average no. of leaflets/ seedling	Average leaflet area (sq.cm)	Average dry matter accumulation/ seedling (g)	Average Plant height (cm)	Average no. of leaflets/ seedling	Average leaflet area (sq.cm)	Average dry matter accumulation/ seedling (g)
1	2	3	4	5	6	7	8	9
				Nursery bed				
APRIL I	22.40	15.67	8.73	0.40	52.40	18.93	63.75	6.93
APRIL II	21.77	16.67	15.27	1.04	65.32	21.78	82.42	6.93
APRIL III	22.57	18.57	14.74	0.85	72.55	17.22	86.13	7.00
APRIL IV	23.00	17.33	14.31	0.79	74.22	18.44	89.09	8.00
MAY I	11.30	20.10	10.79	0.59	60.57	16.33	94.46	5.43
MAY II	14.47	15.37	15.53	0.75	59.57	16.22	84.17	7.13
MAY III	28.57	13.87	22.82	0.76	59.77	19.00	65.60	5.06
MAY IV	28.67	12.70	29.75	1.08	58.78	15.33	53.50	3.53
CD at 5 per cent	8.09	3.99	8.04	0.41	NS	NS	NS	NS

Medium size polythene bag (15x25 cm)

APRIL I	13.77	17.90	5.22	0.30	24.43	25.67	40.88	4.40
APRIL II	17.27	21.10	0.61	0.56	39.78	27.43	54.59	5.50
APRIL III	17.63	20.23	13.53	0.50	43.33	26.11	49.33	4.76
APRIL IV	17.90	18.57	9.67	0.44	61.00	17.21	85.67	6.66
MAY I	9.57	21.90	9.96	0.47	55.44	14.89	90.47	5.43
MAY II	13.67	17.13	15.88	0.61	61.66	13.78	88.18	6.76
MAY III	21.20	13.70	24.26	1.04	60.22	17.67	87.62	7.57
MAY IV	25.03	13.53	31.97	1.08	54.78	17.89	71.85	4.30
CD at 5 per cent	2.88	3.40	9.62	0.71	12.60	4.79	32.41	NS

Small size polythene bag (10x25 cm)

APRIL I	9.93	13.67	4.01	0.11	17.20	17.73	63.75	1.63
APRIL II	13.73	17.20	6.47	0.34	36.00	18.81	52.52	4.36
APRIL III	15.70	17.00	8.41	0.38	41.00	19.78	48.93	3.36
APRIL IV	16.13	19.43	10.61	0.58	53.11	14.45	52.52	3.83
MAY I	9.43	17.67	6.39	0.30	48.67	16.89	86.17	4.46
MAY II	11.70	15.57	11.80	0.36	50.33	15.22	80.16	5.60
MAY III	18.13	15.77	20.51	0.65	53.55	16.89	66.79	4.40
MAY IV	18.27	12.90	15.13	0.57	39.67	12.67	46.93	1.90
CD at 5 per cent	4.43	NS	5.97	0.19	19.60	NS	23.00	NS

Leaflet area = L x B x K, K = 0.746

Table-9
Yield and economics of intercrops with *bhalia* and *galwang*

Treatment (intercrop)	Yield of intercrops quintal/ha	Combined stick lac yield *galwang* + *bhalia* (quintal/ha)	Return from inter crops (Rs./ha)	Return from stick lac (Rs./ha	Total gross return (Rs./ha)
No intercrop (Control)		100.00	-	1008.00	1008.00
Kachu	24.28	280.2	3642.00	2802.00	6444.00
Sweet potato	11.01	252.0	1101.00	2520.00	3621.00
Ginger	1.96	390.0	1960.0	3900.00	5860.00
Turmeric	10.59	284.0	3177.00	2840.00	6017.00
Kachu + Ginger	23.51+ 0.50	229.2	4026.50	2292.00	6318.50
Kachu + Turmeric	23.69+ 3.39	306.6	4570.50	3066.00	7636.50
Sweet potato + Ginger	8.01+ 1.00	410.4	1801.00	4104.00	5905.00
Sweet potato + Turmeric	9.04+ 4.01	387.6	2143.00	3876.00	6019.00
Sweet potato + Ginger + Turmeric	6.25+ 0.54+ 2.50	313.2	1915.00	3132.00	5047.00

Rate per quintal : *Kachu* = Rs.150, Sweet potato = Rs.100, Ginger = Rs.1,000, Turmeric = Rs.300 and Sticklac = Rs.1,000.

replications. The yield of paddy was not satisfactory. The wheat was sown in the middle of Dec. 1987.

(B. P. Singh)

2.1.9 Standardization of agro-forestry practices for raising high lac yielding *kusum* through air layering

Total 419 air layers were prepared at Hesal broodlac farm and the Institute Plantation during June/July 1987 using 100 ppm mixture of IAA and IBA (1:1). The basal diameter and the length of the shoots used for air layering ranged from 1.1 to 1.7 and 35 to 90 cm respectively. Only 6.4 per cent rooted and 81.9 per cent callused air layers were obtained.

In another set of experiment, 124 rooted air layers were transplanted in 3 different substrates namely sand + garden soil (1:1), F. Y. M. + garden soil (1:2), and F. Y. M. + garden soil + soil from *kusum* root zone (1:1:1) and 5.5, 18.5 and 20.3 per cent survival was recorded respectively.

(S. C. Srivastava)

Genetics and Breeding of Lac Host Plants

2.2.3 Evaluation and improvement of *arhar* varieties for lac yield as well as pulse production

Baisakhi 1986-87 lac crop raised on *arhar* (Pigeon - pea) varieties failed due to severe drought.

Forty one germ lines of *arhar* were raised during July 1987 in a separate plot. Plant growth attributes were recorded prior to lac inoculation and five plants from each line were inoculated during Nov. 1987. Plant growth attributes namely plant height, number and length of primary branches, canopy size, girth of shoots, leaf size etc. were found to vary with the varieties. Twelve varieties were recorded to develop more than 10 metres of primary branches per plant namely ICP 3682 (12.50), Laxmi (12.2), MA-2 (12.0), ICP 7197 (11.6), MA-1(11.4), ICP 7221 (11.3), K35/6 (11.2), BR-183 & TT6 (10.8), ICP 6973 & Intergeneric cross (10.7), ICP 8310 (10.3).

(P. Kumar and S. C. Srivastava)

2.2.6 Survey of genetic variation in lac potential of host plants

2.2.6.1 Survey of genetic variation of *galwang (Albizzia lucida)*

Last year sufficient number of plants could not be raised through cuttings, thus the experiment could not be initiated. Attempts were made again to raise sufficient number of plants and 1450 cuttings were prepared from 20 trees (parent stock) using the procedure described earlier (*A. Rep.* 1986). Average variation in survival ranged from 1.4 to 30.0 per cent. Only 41 cuttings from 6 stocks survived till Dec. 1987, which were not adequate for proper lay out of the experiment.

2.2.6.2 Survey of genetic variation in *bhalia (M. macrophylla)*

The plant raised earlier have been found growing satisfactorily and were ready for inoculation. However, due to non-availability of kusum brood lac the plants could not be inoculated in July. The observations recorded on various plant growth attributes were analysed statistically (Table 10). Highest heritability was recorded in case of the length of internodes (51.8 per cent).

(S. C. Srivastava, P. Kumar & Y. D. Misra)

2.2.7 Survey, collection, maintenance, evaluation and characterisation of lac hosts

The project was taken up in order to collect and characterise indigenous as well as exotic lac host germ plasm and evaluate them for their lac production

potential and utilise them for breeding purposes. The seedlings of the two Chinese lac host species namely *Dalbergia siemaoensis* and *Eriolaena spectabilis* and one indigenous species

Lac crop on *Dalbergia siemaoensis*

namely *Flemingia strobilifera* were raised last year and also inoculated during Oct./Nov. 1986. The *baisakhi* 1986-87 crop was harvested during July 1987. Although lac crop on Chinese species was very poor in general but one dwarf genotype of *D. siemaoensis* developed very good lac crop. Indian lac insect completed its life cycle successfully on this genotype and fertile progeny was obtained. Attempts were made to vegetatively propagate this species and encouraging results were obtained through stem cutting. The lac crop on *F. strobilifera* developed satisfactorily and fertile progeny was obtained.

The dye level of lac obtained from *D. siemaoensis* and *F. strobilifera* was determined by measuring the optical density at 425 nm of 0.1 per cent solution in ethyl alcohol, using spectronic-20 spectrophotometer, and was found to be 0.15 and 0.07 respectively.

Seeds of 5 species of *Flemingia* namely *F. macrophylla, F. stricta, F. strobilifera, F. spectabilis* and *F. paniculata* were obtained from ICRISAT (International Crop Research Institute for Semi-Arid Tropics), Hyderabad and seedlings were raised.

Seedlings of *Acacia farnesiana* and *Robinia pseudocacia* were raised from seeds and transplanted in field. Suckers of *Croton oblongifolius* obtained from the Institute plantation and seedlings of *Acacia auriculaeformis* obtained from Forest Department Bihar were also transplanted in field.

(P. Kumar)

Table - 10

Analysis of variance for growth attributes in *bhalia* raised from cuttings (July-Sept. 1987)

Source of variance	D.F.	Plant height (cm)	No. of tillers/bush	Total shoot length(cm)	Length of internode(cm)	maximum diametre of stem (cm)
Replication	3	2923.36**	27.20**	2401478.53**	3.472**	0.218
Parent/ treatment	19	573.03	1.02	309866.43	1.378**	0.046
Error	57	447.03	2.08	335828.96	0.559	0.253
Total	79	571.37	2.78	408027.19	0.866	0.202
Heritability per cent	25.66	−38.21	−7.12	51.810	−50.750	

** significant at 1 per cent level

D. DIVISION OF CHEMISTRY

(a) RESEARCHES COMPLETED

Chemistry of Lac/Constituents

3.1.8 Bio-physical studies on the interaction between laccaic acid and DNA

The water soluble lac-dye (laccaic acid) possesses some similarity in structure with the antitumour antibiotics such as nogalamycin and daunomycin whose biological manifestations are believed to arise from their ability to bind with DNA. Studies on the interaction between laccaic acid and DNA were undertaken to understand the nature and mode of binding, if any, between the two.

The interaction of laccaic acid with DNA (ex-Salmon testis; Sigma chemical Co., USA) was first studied at different DNA Phosphate to dye ratios (P/D) in 0.001 M NaCl solution (pH 6.8) by the spectrophotometric measurements following Peacocke and Skerrett's method (*Trans. Faraday Soc.*, 1956). A gradual hypochromism together with bathochromic shift was observed in the spectrum of laccaic acid due to the progressive addition of DNA upto P/D= 23. A maximum red shift of 20nm (490 to 510 nm) was obtained up to P/D=45.7. An isosbestic point was observed at about 507 nm. The above spectral characteristics suggest that laccaic acid binds with DNA. The data were analysed with the help of Scatchard binding equation.

$$\frac{r}{c} = k\ (n - r)$$

Where, r is the number of dye molecules bound per nucleotide, c is free dye concentration, k the apparent association constant and n the total number of binding sites available per nucleotide.

The linearity obtained in the Scatchard plot (r/c vs. r) suggested one mode of binding of lac-dye with DNA, possibly the intercalative type. The value of n was found to be 0.065 and k was obtained to be $8.3 \times 10^5\ M^{-1}$. The dependence of binding of lac-dye on the ionic strength of the medium was also studied. Ionic strength of the medium did not seem to have any marked effect on the binding of lac-dye with DNA, suggesting that the binding of lac dye is non-electrostatic in nature.

The interaction of lac-dye with DNA was then studied at different D/P ratios in phosphate buffer of pH 6.8 (sodium ion concentration 0.001 M) by the viscometric measurements. An increase in the ratio ($\eta'sp/\eta sp$) of specific viscosities of DNA in the presence ($\eta'sp$) and in absence (ηsp) of dye was notice with the increase in D/P up to 0.1, after which it reached a plateau indicating the binding of lac-dye with DNA.

Melting profiles of DNA and the lac-dye bound DNA molecules were also studied at different D/P ratios in the phosphate buffer (pH = 6.8) by spectrophotometric measurements. An increase in the ΔTm (difference in the melting temperatures of DNA-dye complex and dye free DNA) was observed with the increase in D/P up to around 0.5, after which it levelled off. The rise in the melting temperature also indicated that the laccaic acid binds with DNA and this observation corroborates with the findings obtained by the spectrophotometric and viscometric measurements.

Laccaic acid is about 90 per cent soluble in hot water while its monosodium and disodium salts are completely soluble. The spectrophotometric studies on the binding of monosodium salt of laccaic acid (MSLA) with DNA, in 0.001 M NaCl solution at different P/D ratios have revealed a gradual hypochromism together with bathochromic shift in the spectrum of MSLA up to P/D =8. This observation suggests that MSLA binds with DNA. For further addition of DNA, hyperchromism together with bathochromic shift was

noticed in the spectrum of MSLA - DNA complex. A Maximum bathochromic shift of about 28 nm (492 to 520 nm) was obtained for P/D = 50. No clear isosbestic point was obtained in the case of MSLA-DNA complexes. The number of strong binding sites(n) available per nucleotide for MSLA was found to be about 0.13 from the Scatchard plot). This value was found to be higher compared to that obtained (0.064) in the case of laccaic acid. The binding characteristics were also studied at different ionic strengths of the medium. The number of binding sites available per nucleotide for MSLA at different ionic strengths have been shown alongwith those of laccaic acid in the Table 11. The binding of MSLA with DNA was found to decrease at higher ionic strength, indicating its electrostatic nature of binding with DNA.

Table 11

The value of *n* calculated from the scatchard plot for laccaic acid and its sodium salt at different ionic strength in NaCl solution.

Ionic Strength (M)	n	
	Laccaic acid	Monosodium salt of Laccaic acid
0.001	0.065	0.13
0.01	0.07	0.06
0.1	0.05	0.05

Studies were also made on the specific viscosities of DNA-MSLA complexes at different dye (D) to DNA phosphate (P) ratios (D/P) in phosphate buffer (sodium ion concentration 0.001 M) of pH 6.8. An increase in the ratio ($\eta'sp/\eta sp$) of viscosities of DNA - MSLA ($\eta'sp$) complexes to that of dye free DNA (ηsp) was observed up to D/P = 0.2, after which a plateau was reached. This increase in the viscosity indicates that MSLA binds with DNA, corroborating with the result obtained by the spectrophotometric measurements.

The interaction of disodium salt of laccaic acid (DSLA) with DNA was also studied by the spectrophotometric measurements in 0.001 M NaCl solution. A bathochromic shift together with hyperchromism was obtained in the spectrum of the dye upon addition of DNA. The bathochromism shift was obtained about 20 nm (500 to 520nm) up to P/D=20. The spectral changes obtained do not resemble to those available in the literature for other dyes/ drugs which are known to bind with DNA.

It is concluded from the above studies that (i) laccaic acid and its monosodium salt bind with DNA, (ii) the binding is of mainly intercalative type, (iii) binding of laccaic acid with DNA is non-electrostatic in nature while the binding of its monosodium salt is electrostatic in nature, and (iv) monosodium salt of laccaic acid possesses more affinity for binding with DNA compared to that of laccaic acid.

(D.N. Goswami, N. Prasad & K.M. Prasad)

3.1.11 Isolation of jalaric acid from lac on technical scale and its utilisation

Jalaric acid is one of the major constituent of lac resin and is present to the tune of 11-13 per cent in shellac and 33-37 per cent in hydrolysed lac (A. Rep. 1971). A number of possibilities exist for its utilisation in various fields. Hence studies were made to evolve a suitable technique for its isolation from lac on technical scale.

