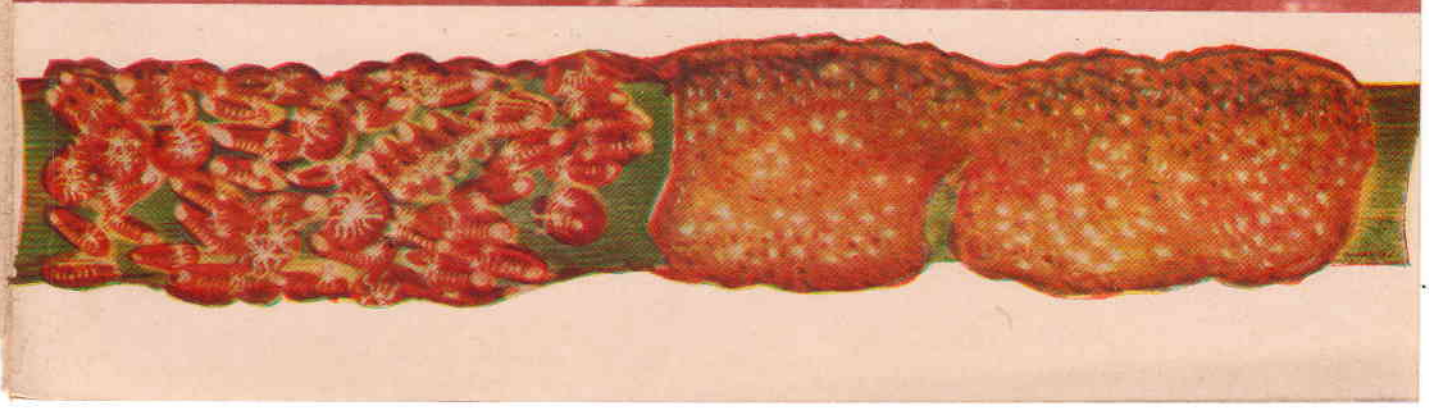
INDIAN LAC RESEARCH INSTITUTE
RANCHI-834010 INDIA

ANNUAL PROGRESS REPORT 1986



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RANCHI - 834 001 (Bihar) INDIA

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI - 110 001

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INDIAN LAC RESEARCH INSTITUTE

Annual Report for 1986, *Namkum, Ranchi*-834010, *India*

ANNUAL REPORT

(January 1986 — December 1986)

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Explanation of cover

Figure on top right in window: A female lac insect
Central figure: Lac secretion gland in active secretion of resin droplets
Bottom figure: Male and female lac insect cells and mature lac on *Zizyphus mauritiana*

CONTENTS

1. PROLOGUE — DIRECTOR'S VIEW-POINT AND NEW CHALLENGES

In spite of the fact that the Institute has struggled through past sixty years and if the techno-scientific directions would have been channelised in a fashion to achieve excellence, there would have been no wonder that the Institute could have attained an International status. But this could not happen for many bizarre reasons and for that matter some bright points that emerged through the hard work of a certain number of devoted research workers were sadly got clouded. This is a small dismal story of this Institute and its working. It is not yet too late to recover provided the Indian Council of Agricultural Research, New Delhi lends a full administrative and liberal financial support matching the present and future needs of the Institute so that it gains its glory of which the Council may be proud of during the future years to come and stop throwing up arms in despair by now.

In order to achieve this goal, the research programmes for the year 1987 have been revamped on the following lines:

(i) All biological work concerning host plant and lac insect has been reorganized to improve the existing lac cultivation technology and addition of more technological steps drawn through better cultivation and management of host plants and genetical improvement of the lac insect. Creation of *de novo* brood lac production technology is a step absolutely necessary for future improvement in the production of quality lac.

(ii) The chemical and technological works/ projects have been redirected for improvement of the technologies already evolved by the Institute and its upscaling besides development of new products and processes to meet the future requirements of growing industries like electronics, pharmaceuticals specially family planning, microsurgery etc.

Expectedly, some results from the planning of research on above lines shall be available in five years from now are likely to add a new dimension to the future growth of lac based industries. It is further expected that the production of lac may increase 3 to 4 times besides production of final products to substitute imports of some and export of others not produced elsewhere in the world. The national value of lac and its products shall be enhanced by the same factors as increase in the production of lac adding hence to the national exchequer rupees one hundred fifty crores and generation of six-seven million more jobs specially in the tribal areas of the country.

General information

The Indian Lac Research Institute which has been functioning under the administrative control of the Indian Council of Agricultural Research, New Delhi since April 1966, is located at Namkum (9 km east of Ranchi town) and the area has ecologically mild salubrious climate, the temperature varying between 24°C in January and 41°C in April-May. The total rainfall during the year has been 1239·4 mm of which the monsoon rainfall was 836·0 mm. The Institute has an area of 49 ha, split into three sections. Of these, two are comprised of Institutional campuses and the third is a plantation area, spreading over 36·5 ha.

Aims and objectives

The Institute aims to serve the country with the following mandate:

☐ Development of brood lac cultivation technology based on selection, hybridization,

mutation research and studies on ecological genetics of lac insect for obtaining lac with improved physico-chemical properties.

☐ Development of lac cultivation schedule technology and its improvement for increased production per unit tree or area.

☐ Development of technologies for improvement of host plants and crops by conventional methods of breeding and somatic hybridisation techniques. Improvement for agrosilviculture and silviculture pasture systems for utilization of waste lands for lac production.

☐ Development for improvement and standardization of raw lac processing techniques to convert it into middle stage lac products.

☐ To conduct problem-oriented studies both on the fundamental and applied aspects of lac chemistry in order to make improvement and desired modifications for developing fine chemicals and such products which may increase the utilization of lac in newer fields and various industries related to surface coatings, adhesives, printing ink, electrical, drugs and pharmaceuticals, perfumery, rubber, agro-based etc.

☐ To conduct pilot-plant studies for obtaining process design and engineering data and to determine techno-economic feasibility.

☐ Transfer of established technology to the lac cultivators and industrialists/entrepreneurs through publicity by various mass communication means, training by refresher and short-term courses to personnel from industries, State Forest and Industries Departments, Khadi and Village Industries, field project officer, ex-servicemen etc.

☐ Conducting International training programme for candidates nominated under bilateral programmes between the Government of India and Governments of friendly countries, nominees of FAO/UNDP and other international agencies. Programme include Post-Graduate Diploma Course in Lac Technology for one year and six month's Refresher Course in either brood lac and lac cultivation technology or in the Products and Processing Technology depending upon choice/requirements. These courses will also be open to national candidates.

Organisational set-up

The main campus of the Institute has an agglomeration of laboratories for the Divisions of Chemistry, Entomology, Extension, Insect Genetics and Breeding and Plant Sciences. The second campus has laboratories for Technology Divisions. The Institute is headed by a Director, the present one being 10th in six decades. The divisions are headed by their respective head of divisions. The organizational set-up of the Institute is depicted on page no. 3.