Shellac was hydrolysed with aqueous caustic soda solution (1.75 N) for 5 hours under constant stirring and the hydrolysed product was decomposed with aqueous phosphoric acid solution (1:1). A gummy mass was separated out from the water soluble protion. The aqueous portion was filtered and the gummy mass was washed repeatedly with distilled water to make it acid free. All the washings were collected in the filtrate

and extracted with ethyl acetate. The extract was dried over anhydrous sodium sulphate and concentrated to one fifth of its total volume under vacuum distillation. On keeping the concentrated extract at room temperature for overnight, a crystalline product separated out, which was filtered and dried. The m.p. of the solid and its 2,4 DNPH derivative were 160-162°C and 225-227°C respectively. TLC examination of the compound when compared with authentic sample in the solvent system chloroform:methanol : acetic acid (90:10:1), revealed that it is to be jalaric acid (Rf 0.36). Experiments were carried out with both fresh and old samples of shellac (*kusmi* and *rangeeni*) and the yield of crude jalaric acid was only 6 to 7 per cent.

In order to increase the yield of jalaric acid, effect of addition of sodium sulphite (1 to 7 per cent) during the process of hydrolysis was studied. It was observed that addition of sodium sulphite (5 per cent on the weight of lac) during hydrolysis was optimum to increase the yield of jalaric acid up to 10-12 per cent.

The method was standardised taking different samples of shellac and consistent yield of (10-12 per cent) jalaric acid was obtained. Further, experiments were carried out to explore the possibility of utilising the gummy mass left after separation of water-soluble portion. Its best utilization appeared to be in the isolation of aleuritic acid from it by adopting the method evolved earlier. About 20 per cent aleuritic acid on the weight of shellac was obtained from the gummy portion. It was observed that the gummy mass took less time for hydrolysis to separate out sodium aeuritate in comparison to shellac and its filtration was earlier. The crystals of aleuritic acid obtained were also better in colour.

The final material left after separation of jalaric acid and aleuritic acid was found suitable for preparing spirit based varnishes to be used as primary coating on wooden surfaces.

(N. Prasad & S. C. Agarwal)

Modification of Shellac/ Constituents and their Utilisation

3.3.6.2 Modification of Lac/ hydrolysed lac with polyisocyanates

A number of polyisocyanates have recently been evolved which on reaction with compounds containing hydroxyl groups give polyurethanes having excellent weather and chemical resistance. Shellac, which has poor weather and chemical resistance, contains hydroxyl groups. Work was, therefore, initiated to modify lac, hydrolysed lac and lac-oil combinations with some of the recently evolved polyisocyanates, namely Desmodur N, Desmodur L, Desmodur VL and Desmodur E21 and to study the properties of the resultant products.

Modification of shellac with polyisocyanates

Shellac solution (25 percent) in Dioxan was prepared and treated with Desmodur N and Desmodur VL separately at room temperature. After fifteen minutes films were prepared on clean glass slides air-dried for seven days. Another set of films was baked at 150°C for 30 minutes. These films were tested for water (48 hours), acid (1 per cent, 48 hours) and alkali (1 per cent NaOH, 24 hours) resistance. Baked films obtained from shellac Desmodur N (15 per cent and 30 per cent) showed good water, acid and alkali resistance. Both air dried and baked films obtained from Desmodur VL (15 per cent) showed good water and acid resistance but poor alkali resistance. For comparison, shellac was also treated with toluene diisocyanate (TDI 20 and 30 percent) and film properties of the resultant products were studied. Baked film with TDI (30 percent) showed good water, acid and alkali resistance.

Modification of hydrolysed lac with polyisocyanates

A solution of hydrolysed lac (25 per cent) in anhydrous methyl ethyl ketone (M.E.K.) was treated separately

with different proportions (based on the weight of hydrolysed lac) of Desmodur N, Desmodur L and Desmodur VL to yield polyurethanes. The films were prepared and tested. It was observed that air-dried films of the polyurethanes prepared from the reaction of hydrolysed lac with Desmodur N showed good water and acid resistance but poor alkali resistance, while baked films showed slight improvement in alkali resistance. Both air-dried and baked films of the polyurethanes prepared from the reaction of hydrolysed lac with Desmodur L (45 and 60 per cent) showed good water and acid resistance but poor alkali resistance excepting baked films based on Desmodur VL (60 per cent) which showed good alkali resistance. Films of polyurethanes prepared from Desmodur VL became dark after baking.

Baked films based on hydrolysed lac reacted with Desmodur L (100 per cent) showed good alkali resistance while the films of polyurethanes prepared from Desmodure L (75 per cent) and air-dried films based on Desmodur L (100 per cent) showed good water and acid resistance but poor alkali resistance.

Modification of lac-oil combinations with polyisocyanates

Lac-linseed oil combination was prepared according to the method already reported (A. Rep., 1967). It was dissolved in M. E. K. and treated with Desmodur N and Desmodur VL separately and the properties of the resultant products were examined. The films obtained were uniform, hard and flexible. It was observed that the air-dried films obtained after treatment of lac-linseed oil combination with Desmodur N (75 per cent) showed very good water, acid and alkali resistance, while with Desmodur VL (30 and 50 per cent) the above properties were obtained only after baking of the films.

Similarly, lac-castor oil combination was prepared as per the method already reported (A. Rep. 1966). This combination was dissolved in M. E. K. and treated with Desmodur N, Desmodur VL and Desmodur E21 separately and film properties of the resultant products were examined. The films were uniform, hard and flexible. The baked films obtained with Desmodur N and Desmodur VL showed good water, acid and alkali resistance, while those obtained using Desmodur E21 showed poor alkali but good water and acid resistance.

Amongst all the compositions tried, the lac-linseed oil combination after treatment with Desmodur N (75 per cent) showed best properties. Even air-dried films were resistant to water, acid and alkali.

Pigmented composition

Lac-linseed oil combination was dissolved in xylene and pigmented with titanium dioxide/lamp black. The resultant paints were thereafter reacted with 5 per cent desmodur N and films were prepared on glass slides and tin panels. Black and white paint films were tested for water, acid and alkali resistance and scratch hardness. White paint showed good hardness and resistance to water, acid and alkali, while the black paint showed only good water resistance.

(B. B. Khanna & P. M. Patil)

(b) RESEARCHES IN PROGRESS

Chemistry of Lac/Constituents

3.1.9 Thermal polymerisation of lac - Studies on the molecular weight, shape and size

The dried and desiccated seedlac samples (10g) were polymerised at 150°C for different periods of time in the manner described earlier (*A. Rep.* 1958-59).

The polymers, so obtained were finely crushed and passed through 40 mesh sieve. Solution of these polymers (1 per cent) were made in ethanol and filtered for testing the physical and chemical properties. The acetal value was determined by the hydroxylamine hydrochloride method, in which methanol was used to facilitate the dissolution of the precipitate formed.

The acetal value changed linearly with the time of polymerisation in the pregelation stage and then showed an upward trend similar to that obtained previously with the viscosity measurements (*A. Rep.* 1960-61).

(A. Kumar)

3.1.12 Degradation studies on lac

One pure component from shellac, three from aleuritic acid and one from jalaric acid were isolated last year. The experiment was continued and different samples of shellac were oxidised to isolate the pure compounds in quantity. Three components were isolated having m.p. 120-121, 120-129 and 118-119°C from shellac with an yield of 20, 25, & 15 per cent, respectively.

The compounds appeared to have close resemblance with substituted C_5, C_8 & C_9 dicarboxylic acids. These compounds are being characterised with the help of IR, elemental analysis and Mass spectra etc.

Preliminary experiments on oxidative degradation of shellac with selenium dioxide resulted in one pure component. This component decolourised the alkaline potassium permangnate solution indicating the presence of unsaturation.

(S.C. Agarwal & N. Prasad)

Fine Chemicals from Lac

3.2.10 Synthesis of pheromones and juvenile hormone analogues from aleuritic acid

Procedure for synthesis of Z(9) hexadecen -1-yl acetate from *threo* - aleuritic acid was standardised last year. Insect sex pheromones namely, methyl 9(Z)-hexadecenoate and 9(Z)-hexadecen - 1-al were synthesised from *threo*-aleuritic acid this year. The reaction sequence adopted was as follows:

Threo-aleuritic acid (m.p. 99-100°C) was converted to its *erythro*-isomer by treatment with concentrated hydrochloric acid on steam bath followed by aqueous alkaline hydrolysis of the resultant product.

Erythro-aleuritic acid (m.p. 126-28°C) on treatment with phosphonium iodide in glacial acetic acid on steam-bath gave oily acetoxy acid, which was hydrolysed with methanolic KOH to afford oily 16-hydroxy-(Z)-9-hexadecenoic acid. It was treated with tosyl chloride in dry pyridine at—5°C to yield tosyl derivative. This derivative was refluxed with sodium iodide in dry acetone to obtain 16-iodo-(Z)-9-hexadecenoic acid. Its reduction with $NaBH_4$/DMF furnished 9(Z)-hexadecenoic acid as liquid, which was esterified with methanol-sulphuric acid to yield methyl 9(Z)-hexadecenoate as thick liquid. It was purified by column chromatography.

Reduction of the methyl ester by lithium aluminium hydride in tetrahydrofuran, produced hexadecen -1-ol as a liquid, which on oxidation with pyridinium chlorochromate in dichloromethane, yielded 9(Z)-hexadecen-1-al as thick liquid.

Some compounds such as (E)-Z-undecenoic acid hydrazide, benzoate of aleuritic acid were also prepared.

(R. N. Majee & R. Ramani)

3.2.11 Synthesis of bis-heterocyclic compounds from aleuritic acid

Procedure for the synthesis of thiadiazole was standardised using suberic acid as starting compound and preparation of hydrazides of azelaic and pimelic acid were reported last year. Thiadiazoles were prepared from the above hydrazides of azelaic and pimelic acids this year by adopting the sequence given below :

Methanolic solutions of hydrazides were refluxed with phenyl isothiocyanate separately on steam-bath for 5-6 hours and processed to obtain thiosemicarbazides as solid having m.p. 92-93 and 87-89°C respectively. These thiosemicarbazides were dissolved separately in concentrated sulphuric acid with cooling. The reaction mixture was stirred well, kept for 2 hours at room temperature, poured on to crushed ice and the precipitated solid was filtered, washed with water and crystallised from methanol. Thiadiazoles so obtained melted at 105 and 81-83°C, respectively.

Oxadiazoles and triazoles were synthesised in quantity from thiosemicarbazides of suberic, sebacic and pimelic acids by modified methods. Thiosemicarbazides of the above three acids were prepared by adopting the standard procedure.

The above thiosemicarbazides were refluxed separately with NaOH in methanol (4N) and then iodine solution in potassium iodide was added till the colour of iodine persisted. The reaction mixture was concentrated and cooled to obtain the oxadiazoles of three acids namely suberic, sebacic and pimelic oxadiazoles.

Further, thiosemicarbazides of the above three acids were refluxed separately in aqueous NaOH solution (2 N) for 3 hours, cooled, poured into water and filtered. The filtrate on acidification with glacial acetic acid furnished triazoles of the respective acids. The products were identical with those obtained by standard procedure.

Suberic acid hydrazide (m.p. 186-88°C) was treated with concentrated hydrochloric acid on steam-bath for 6 hours and was processed to give a solid having m.p. 136-38°C, which appeared to be pyridazine.

(R. N. Majee)

Modification of Shellac/ Constituents and their Utilisation

3.3.11 Modification of lac with ethyl cellulose

Air dried as well as baked films prepared from the varnish compositions containing a blend of 20 parts of ethyl cellulose and 80 parts of shellac were reported to give best performance in respect of gloss, flexibility and resistance to water, acetone and alcohol, last year.

Attempts were made this year to study the adhesion properties of the compositions based on ethyl cellulose. Shellac and ethyl cellulose were mixed in different proportions and the resulting products were plasticised with dibutyl phthalate. The air dried films prepared from the composition obtained by mixing 80 parts of ethyl cellulose with 20 parts of hand made shellac in spirit and plasticised with 4 parts of dibutyl phthalate, showed poor adhesion even after one month. This is a desirable property for strippable compositions.

(A. K. Dasgupta)

3.3.12 Modification of lac wax

It was reported last year that lac wax extracted from lac-mud and modified with sodium bisulphite was found to possess higher melting point and penetration value.

Testing of Lac-wax for penetration value

Studies were continued and sufficient quantity of lac wax was extracted from lac-mud and then modified with different concentrations (2.5, 5 and 7.5 Per cent) of sodium bisulphite at 250°C for 5 hours under carbon dioxide atmosphere. Commercial lac wax was also modified at 150, 120 and 250°C using same proportions of sodium bisulphite. Physico-chemical characteristics such as m.p., penetration value, ash content, acid value and solvent retention power of the resultant products were determined.

It is evident from the data that the wax obtained from lac-mud after modification with 7.5 per cent sodium bisulphite at 250°C for 5 hours is improved. The m.p. increased from 77° to 86°C whereas penetration value and acid value decreased from 5 to 1 and 15.5 to 3.9 respectively. In the case of commercial lac wax however, no significant improvement was observed (Table 12).

(K. M. Prasad & B. B. Khanna)

3.3.13 Studies on lac based cation-exchange resin as a catalyst

Studies were initiated to evaluate the suitability of lac-based cation exchange resin as a solid catalyst in the esterification process.

Lac based cation-exchange resin was prepared from autoclave as well as hand-made shellac, following the procedure of Rahman *et al.* (*Res. & Industry*, 1977). The total exchange capacity was determined following the standard procedure as well as IS:7330 - 1974. The exchange capacity was found to be considerably lower than the reported value. The use of this resin as a catalyst in esterification reaction was explored. The reaction was carried out in a three-necked flask (500 ml) fitted with a glass stirrer, water condenser and a sampling device. Propionic acid was esterified with n-propanol in 1:3 molar proportion in the presence of lac-based cation exchange resin (3 per cent) at 70°C and at the boiling point of the reactant mixture (around 125°C).

The percentage conversion of the ester was estimated. The lac-based cation exchange resin showed conversion of about 8 per cent at 70°C and 11.4 per cent at the boiling point. The conversion percentage of other catalysts namely, H_2SO_4, (0.6 per cent), Dowex 150 W, Indian CYC 125 and control were about 85, 50, 57 & 7 per cent respectively. Thus the lac based cation exchange resin was not a suitable catalyst in this esteri-fication process.

(B. C. Srivastava)

Use of Shellac and Modified Shellacs in Surface Coating

3.4.5 Studies on anticorrosive primers/paints for use on ferrous metals

Preparation and testing of an anticorrosive primer based on shellac-linseed oil vehicle was reported last year.

Table - 12
Physico-chemical properties of parent and modified lac waxes

Type of wax	Temperature of rection (°C)	Sodium bisul-phite (per cent)	Melting point (°C)	Penetration value	Ash content (Per cent)	Solvent retention value	Acid value
			(a) Lac wax obtained from lac mud				
Parent	—	—	77-78	5	0.5	—	15.5
Modified	150	2.5	80-81	4	—	—	13.7
		5.0	81-82	3	—	—	10.6
		7.5	82-83	2	—	—	7.7
	200	2.5	82-83	3	—	—	11.6
		5.0	83-84	2	—	—	9.6
		7.5	84-85	1	—	—	6.7
	250	2.5	83-84	3	—	—	7.7
		5.0	85-86	2	—	—	5.8
		7.5	85-86	1	—	—	3.9
			(b) Commercial lax wax				
Parent	—	—	70-80	3	0.02	16	6.3
Modified	150	2.5	78-89	3	0.50	28.3	5.6
		5.0	79-80	3	0.60	48.9	5.6
		7.5	79-80	2	0.50	15.2	5.6
	200	2.5	78-79	3	0.70	16.6	2.8
		5.0	79-80	3	0.90	25.2	2.8
		7.5	79-80	2	1.00	27.4	2.8
	250	2.5	80-81	3	0.80	10.0	1.9
		5.0	80-81	2	0.60	16.4	1.8
		7.5	80-81	1	0.70	25.2	—

More lots of the primer based on hand-made shellac - double boiled linseed oil vehicle were prepared this year and tested for their performance in order to confirm the results obtained earlier. Almost similar performance was obtained from all the lots.