RESEARCH HIGHLIGHTS

Entomology Division

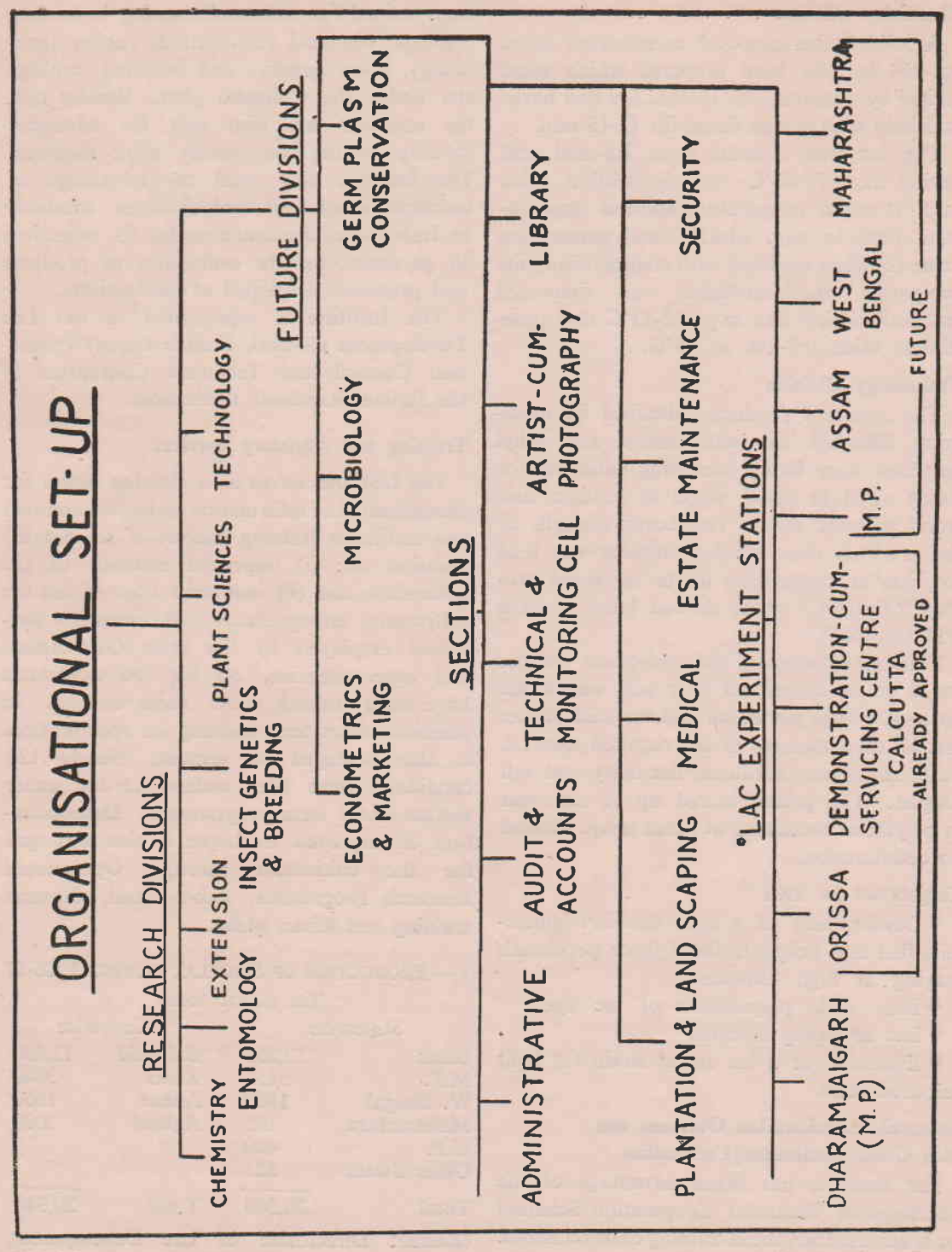
Two new insecticides, Diptrex (trichlorfon) and Evisect (thiocylam) have been found to be safe against lac insects and highly effective against predators making comparisons with Endosulfan (thiodan), the only insecticide so far found in use for the control of predators and safe to lac insects. In other words, diptrex can replace endosulfan at 0·05 per cent concentration.

Insect Genetics and Breeding Division

The new colour forms discovered last year reappeared in some of the progenies reared after one generation of fullsibmating suggesting that the new colour differences are genetic.

The sex ratio of Meghalaya stock of lac insects varied widely with the host tree, the mean female percentage being 28, 18 and 2 on *bhalia* (*Moghania macrophylla*), *arhar* (*Cajanus cajan*) and *ber* (*Zizyphus mauritiana*) respectively.

Study of crosses of lac insects of widely separated regions (Punjab, Orissa, Bihar and Meghalaya) has provided the first known case of reproductive isolation in these insects. The Meghalaya stock has failed to produce any progeny in crosses with the others.


ORGANISATIONAL SET-UP
RESEARCH DIVISIONS
CHEMISTRY
ENTOMOLOGY
EXTENSION
INSECT GENETICS & BREEDING
PLANT SCIENCES
TECHNOLOGY
FUTURE DIVISIONS
ECONOMETRICS & MARKETING
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DHARAMJAIGARH (M.P.)
ORISSA
DEMONSTRATION-CUM-SERVICING CENTRE CALCUTTA ALREADY APPROVED
M.P.
ASSAM
WEST BENGAL
MAHARASHTRA
FUTURE

Chemistry Division

A solid igniter-cum-fuel composition based on *kiri* lac has been prepared which when ignited by a match stick catches fire and burns smoothly with a high flame for 12-15 min.

The lac wax isolated from lac-mud and having m.p. 77-78°C and penetration value as 5 at room temperature showed improvement both in m.p. 84-85°C and penetration value (2) when modified with sodium bisulphite comparing the carnuaba wax (imported material) which has m.p. 82-83°C and penetration value 0·9-2·4 at 25°C.

Technology Division

The resultant products, obtained by modifying bleached lac with methyl and ethyl acrylates, were found promising adhesives for fixing wood to wood, wood to sunmica and wood to mild steel. The bond strength of the products over wooden surfaces was 0·24 ton/inch^2 in comparison to the marketed product " Fevicol " which showed bond strength 0·15 ton/inch^2.

The manufacturing of red-oxide primer based on lac-linseed oil fatty acid was scaled up to 100 litres per batch and the said primer met all the standards of the required tests i.e. water resistance, hardness, flexibility and salt droplet. The primer stored up to one year in polythene containers at room temp. showed no deterioration.

Targets set for 1987

- Development of a coal dust-*kiri* ignitor-cum-fuel and briquette for defence personnels staying at high altitudes
- Pilot scale preparation of lac dye
- Lac scrapping machine
- Evolution of a lac insect strain for light coloured resin

Research Collaboration Overseas and with Other Institutions/Universities

The Institute has taken advantage of the International Technical Cooperation Schemes for specialised advanced training to its scientists. Seven scientists of the Institute have so far been trained for advanced training in surface coatings, chemical constitution, rubber technology, insect genetics and breeding, ecology etc. under the Colombo plan. Besides this, the scientists are also sent for advanced training withing the country when required. The Institute also avail the advantage of technical know-how and facilities available in Institutions/Organizations for its objectives in particular for the evaluation of products and processes developed at the Institute.

The Institute is represented in the Lac Development Council, Shellac Export Promotion Council and Technical Committee of the Indian Standards Institution.

Training and Advisiory Services

The Institute serves as a clearing house for dissemination of information on lac and conduct two certificate training courses of six months duration on: (i) improved methods of lac cultivation and (ii) industrial uses of lac for cultivators, entrepreneurs and extension personnel employed by the State Government and other agencies. So far 750 candidates have been trained under these courses. In addition, short term training on specific lines is also arranged on request. Nearly 120 candidates have been trained so far under various short term programmes. Demonstration of improved technique is also arranged for the cultivators through Operational Research Programme, Lab-to-Land, On-farm training and Kisan Melas.

I — PRODUCTION OF STICKLAC DURING 1986-87
(in metric tons)

Statewise		Cropwise	
Bihar	12,355	*Baisakhi*	12,690
M.P.	5155	*Katki*	3940
W. Bengal	1800	*Jethwi*	1630
Maharashtra	105	*Aghani*	2080
U.P.	400		
Other States	525		
Total	20,340	Total	20,340

(*Source*: Directorate of Lac Development, Ranchi)

II — GRADEWISE EXPORT OF LAC DURING 1986-87

	Quantity (tons)	Value Rs
Shellac and buttonlac	6487	24,65,77,000
Seedlac	350	97,63,000
Others	22·5	3,79,000
Total	6859·5	25,67,19,000

(*Source*: Shellac Export Promotion Council, Calcutta)

Honours and awards

Mr K. M. Prasad, Scientist, S-1 (Organic Chemistry) was awarded the degree of Doctor of Philosophy by Ranchi University for his thesis entitled " Studies on the Constitution of Lac Wax ".

Dr N. Prasad, Scientist, S-2 was awarded Second prize by Nagar Rajbhasha Karayanvan Samiti, Ranchi for " Hindi Essay Competition ".