To bring about further improvement in the film performance of the primer, especially in respect of water and corrosion resistance, it was modified with Desmodur N, a polyisocyanate. The modified primer produced smooth, uniform and adherent films on mild steel panels. Baked as well as air-dried films of the primer passed the tests for flexibility, scratch hardness and resistance to water, alkali & solvents. In respect of corrosion resistance, however, baked films passed the test satisfactorily.

Experiments were also carried out to study the suitability of lac-dehydrated castor oil varnish as vehicle for the preparation of anti-corrosive primer. The varnish was prepared by reacting shellac (50 g) with dehydrated castor oil (100g) at 270°C for 10 minutes in the presence of litharge as catalyst and lime as accelerator. The resultant product was thinned with hexane to the desired consistency and filtered. The varnish was then pigmented with red oxide of iron, mica, talc and zinc oxide to prepare a suitable primer. This primer composition also produced smooth, uniform and adherent films. Both the air-dried and baked films of the primer passed the tests for flexibility and resistance to water and corrosion. The air-dried films, however, did not possess adequate film hardness, which is an essential requirement of a primer.

(S. Kumar & M. Mukherjee)

3.4.6 Styrenation of lac-oil combinations

The results of the preliminary studies on styrenation of lac-linseed oil combination (1:1) and the film properties of the resultant product were reported last year. Further work was carried out in this respect and lac-linseed oil combination and styrene were reacted in different proportion such as 50:50, 30:20 and 20:30 using benzoyl peroxide (2.5 and 5 per cent) as initiator and xylene as solvent. Samples were collected after refluxing for 10 and 20 hours. Films were prepared on glass slides and tin panels and air-dried for 7 days.

It was observed that baked films possessed good water and acid resistance but poor alkali resistance. An appreciable increase was also observed in the scratch hardness of baked films.

(B. B. Khanna & P. M. Patil)

Use of Lac for Encapsulation and Controlled-Release

3.5.5 Slow-release lac-urea formulation for animal feed

The project was initiated with an objective to develop a slow-release lac urea formulation for animal nutrition facilitating improved conversion of N to microbial proteins.

Experiments were carried out to develop a lac-urea composition in slow-release form. Shellac (autoclave) and urea (LR grade) were reacted together at 150 ± 5°C for 2 hours in varied proportions. All the compositions were very hygroscopic but possessed slow-release characteristics. It was observed that combinations having more than 32.1 per cent urea on the weight of lac resin did not pulverise. The dissolution of urea (percentage) in water at room temperature with time was estimated gravimetrically. It was found that the dissolution of urea was slow in the lac-urea compositions (Table 13).

(B. C. Srivastava)

Table - 13
Dissolution behaviour of urea in lac-urea combinations

Sl. No.	Composition		Urea in the composition (Percent)	Urea dissolved out (per cent)	
	Shellac (g)	Urea (g)		One day	Six days
1.	10.00	—	—	—	—
2.	9.90	0.10	1.0	—	—
3.	9.75	0.25	2.5	0.4	0.4
4.	9.50	0.50	5.0	1.0	1.0
5.	9.00	1.00	10.0	1.6	2.0
6.	8.50	1.50	15.0	2.0	2.0
7.	8.00	2.00	20.0	2.4	2.6
8.	7.70	2.30	23.0	4.0	4.0
9.	7.60	2.40	24.0	4.0	4.0

Electrical Properties of Lac and Modified Lacs

3.6.3 Study on the tracking resistance of shellac based varnishes

The results of the studies on the tracking property of air-drying varnishes prepared from seedlac and hand made shellac were reported last year. During the period under report studies were undertaken on the tracking properties of the varnishes obtained after curing shellac and epoxy resin (Molecular weight 1000) in the cold and by fusion.

For studies on the curing in the cold shellac and epoxy resin were dissolved separately in the solvent mixture of methyl ethyl ketone (MEK) and distilled denatured alcohol (2:1) and were mixed in the requisite proportions. After six days of curing in the solution stage, the films were prepared on phenolic resin bonded paper laminates, air-dried and kept over anhydrous $CaCl_2$ for 48 hours before testing for tracking resistance. Testing was done following IS:8264 - 1976, employing a Beckman Tracking Insulation Test apparatus in the presence of NH_4Cl solution (0.1 percent). Studies were also made on films baked at 100°C for 2 hours.

For studies on curing by fusion, requisite proportions of shellac and epoxy resin were fused at 150°C for 15 minutes. The fused products were dissolved in MEK and distilled denatured alcohol mixture (2:1) and the tracking property was investigated as described above.

For the varnish cured in the cold, no failure was noticed upto more than one hour of testing. The baked films prepared from 50:50 shellac-epoxy resin composition failed for 141 drops. For the varnishes prepared from the fused products of 50:50 shellac and epoxy resin, tracking was observed for 90 drops. All the varnishes, exhibited property well above the stipulated IS specification and showed increased resistance towards tracking. The property exhibited by 70:30 shellac-epoxy resin composition was better than that of 50:50 shellac-epoxy resin composition (Table 14).

The thermal resistance of the varnishes was also examined. The air-dried films, did not show any marked improvement over that of shellac. The

Table - 14
Tracking property of shellac-epoxy varnishes

	Type of film	Number of Drops ISS requirement for testing at 200 V	Observation	Remarks	Tracking Index (V)	Thermal resistance test (2 minutes)
1.	**Cured in the cold**					
i)	70:30 Shellac-epoxy air dried films	50 or more (one per 30 Seconds)	Up to 147	No failure up to 73 minutes (observation was discontinued thereafter)	—	No marked improvement over shellac
ii)	50:50 shellac-epoxy air dried films		Up to 163	No failure upto 82 minutes (observation was discontinued thereafter)	—	- do -
iii)	70:30 shellac-epoxy baked films		135	Tracking occured	Erratic behavior, appears above 300V	120°C (Passes)
iv)	50:50 shellac-epoxy baked films		141	Tracking occured	286	120°C (passes)
2.	**Cured by fusion**					
i)	70:30 shellac-epoxy air dried films		Up to 180	No failure up to 90 minutes (observation was discontinued thereafter)	—	—
ii)	50:50 shellac- epoxy air dried films		90	Tracking occured	—	—

Note : No tracking was observed at 135 V for more than 90 minutes, observation was discontinued thereafter.

baked films, however, showed thermal resistance upto 120°C.

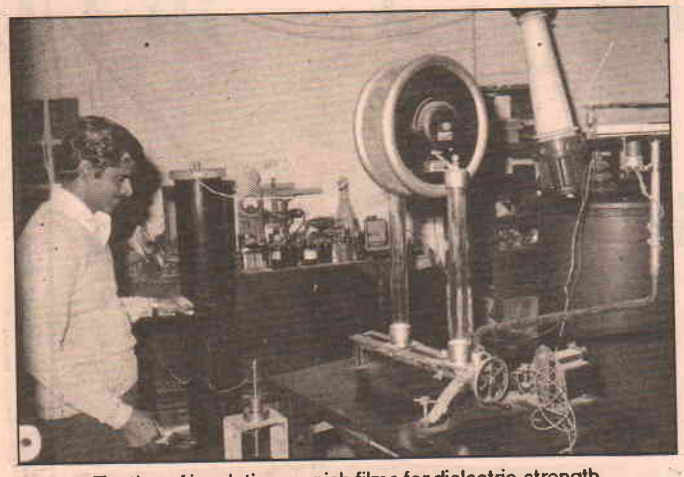
The results of the above study suggest the possibility of using shellac-epoxy resin varnish for antitracking insulation.

(D. N. Goswami)

3.6.4 Studies on the modification of lac for use as high thermal class insulating varnishes

The use of shellac in electrical industry is limited due to its low thermal resistance. On the other hand, silicone resin by virtue of its high heat stability and chemical resistance finds important place for the purpose. Modification of shellac with silicone resin was, therefore, taken up to develop high thermal resistance varnishes.

To study the compatibility of shellac with silicone resin, experiments were carried out by blending the two in different solvent mixtures namely dioxane:toluene (2:1), dioxane:xylene (2:1) and dioxane: methyl ethyl ketone (3:1) and dioxane alone. The blends so prepared were homogeneous and produced hard, flexible and water resistant films but the films were not uniform.



Testing of insulating varnish films for dielectric-strength

Experiments were carried out on the blends prepared by taking different proportions of lac-linseed oil combination and silicone resin (10:1, 10:3, 10:5, 10:7) in different solvents namely, cyclohexane, toluene and xylene. The varnish obtained from the first composition in cyclohexane produced hard, smooth, uniform and flexible films on air drying for 3 hours. On baking at 150°C for 30 minutes, these films became resistant to water and toluene. The dielectric strength of the film was found to be 1. 8KV/mil at 30°C.

(M. Mukherjee, S. Kumar & D. N. Goswami)

Biochemical Aspects of Insect-Host Plant Relationship

3.8.1 Transformation of sap constituents and their incorporation in lac secretion

The study was initiated to understand (i) the nature of biochemical transformation occuring in various plant sap constituents, which go inside the body of lac insect from the phloem tissue of the host plants, and (ii) the host plant-insect relationship with special reference to lac resin secretion.

Attempts were made to collect the phloem sap through the cut proboscis of the settled lac insects. For this, mated female cells developing on potted plants of *M. macrophylla (bhalia)* and *S. oleosa (kusum)* trees situated in the plantation were taken and the resinous coverings of the insects were slowly and completely removed with the help of a fine cataract knife and De Weckers's scissors. Stereo binocular microscope was used in the case of potted *bhalia* plants and pocket magnifier in case of *kusum* trees in the field. Around 200 insects were tried in all. The thickness of the resinous covering and the position of the rostrum with respect to the orien-

tation of the settled insects on the twig was determined photographically. The thickness of the proboscis was also measured with the help of an ocular micrometer. The proboscis of the uncovered insects was cut from its base so as to obtain the droplets of the phloem sap oozing out through the cut end.

From the above technique the collection of phloem sap was not possible due to the reasons stated below:

The proboscis of the lac insect is centrally situated, almost vertically opposite the anal tubercle. It is extremely thin (0.01 mm in diameter) and becomes visible only when the hard brittle and thick resinous coat (1.3 to 1.4 mm) enveloping the insect from all sides is removed. The skin of the insect is also very delecate and more often ruptures during the removal of the resin. Moreover the inner layer of the resin which sourround the oral area is soft, sticky and gummy in nature and the attempts to remove this resinous lump generally detaches the insect from the twig.

Collection of phloem sap directly from the plant through the available techniques were also tried. No sap could be obtained by cutting the bark with a sharp knife. Only a little quantity of sap could be collected through scraping of phloem tissues and tranverse cutting of sections of *B. monosperma (palas)* and *kusum* twigs.

The pH of the sap obtained from *palas* was found to be 5.5 and the presence of amino acids and sugars was also detected.

For the analysis of the whole bark, the same was stripped from one year old shoots of *kusum* and extracted successively with petroleum ether (40-60°C), chloroform-methanol mixture (2:1), methanol and ethanol. The residue was then steam distilled and further extracted with water. The six extracts so obtained were subjected to different colour tests for finding out the presence of organic compounds. The TLC examination of the petroleum ether extract which consists of fats and lipids indicated the presence of at least nine components. It was also eluted through a column of silicagel with petroleum ether, petroleum ether-benzene mixture (1:1), benzene, benzene-ethyl acetate mixture (1:1), ethyle acetate, ethyl acetate - methanol mixture (94:1) and methanol.

Seven fractions were thus obtained but none of them was found to be pure on TLC. The first fraction obtained from petroleum ether elution was rechromatographed and one pure fraction (Rf 0.63) was obtained. The second fraction obtained from petroleum ether benzene mixture yielded 4 fractions but they were found to be mixtures.

The methanol, ethanol and water extracts of the bark gave positive tests for the presence of sterols, alkaloids and reducing sugars, respectively.

(R. P. Kapil, S. C. Agarwal, P. Kumar, A.K. Sen, K. M. Prasad & P. C. Sarkar)

E. DIVISION OF TECHNOLOGY

(a) RESEARCHES COMPLETED

Rubber Shellac Combination

4.2.1 Incorporation of modified lacs into rubber

The effect of incorporation of various types of shellac into natural rubbers (NR) and styrene butadine rubber (SBR) was reported earlier (*A. Rep.* 1968 to 72). Shellac can be modified in a number of ways. The present work was undertaken to study the effect of incorporation of some of the modified lacs into NR, SBR and a blend of the two, on their mechanical properties.

Rosin-lac ester in SBR

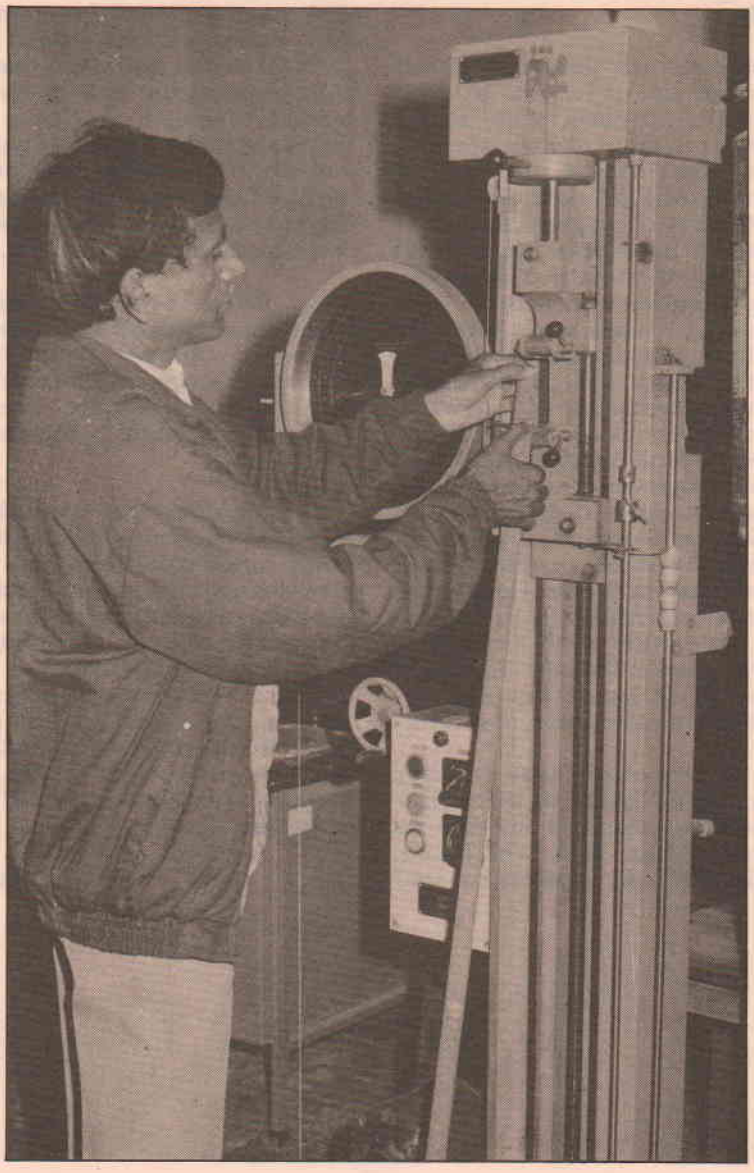
Rosin lac ester was obtained by reacting 25g of lac with 50g of rosin (1:6.6 molecular proportion) at a temperature of 260 ± 5°C for 35 minutes. The product had an acid value of 93.0 and hydroxyl value of 86.3. It was observed that the optimum time of cure remained the same on incorporation of rosin-lac ester into styrene butadiene rubber. Mooney viscosity scorch time and modulus at 200 per cent elongation decreased with the addition of rosin-lac ester in the stock of SBR, using both MBT and CBS as accelerators. Hardness and tear resistance also decreased slightly with the addition of rosin-lac ester in the stocks of SBR using both the above accelerators.