2. PROGRESS OF RESEARCH

A. DIVISION OF ENTOMOLOGY

(a) RESEARCHES COMPLETED

Entom. 3.9 Studies on the Lac Larval Settlement and Factors Affecting it

The aim of the project was to study the behaviour of the larval settlement in lac insect to determine the key factors influencing settlement in lac insects with the ultimate objective of improving the host plant coverage.

The following aspects of the larval settlement behaviour have been studied under this project: (i) emergence behaviour of lac larvae, (ii) behaviour of the crawlers, (iii) behaviour and pattern of settlement, (iv) mortality soon after settlement.

(i) *Emergence behaviour of lac larvae*

Behaviour of the mature female, formation of yellow spot and development of brood chamber have already been studied by previous workers in detail. In the present work emphasis has been given on the emergence behaviour of young crawlers from *kusmi* and *rangeeni* brood lac in different crop seasons. A set of five brood sticks was taken for observation and five individual females in the brood lac were watched constantly for the emergence of lac larvae. The emergence of lac larvae in *katki*, *baisakhi* and *aghani* crops start at sun rise (+10 minutes) and in *jethwi* one hour (+15 minutes) after sun rise. The peak of emergence is achieved after 2-3 hrs of onset and finishes at 12 noon. In cloudy days particularly during the rains, emergence stops and restarts when the rain is over. The rate of emergence of larvae from the mother cells was observed to vary from 5 larvae per hour to 150 larvae per hour. This variation in the rate of emergence appears to be determined by the number of larvae present in the brood chamber, size of the anal opening and weather conditions.

(ii) *Behaviour of the crawlers*

Crawlers were minutely observed under binocular for behavioural studies. Speed of the larvae was measured on graph paper by tracking the crawling path of the larvae and noting the time. The lac insect larvae immediately after emergence starts crawling at random in adjacent areas with an average speed of 2·04+0·142 meters per hour in search of proper site for feeding. Site selection behaviour was studied on potted *bhalia* (*Moghania macrophylla*) host. After crawling for some time the larvae start finding out the proper place of settlement by repeatedly piercing the shoot. When proper site for food is obtained the larvae start sitting on the twigs with legs spread out. These sitting larvae shift their position when exposed to adverse conditions like direct sun light, but when left as such they withdraw the legs under ventral surface of body and settle down on the twigs.

(iii) *Behaviour and pattern of settlement*

To study the proper time of settlement, a number of *bhalia* plants were inoculated with fresh larvae at an interval of one hour from

commencement of emergence. It was found that irrespective of time of emergence the process of sitting and complete settlement of larvae never starts before 10.30 a.m. and 12.30 p.m. respectively in all the crops except *jethwi* in which regular pattern was observed. This clearly indicates that the instinct of settlement of larvae has no relation with the age of the crawlers.

The pattern of larval settlement in relation to sex was studied and found that the males show a strong tendency to settle facing upper end of the shoot but not the female. On this basis a rough estimate of sex ratio can be made right at the time of larval settlement by magnitude of differences of lac larvae facing the two ends of the shoot.

The inclination of shoot from the ground level has also been found to affect the pattern of larval settlement. The shoots inclined from 0° to 60° from the ground level show partial coverage, whereas those which are erect i.e. inclined at 75° to 90° show all-round coverage of the shoot. This effect of inclination is probably due to photo negative nature of lac larvae which avoid direct sun light. In case of inclined shoots, half portion is exposed to direct sun light whereas erect shoots are shaded by crown of the plant.

(iv) *Mortality of lac larvae soon after settlement*

Twenty *M. macrophylla* bushes were taken to study the plant effect on the initial mortality of lac larvae following settlement. The bushes were inoculated with brood lac and sampled for mortality counts after 10 days of inoculation. Five shoots from each bush were cut and mortality counts were made from five equidistant sectors from each shoot.

Table 1 shows the per cent mortality of lac nymphs in 20 bushes of *bhalia*. Highest mortality was observed in the bush at Sl no. 1 and 2 which are highly significant than all other bushes. Similarly mortality of lac

TABLE 1 — THE EFFECT OF HOST PLANT (*bhalia*) ON THE MORTALITY OF LAC NYMPHS (ARRANGED IN DESCENDING ORDER OF MORTALITY)

Sl No.	Mortality %
1	34·20
2	32·63
3	25·05
4	24·49
5	23·95
6	22·84
7	22·73
8	22·30
9	21·86
10	20·79
11	20·30
12	17·85
13	17·08
14	16·85
15	16·28
16	15·81
17	15·57
18	15·57
19	12·04
20	9·78
C.D. at 5%	5·66
C.D. at 1%	7·44

TABLE 2 — THE EFFECT OF DIFFERENT SHOOTS VIS-A-VIS DIFFERENT SITES ON THE MORTALITY OF LAC NYMPHS

Shoots	Sites					
	I	II	III	IV	V	Average
1	26·58	28·83	19·95	18·76	17·52	22·33**
2	21·22	26·30	22·92	17·01	18·90	21·27*
3	20·01	24·21	17·57	16·97	19·37	19·63
4	22·25	24·73	22·67	15·89	16·36	20·38
5	18·76	20·57	20·00	16·38	14·22	17·99
Average	21·76	22·93**	20·62	17·00**	17·27	
		C.D. at 1%	3·56			
		at 5%	2·59			

nymphs in bush at Sl no. 20 is significantly lower than all others except 19.

Table 2 indicates the per cent mortality in different shoots vis-a-vis different sites. Highest mortality was recorded in shoot no. 1 and 2 in succession from the ground level which differs significantly from shoot no. 5. Similarly, among the sites, site no. 2 i.e. second from the base shows significantly higher mortality from site no. 4 (just below the apical region). This shows that not only the individual plant genotype has its influence on the survivality of lac nymphs but also spatial condition like different shoots of the same plant and different sites within the same shoot also influence the survivality.

(Y. D. Mishra)

(b) RESEARCHES IN PROGRESS

Entom. 2 Physiology of Lac Insects and Associated Insects

Entom. 2.2 Evolution of a Suitable Synthetic Diet for Artificial Rearing of Lac Insect

Rearing trials were repeated during *jethwi* 1986 and *aghani* 1986-87 seasons with certain modification in the synthetic diet.

During *jethwi* 1986 season lac larvae were reared on usual substrate of agar slants soaked with two types of diet (i) used during *baisakhi* 1985-86 i.e. consisting of 2·32 g amino acids, 0·222 g vitamins, 0·004 cholesterol, 0·202 g mineral salts, 15 g sucrose, 0·15 g sorbic acid and 100 ml double distilled water and (ii) a mixture of 50% of above diet and 50% of water extract of *bhalia* leaf obtained by soaking 150 g leaf in 150 ml distilled water overnight and crushing it in mortar and pestle and finally filtered it through fine muslin cloth. Performance of lac larvae as compared visually on the basis of production of waxy filaments, excretion of honey dew, resin secretion as well as survivality was better in diet no. II, in which 80% of larvae survived for a maximum period of 42 days whereas on diet no. I only 10% larvae survived up to 35 days. Sudden and severe fungal attack caused total mortality of lac larvae after 35 and 42 days in diet nos. I and II respectively.

During *aghani* 1986-87 season, encouraging results shown by leaf extract of *bhalia* the trial was made with certain modfications. Plain diet consisting of water extract of *bhalia* leaf (as above), 5 g sucrose and 0·15 g sorbic acid was used to feed the lac larvae through agar slants. Survival of lac larvae was 90, 63·5, 50 and 35 per cent for 10, 30, 45 and 55 days respectively. Since the substrate was destroyed by severe fungal contaminations, only few larvae could survive for 62 days.

(A. H. Naqvi)

Entom. 2.5 Studies on Some Physiological Aspects of Lac Insect in Relation to Host Plants

During *baisakhi* 1986-87 season, the experiment was repeated on 128 potted plants of *bhalia* with some modifications in application technique and dosages of N, P and K. Out of 128 potted plants, 16 each were supplied with fertilizers, namely, N, P and K under A, B, C, D, E, F and G treatments (i.e. for N, P, K, N+P+K, N+P, N+K and P+K respectively) and 16 plants were kept under control. For N, 10 g of urea per pot was used in split doses, first at the time of sowing, second after 3 weeks, third at the time of inoculation of plants with lac larvae and 4th at sexual maturity of lac larvae. For P and K, 50 g and 8 g of single super phosphate and murate of potash respectively were used at the time of sowing of seed in single dose. Response of shoot growth to fertilizers was not distinct in any of the hosts under any treatment as evident from the height (ranging from 1 ft to 1·1/2 ft). Inoculation of all the plants was done with lac larvae as per schedule during October 1986. Density of larval settlement and initial mortality was recorded

TABLE 3 — SHOWING LARVAL SETTLEMENT AND PER CENT INITIAL MORTALITY PER CU CM

Treatment	Fertilizer applied	Per cent (i) mortality	No. of larvae (ii) settled per 1 cm length of shoot
A	N	38·53 (39·25)	10·53 (110·50)
B	P	51·93* (61·82)	9·12 (84·75)
C	K	52·50* (62·63)	9·60 (92·50)
D	N+P+K	39·09 (40·32)	9·73 (96·62)
E	N+P	47·75 (54·51)	9·76 (97·50)
F	N+K	49·21 (57·29)	9·86 (98·87)
G	P+K	54·40** (65·91)	8·53 (73·50)
H	Control	44·90 (49·75)	9·31 (98·12)
	C.D. at the rate of 5%	6·69	1·38
	C.D. at the rate of 1%	8·94	NS

(i) Data transformed into degrees ($P = \sin^2 \theta$). Figures in the parentheses are original value.

(ii) Data transformed into $\sqrt{n+1}$. Figures in the parentheses are original values.

in 1 cm length of shoot from the sample collected from middle region of main shoot. Data on settlement and initial mortality recorded by the end of year under report are presented in Table 3.

The data indicate that treatments B, C and G had significantly higher mortality than control. Treatment A, however, had the lowest mortality and was highly significantly superior to all others except the treatment D and H. Phosphorus and potash alone or in combination increased the mortality and the treatments involving potash had highest average mortality. This indicates that nitrogen has the tendency to reduce the mortality and the potash to increase it.

Regarding the settlement of crawlers per unit area, it was found again that treatment A had the highest density of larval settlement which is significantly superior to treatment G and B thus indicating that nitrogen application also supports higher settlement of larvae in the middle region of the main shoots.

(A. H. Naqvi)

Entom. 2.6 Biochemical Studies on Lac Insects to Ascertain Strain Differences

The experiment was repeated during the year for *jethwi* '86 generation to isolate and identify the fat contents. The extraction of fat was done as per the method described earlier. The extract, so obtained, was fractionated on silica gel column. Four fractions of the material were obtained by successive elution with petroleum ether, benzene, benzene+ether (10%) and ether alone. These fractions when subjected to TLC revealed to be consisting of two, four, six and three components. The respective Rf values are as follows:

Fraction I 0·58 and 0·73
Fraction II 0·58, 0·66, 0·73 and 0·84
Fraction III 0·02, 0·10, 0·17, 0·58, 0·66 and 0·73
Fraction IV 0·02, 0·10 and 0·17

It was confirmed that *jethwi* insects (crawlers) contain 7 components of fat.

Out of the above, the components of fraction-I have been separated out by PLC and further purified by TLC using solvent system hexane: ether: acetic acid (70 : 30 : 0·5 v/v).

(A. K. Sen and K. M. Prasad)

Entom. 1.9 Ecological Studies on Lac Insects and Associated Insects

Entom. 1.3.5 Ecological studies taken up at Dharamjaigarh, M.P.

The Regional Field Research Station at Dharamjaigarh, M.P. continued to function

TABLE 4 — RELATIVE ABUNDANCE OF INIMICAL AND BENEFICIAL INSECTS IN DIFFERENT LOCATIONS AND CROPS

Kusmi crops

Crop	Inimical parasite						Beneficial parasite						Predators					
	Bastar	Bilaspur	Hoshangabad	Raigarh	Raipur	Mean	Bastar	Bilaspur	Hoshangabad	Raigarh	Raipur	Mean	Bastar	Bilaspur	Hoshangabad	Raigarh	Raipur	Mean
Aghani 1985-86	10·82	7·63	5·94	18·87	11·30	10·91	12·37	11·56	2·02	16·68	10·28	10·58	28·76	44·19	41·01	81·12	51·04	49·22
Jithwi 1986	1·62	—	9·00	1·11	—	2·93	1·35	—	0·30	1·92	—	0·89	27·77	—	18·30	64·81	18·00	32·22
Aghani 1986-87	10·66	—	31·50	28·50	7·30	19·49	10·00	—	9·00	76·29	17·28	28·14	16·44	—	8·00	231·10	42·00	74·39
Mean	7·70	7·63	15·48	16·16	6·20		7·91	11·56	3·77	31·63	9·19		24·32	44·10	22·44	125·68	37·01	

Rangeeni crops

	Bilaspur	Mandla	Umaria	Mean	Bilaspur	Mandla	Umaria	Mean	Bilaspur	Mandla	Umaria	Mean
Baisakhi 1985-86	19·00	3·00	5·30	9·10	4·00	2·50	0·16	2·22	51·50	19·50	3·66	24·88
Katki 1986	75·20	31·75	39·50	48·82	117·50	50·25	36·50	68·08	287·50	114·75	88·50	163·58
Mean	47·10	17·37	22·40		60·75	26·38	18·33		169·50	67·13	46·08	

during the period under report. Following investigations were carried out:

(c) Survey of inimical and beneficial insects associated with *kusmi* and *rangeeni* lac in the region.

The study was continued in *aghani* 1985-86, *jethwi* 1986 and *aghani* 1986-87 crop. Data on the *rangeeni* crops were also collected this year in *baisakhi* and *katki* '86 crop seasons. Samples of lac twigs generally weighing 4 kg were collected from different localities of Madhya Pradesh as mentioned earlier for *kusmi* crop. For *rangeeni* crops, samples (2 kg) were collected from Bilaspur, Mandla and Umaria districts. Samples were caged at RFRS, Dharamjaigarh and emergence of insects were recorded daily for two months from the date of caging. The samples collected from *aghani* 1985-86 and caged in December 1985 under observation till February 1986. Hence, the emergence data obtained in January and February were included in the last years' report. Results are presented in Table 4. Total number of species isolated in different *kusmi* and *rangeeni* seasons were 6 inimical parasites, 7 beneficial parasites and 3 predators. *Tetrastichus purpureus* and *H. pulverea* were the most dominant inimical parasite and predator respectively in all the places and in all the seasons. Among parasites *A. tachardiae* was most dominant followed by *A. fakhrulhajiae* in all the seasons except in *baisakhi* where *A. fakhrulhajiae* was most dominant. It was also observed that all the three categories of insects were more abundant in rainy season crops (*aghani* and *katki*) than summer crops (*baisakhi* and *jethwi*). Locationwise abundance of all the three categories of insects were highest in Raigarh and Bilaspur district for *kusmi* and *rangeeni* crops respectively. This result, however, differs from that of last year when no definite trend was noticed.

(d) To study the relative performance of *kusum* brood lac from different sources.

The study was continued in *aghani* 1985-86, *jethwi* 1986 and *aghani* 1986-87 crop. The trials were conducted in RBD with 5 replications (2 *kusmi* trees in each replication). Number of treatments were 4 in *jethwi* crop and three in *aghani* crop. Crop wise details are given below and the results are presented in Table 5.