Ultimate elongation, tensile strength and tear resistance increased as the proportion of rosin-lac ester was increased in SBR stocks. These properties were more pronounced when 20 parts of rosin-lac ester was present per hundred parts of SBR.

Zinc-salt of lac in SBR/NR

Incorporation of zinc-salt of lac into NR/SBR affected mooney viscosity and scorch time favourably indicating potential of its use as a processing aid and antiscorching agent. Mechanical properties were more favourably influenced in case of SBR. Therefore, a comparative study was made in detail on the effect of incorporation of shellac and zinc-salt of lac in blends of 50 parts each of NR and SBR using MBT and CBS as accelerators in gum-stock. In the case of MBT, the optimum time of cure remained almost unchanged with shellac, whereas with zinc-salt of lac it decreased first and then increased with further addition of zinc-salt. The modulus at 200 per cent elongation was enhanced with zinc-salt of lac compared to that of shellac. In the case of CBS, the optimum time of cure was unchanged with the addition of shellac, but was reduced with the incorporation of zinc-salt of lac. The modulus remained unchanged but tensile strength increased with the addition of zinc-salt of lac whereas the modulus was increaseds when shellac was used. Tear resistance and hardness were more favourably influenced with the zinc-salt of lac as compared to shellac.

The above study was further carried out using EPC/HAF as black fillers and china clay/alumnium silicate as white fillers. In case of shellac, the optimum time of cure decreased when black fillers were used. The modulus was affected slightly but ultimate elongatioin increased. Tensile strenth increased with the incorporation of shellac upto 10 parts in the case of EPC and 5 parts in the case of HAF. A decrease was noticed in tear resistance. With all proportions of zinc-salt of lac, decrease in mooney number was observed. For stocks containing 5 parts of zinc-salt of lac and EPC/HAF as filler, an improvement in tear resistance and hardness was noticed. Tensile strength was slightly improved with EPC. With white fillers, zinc-salt of lac gave better result than shellac in respect of abrasion. However, the flexing



Testing of shellac rubber combinations for tensile strength

property was better with shellac.

Magnesium-salt of lac in the blend of NR and SBR

Similar studies were carried out with magnesium salt of lac into a blend of NR and SBR (50 parts each) using MBT/CBS as accelerator in gum stock. It was observed that in the presence of MBT, optimum time of cure decreased when 5 to 10 parts of magnesium-salt of lac was added in the stocks but with 20 parts of the salt it remained constant. The mooney number and scorch time decreased upto 10 parts and thereafter increased. There was no improvement in the mechanical properties of the stocks by raising the concentration of salt. When CBS accelerator was used, the optimum time of cure remained constant upto 10 parts of added magnesium-salt of lac, but at higher concentration, it decreased. No definite trend was observed in regard to mooney number and scorch time. However, modulus, ultimate elongation, tear resistance, hardness and tensile strength increased with both the accelerators upto 20 parts of added magnesium-salt of lac. A decrease in impact resilience was however, observed.

The above study was further carried out using EPC/HAF as black filler and china clay/aluminium silicate as white fillers. When EPC was used, ultimate elongation, resilience and hardness increased, while scorch time, modulus, tensile strength, tear resistance and abrasion resistance decreased. When HAF was employed, the optimum time of cure remained unchanged with 10-15 parts of added salt. Modulus at 200 per cent elongation was decreased while tensile strength and tear resistance increased with 10 parts of salt. Hardness and abrasion resistance increased with 5 parts of salt whereas impact resilience decreased. Mooney number was found to increase with both the fillers.

With both the white fillers, hardness increased but other properties decreased. Ultimate elongation, modulus and tear resistance increased in the case of aluminium silicate. The other properties were found to decrease with both the fillers.

Besides the above blend of NR and SBR, two more blends in the ratio of 80:20 and 20:80 were also studied for abrasion and flexing properties. In these blends, shellac and its zinc and magnesium salts in different proportions were incroporated. It was found that abrasion resistance was better when 5 parts of zinc-salt of lac was incroporated in 80:20 blends, while with shellac it improved with 20:80 blend. The flexing property was better with all proportions of shellac.

(R. Singh & B. B. Khanna)

(b) RESEARCHES IN PROGRESS

Improvement in the Processing Techniques

4.1.6.2 Improvement in dewaxing and decolourising techniques in solvent medium

Decolourisation of lac with different grades of activated carbon was studied last year and it was observed that decolourisation was most effective with pure grade of activated carbon. The effect of oxalic, tartaric, succinic and acetic acids (0.1 to 0.6 per cent on the weight of seedlac) was studied during decolourisation. It was observed that the presence of these acids slightly improved the decolourisation but at the same time, the life and flow decreased with the increase in the percentage of acid in the sample (Table 15). The optimum amount of the acid that can be used without affecting the life and flow was found to be 0.1 to 0.2 per cent on the weight of seedlac. The best results were obtained with the acetic acid when the colour index could be lowered by 0.3 unit without deteriorating the life and flow.

(R. K. Banerjee)

4.1.8 To study the industrial parameters affecting the preparation of bleached lac

The project was taken up to study the various industrial parameters (life, flow, bleach index etc.) of the parent seedlac for the preparation of bleached lac of good keeping quality. Five samples of seedlac of different age (1-5 years) were converted into bleached lac by the conventional method and their properties were studied (Table 16).

The yield of bleached lac decreased with the age of seedlac used apparrently due to increase in the unsoluble portions. No deterioration in the solubility of the bleached lac was however, observed up to 3 months.

(R. K. Banerjee)

Rubber - Shellac Combinations

4.2.2 Electrical properties of rubber-shellac blends

The results of the studies on the variation of dielectric properties of a blend of 50 parts each of NR and SB on incorporation of different proportion of shellac in china clay filled stock were reported previously (*A. Rep* 1985-86). Similar studies were carried out in the presence of aluminium silicate as filler by varying the curing time from 10 to 50 minutes. The results are presented in Table 17.

Dissipation factor (Tan δ) was found as low as 0.003 with 10 parts of shellac cured for 20 minutes, however, in other cases the values increased. A variation was noticed in values of dielectric loss.

No systematic trend of change was revealed in the values of dielectric constant and dielectric strength due to incorporation of shellac in the filled stock. The dielectric properties of the china clay filled stock were better (*A. Rep.* 1985 & 1986) than aluminium silicate filled stock.

(R. Singh, D. N. Goswami & B. B. Khanna)

Use of Lac in Adhesive

4.3.5 Modified lac (with synthetic resins) as adhesives

Adhesive property of shellac as such is poor and finds limited use for bonding different surfaces.

A detailed study was, therefore, taken up to modify lac with synthetic resins such as epoxy, melamine, urea-formaldehyde, alkyd, polyamide etc. in order to increase its adhesive property.

Autoclave shellac (ASK) was modified with epoxy resin (Molecular weight 5000). Fifty per cent solution of epoxy resin was prepared in a mixture of

Table - 15
Effect of some organic acids on decolourisation of *kusmi* seedlac

Sl.No.	Acid	Amount of acid (per cent)	Colour Index	Life (minutes)	Flow (mm)
1.	Control	0.0	1.5	36	35
2.	Acetic acid	0.1	1.4	36	35
		0.2	1.2	40	32
		0.3	1.2	34	30
		0.4	1.3	27	24
		0.5	1.3	15	18
		0.6	1.4	12	15
3.	Oxalic acid	0.1	1.4	35	32
		0.2	1.3	27	26
		0.3	1.3	24	21
		0.4	1.3	12	11
		0.5	1.2	10	10
		0.6	1.2	8	6
4.	Succinic acid	0.1	1.4	36	34
		0.2	1.3	34	32
		0.3	1.3	30	28
		0.4	1.3	25	24
		0.5	1.2	25	22
		0.6	1.2	23	20
5.	Tartaric acid	0.1	1.4	31	28
		0.2	1.4	28	26
		0.3	1.3	26	24
		0.4	1.3	25	23
		0.5	1.2	24	22
		0.6	1.2	24	21

Table - 16
Properties of seedlac used vis-a-vis bleached lac obtained

	Seedlac used				Bleached lac obtained			
Strain	Age (years)	Life (minutes)	Flow (mm)	Bleach index	Yield (per cent)	Life (minutes)	Flow (minutes)	Colour index
Kusmi	1	61	38	70	82.0	10	8	0.40
Kusmi	2	54	31	75	74.0	10	10	0.40
Kusmi	3	33	Nil	95	72.5	10	12	0.30
Kusmi	4	31	Nil	98	65.1	10	8	0.35
Rangeeni	5	35	Nil	105	65.0	10	8	0.30

Table - 17

Effect of incorporation of shellac on different dielectric parameters of the blend of NR & SBR (50:50) with aluminium silicate as white filler

Curing Time	Dielectric constant at 100 kHz					Dissipation factor at 100 kHz					Dielectric loss at 100 kHz					Dielectric strength (V/mil)				
(minutes)	Shellac content (percentage)					Shellac content (percentage)					Shellac content (percentage)					Shellac Content (percentage)				
	0	5	10	15	20	0	5	10	15	20	0	5	10	15	20	0	5	10	15	20
10	3.72	4.41	3.04	—	—	0.013	0.018	0.010	—	0.015	0.047	0.077	0.030	—	0.049	285	312	355	334	294
20	3.51	4.13	4.01	3.90	3.85	0.011	0.012	0.003	0.024	0.015	0.040	0.050	0.011	0.094	0.058	312	322	330	281	305
30	3.53	4.02	4.17	5.04	3.86	0.006	0.016	0.011	0.041	0.017	0.020	0.062	0.047	0.210	0.064	336	334	323	337	322
40	4.40	4.38	4.07	4.97	4.19	0.015	0.013	0.015	0.031	0.019	0.065	0.057	0.062	0.150	0.079	337	341	331	327	310
50	5.52	3.97	4.32	5.06	4.51	0.015	0.019	0.009	0.032	0.017	0.066	0.074	0.039	0.160	0.120	345	340	323	326	299

Base mix : NR,50; SRB,50; ZnO,4; Stearic acid, 1; Electrol H, 1; Sulph, 2; CBS 1; filler, 46.5.

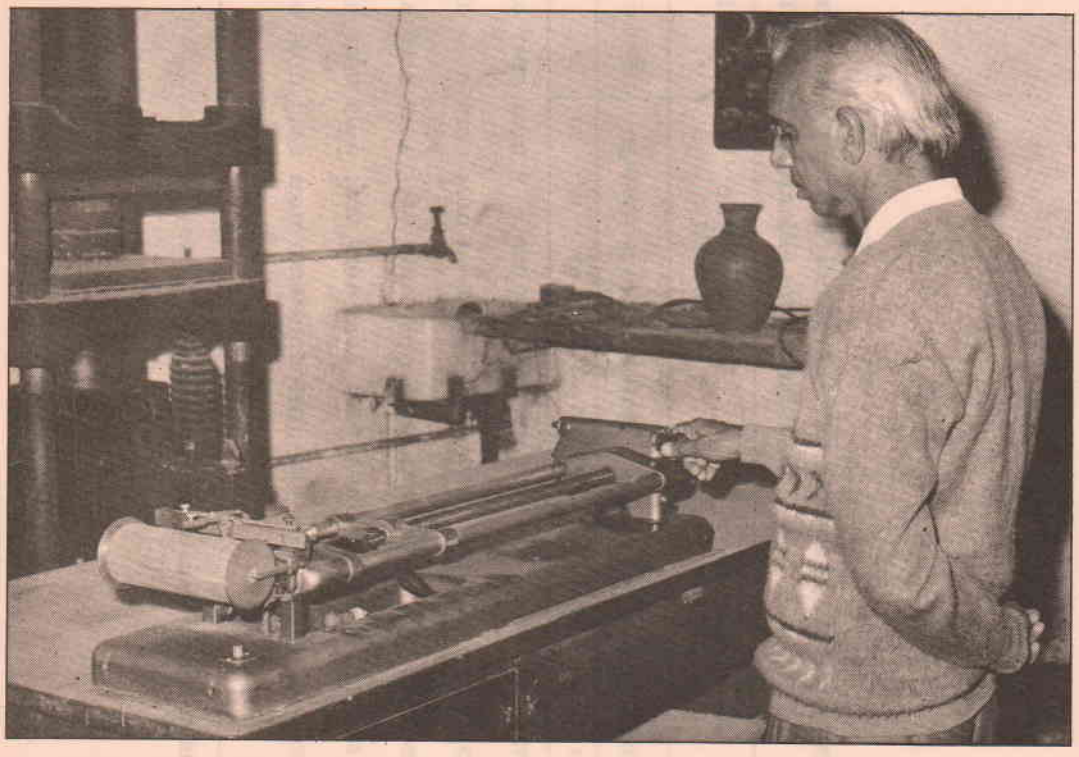
spirit and toluene (70:30). This solution was mixed in different ratios with 50 percent shellac solution in rectified spirit. The adhesive property of these com - positions was then determined over mild steel to mild steel surfaces after pressing at 150°C under 2000 lbs pressure for 1 hour (Table-18). It was found that 50:50 blend imparted the best bond strength (0.33 ton sq. inch) against 0.08 ton sq. inch for plain shellac.

Similarily alcoholic solution of butylated melamine resin was incorporated into 50 per cent shellac solution in different ratios. The resulting compositions were then applied over mild steel to mild steel, wood to mild steel and wood to wood surfaces. These were clamped for 24 hours and left for 7 days for cold curing after release. Thereafter, the bond strength was determined (Table -19).

In case of wood to metal surfaces 80:20 blend gave the best bond strength to 0.20 ton/sq. inch and wood to wood surfaces were bonded best (0.12 ton/sq. inch) by the 70:30 and 60:40 blends.

In case of metal to metal surfaces cold curing could not succeed, therefore, the bond strength was determined after conditioning as described for shellac epoxy blends. In this case, best bond strength (0.14 ton/sq. inch) was imparted by 60:40 blend.

(P. C. Gupta)



Testing of modified lac for bond-strength

Table-18

Bond strength of shellac (ASK) modified with epoxy resin

Sl.No	Shellac : Epoxy resin	Bond strength (ton/sq.inch) (mild steel to mild steel)
1.	100 : 0	0.08
2.	80 : 20	0.13
3.	70 : 30	0.21
4.	60 : 40	0.21
5.	50 : 50	0.23
6.	40 : 60	0.22
7.	30 : 70	0.18
8.	20 : 80	0.16
9.	10 : 90	–
10.	0 : 100	–

Table - 19

Bond strength of shellac (ASK) modified with butylated melamine resin.

Sl.No.	Shellac : Melamine resin (butylated)	Bond strength (ton/Sq. inch)		
		Metal to Metal	Wood to metal	Wood to wood
1	100 : 0	0.08	0.05	0.05
2.	80 : 20	0.08	0.20	0.08
3.	70 : 30	0.07	0.17	0.12
4.	60 : 40	0.14	0.17	0.12
5.	50 : 50	0.12	0.11	0.06
6.	40 : 60	0.11	0.12	0.07
7.	30 : 70	0.08	0.11	0.07
8.	20 : 80	0.04	0.09	did not dry
9.	0 : 100	—	did not dry	- do -

4.3.6 Use of lac by-products for making coal blocks

A huge amount of coal in the form of small pieces/dust obtained during mining and processing is abundantly available. These forms of coal are unsuitable for the purpose of cooking unless a suitable bigger shape is given. Presently available coal block are fragile and susceptible to water. The by-products of lac which are availabe in plently also find limited use. It was therefore, proposed to use these materials in making water and impact resistant block/ briquettes, suitable for domestic fuel.

The F grade coal from North Karanpura (Bachara Colliery) and *kiri* (50 per cent lac content) were used for preparation of coal blocks. The two ingrediencts were initially powdered with the help of disintegrater to 40 mesh size and thoroughly mixed together. This mixture was then moulded in a cylinderical mould at different temperature, pressure and time under a hydraulic press. The blocks immediately taken out with the help of plunger. Cylinderical blocks of 7.5 cm diamter and height 5 cm with 7 holes were moulded and tested (Table - 20). It was found that minimum quantity of binder required to produce block of desired properties was 3 per cent (at 140°C, 25 ton/sq. inch pressure for 2 minutes).

Experiments were also carried out to prepare coal blocks using different mesh size of coal dust to study the rate of evaporation of water i.e. useful heat value and the extent of burning.

When 60-80 mesh size coal dust was used, maximum water evaporation was observed (164 ml/hour) from the blocks. A known amount of ash of the burnt coal blocks was kept in a muffle furnace for 5 hours at 700°C and it was recorded that on an average 99.2 per cent coal was burnt in all cases (Table - 21).

(P.C. Gupta)

Use of Lac in Printing Inks

4.5.1 Development of printing inks based on lac/modified lacs

Use of lac/modified lac in the manufacture of printing ink is well known. The present study was undertaken with an objective to develop *typography* and *offset* printing inks based on lac and modified lacs. Attempts were made to prepare printing ink by shellac with furnace black carbon (65:35 parts) in alcohol, but the composition dried due to evaporation of solvent.

Partial butyl ester/ether and ethylene glycol ester/ether of lac were also taken separately in alcohol. In the case of former, n-butyl alcohol and furnace black were added but some livering was observed during mixing. However, the same was reduced when washed channel black carbon was used. In the case of latter, when n-butyl alcohol, washed channel black and alkali refined linseed oil were added and mixed properly no difficulty was experienced in milling. The film of this product prepared on the glass slide was found comparable with commercial sample of offset printing ink in respect of smoothness and flow. This product did not show either *strike through* or *show through* property but possessed certain drawbacks such as poor consistency, hue and undesirable stickiness.

(A. Pandey)

Ad-hoc Research

Preparation of improved cation-exchange resin from shellac on large scale

Cation exchange resin from shellac was developed earlier by Rahman *et al* . (*Res.* & *Industry* , 1979) and the value of its exchange capacity was reported to be 4.58 m. eq./g. In view of the high value and good properties, it was desired to prepare the cation exchange resin on a large scale, following the

Table - 20

Conditions of preparation and characteristics of lac based coal-blocks.

Sl. No.	Percentage of *Kiri* used on the weight of coal dust	Pressure (ton/ Sq.inch)	Temperature (°C)	Time of pressing (minutes)	Nature of the block	Disintegration in water after 48 hours of immersion
1.	20.0	5.0	120	10.0	Fine cracks	Soften
2.	"	10.0	"	"	Smooth	unaffected
3.	"	15.0	"	"	"	"
4.	"	20.0	"	"	"	"
5.	"	15.0	60	"	"	Disintegrate
6.	"	"	80	"	"	Unaffected
7.	"	"	100	"	"	"
8.	15.0	5.0	120	"	"	Slightly soften
9.	"	10.0	"	"	"	Unaffected
10.	10.0	"	100	"	"	"
11.	5.0	"	120	"	"	Disintegrate
12.	10.0	"	100	3.5	"	Unaffected
13.	"	"	"	3.0	"	"
14.	"	"	"	2.0	"	Slightly soften
15.	3.0	25.0	140	3.0	"	Unaffected
16.	"	"	"	2.0	"	"

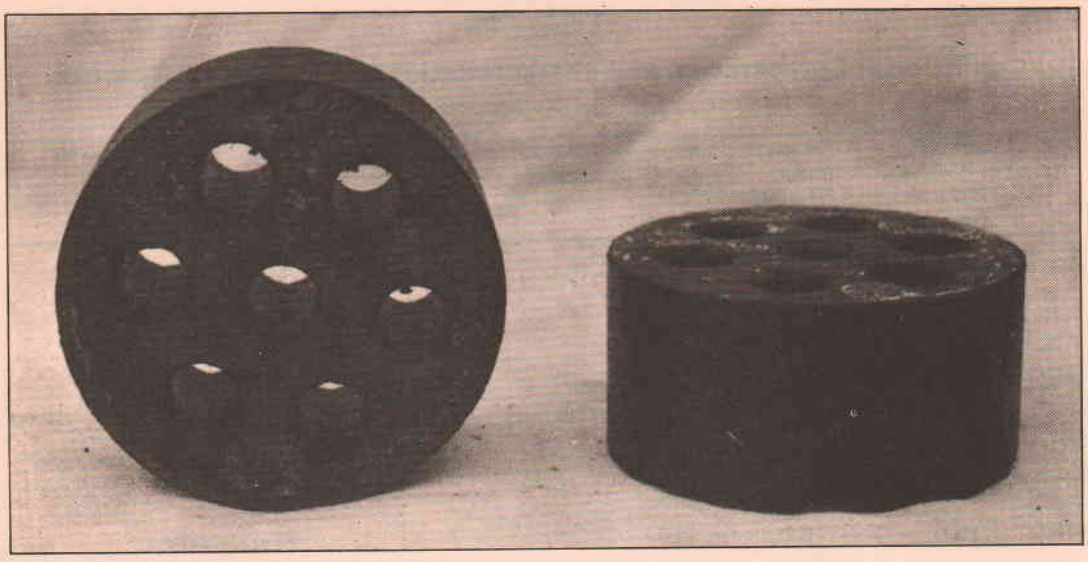
Kiri lac - 40 mesh, 50 per cent lac content; coal dust - 40 mesh, F grade.

Table - 21

Effect of particle size of coal dust on the water evoperation and burning efficiency of coal blocks prepared by using 15 per cent *kiri* as binder.

Mesh size of coal (B.S.S.)	Time of boiling of 200 ml water (minutes)	Quantity of water evaporated per hour (ml)	Burnt (per cent)
10-20	10	120	99.17
20-30	10	115	99.30
30-40	10	114	99.20
40-60	10	160	99.15
60-80	10	164	99.17

Temperature of moulding - 100°C; Moulding pressure - 10 ton/sq. inch



Water resistant coal-blocks

Characteristics and performance of the coal block

1.	Appearance	:	Compact Block
2.	Weight	:	200-205 g
3.	Impact strength	:	Quite strong and does not break when falls from a height of 1 metre
4.	Hygroscopicity	:	Non-hygroscopic
5.	Water resistance	:	Does not disintegrate when immersed in water for 48 hours or even more
6.	Burning property	:	Easily catches fire when ignited with fire wood or coal-block ignitor (ILRI)
7.	Period of burning	:	About 2 hours
8.	Flame length	:	1-2 cm.
9.	Nature of Flame	:	Blue
10.	Heating capacity	:	200ml. water boils in 5-6 minutes in pressure cooker (1 litre capacity)
11.	Cooking performance	:	One block can cook 200g rice in 400 ml water in 30 minutes, 50 g pulse in 150 ml water in 15 minutes and 20 chapatis (400 g wheat flour).

Demonstration of cooking performance of coal-blocks

reported method. The cation exchange resin was prepared several times but the value of exchange capacity was found to be very low (0.2 m eq./g) which seems to be anamolous. Hence a systematic study was undertaken. In case of *amberlite* cation exchange resin, firstly gel is prepared from styrene/divinyl benzene and then it is sulphonated. Similarly shellac was converted into a gel adopting the Dhar's method and then sulphonated using various sulphonating agents such as concentrated sulphuric acid, oleum (20 per cent) and chlorosulphonic acid. In case of sulphuric acid, the optimum proportion required was found to be 1:5 (gel sulphuric acid). The cation exchange capacity of the product was 1.08 m.eq./g which compared to that of Dhar *et. al.* The yield in the present case was nearly 25 per cent in the case of oleum, the optimum proportion was 1:6 (gel:oleum) and cation exchange capacity was nearly 2.4 m. eq/g and yield was about 60 per cent. With chlorosulphonic acid, the ratio was found to be 1 : 3, while the cation exchange capacity and yield were 1.44 and 41 per cent respectively. Amongst the sulphonating agents used the oleum gave best performance.

(K. K. Sharma & P. C. Gupta)

F. DIVISION OF EXTENSION

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES IN PROGRESS

5.5. Operational research project for maximising lac production in Chhotanagpur area

Operational researches on the transfer of technologies in respect of lac, honey and other crop production, animal husbandry etc. were continued in the old operational area (Phase II) comprising four backward tribal villages namely Barguttu, Hardag, Koenjari and Saheda. A new area comprising of two villages, namely, Chitir and Dundu was also selected in the Namkum Development block of Ranchi district for the Phase III of the project.

PHASE II

A. INSECT CULTURE PROGRAMME

(a) Lac Culture

Trial-cum-demonstrations of improved methods of lac cultivation on *ber* were continued.

From *rangeeni* sticklac coupe, *baisakhi* 1986-87*ari* (immature) crop was harvested from a set of 27 *ber* trees of 6 farmers during May, 1987. These trees were inoculated during October 1986. An average yield of 3.88 kg sticklac/tree was obtained as against 0.407 kg from the trees operated traditionally.

(b) Apiculture

Follow up and technical support service was continued and by the end of the year, 76 bee-keepers owned 219 hives and 89 bee colonies. One hive was fabricated locally by a progressive keeper. Total 35 bee-keepers produced 296 kg honey from 85 bee colonies which fetched them an average annual income of Rs. 254 per bee keeper. Measures were taken for the prevention of the American foul brood disease which devasted large number of bee colonies in an around Ranchi. No diseased colony, however, was recorded in any village of the area.

B. CROP PRODUCTION PROGRAMME

(a) Agricultural Crops

Farmers having irrigation facilities were encouraged to grow wheat crop during *rabi* 1986-87 season. Due to fear of elephant damage and cattle grazing, only 3 farmers raised wheat crop on a total 0.4 ha area after paddy harvesting. Maximum 25 q/ha yield was obtained and one field was completely grazed by cattle. Average gross income of Rs. 1018.00 was recorded for 2 farmers. Six Soyabean demonstrations covering 0.92 ha area were also conducted. The crop failed due to grazing by cattle and only one farmers obtained 100 kg/ha yield.

(b) Horticultural crops and Agro-forestry

One hundred *bhalia*, 25 *ber* and 25 *galuxng* lac host seedlings raised at the Institute Plantation were distributed in 11 farmers for planting in their fields. Twelve papaya seedlings, 2 guava grafts, 4 banana suckers of improved varieties were arranged for 5 farmers from Central Horticultural Experiment Station, Ranchi.

C. ANIMAL HUSBANDRY PROGRAMMES

(a) Swine Husbandry

Two keepers continued to maintain hybrid (Yorkshire X Local) stock and 3 farrowings were recorded during April and May 1987, yielding 13 piglets in all (average litter = 4.3, range 2 to 7). Six piglets died within a month of their birth but remaining 7 survived till the end of the period under report and attained 7-8 months age. One 12 month old male was consumed by the owner. No sale was reported. Four sows and 1 boar

in the age group of 27-34 months survived till the end of period under report.

(b) Dairying

One crossbred heifer and 2 crossbred bullocks continued to survive till the end of the year. The local cow gave birth to a female calf which died within a week. The local bullock which survived till the end of the last year died during May 1987, after attaining the age of 20 months.

(c) Goat Keeping

The only surviving Black bengal goat gave birth to a kid during January 1987. Both survived till the end of the year.

D. EXTENSION EDUCATION PROGRAMMES

Farmer's Forum meetings were conducted and discussions were held on the new technologies, constraints and needs of the farmers.

Krishi Vikas Club activities were also continued.

PHASE III

BENCH MARK SURVEY

Bench mark survey in respect of resources such as land, humen, animals, vegetation and machineries etc. was initiated during September 1987. Salient features of the survey details collected till the end of the year are given on the table.

Since the area was taken up late in the year, the pruning of host trees could not be demonstrated. Three lac demonstrations on 12 unpruned *palas* and 4 *ber* trees were initiated during October 1987, using 24.0 kg. *palas* broodlac. Training in selection of broodlac, bundling and inoculation was organised. The farmers in the area were also encouraged to participate in the *Radio Krishi Pathshala* programme of the Institute.

Seedlings of *galwang, bhalia* and *ber* totalling 807 were distributed among 30 farmers for planting in their field/ backyard. Improved planting materials of guava, banana and papaya (totalling 87) were arranged from Central Horticultural experiment Station and Birsa Agricultural University, Ranchi and supplied to the farmers at their own cost. Training in the techniques of planting was also imparted.

One of the farmer was motivated to obtain a bank loan of Rs. 2,000 for the purchase of one pair of bullock.

(R. C. Mishra & J. Lal)

5.6 Pilot studies on pre-harvest forecasting of yield of sticklac

The project was taken up in collaboration with the Indian Statistical Research Institute, New Delhi (IASRI) with a view to develop a suitable statistical model for forecasting yield of sticklac. For study during the *baisakhi* 1987-88 crop season, 110 *palas* trees were selected randomly from a group of 1200 trees situated at Kundri Lac Orchard in the Palamau district of Bihar and pruned during April. These trees were inoculated during November using 94.0 kg *palas* broodlac at rates ranging from 200 to 1800 g per tree depending on their size. Five samples of 5-7 cm long lac bearing sticks were collected from the 100 trees at four stages of crop development. Remaining ten trees were left undisturbed in order to determine the yield losses due to sampling.

(S. K. Saha , A. K. Jaiswal, ILRI & B. H. Singh, IASRI)

Ad-hoc Research

Shellac bonded abrasive stone for polishing marble

Shellac bonded abrasive stones are reported to be in use in Italy for getting mirror like finish and gloss on marbles and there appears to be a good demand of this material in India.

Preliminary experiments were carried out to develop such material for polishing marbles. A composition based on aluminium oxide, oxalic acid and shellac was prepared for evaluation.

(S. K. Saha)

BENCH MARK SURVEY (Phase III)

Resources		Name of village		Total	Percentage of total
		Chitir	Dundu		
A. *LAND* (in hectare)					
1. Total		89.65	202.74	291.74	—
2. Unirrigated		88.03	200.07	288.10	98.75
3. Irrigated		1.62	2.02	3.64	1.25
4. Culturable waste		Nil	Nil	Nil	—
5. Forest		Nil	Nil	Nil	—
B. *HOUSEHOLDS*					
1. Total		34	81	115	—
2. Possessing lac host plants.		32	77	109	93.2
3. Engaged in lac cultivation		28	75	103	88.0
C. *MANPOWER* (RESIDENT)					
1. Sex :	Male	94	255	349	50.4
	Female	72	271	343	49.6
	Total	166	526	692	100.0
2. Caste :	S. Tribe	159	509	668	96.5
	S. Caste	Nil	Nil	Nil	—
	Others	7	17	24	3.5
3. Religion :	Hindu	155	457	612	88.4
	Christian	11	52	63	9.1
	Muslim	—	17	17	2.5
4. Literacy :	Literate	23	41	64	9.25
	Illitrate	143	485	628	90.75
D. *VEGETATION* (PROVISIONAL)					
	LAC HOSTS :				
	1. *Palas*	1033	795	1828	—
	2. *Ber*	366	922	1288	—
	3. *Kusum*	3	33	36	—
	4. *Ficus spp.*	24	40	64	—

(c) EXTENSION ACTIVITIES

Training

One Forester from Assam completed regular training of six month duration in *Improved Methods of Lac Cultivation* during the session October 1986 to March 1987.