TABLE 5 — SHOWING THE RATIO OF BROOD LAC AND YIELD OF LAC FROM DIFFERENT SOURCES

Sources of brood lac	*Aghani* 1985-1986				*Jethwi* 1986			
	1st generation		2nd generation		1st generation		2nd generation	
	Brood lac used to brood lac obtained (Lac stick)	Brood lac used to total yield (Stick lac)	Brood lac used to brood lac obtained (Lac stick)	Brood lac used to total yield (Stick lac)	Brood lac used to brood lac obtained (Lac stick)	Brood lac used to total yield (Stick lac)	Brood lac used to brood lac obtained (Lac stick)	Brood lac used to total yield (Stick lac)
M.P.	1:0·27	1:0·90	1:0·48	1:1·26	1:0·64	1:0·92	1:1·16	1:2·82
Bihar	1:0·37	1:1·34	1:0·72	1:1·74	1:0·50	1:0·98	1:2·67	1:1·47
Orissa					1:3·01**	1:3·13**		
W. Bengal	1:0·71	1:1·20	1:0·24	1:0·72	1:1·09	1:1·52	1:1·35	1:1·18
C.D. at the rate of 52	NS	NS	—	—	1:1·44	1:1·32	—	—
C.D. at the rate of 5%	NS	NS	—	—	1:2·02	1:1·85	—	—

Aghani 1985-86 (*1st generation*) *crop*

Brood lac procured from Puri (Raigarh, M.P.), Namkum (Ranchi, Bihar) and Kuten (Purulia, W. Bengal) were studied. Statistical analysis of the data revealed that there was no significant difference in the performance of brood lac used from different localities. This result is, however, different from that of last year in which brood lac from M.P. gave better performance.

Aghani 1985-86 (*2nd generation*) *crop*

Brood lac obtained from the *jethwi* 1985 crop at Khadgaon raised from *kusum* brood lac collected from Namkum, Kuten were studied. By numerical observation of the data it was found that unlike previous year brood lac from Bihar gave better performance in terms of ratios of brood lac used to brood lac obtained and brood lac used to total yield (stick lac).

Jethwi 1986 (*1st generation*) *crop*

Brood lac obtained from Khadgaon (Raigarh, M.P.), Namkum (Ranchi, Bihar), Satuguda (Kalahandi, Orissa) and Udaisri (Purulia, W. Bengal) were studied Brood lac from Orissa performed highly significantly better than that of all other localities in respect of ratios of brood lac used to brood lac obtained and brood lac used to total yield (stick lac) whereas the performance of brood lac from Bihar, M.P. and W. Bengal was not significantly different among themselves.

Jethwi 1986 (*2nd generation*) *crop*

Brood lac obtained from the *aghani* 1985-86 crop at Khadgaon raised from *kusmi* brood lac collected from different sources were studied. From the numerical examination of the data it was observed that brood lac from M.P. (local) gave better performance in respect of brood lac used to total yield (stick lac) and Bihar gave better performance in respect of brood lac used to brood lac obtained.

Aghani 1986-87 crop (1st generation) from the brood lac collected from Bartapali (Raigarh, M.P.), Namkum (Ranchi, Bihar) and Tulin (Purulia, W. Bengal) and brood lac obtained from the *jethwi* 1986 crop from different sources raised at Khadgaon (2nd generation) were inoculated and the observations are in progress.

From overall performance in second generation it appears that Bihar broods are slightly better than M.P. whereas from 1st generation brood, no clear trend is available.

(B. N. Sah)

Entom. 3.6 To Study the Population Dynamics of *kusmi* Strain of the Lac Insect

The study continued in *aghani* 1985-86, *jethwi* 1986 and *aghani* 1986-87. Samples were collected from different states and examined as done earlier.

Aghani 1985-86

This year survival of lac larvae from inoculation to crop maturity has been recorded: It was observed that only 9·51% of the original population of lac larvae reached maturity stage.

In *jethwi* 1986 crop, it was observed that the average number of lac larvae settled was $174{\cdot}81 \pm 51{\cdot}00$ per cm shoot length of which $24{\cdot}51 \pm 8{\cdot}51$ and $27{\cdot}70 \pm 4{\cdot}71$ died due to starvation and other causes respectively, the average initial mortality being 29·81% within a month of inoculation. In second sampling taken after fortnight, there was 43·5% mortality of the existing larvae which accounted for 73·31% of the original population.

In *aghani* 1986-87 crop, average settlement of lac larvae was $163{\cdot}11 \pm 27{\cdot}61$ of which $27{\cdot}21 \pm 4{\cdot}21$ and $15{\cdot}61 \pm 2{\cdot}81$ died due to starvation and other causes respectively, total percentage of mortality thus being 26·31% of the initial population. In second sampling, rate of mortality increased to 54·01% of the existing larvae, total mortality being 80·31% of the original population.

After analysing the data statistically, it was observed that there were no significant differences in the population of larvae settled per unit area in quadrates (directions). Significant differences in different canopies were observed only in *aghani* 1986-87 crop in which settlement was highest in lower canopy (172·72/cm) and was significantly higher to that of middle canopy (165·20 cm) which in turn was significantly higher to that of upper canopy (151·10/cm).

The density of lac larvae per unit area in the middle segment was significantly higher as compared to basal and apical segments whereas there was no significant difference in density between apical and basal segments [Table 6(a)].

TABLE 6(a) — EFFECT OF SEGMENTS ON SAMPLING

Segments	Average number of lac larvae per cm shoot length	
	Jethwi 1986	*Aghani* 1986-87
Basal segment	155·60	156·59
Middle segment	206·80	190·40
Apical segment	162·00	141·95
C.D. at 5%	31·94	19·69
C.D. at 1%	46·47	28·65

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

Entom. 3.8 Studies on the Factors Affecting the *Rangeeni* Lac Insect Population

The experiment was repeated in randomised block design with three treatments and 4 replications (one plant in each replication). Three treatments were the lac host plants viz. *palas*, *ber* and *bhalia*. Uniform mature single cell was inoculated on 4 shoots of each plant of each host and the initial mortality was scored after a month in both *baisakhi* 1985-86 and *katki* 1986 crops. Results are presented in Table 6(b).

TABLE 6(b) — MORTALITY PERCENTAGE IN RELATION TO HOST PLANTS

Host	Percentage of mortality			
	Baisakhi 1985-86		*Katki* 1986	
	Starved	Dead	Starved	Dead
Palas	14·98	34·47	17·13	24·11**
Ber	12·87	36·05	19·63	10·87
Bhalia	12·57	35·12	16·17	13·44
C.D. 5%	NS	NS	NS	4·28
C.D. 1%	—	—	—	6·48

The result indicates that there is no significant difference in mortality of lac insect either due to starvation or other causes on the different hosts in *baisakhi* 1985-86 crop whereas in *katki* 1986 crop, the *palas* had highly significantly higher mortality of lac insect in comparison to that on *ber* and *bhalia*.

The result thus differs from that recorded earlier when *palas* had highest mortality in *baisakhi* season also.

(M. L. Bhagat)

Entom. 3.10 Abundance of Lac Pests in Relation to Different Agro-climatic Situations and Lac Insects of Different places

The trial was repeated this year also. The samples were collected from six different places viz. Malichak, Salga, Kundri, Namkum, Lota and Mako in *baisakhi* 1985-86. The samples were caged to record the daily emergence of inimical insects.

Results are presented in Table 7. Predator population was very negligible during male emergence stage in all the localities. However, at maturity, population was very high in Lota. Parasite population was very high in all the places during male emergence stage being highest at Namkum followed by Mako and Malichak.

TABLE 7 — THEAVERAGE EMERGENCE OF INIMICAL INSECTS PER METER LAC ENCRUSTATION

Locality	Predators		Parasites	
	Male emergence	Crop maturity	Male emergence	Crop maturity
Malichak	0·73	29·64	122·27	12·93
Salga	1·37	37·37	52·82	16·67
Kundri	1·18	11·89	47·68	13·95
Namkum	0·09	33·70	439·20	18·19
Lota	0·11	64·57	60·39	24·11
Mako	0·34	23·54	152·54	25·80

(M. L. Bhagat)

Entom. 4. Control of Enemies of Lac Insects

Entom. 4.1(ii) Field Trials on Integrated Control Schedules Against the Lac Predators

Eight control schedules (including control) were tried at Kundri orchard in a randomized block design replicated thrice. Experiments were carried out as per programme (Annual Report 1982-85) on *baisakhi* 1985-86-cum-*katki* 1986 crop. One fifth of total *palas* trees under treatments B, AB, BC and ABC were heavily inoculated in July 1986 for trap cropping. Endosulfan (0·05 per cent) was sprayed under treatment A, AB, AC and ABC during August 1986. Samples were collected at 3 different stages of the crop and also before and after insecticidal treatment to assess the effect of treatments on pest population. Samples were examined and data were analysed. Crop was harvested in Oct.-Nov. 1986. Results are presented in Table 8.