Another batch of 3 trainees (one Forester from Karnataka and 2 growers from West Bengal) were admitted to the session October 1987 to March 1988 of the same course.

A set of six lectures on improved methods of lac cultivation were arranged to be delivered by the scientists of the Institute at Divyayan K. V. K., R. K. Mission Ashram, Ranchi to a batch of 30 progressive farmers.

On the spot training/guidance was given to 856 lac growers in 7 villages of Ranchi district in cooperation with the voluntary organisations as per the details given below :

In order to utilise the mass media for transferring the technologies developed at this Institute, a *Radio Krishi Pathshala Karyakram* was organised in cooperation with the All India Radio, Ranchi. The programme consisted of 26 broadcasts of ten minutes each which were transmitted every Sunday covering all aspects of lac cultivation and processing. Since the programme was started from October 1987, only 13 talks were transmitted as per the list (Table-22). This was in addition to a radio talk and two television programme recorded and transmitted during the year.

Method demonstration-cum-short term training in the testing and preparation of lac based products was also organised for the representative of Industrial houses as per details given on page no. 56.

Village	Date of visit	No. of farmers trained	Cooperating voluntary organisation
Chippibandhdih	5.1.87	200	Sanskriti Vihar, Ranchi
Hesadih (Sonahatu)	5.2.87	250	do
Manikadih	21.4.87	60	do
Deogaon	12.3.87	28	R. K. Mission, Ranchi
do	14.4.87	33	
Gutigara	21.3.87	22	do
do	15.4.87	33	do
do	26.6.87	75	do
Akra	13.6.87	55	do
Hakaduah	25.6.87	100	do

Table - 22
Radio Krishi Pathshla Karyakram
(Farm School On Air)

Sl.No.	Date of recording/ broadcast	Name of the scientist/specialist	Topic
1.	04.10.87	Dr R.P. Kapil	Lah Kee Kheti ka Mahatava
2.	11.10.87	Dr S.K. Saha	Bhartiya Lakh Anusandhan Sansthan Aur Uske Karyakalap
3.	18.10.87	Sri A.H. Naqvi	Lah Keet ki Prajatian, Jiwan Chakra Aur Phasalen
4.	25.10.87	Sri N.S. Chauhan	Lah keet Ki Unnat Naslon Ke Vikas Kee Sambhavnayen
5.	01.11.87	Dr P. Kumar	Lah Keet Ke Paramparagat Poshak Vriksha
6.	08.11.87	Dr B.P. Singh	Lah Ke Naveen Poshak Paodhe Evam Unke Bagan Lagane Ki Vidhi
7.	15.11.87	Sri S.C. Srivastava	Poshak Vrikshon Kee Kaat Chhant Kee Unnat Vidhiyan
8.	22.11.87	Sri R.C. Mishra	Lah Phasal Sancharan Evam Phunki Utarai Ki Unnat Vidhiyan
9.	29.11.87	Sri L.C. Nath Shahdeo	Lah Phasal Katne Ka Uchit Samay Jananen Kee Vidhiyan
10.	06.12.87	Dr S.K. Jaipuriar	Lah Ke Shatru Keeton Ki Pahchan
11.	13.12.87	Sri S.G. Chaudhary	Lah Ke Shatruon Ki Roktham Ke Samanya Upaya
12.	20.12.87	Sri A.Bhattacharya	Lah Phasal Suraksha Hetu Keet Nashak Davaon Ka Prayog
13.	27.12.87	Sri B.N. Sah	Phasal Katai Kaise Karen?
		RADIO TALK (OTHER THAN R.K.P.)	
1.	05.3.87	Sri R.C. Mishra	Lah Ke Shattruon Per Keetnashi Davaiyan Kaise Chhirken
		TELEVISION PROGRAMME	
1.	19.6.87	Sri R.C. Mishra	Adhunik Dhang Se Kusum Par Lakh Ki Kheti
2.	20.6.87	Dr R.P. Kapil & R.C. Mishra	Bhalia Aur Galwang Ke Bagan Kaise Lagayen.

Topic	Name of the Firm
1. Preparation of Gasket Shellac compound and Hydrolysed Lac	M/S Prakasham Departmental Stores. Guntur Road, Ongale - 2. Andhra Pradesh.
2. Preparation of Gasket Shellac Compound	M/S Milton Tractors 2751/2, Ist Floor, Chowk Mori Gate Delhi - 110006.
3. do	M/S Deepak & Co., 11, Nagardas Park, Old Nagardas Road, Andheri (E) Bombay-69, Maharashtra.
4. Testing & Analysis of Lac	M/S Acchruram Kalkhof & Co . (Shellac) Pvt. Ltd. Murhu, Ranchi. Bihar

Training on various aspects of lac was organised for 8 F. A. O. nominees from Vietnam in two batches. The first batch consisting of Mrs. Le Thi Phi, Mr. Cao Ngoc, Mrs. Mai Tan and Mr. Trinh Kin Thanh arrived in March for 3 month training. Initially all the four candidates were given *General Orientation Training in Lac Cultivation and Utilisation* for 3 weeks and thereafter the first two candidates were separately trained in Processing, Uses and Chemistry of Lac for 9 weeks.

The second batch consisting of Mr. T. V. Canh, Mr. V. D. Quang, Mr. K. C. Khanh and Mr. N. V. Chua arrived in September and was given training in *Improved Methods of Lac Cultivation and Pest Control and Processing* for 2 months. In addition, programmes for their field trips to Dehra Dun and Calcutta were also organised.

Technical Advisory Service

A large number of querries (108) received from all over the country and abroad were attended. These querries related to the problems of lac cultivation, manufacture of lac and lac products, availability of raw materials and machineries etc. Problems of the visiting industrialists, entrepreneurs, extension workers and Government functionaries were solved with the help of the scientists of the Institute.

Total 15 crop samples received from the lac growers/organisations were examined and forecasting of the emergence of crawlers and analysis of the causes of crop mortality was done and reports were issued free of cost.

Large Scale Cultivation of Lac at Kundri

Regular technical assistance to the Forest Department, Bihar in running their Kundri Lac Farm having 40,000 *palas* trees was continued. Pruning cum *ari* harvesting operation of 17,710 trees during May yielded 49,813 kg of sticklac. Partial harvesting of 900 trees during July-August yielded 245 Kg broodlac of which 125 Kg was sold and the rest was used for inoculating 120 *palas* trees in the experimental plot. During November/ December, 19,745 trees were harvested yielding 13,337 Kg broodlac. From this 12.737 Kg was utilised for inoculating 16,816 trees. Six hundred Kg broodlac was distributed free of cost to 285 SC/ST families belonging to villages adjoining the farm as a part of the development programme of the Forest Department. An expenditure of Rs. 33226 only was incurred and a net profit of Rs.34,909 is expected.

Kisan Mela and Exhibitions

Exhibition stalls were put up in 3 Kisan Melas organised by *(i) Divyayan Krishi Vigyan Kendra*, Ranchi on 16-18 January *(ii) Parvatiya Durgam Siksha Vikas*, Ranchi on 15 January and *(iii) Birsa Agricultural University*, Ranchi on 16-18 November. Nearly 4,000 visitors attended these stalls. Exhibits were supplied to ICAR for display at the Science and Technology Exhibits were supplied to ICAR for display at the Science and Technology Exhibition organised at Moscow during the 1st week of November.

Testing

Facilities for testing the lac and lac products were extended to the manufacturers and other organisations on payment of a nominal fee. Total 127 samples of seedlac, shellac and other lac-based products were received and in all 455 tests were carried out in respect of them.

A comparative study of the physico-chemical characteristics of lac resin obtained from different lac producing countries was taken up. Two samples obtained from Vietnam and one from Thailand were tested for flow, life, colour, wax content, melting point and acid, saponification, carbonyl, ester and iodine values. Some electrical properties were determined. Spectral and chromatographic analysis was also carried out.

The results show that both Thai and Vietnamese lacs possess higher melting point, acid value and colour but their wax content and flow were low as compared to Indian lac (Table 23).

Standardisation

Standardisation activities of the Bureau of Indian Standards in respect of lac and lac products were supported by providing assistance in drafting and scrutiny of 5 standards, evolving new test methods and evaluation & extension of the existing methods.

(i) Methods for determining pitch content of sealing wax

The inferior grade sealing waxes contain pitch as one of the ingredients but no method is available for its quantitative estimation. On the recommendation of the Lac and Lac Products Sectional Committee (CDC-9) of Bureau of Indian Standards, a method based on extraction of sealing wax with benzol (benzene + toluene + xylene) was developed and passed on to the Bureau.

(ii) Adhesion of sealing wax on various paper surfaces

Investigations were taken up on the adhesion of various grades of sealing waxes on different paper surfaces namely, Kraft paper (80 G.S.M.), Wrapping paper (120 G.S.M.), Printing paper (60 G.S.M.), Yellow insured envelope, Mill board, Brown paper envelope, Brown envelope (rough surface), Big envelope (white) and White insured envelope of P & T department. The tests were conducted with six standard samples of sealing waxes supplied by Bureau of Indian Standards. The test results form the basis of the revised Indian Standards for sealing wax, (IS-868, 1956).

Production Unit

The unit produced 140 kg of Slow-release lac-coated urea fertiliser out of which 87 kg was supplied to the Field station of Central Arid Zone Research Institute at Bikaner, Central Plantation Crop Research Institute, Kasargod and Assistant Agronomist, Adaptive Research, Ranchi.

Museum

Total 369 visitors including 6 batches of farmers, 1 batch of trainee Forest Officers, 1 batch of I.F.S. Probationers and 5 batches of school/college students were shown round the museum. Film/slide shows were arranged for those who came in groups.

Table - 23

Physico-chemical characteristics of lac from different countries

Sl. No.	Properties	Thai seedlac-1986 (Host- *Samania saman*)	Vietnamese seedlac-1986 (Host- *Protium serratum*)	Vietnamese seedlac-1987 (Host- *Cajanus cajan*)	Indian seedlac *baisakhi1986* (Host- *Butea monosperma*)
1.	Flow (mm)	16	35	30	48
2.	Life (minutes)	44	45	56	55
3.	Colour	33	27	39	14
4.	Wax percent	2.8	3.3	4.5	5.5
5.	Melting point (°c)	82	83	86	78
6.	Acid value	79.7	80	79.2	66
7.	Saponification value	235.6	229.0	227.3	235.0
8.	Ester value	155.9	149.0	148.1	158.0
9.	Carbonyl value	34.2	33.9	36.6	16.5
10.	Iodine value (Wij's method)	16.6	16.8	17.1	15.0
11.	Optical density at 425 nm (for 10 g/ml solution in absolute alcohol)	0.22	0.16	—	—
12.	TLC*				
	(a) Number of major spots	Four	Four	One	Three
	(b) Rf values	0.12	0.12	0.13	0.13
		0.19	0.19	—	0.33
		0.52	0.52	—	0.80
		0.64	0.64	—	—
13.	Tan δ at 100 KHz.	0.195	0.121	—	0.425
14.	Conductivity at 100 KHz (mho/cm)	8.1×10^{-7}	3.8×10^{-7}		4.7×10^{-7}
15.	B. D. S. (KV/mil)	1.3	1.0		1.2

* Solvent system : Chloroform, 90 : methenol, 10 : acetic acid, 2.

3. PUBLICATIONS DURING 1987

Sl. No.	Author(s)	Title	Name of Journal/ Publisher etc.
	ENTOMOLOGY DIVISION		
1.	A.K.Sen, A.Bhattacharya and S.C.Srivastava	Record of *Aphis craccivora* Koch and *Aphis gossypi* Glov. on *Moghania macrophylla*, a Host Plant of Lac Insect	*Entomon*, **12**(3): 229
	PLANT SCIENCES DIVISION		
2.	S.C.Srivastava, P.Kumar and K.K.Nag	Floral Biology of Lac Host of *Bara salpan (Moghania chhappar* Ktze)	*Indian Journal of Forestry*, **10**(1) : 6-12
	CHEMISTRY DIVISION		
3.	S.C.Agarwal	Importance of Lac and Tasar Culture on Tribal Uplift	National Seminar on Tribals and Forests Bihar Tribal Welfare Research Institute, Ranchi, Bulletin No. 1 and 2, *26* : 29-34
4.	B.B. Khanna	Recent Advances in Chemical and Technological Research on Lac.	Indian Shellac, Annual Number, 1986-87 : 19–24
	TECHNOLOGY DIVISION		
5.	R.K.Banerjee and P.C. Gupta	Cold Setting Adhesive from Rebulac	Popular Plastics, **32** (11) : 16-17
	EXTENSION DIVISION		
6.	R.P. Kapil, R.C. Mishra and S.Kumar	Lac Based Industries for Rural Areas-Present Status and Future Prospects.	Proceedings of National Seminar on Current Status of Agro-based Technologies and Futuristic Approaches to Rapid Rural Industrialisation, February 7-9, Narendra Dev University of Agriculture and Technology Faizabad, U.P., pp. 58-60

An illustrated coloured booklet entitled *ILRI*-Its Dimensions (Edited by Dr R.P. Kapil and compiled by Dr S.C. Agarwal) was published by the Institute.

4. SYMPOSIA & SEMINARS ETC.

A. ATTENDED BY INSTITUTE SCIENTISTS

1. Dr. P. Kumar, Scientist S-2 and Head, Division of Plant Sciences participated in the *National Symposium on Plant Genetic Resources* held at National Bureau of Plant Genetic Resources, New Delhi, from March 3 to 6.

2. Sri R.C. Mishra, Scientist S-2 and Incharge O.R.P. participated in the *National Seminar on Current Status of Agro-based Technologies and Futuristic Approaches to Rapid Rural Industrialisation* held at Narendra Deo University of Agriculture and Technology, Faizabad, U.P. from February 7 to 9 and presented a paper entitled *Lac Based Industries for Rural Areas, Present Status and Future Prospects* by R.P. Kapil, R.C. Mishra and S. Kumar.

3. Sri R.C. Mishra participated in the *National Workshop on Operational Research Projects* held at Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, from March 7 to 10 and presented *Status paper on Operational Research Project for Maximising Lac Production in Chhotanagpur Area.*

4. Sri R.C. Mishra participated in the *Technical session of the Annual Meeting of the ex-trainees of Divyayan K.V.K., R.K. Mission, Ranchi* , held on May 5 and delivered a talk on *Improved Methods of Lac Cultivation.*

B. INSTITUTE SEMINARS

Sl. No	Date	Speaker	Topic	Reviewer
1.	07.11.87	Dr. B.B. Khanna, S-4	Chemistry and Technology of Bleaching	Dr. P.C. Gupta,S-3
2.	20.11.87	Sri S.C. Srivastava, S-1	Possibility of Interspecific Crossing in *Moghania*	Dr. P. Kumar,S-3
3.	28.11.87	Dr. S.K. Jaipuriar, S-1	Cytological Studies on Lac Insect *Kerria lacca* (Kerr)	Sri R. Ramani,S-2
4.	04.12.87	Sri S.G. Choudhary, S-1	Advances in the Management of Pests of Lac Insects	Sri A.Bhattacharya,S-1

5. TECHNICAL, AUXILIARY & SUPPORTING SERVICES

A. LIBRARY

The library continued to provide services to the scientists and other staff members of the Institute as well as the visitors.