Treatment AB had the highest sticklac as well as lac stick yield which is significantly higher than all other treatments except treatment A. Treatment ABC also had no significant difference than AB and A on lac stick yield. Predatory population was significantly lower in all the treatments than the control.

TABLE 8 — EFFECT OF THE DIFFERENT CONTROL SCHEDULES ON THE PREDATORS POPULATION VIS-A-VIS ON LAC CROP YIELD

Treatments		Average lac stick yield/ tree in (kg)	Average stick lac yield/ tree in (kg)	Average predators population per meter of encrustation	Percentage increase of yield over control	Total percentage suppression in predators population
A	(Spraying of Thiodan at 0·05% endosulfan)	5·17**	1·29**	12·0**	74·8	57·1
B	(Trap cropping by heavy inoculation of 2/5th trees)	4·40	1·11**	15·0**	50·2	46·4
C	(Desynchronisation of pest incidence by making 15 days late inoculation treatments)	4·23	0·74	23·0**	0·0	17·8
AB	(Integration of insecticidal and trap cropping treatment)	5·40**	1·44**	9·0**	94·5	67·8
AC	(Integration of insecticidal and 15 days late inoculation treatment)	4·53	0·97*	14·0**	31·4	50·0
BC	(Integration of heavy inoculation for trap cropping and 15 days late inoculation treatment)	3·43	0·77	17·0*	8·3	39·2
ABC	(Integration of insecticidal, heavy inoculation for trap cropping and 15 days late inoculation treatment)	4·77*	0·98*	14·0*	32·5	50·0
Control		3·87	0·74	28·0		
C.D. at 5%		0·79	0·18	4·75		
C.D. at 1%		1·10	0·26	6·60		

Treatment AB was significantly superior to all other treatments except treatment A.

Thus from the crop yield data of all the 8 schedules alongwith pest population, it appears that schedule AB i.e. (integration of insecticidal application with that of heavy inoculation treatment) is highly effective resulting in significant increase of crop yield and significant reduction of predators population. However, its superiority over treatment A, i.e. (chemical control alone with endosulfan) requires further confirmation.

(S. G. Choudhary)

Entom. 4.3 Effect of Insectcides on the Lac Insect *Kerria lacca* (*Kerr*) and the Associated Fauna

Entom. 4.3.1 Screening of insecticides for their safety to the lac insect and toxicity to the lac predators

Effect of two insecticides, namely, trichlorfon (Dipterex) and thiocylam (Evisect) at 0·025 and 0·05 per cent concentrations was studied on 70-75 days stage of the lac insects in field conditions. Population of the living lac insects was counted before the insecticidal treatment and one, two and four weeks after treatment. Samples were collected from three sites (upper, lower and middle) of three shoots from each plant and the number of living and dead lac insects were counted.

In other set of experiment, insecticides namely, trichlorfon (Dipterex), thiocylam (Evisect) and endosulfan (Thiodan) were sprayed at 0·05 per cent concentration on the advanced stage larvae of *E. amabilis* and *H. pulverea* developing in mature lac crop (*katki*) of 60-70 days stage. Results are presented in Tables 9a, b.

There is no difference in mortality of the lac insects among the treatments, thus showing that the insecticides used are safe against lac insects.

As regarded the effectiveness of insecticides on advanced stage larvae of the predators,

TABLE 9(a) — EFFECT OF INSECTICIDAL TREATMENT ON THE LAC INSECT (70-75) DAYS STAGE

Treatment	Conc.	No. of living lac insects under observation	Percentage mortality	Corrected percentage mortality
Dipterex	0·025	485	5·9	Nil
	0·05	483	5·0	Nil
	0·025	461	6·9	0·214
Evisect	0·05	434	6·3	Nil
Control	—	398	6·7	—

TABLE 9(b) — EFFECT OF INSECTICIDAL TREATMENT ON ADVANCED STAGE LARVAE OF PREDATORS INFESTING MATURE CROP

Treatment	Conc.	Average per cent mortality (After Arc. Sine transformation) $P = \sin^2 \theta$ (i)
Evisect	0·05%	23·49 (16·23)**
Dipterex	0·05%	28·32 (23·08)**
Thiodan	0·05%	29·58 (24·51)**
Control	—	12·35 (4·66)
S. Em = ±		2·68
C.D. at 5%		5·71
C.D. at 1%		7·89

(i) *The figures in parentheses are original values.

it was found that all the 3 insecticides are highly effective against the predators in comparison to control. Endosulfan is the most effective and significantly superior to thiocylam, and the trichlorfon is at par with endosulfan.

(S. G. Choudhury)

Entom. 4.3.2 Screening of plant poisons for their safety to the lac insect and toxicity to the lac predators

The extracts of various plant materials viz. *Butea monosperma*, *Acorus calomus*, *Vitex negunda*, and *Melia azederach*, prepared last year were tried against lac predators and lac insects. All the above plant extracts are safe

to lac insect up to 0·05 per cent concentration. Encouraging results were obtained for lac predators in laboratory trials.

(A. Bhattacharya)

Entom. 4.3.3 Effect of insecticides (safer to lac insect) against harmful parasites of lac insect

Screening trials carried out with five insecticides, BHC, chlordane, sevin, Thiodan and lindane against four common lac insect parasitoids viz. *T. purpureus*, *T. tachardiae*, *E. tschirchii* and *E. tachardiae* confirmed the previous year findings that BHC is most toxic followed by sevin in all the cases. These insecticides showed toxicity of the order of BHC > Sevin > Thiodan > Chlordane > and Lindane for *T. purpureus*; BHC > Sevin > Chlordane > Thiodan > and Lindane for *T. tachardiae* and BHC > Sevin > Chlordane > Thiodan > for *E. tschirchii*.

(S. G. Choudhury)

Entom. 4.3.4 Effect of insecticides (safer to lac insects) against beneficial parasites of lac insects

The experiments could not be conducted due to non-availability of beneficial parasites in adequate number.

(B. N. Sah and S. G. Choudhury)

Entom. 4.3.5 Effect of the recommended control schedule on the associated fauna of lac insect under field conditions

To study the effect of recommended control schedule on the associated fauna of lac insect, trials were repeated as per programme (AR: 1981-85) during *baisakhi* 1985-86, *aghani* 1985-86, *jethwi* 1986, *katki* 1986 crop seasons. Results of various experiments are appended in Table 10.

The results obtained from various crop seasons have confirmed the previous years findings indicating high degree suppression of predators and harmful parasites in both aspects

TABLE 10 — EFFECT OF RECOMMENDED CONTROL SCHEDULE ON THE ASSOCIATED FAUNA

(*Percentage reduction in the associated insects*)

Crop	First sampling 4 weeks after inoculation			Second sampling 8-9 weeks after inoculation			Third sampling at crop maturity		
	Predator	Harmful parasite	Beneficial parasite	Predator	Harmful parasite	Beneficial parasite	Predator	Harmful parasite	Beneficial parasite
Baisakhi 1985-86 (*Palas*)	83·3	67·7	42·30	66·67	51·61	35·12	60·00	45·45	28·57
Aghani 1985-86 (*Kusmi*)	87·5	65·9	31·1	92·0	45·0	17·65	57·5	23·4	24·32
Jethwi 1986 (*Kusmi*)	85·7	33·3	18·18	93·3	50·0	45·45	71·42	38·09	35·71
Katki 1986 (*Palas*)	93·75	56·52	37·14	79·17	51·28	34·61	70·85	41·46	31·25

of control schedules viz., thiodan alone at 0·05 per cent after 4 weeks of inoculation and thiodan combined with thuricide (1:1) both at 0·05 per cent concentration. However, some detrimental effect on beneficial fauna was observed which is in conformity with previous years findings.

(B. N. Sah and S. G. Choudhury)

Entom. 4.3.7 Treatment of brood lac with selective insecticides

Experiments were repeated with brood lac obtained from *aghani* 1985-86 and *jethwi* 1986 crop seasons after slight modification of the programme reported earlier (A.R.: 1985; Project no. 1.4.14). Treatments were given by dipping the brood lac in different concentrations of endosulfan ranging from 0·025 to 0·4 per cent under four varying durations of 2 to 10 min. Treated brood lac, when dried, was caged for noting the emergence of inimical insects. A portion of the treated brood lac was inoculated on *bhalia* plants for noting the emergence and settlement of lac insects. There were altogether 15 treatments including control for *aghani* 1985-86 and 16 treatments for *jethwi* 1986, replicated thrice.

The results are presented in Tables 11 and 12 which indicate that: (i) all the treatments are highly effective in reducing the emergence of lac predators and had no significant adverse effect on the lac crawlers; (ii) during *aghani* 1985-86 concentration of endosulfan (0·1 per cent and above) and the dipping duration of 5 min and more are equally good against *E. amabilis* whereas for *H. pulverea*, 0·2 and 0·4 per cent are superior and the dipping duration of 10 min is the best; (iii) the trend is almost similar in the case of *jethwi* 1986 also. The concentration of 0·05 per cent and above and the dipping duration of 4 min and more are effective against both the predators. It is also indicated that higher the concentration more effective in case of *E. amabilis*.

(A. Bhattacharya and S. G. Choudhury)

TABLE 11 — EFFECT OF BROOD LAC TREATMENT (BY DIPPING) ON THE EMERGENCE OF *Eublemma amabilis* AND *Holcocera pulverea* DURING *aghani* 1985-86

Sl No.	Treatment	Average number of predators emerging from treated (caged) brood lac* (i)	
		E. amabilis	*H. pulverea*
1	C_1D_1	2·57 (6·00)	5·84 (33·66)**
2	C_1D_2	2·12 (3·66)**	5·93 (34·66)**
3	C_1D_3	2·21 (4·00)*	6·04 (35·66)**
4	C_2D_1	2·05 (3·33)**	5·23 (26·66)**
5	C_2D_2	1·95 (3·00)**	4·31 (17·66)**
6	C_2D_3	1·79 (2·33)**	3·83 (14·33)**
7	C_3D_1	1·86 (2·66)**	4·23 (17·33)**
8	C_3D_2	1·89 (2·66)**	3·19 (9·33)**
9	C_3D_3	1·98 (3·00)**	4·06 (16·33)**
10	C_4D_1	1·82 (2·33)**	3·23 (9·66)**
11	C_4D_2	1·86 (2·66)**	3·95 (14·66)**
12	C_4D_3	1·88 (2·66)**	3·93 (14·66)**
13	C_5D_1	3·91 (14·33)	10·40 (107·33)
14	C_5D_2	3·23 (9·66)	10·16 (102·33)
15	C_5D_3	4·29 (17·66)	8·70 (81·00)
	C.D. 5%	0·78	1·66
	C.D. 1%	1·05	2·24

(i) *Data transformed into $\sqrt{n+1}$. Figures in parentheses are original values.

$C_1 = 0·05\%$, $C_2 = 0·1\%$, $C_3 = 0·2\%$, $C_4 = 0·4\%$, C_5 = Control (water); $D_1 = 2$ min, $D_2 = 5$ min, $D_3 = 10$ min.

Entom. 4.9 Studies on the Application of Insect Growth Regulators for the Control of Major Lac Predators

The studies on the effect of diflubenzuron ("Dimilin") on the eggs and larvae of the lac predator, *Eublemma amabilis* and the lac insect were continued.

Three experiments were conducted in randomised block design with 4 replications (Expt. I) and 5 replications (Expt. II and III).

Experiment I — *Effect of diflubenzuron on the eggs of E. amabilis*

TABLE 12 — EFFECT OF BROOD TREATMENT (BY DIPPING) ON THE EMERGENCE OF PREDATORS, LAC CRAWLERS AND INIMICAL PARASITES DURING *jethwi* 1986

Sl No.	Treatment	Average number of predators emerging from treated (caged) brood lac*		Average per cent mortality of lac crawlers after settlement*	Average caged number of inimical parasites emerging from treated brood lac*(i)
		E. amabilis	*M. pulverea*		
1	C_1D_1	5·80 (37·33)**	4·31 (21·33)**	34·51 (32·39)	17·93 (362·66)
2	C_1D_2	5·24 (28·66)**	3·57 (14·66)**	29·50 (24·34)	23·31 (548·66)
3	C_1D_3	6·52 (44·00)*	3·97 (15·00)**	31·66 (29·05)	21·37 (468·66)
4	C_1D_4	5·55 (31·33)**	3·62 (12·33)**	33·03 (30·13)	20·33 (424·00)
5	C_2D_1	4·98 (24·66)**	3·16 (9·66)**	26·88 (20·88)	25·52 (667·00)
6	C_2D_2	4·29 (20·00)**	2·91 (8·00)**	39·41 (40·83)	24·16 (584·33)
7	C_2D_3	3·80 (14·66)**	2·58 (6·00)**	29·98 (25·23)	24·07 (608·00)
8	C_2D_4	4·17 (17·33)**	3·16 (9·66)**	27·26 (21·23)	24·69 (618·66)
9	C_3D_1	5·20 (26·33)**	2·69 (4·33)**	32·65 (29·22)	18·67 (350·66)
10	C_3D_2	3·66 (13·33)**	3·08 (9·00)**	38·12 (38·23)	24·12 (590·00)
11	C_3D_3	2·72 (6·66)**	2·87 (7·66)**	37·53 (37·28)	23·57 (569·66)
12	C_3D_4	3·97 (15·66)**	3·08 (9·00)**	33·78 (31·07)	27·94 (780·66)
13	C_4D_1	9·54 (90·33)	11·18 (124·33)	40·57 (42·39)	21·44 (479·00)
14	C_4D_2	8·47 (71·33)	9·45 (89·00)	30·12 (26·04)	19·78 (40033)
15	C_4D_3	9·18 (84·66r	9·73 (94·00)	27·01 (22·00)	20·59 (425·66)
16	C_4D_4	8·75 (76·00)	10·27 (105·00)	30·58 (26·18)	20·81 (460·66)
	C.D. at 5%	2·26	1·71	×S	×S
	C.D. at 1%	3·04	2·31	×S	×S

(i)*Data transformed into $\sqrt{n+1}$. Figures in parentheses are the original values.

$C_1 = 0{\cdot}025\%$, $C_2 = 0{\cdot}05\%$, $C_3 = 0{\cdot}1\%$, C_4 = Control (Water), $D_1 = 2$ min, $D_2 = 5$ min, $D_3 = 6$ min, $D_4 = 10$ min.

TABLE 13 — EFFECT OF DIFLUBENZURON ON *E. amabilis* EGGS OF VARIOUS AGES

Treatment (%)	Average per cent hatching of eggs (After Arc. Sine transformation)*(i) $P = \sin^2 \theta$			
	0-24 hr	24-48 hr	48-72 hr	72-96 hr
0·015	2·30 (0·43)**	6·82 (1·86)**	6·81 (2·56)**	23·97 (18·20)**
0·025	2·06 (0·33)**	9·23 (2·65)**	17·64 (16·30)**	14·53 (6·42)**
0·05	3·01 (0·81)**	7·61 (2·31)**	6·20 (2·08)**	9·48 (2·82)**
0·1	3·16 (0·89)**	5·64 (1·81)**	7·16 (2·85)**	11·09 (4·15)**
0·2	6·76 (1·84)**	3·08 (0·86)**	33·65 (31·44)**	15·34 (7·08)**
Control	21·34 (15·63)	49·23 (56·17)	54·05 (64·98)	50·41 (57·93)
C.D. at	9·629	12·909	17·150	13·885
C.D. at	13·317	17·852	23·717	19·202

(i)*The figures in parentheses indicate original values.