The holdings of the library grew rapidly and 520 scientific documents including 225 bound volumes and books were added. In addition, 162 periodicals were subscribed. The total number of holdings of books and periodicals at the end of the year was 18,710.

Classification and cataloguing of books and journals was continued during the year with the help of latest editions of classification schemes and cataloguing code.

In order to provide the information about the forthcoming conferences in the field of Agricultural and allied sciences, selected lists of forthcoming conferences/seminars and symposia were complied and circulated from time to time.

A total sum of Rs.2.07 lakhs was spend on the acquisition of scientific periodicals and purchase of books.

B. MAINTENANCE AND WORKSHOP

The workshop unit of the Institute undertook the maintenance of water, electricity and gas supply lines to the laboratories and the campus, including staff quarters, farm etc. Minor repairs of laboratory and farm equipments and fabrication of parts were also undertaken.

C. TECHNICAL AND MONITORING CELL

Salient features of the activities were as follows :

Research monitoring : The progress of 49 research projects was monitored periodically. Staff Research Council meetings were organised and the proceedings were prepared. The research accomplishments and action plans of research projects were compiled in the form of *Activity Mile-Stone* and submitted to the ICAR, New Delhi.

Reports : Various reports namely, Monthly report for the Cabinet, Quarterly reports of ORP and 20 Point Programme, Status Paper for Regional Committee, DARE Report, Research Highlights for ICAR Report etc. were compiled. A separate committee constituted for scrutinising and editing the Institute Annual Report, held 23 meetings for finalising the Annual Report for the year 1986.

Other activities : Various scientific and technical meetings and Institute seminars were organised. General information about the Institute activities were supplied to various agencies including ICAR, NAARM and DST. The research papers and articles submitted by the scientists were processed and communicated to the journals.

D. PLANTATION AND LANDSCAPING

The Institute Plantation covers an area of 36.5 ha and consists of separate blocks of lac host plants namely *palas, kusum, ber, khair, bhalia, galwang, ghont, etc.* besides the nursery.

General management and upkeep of the plantation including maintenance of roads, paths, hedges and fencing were continued. Effective improvements in lac host plants were brought about through proper management and adoption of modern agro-forestry practices.

Seedlings of various lac hosts were raised in the nursery beds for filling up vacant places in the respective plots and for experimental pots. Five hundred *A. articulaeformis* and 200 *palas* seedlings were transplanted in two separate plots.

To make use of the vacant land, paddy *(Sita)* was grown in the low land area of the plantation. In addition, one nutrition garden was started for demonstration. Vegetable crops like potato, cauliflower, cabbage, pea, radish, spinach, french-bean, turnip, cowpea etc. were grown and the produce was sold among the staff members.

A plot was developed for maintaining mother plants of ornamental and foliage plants and seedlings were raised for landscaping. Various operations were carried out and new hedges were planted on road sides to beautify the estate. The total return from sale of farm produce namely paddy, vegetables, fruits, flower, ornamental plants, grasses, firewood etc. was Rs.3245.

E. ART & PHOTOGRAPHY

Services in support of research and extension activities were rendered. Seven hundred coloured as well as black & white photographs and coloured transparencies were prepared. Salient features of art work done include preparation of graphs (38), maps (21), charts (9), layout plans (8), entomological plates and drawings (9), histogrames (6), posters (41) and cover designs for book.

F. MEDICAL

The Institute provides day to day medical facilities to its employees. A total of 6,756 consultations were provided by the part time Authorised Medical Attendant (AMA) to the Institute staff at the Institute Dispensary. Twenty two patients were also attended at their residences by the AMA. In addition, 63 cases needing specialized treatment were referred to the Medical Institutions of repute.

6. DISTINGUISHED VISITORS

1. Group Study Team headed by Mr. Statan Dravsal from Argentina, consisting of 3 members.

2. Mr. Theodore L. Laufenberg, U. S. Forest Products Lab., Madison, Wisconsin, USA.

3. Mr. Kiwumulo Michael Yorn, Kawanda Research Station, Kampala, Uganda.

4. Mr. Wippich Waldenw - An den Sohanen, West Germany.

5. Mr. N. M. Manchanda, Chief Engineer, Metallurgical Consultants India Ltd. (MECON), Ranchi.

6. Dr. R. K. Singh, Director (Research), Narendra Dev University of Agriculture & Technology, Faizabad.

7. Dr. S. S. Bains, Professor of Entomology, Punjab Agricultural University, Ludhiana.

8. Sri P. Ray, Director, Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Govt. of India, New Delhi.

9. Dr. A. S. Prasad, Director (Technical), Coal Mining Planning & Design Institute Ltd. (CMPDIL), Ranchi.

10. Sri Amrendra Singh, Bureau Chief, United News of India (UNI), Ranchi.

7. PERSONNEL

A. STAFF POSITION

Class of post	No. of posts sanctioned	Total No. of employees in position	No. of SC employees	No. of ST employees
Director	1	1	Nil	Nil
Scientific				
Scientist, S	24	Nil	Nil	Nil
Scientist, S-1	22	24	1	Nil
Scientist, S-2	10	9	Nil	Nil
Scientist, S-3	4	8	2	Nil
Total	**60**	**41**	**3**	**Nil**
Technical				
Category I	46	43	5	10
Category II	36	29	1	2
Category III	4	3	Nil	Nil
Total	**86**	**75**	**6**	**12**
Administrative				
Administrative Officer	1	1	Nil	Nil
Assistant Administrative Officer	1	1	Nil	Nil
Accounts Officer	1	1	Nil	Nil
Hindi Officer	1	Nil	Nil	Nil
Superintendent	3	2	Nil	1
Senior Stenographer	1	1	1	Nil
Junior Stenographer	4	4	1	1
Assistant	8	8	1	1
Senior Clerk	13	13	Nil	2
Junior Clerk	16	14	1	3
Total	**49**	**45**	**4**	**8**
Auxiliary				
Class I	2	1	1	Nil
Class II	1	Nil	Nil	Nil
Class III	11	5	Nil	3
Total	**14**	**6**	**1**	**3**
Supporting				
Supporting I	64	52	6	21
Supporting II	45	33	3	15
Supporting III	18	14	4	5
Supporting IV	9	5	Nil	1
Total	**136**	**104**	**13**	**42**

(As on 31.12.1987)

B LIST OF STAFF MEMBERS

Sl. No.	Name of the post	Staff in position as on 31.12.87
	Director	Prof Dr R. P. Kapil
	Division of Entomology	
1.	Head of the Division	1) Sri B.B. Das up to 6.11.87 2) Sri A.H. Naqvi from 7.11.87 As incharge
2.	Scientist, S-1 (Agricultural Entomology)	1) Sri S.G. Choudhary 2) Dr A.K. Sen 3) Sri B.N.Sah 4) Dr S.K. Jaipuriar 5) Sri A. Bhattacharya 6) Sri Y.D. Mishra 7) Sri M.L. Bhagat 8) Miss P. Chandrika 9) Miss P. Rani George
3.	Field / Farm Technician (T-5)	Sri M.K. Choudhary
4.	Field / Farm Technician (T-4)	1) Sri K.U.S. Sinha 2) Sri A.K. Sahay 3) Sri R.N. Vaidya
5.	Field / Farm Technician (T-1-3)	1) Sri R.D. Pathak 2) Sri K.P. Gupta 3) Sri H.N. Shukla 4) Sri R.L. Ram
6.	Laboratory Technician (T-1-3)	1) Sri G.M. Borkar 2) Sri S.K. Chatterjee 3) Sri B. Ram 4) Sri B.B. Chakravarti
7.	Field / Farm Technician (T-2)	Sri M.L. Rabidas
8.	Laboratory Technician (T-2)	Sri G. Das
9.	Field / Farm Technician (T-1)	1) Sri D.W. Runda 2) Sri D.K. Singh
10.	Laboratory Technician (T-1)	Sri R.K. Swansi
11.	Junior Stenographer	Sri Sant Kumar up to 30.11.87
	Regional field Research Station, Dharamjaigarh (M.P)	
12.	Field / Farm Technician (T-II-3)	Sri R.S. Maliya

13.	Laboratory Technician (T-1-3)	Sri A. Hussain
14.	Field / Farm Technician (T-2)	Sri J. Lal
15.	Field / Farm Technician (T-1)	Sri P.A. Ansari

Division of Insect Genetics & Breeding

1.	Head of the Division	Sri N.S. Chauhan
2.	Scientist, S-2 (Agricultural Entomology)	Sri R. Ramani
3.	Scientist, S-1 (Agricultural Entomology)	Sri K.K. Sharma
4.	Field / Farm Technician (T-1)	Sri A.K. Sinha

Division of Plant Sciences

1.	Head of the Division	Dr P. Kumar
2.	Scientist, S-2 (Agronomy)	Dr B.P. Singh
3.	Scientist, S-1 (Plant Breeding)	Sri S.C. Srivastava
4.	Laboratory Technician (T-1-3)	Sri D.D. Prasad
5.	Laboratory Technician (T-1)	Sri Mohan Singh
6.	Field / Farm Technician (T-1)	Sri K.A. Nagruar

Division of Chemistry

1.	Head of the Division	1) Sri Shravan Kumar up to 23.11.87 2) Dr S.C. Agarwal from 24.11.87
2.	Scientist, S-4 (Organic Chemistry)	Dr B.B. Khanna
3.	Scientist, S-2 (Physical Chemistry)	Dr A.Kumar
	Scientist, S-2 (Physics)	Dr D.N. Goswami
	Scientist, S-2 (Organic Chemistry)	1) Dr B.C. Srivastava 2) Dr N. Prasad 3) Dr R.N.Majee
4.	Scientist, S-1 (Organic Chemistry)	1) Sri A.K.Dasgupta 2) Dr K.M. Prasad 3) Dr M. Mukherjee 4) Sri P.C. Sarkar 5) Sri I. Rajendran
	Scientist, S-I (Physical Chemistry)	Sri P.M.Patil
5.	Laboratory Technician (T-4)	1) Sri T.K. Saha 2) Sri N.K. Dey 3) Sri D.D. Singh 4) Sri M. Ekka 5) Dr M.K. Mishra up to 1.9.87 6) Sri S.N. Sharma

6.	Laboratory Technician (T-II-3)	Mrs. P.R. Ghatak
7.	Laboratory Technician (T-I-3)	1) Sri U.Sahay 2) Sri B.P. Keshry
8.	Laboratory Technician (T-2)	1) Sri P.B. Sen 2) Sri G. Mishra 3) Smt. P.Devi
9.	Glass Blower (T-1)	Sri B.S. Choudhary
10.	Junior stenographer	Sri B.K. Rajak

Division of Technology

1.	Head of the Division	Dr. P.C. Gupta
2.	Scientist,S-2(Physical Chemistry)	Dr. A. Pandey
3.	Scientist,S-1(Organic Chemistry)	1) Sri R.K. Banerjee 2) Sri K.K. Sharma
	Scientist,S-1(Physical Chemistry)	Sri Radha Singh
4.	Laboratory Technician (T-5)	1) Sri M.Islam 2) Sri B.P. Banerjee 3) Sri Ramesh Prasad
5.	Laboratory Technician (T-4)	Sri K.K. Prasad
6.	Senior Mechanic (T-II-3)	Sri S.K. Bhaduri
7.	Laboratory Technician (T-I-3)	1) Sri D. Runda 2) Sri N. Minz 3) Sri M.K. Singh 4) Sri Tulsi Ram

Division of Extension

1.	Head of the Division	Dr. S.K. Saha
2.	Scientist,S-1 (Agricultural Entomology)	Dr. A.K. Jaiswal
3.	Scientist,S-1.(Organic Chemistry)	Miss M. Joardar
4.	Technical Officer (T-6)	Sri A.K. Ghose
5.	Lac Information Officer (T-6)	Dr. R.K. Suri
6.	Publicity Officer (Auxiliary)	Sri Lakhan Ram

7.	Field / Farm Technician (T-5)	Sri R.C. Maurya
8.	Laboratory Technician (T-5)	Sri A. Rahman
9.	Senior Artist (T-5)	Sri R.L. Singh
10.	Commercial Artist (T-4)	Sri P. Das
11.	Laboratory Technician (T-4)	1) Sri K.M. Sinha 2) Sri D. Ghosh 3) Sri J. Singh
12.	Laboratory Technician (T-2)	Sri B.P.Ghosh
13.	Junior Artist cum Photographer (T-2)	Sri R.P. Srivastava
14.	Museum Assistant (T-1)	Kumari R. Dutta
15.	Laboratory Technician (T-1)	Sri J.K. Ambuj
16.	Junior Stenographer	Sri A.K. Sinha
	Operational Research Project	
17.	Scientist, S-2 (Agricultural Entomology), Incharge	Sri R.C. Mishra
18.	Scientist, S-1 (Agricultural Entomology)	Sri Jawahir Lal
19.	Field / Farm Technician (T-4)	1) Sri L.C.N. Shahdeo 2) Sri H. Bhengra
20.	Field / Farm Technician (T-1-3)	Sri S.S. Prasad
21.	Field / Farm Technician (T-2)	Sri K.C. Jain
22.	Field / Farm Technician (T-1)	Sri S.B. Azad
	Administrative, Audit & Accounts Section	
1.	Administrative Officer	Sri S.N.Sharma
2.	Assistant Administrative Officer	Sri R.K: Singh
3.	Assistant Accounts Officer	Sri B.S. Mishra
4.	Superintendent	1) Sri P.K. Choudhury 2) Sri H.S. Munda
5.	Assistant	1) Sri D.P. Sengupta 2) Sri R.P.Singh 3) Sri Musafir Singh

		4)	Sri Enamul Haque
		5)	Sri Md. Samiullah
		6)	Sri A.K. Lal
		7)	Sri E. Tirkey
		8)	Sri N. Mahto
6.	Senior Stenographer		Sri R. Rabidas
7.	Senior Clerk	1)	Sri A.K. Choudhury
		2)	Sri A. Haque
		3)	Sri S.K.P. Keshri
		4)	Sri R.B. Singh
		5)	Sri K.D. Pandey
		6)	Sri K.N. Sinha
		7)	Sri S. Ram
		8)	Sri D. Ram
		9)	Sri D.N. Mahto
		10)	Smt. Sati Guha
		11)	Sri K.L. Choudhury
		12)	Sri R.K. Upadhyaya
		13)	Sri N. Topno
8.	Junior Stenographer		Smt. S. Prasad
9.	Junior Clerk	1)	Sri Budhan Ram
		2)	Sri Md. Mobarak
		3)	Sri V. Ram
		4)	Sri E. Gari
		5)	Sri J.P. Srivastava
		6)	Sri N. Gope
		7)	Sri Thibu Minz
		8)	Sri B.N. Gope
		9)	Sri Ravi Shankar
		10)	Sri Anant Pandey
		11)	Sri Prahlad Singh
		12)	Sri S.C. Lal
		13)	Sri R.N. Mahto
		14)	Sri Bihari Sahu
		15)	Sri Wilson Guria
10.	Hindi Translator (T-II-3)		Sri Lakshmi Kant
11.	Driver (Auxiliary)		Sri J. Tewari
12.	Driver (T-2)	1)	Sri M. Khalkho
		2)	Sri B. Runda
	Technical and Monitoring Cell		
1.	Technical Officer (T-7)		Sri S.K.M. Tripathi
2.	Senior Technical Assistant (T-5)		Sri P. Sen up to 24.3.87

Library

1.	Senior Library Assistant (T-5)	Sri R. P. Tewari
2.	Library Assistant (T-4)	Sri V. K. Singh

Maintenance and Workshop Unit

1.	Chief Mechanic (T-II-3)	Sri S. K. Srivastava
2.	Turner (T-2)	Sri A. S. Manoranjan
3.	Instrument Maker (T-I)	Sri H. L. Bhakta

Medical Unit

1.	Authorised Medical Attendant (Part time)	Dr. S. S. Sahay
2.	Stockman-cum-Compounder (T-I-3)	Sri C. Pandey

Institute Plantation

1.	Farm Superintendant (T-7)	Sri B. K. Purakayastha up to 28.2.87
2.	Field/Farm Technician (T-I-3)	1) Sri Md. Ali Ansari 2) Sri R.C. Singh
3.	Field/Farm Technician (T-I)	Sri V. K. Tewari
4.	Tractor Driver	Sri Markus Surin

	Name	Promoted to		With effect from
	Promotion			
1.	Dr B.C. Srivastava	Scientist,	S-2	1.1.83
2.	Dr P.C. Gupta	do	S-3	1.1.84
3.	Sri S.K. Chatterjee	Technician,	T-1-3	1.1.86
4.	Sri A.K. Sahay	do	T-4	1.7.84
5.	Sri H. Bhengra	do	T-4	1.7.86
6.	Sri V.K. Singh	do	T-4	1.7.86
7.	Sri Bandhan Runda	do	T-2	1.1.86
8.	Sri S.N. Sharma	do	T-4	1.1.86
9.	Sri R.N. Vaidya	do	T-4	1.1.86
10.	Sri K.P. Gupta	do	T-1-3	1.1.86
11.	Sri Tulsi Ram	do	T-1-3	1.1.86
12.	Sri Bhola Ram	do	T-1-3	1.1.86
13.	Sri H.N. Shukla	do	T-1-3	1.7.86
	Resignation/Transfer			
1.	Dr M.K. Mishra	Laboratory Technician,T-II-3		(Resigned 1.9.87 A/N)
2.	Sri B.B. Das	Scientist,S-3		(Transferred to J.A.R.I. Barrackpore on 6.11.87A/N)
	Appointments			
1.	Sri Lakhan Ram	Publicity officer		w.e.f. 16.4.87 (F/N)
	Retirement			
1.	Sri B.K. Purakayastha	Farm Superintendant (T-7)		28.02.87 (A/N)
2.	Sri Sant Kumar	Junior Stenographer		30.11.87 (A/N)
3.	Sri B.B. Chakraborty	Laboratory Technician (T-1-3)		31.07.87 (A/N)
	Death			
1.	Sri Parimal Sen	Senior Technical Assistant (T-5)		24.3.87

8. APPENDICES

I. RESEARCH PROGRAMME - 1987

Project code No.	Project	Project Leader and Associates	Year of start	Year of completion
1	2	3	4	5
	A. DIVISION OF ENTOMOLOGY			
	Improvement in Lac Cultivation Techniques			
1.1.9	To evolve suitable management practices for brood and stick lac production in recent findings	Sri Y.D. Misra, S-1 Sri S.G. Choudhary, S-1 Sri M.L. Bhagat, S-1	1987	1992
	Physiology of Lac Insect and Associated Insects			
1.2.5	Analysis of physico-physiological factors causing lac insect preferance for host plants	Sri A.H. Naqvi, S-2	1981	1987
1.2.6	Biochemical studies on the lac insects to ascertain strain differences	Dr A.K.Sen, S-1	1981	1988
1.2.9	Determination of physical and biochemical bases of lac insect host preference	Sri A.H. Naqvi, S-2 Dr A.K. Sen, S-1	1987	1990
1.2.10	Studies on the factors influencing growth and development in the sexually reproducing female lac insect.	Dr A.K. Sen, S-1 Sri A.H. Naqvi, S-2 Sri Y.D. Misra, S-1	1987	1992
	Ecology of lac Insect and Associated Insects			
1.3.5	Ecologocial studies taken up at Dharamjaigarh, M.P.	Sri B.N. Sah, S-1		
1.3.5.1	To study the relative performance of kusum broodlac from different sources (states) at Khadgaon		1981	1988
1.3.5.2	To study the relative abundance of parasites and predators in different regions of M.P. in different crops of *kusum*		1981	1987
1.3.5.3	To study the relative abundance of parasites and predators in different reasons of M.P. in different crops on *palas*		1986	1990

1	2	3	4	5
1.3.6	Population dynamics of insect *kusmi* strain of lac to ascertain the causes of *kusmi crop* failures (First Phase)	Sri B.N. Sah,S-1 Sri M.L. Bhagat,S-1	1979	1987
1.3.8	Factors effecting *rangeeni* lac insect population clubbed with 1.3.10		1986	1990
	Control of Enemies of Lac Insect			
1.4.3	Effect of insecticides on the lac insect, *Kerria lacca* (Kerr) and the associated fauna		1986	1990
1.4.3.1	Screening of insecticides for their safety to the lac insects and toxicity to the lac predators	Sri S.G. Choudhary,S-1		
1.4.3.2	Screening of plant poisons for their safety to the lac insect and toxicity to the lac predators	Sri A. Bhattacharya,S-1		
1.4.3.3	Effect of insecticides (safer to lac insect) against harmful parasites of lac insects.	Sri S.G. Choudhary, S-1		
1.4.3.4	Effect of insecticides (safer to lac insect) against beneficial parasites of lac insects.	Sri Y.D. Misra,S-1		
1.4.3.5	Effect of the recommended control schedule on the associated fauna of lac insect under field conditions	Sri B.N. Sah, S-1 Sri S.G. Choudhary, S-1		
1.4.3.6	Hormoligatory effect of the insecticides on the lac insects.	Sri S.G. Choudhary,S-1 Dr A.K. Sen, S-1		
1.4.3.7	Treatment of broodlac with selective insecticides	Sri A. Bhattacharya, S-1 Sri S.G. Choudhary, S-1		
1.4.9	Studies on application of insect growth regulators for the control of major lac predators.	Sri A. Bhattacharya, S-1	1984	1988
1.4.13	Studies on the economic threshold of *Eublemma amabilis and Holcocera pulverea* infesting lac crop	Sri S.G. Choudhary, S-1	1981	1987
1.4.16	Effect of intercropping of cotton and okra with lac hosts on the incidence of lac predators *Eublemma amabilis and Holcocera pulverea.*	Sri B.B. Das, S-3 Dr B.P. Singh, S-2 Sri A. Bhattacharya, S-1	1986	1991

1	2	3	4	5
1.4.17	Survey of the pathogenic micro-organisms and their effect on the development of lac insect	Sri B.B. Das, S-3	1986	1991
	Studies on Germplasm of Lac Insects			
1.5.8	Studies on germplasm collection, conservation and characterisation of indigenious exotic lac insect	Dr S.K. Jaipuriar,S-1	1976	1989
1.5.11	Studies on chromosomal behaviour of lac insect strains	Dr S.K. Jaipuriar,S-1	1981	1987
	B. DIVISION OF INSECT GENETICS AND BREEDING			
	Lac Insect Genetics			
6.1.1	Studies on sex determination in lac insects	Sri N.S. Chauhan,S-3	1980	1987
6.1.2	Survey of genetic variation in lac insects	Sri R. Ramani, S-2 Sri K. K. Sharma, S-1	1986	1988
	Lac Insect Breeding			
6.2.1	Mutation studies in lac insects	Sri N.S. Chauhan, S-3	1986	1989
	C. DIVISION OF PLANT SCIENCES			
	Propagation and Management of Lac Host Plants			
2.1.2	Management of *bhalia* for lac cultivation	Dr. B.P. Singh, S-2	1975	1987
2.1.3	Integration of lac cultivation with general agriculture under dry farming conditions.	Dr B.P. Singh, S-2	1978	1993
2.1.6	Agricultural utilization of lac mud as organic manure	Dr. B.P. Singh, S-2	1981	1992
2.1.9	Standardisation of forestry practices for raising high yielding *kusum* through air-layering.	Sri S.C. Srivastava, S-1	1980	1990
	Genetics and Breeding of Lac Host Plants			
2.2.3	Evaluation and improvement of arhar varieties for lac yield as well as pulse production	Dr P. Kumar, S-3 Sri S.C. Srivastava, S-1	1978	1988
2.2.6	Survey of genetic variation in lac potential of host plants	Sri S.C. Srivastava, S-1 Dr P. Kumar, S-3 Sri Y.D. Mishra, S-1	1985	1990

1	2	3	4	5
2.2.7	Survey, collection, maintenance, evaluation and characterisation of lac hosts.	Dr P. Kumar, S-3	1987	1992
	D. DIVISION OF CHEMISTRY			
	Chemistry of Lac/Constituents			
3.1.8	Biophysical studies on the interaction between laccaic acid and DNA.	Dr. D. N. Goswami, S-2 Dr. K. M. Prasad, S-1 Dr. N. Prasad, S-2	1982	1987 (Completed)
3.1.9	Thermal polymerization of lac-Studies on the molecular weight, shape and size	Dr. A. Kumar, S-2	1983	1988
3.1.11	Isolation of jalaric acid from lac on technical scale	Dr. N. Prasad, S-2 Dr S. C. Agarwal, S-3	1983	1987 (Completed)
	Modifications of Shellac/Constituents and their Utilisation			
3.3.6.2	Modification of lac/hydrolysed lac with (ii) polyisocyanates	Sri B. B. Khanna, S-4 Sri. P. M. Patil, S-1	1983	1987 (Completed)
3.3.11	Modification of lac with ethyl cellulose	Sri A. K. Dasgupta, S-1	1983	1987
3.3.12	Modification of lac wax	Dr. K. M. Prasad, S-1 Dr B. B. Khanna, S-4	1984	1988
3.3.13	Studies on lac based cation-exchange resin as catalyst	Dr. B. C. Srivastava, S-2	1987	1989
	Use of Shellac and Modified Shellac in Surface Coating			
3.4.5	Studies on anticorrosive primers/paints for use on ferrous metals	Sri Shravan Kumar, S-4 Dr. M. Mukherjee, S-1 Sri A. Rahman, T-5	1981	1987
3.4.6	Styrenation of lac-oil combinations	Dr. B. B. Khanna, S-4 Sri P. M. Patil, S-1	1986	1988
3.4.7	Modification of by product obtained during the preparation of aleuritic acid and its use in surface coatings.	Sri A. K. Dasgupta, S-1	1987	1990
	Use of Lac for Encapsulation and Controlled-Release			
3.5.5	Slow-release lac urea formulation for animal feed.	Dr. B. C. Srivastava, S-2	1987	1989

1	2	3	4	5
	Electrical Properties of Lac and modified Lacs			
3.6.3.	Study on the tracking resistance of shellac based varnishes	Dr. D. N. Goswami, S-2	1986	1989
3.6.4	Studies on the modification of lac for use as high thermal class insulating varnishes	Dr. M. Mukherjee, S-1 Sri Shravan Kumar, S-4 Dr. D. N. Goswami, S-2	1987	1989
	Studies on Biochemical Aspects of Insect Host Plant Relationship			
3.8.1	Transformation of sap constituents and its incorporation in lac secretion	Prof Dr. R. P. Kapil, Director Dr S. C. Agarwal, S-3 Dr. P. Kumar, S-3 Dr. A. K. Sen, S-1 Dr K. M. Prasad, S-1 Sri P. C. Sircar, S-1	1987	1992
	E. DIVISION OF TECHNOLOGY			
	Improvement in the Processing Techniques			
4.1.6.2	Improvements in dewaxing and decolourising technique in solvent medium	Sri R. K. Banerjee, S-1	1980	1987
4.1.8	To study the industrial parameters affecting the preparation of bleached lac	Sri R. .K. Banerjee, S-1	1987	1991
	Rubber-Shellac Combinations			
4.2.1	Incorporation of modified lacs into rubber	Sri R. Singh, S-1 Dr. B. B. Khanna, S-4	1973	1987 (Completed)
4.2.2	Electrical properties of rubber-shellac blends	Sri R. Singh, S-1 Dr. D. N. Goswami, S-2 Dr. B. B. Khanna, S-4	1983	1988
	Use of Lac in Adhesives			
4.3.5	Modified lac (with synthetic resins) as adhesives.	Dr. P. C. Gupta, S-3	1987	1990
4.3.5	Use of lac by products for making coal blocks	Dr P. C. Gupta, S-3	1987	1990
	Use of Lac in Printing Inks			
4.5.1	Development of printing inks based on lac/modified lac.	Dr Dr. A. Pandeys, S-1	1987	1992

1	2	3	4	5
	Ad - hoc Research			
	Preparation of Improved cation exchange resin from shellac on large scale	Dr P.C. Gupta, S-3 Sri K. K. Sharma, S-1		
	F. DIVISION OF EXTENSION			
5.5	Operational Research Project for Maximising Lac Production in Chhotanagpur Area	Sri R. C. Mishra, S-2 Sri J. Lal, S-1	1975	1992
5.6	Pilot studies on pre-harvest forecasting of yield of stick lac	Dr S. K. Saha, S-4 Dr A. K. Jaiswal, S-1 Dr B. H. Singh, S-1 (IASRI)	1987	1991
	Ad - hoc Research			
	Shellac based abrasive stone for polishing marbles	Dr S. K. Saha, S-4		

II. METEOROLOGICAL DATA - 1987

Month	Mean barometric pressure (mm)	Mean maximum temperature (°C)	Mean minimum temperature (°C)	Highest maximum temperature (°C)	Lowest minimum temperature (°C)	Mean dry bulb temperature (°C)	Mean wet bulb temperature (°C)	Mean humidity (per cent)	Total rain fall (mm)
January	709.12	27.18	8.57	26.6	5.5	16.21	14.11	79.16	12.6
February	708.31	27.80	11.90	32.0	8.3	20.80	17.80	75.00	38.8
March	705.18	31.35	15.67	36.5	12.2	27.17	20.37	65.38	7.4
April	681.50	36.65	20.49	40.0	16.1	29.96	23.95	60.86	9.4
May	701.68	37.06	22.74	43.0	16.6	31.19	22.24	65.22	34.4
June	697.57	37.45	24.88	41.5	22.2	31.20	27.63	75.83	95.0
July	698.08	30.33	22.92	33.0	21.1	26.04	24.74	90.09	482.6
August	699.11	29.87	22.94	34.0	20.0	25.93	24.74	90.74	329.4
September	700.97	30.56	22.62	33.5	21.6	26.61	25.03	88.06	230.2
October	706.67	30.62	18.67	34.0	11.6	25.77	22.98	78.54	0.6
November	707.38	27.81	11.26	32.0	7.7	20.10	18.05	82.06	96.2
December	709.89	25.09	9.39	28.0	7.2	17.59	15.25	78.22	12.4

Highest maximum temperature	:	43°C on 24th May
Lowest minimum temperature	:	5.5°C on 1st, 2nd & 5th January
Total rain fall	:	1349.0 (110 mm more than 1986)
Monsoon rain fall (June-September)	:	1137.2 mm
Hail storm	:	2nd March

III. PRODUCTION & EXPORT OF LAC

I. Production of sticklac during 1987 - 88
(metric tonne)

Statewise		Cropwise	
Bihar	7,575	Baisakhi	8,750
Madhya Pradesh	5,170	Katki	3,400
West Bengal	1,070	Jethwi	1,000
Maharashtra	105	Aghani	1,450
Utter Pradesh	420		
Other States	260		
Total	14,600		14,600

Source : Directorate of Lac Development, Ranchi

II. Gradewise export of lac during 1987 - 88

	Quantity (tonne)	Value (rupees)
Shelac & Button lac	4,705	15,66,81,000
Seed lac	341	84,38,000
Other lac	3	10,75,000
Total	5,049	16,61,94,000

Source : Shellac Export Promotion Council, Calcutta.

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