E. amabilis eggs (laid on paper strips in the laboratory) of different age groups were collected and dipped in different concentrations of diflubenzuron emulsion for 20 sec.

Results (Table 13) indicate that diflubenzuron had ovicidal activity against the eggs of *E. amabilis* as there was significant reduction in the hatching of the eggs in all the concentrations.

Experiment II — *Effect of diflubenzuron on the larvae of E. amabilis*

Katki 1986 crop, raised on potted *bhalia* plants was sprayed with different concentrations of diflubenzuron emulsion, prior to release of laboratory laid *E. amabilis* eggs (on paper strips) which were about to hatch within 24 hr.

Observations taken 3 weeks after the treatment indicate that there has been significantly higher mortality in the *E. amabilis* larvae due to diflubenzuron treatment (Table 14).

TABLE 14 — MORTALITY IN *E. amabilis* LARVAE DUE TO DIFLUBENZURON TREATMENT

Treatment (%)	Average per cent mortality (After Arc. Sine transformation) $P = \sin^2 \theta$ *(i)
0·0125	74·80 (91·20)**
0·05	85·98 (97·65)**
0·2	87·94 (99·36)**
Control	59·14 (73·47)
C.D. at 5%	11·152
C.D. at 1%	15·635

(i) *The figures in parentheses indicate original values.

TABLE 15 — EFFECT OF DIFLUBENZURON ON THE MORTALITY AND SEX-RATIO OF LAC INSECT

Treatment	Average per cent mortality of lac insect*	Average per cent male population*
0·05%	43·06 (46·74)	22·57 (14·91)
0·1%	43·93 (48·02)	22·25 (14·54)
0·15%	46·63 (52·77)	27·88 (22·52)
Control	42·60 (45·89)	24·89 (18·28)
C.D. at 5%	NS	NS

*Data subjected to Arc. Sine transformation; $P = \sin^2 \theta$. The figures in parentheses indicate original values.

Experiment III — *Effect of diflubenzuron on lac insect*

Katki 1986 crop raised on potted *bhalia* plants was sprayed with various concentrations of diflubenzuron emulsions 7-10 days prior to first moulting for observing the effects of moulting, mortality, sex ratio, etc. of the lac insects.

Results (Table 15) indicate that diflubenzuron treatment did not have any adverse effect on the lac insect.

(A. Bhattacharya)

Entom. 4.4.13 Studies on economic threshold level of *E. amabilis* and *H. pulverea* infesting lac crops

Trials were continued on *baisakhi* 1985-86 and *jethwi* 1986 crop seasons at three developmental stages with varying levels of pest densities.

Five levels of larval densities (each representing a treatment) viz., 2, 4, 6, 8 and 10 per 30 cm of lac encrustation were maintained at three developmental stages viz., 1-30 days stage, 30-60 stage and mature stage (60 days onward stage).

Different levels of pest densities were created by artificial infestation on developing crop and was maintained under the cover of synthetic cage throughout the crop season including control.

Lac crop yield/30 cm lac encrustation obtained from various treatments was compared with control (no infestation) after harvesting. Results are appended in the Histogram (Fig. 1.)

Data from *jethwi* 1986 crop indicate that about 10% damage is caused by 4, 6 and 8 larvae per 30 cm in 1-30, 30-60 and 60 days onward stage respectively. Trend is almost similar in *baisakhi* 1985-86 season, where about 10% loss was caused by 6 larvae/30 cm in both 30-60 days and 60 days onward stages.

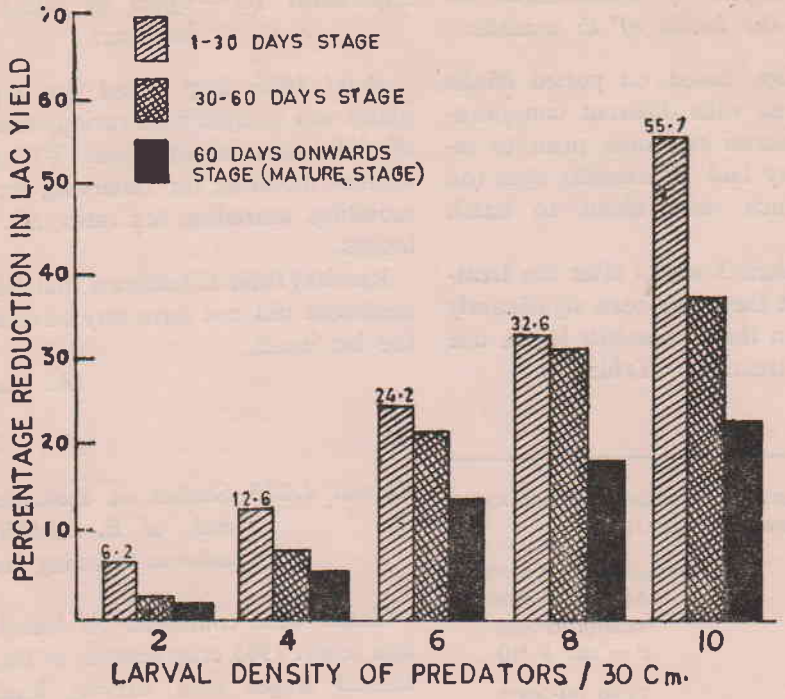


Fig. 1

It is evident from the histogram that early stage of crop is more susceptible. The relation between yield loss and pest density also shows a linear nature i.e. a positive correlation.

(S. G. Choudhary)

Entom. 4.15 Not started in 1986.

Entom. 4.16 Effect of Inter-cropping of Cotton and Okra with Lac Host on the Incidence of Lac Predators, *Eublemma amabilis* and *Holcocera pulverea*

The project was initiated with the aim of augmenting the natural control of the lac predators *E. amabilis* and *H. pulverea* by encouraging the multiplication of parasites of predators common to cotton boll worms, (Pectinophora glossy piella) and okra spotted boll worm (*Earias spp.*).

Initial trial on *aghani* and *baisakhi* lac crop only on *Moghania* host was laid out during July 1986 in randomized block design with 12 treatments and three replications. Treatments were pure crops of cotton (*Gossypium hirsutam*), okra, *aghani* 1986-87 and *baisakhi* 1986-87 lac and the inter crops of cotton and okra (chemically protected as well as unprotected) with both the lac crops. Plot size was 10×6 sq. mt with total six rows of 1 mt distance in each plot. Plant to plant spacing was 1 mt, 0·5 mt and 0·5 mt for *bhalia*, cotton (variety BAR COT-100) and okra (variety Pusa Swami) respectively. In inter crop plots, one cotton or okra row was sown in between two *bhalia* rows. Agronomic practices and inter cultural operations were done as per requirement.

Data were recorded on vegetative and reproductive growth of inter crops, incidence

TABLE 16 — GROWTH, INSECT INCIDENCE AND YIELD IN COTTON UNDER PURE AND INTER CROP CONDITION

Treatment	Plant height (cms) taken during		No. of leave/plant during			No. of square/flower per plant during		Dry matter accumulation (g/mt²) at		Per cent Boll worm (i) infestation		Incidence of sucking pests (Total number per 15 leaves in two observations (ii)		Yield (g/plant)
	40 DAS	170 DAS	40 DAS	60 DAS	105 DAS	70 DAS	165 DAS	Flowering	30 DAF	Green boll basis	Open boll basis	Jassid	Thrips	
T1 Cotton protected+*aghani* 1986-87	15·60	51·53	5·73	9·10**	14·13**	2·60*	3·40	9·25*	15·18*	17·50 (9·44)	8·03 (2·82)	9·83 (97·67)	5·00	6·80
T2 Cotton protected+*baisakhi* 1986-87	18·93	52·27	6·37	8·60**	12·17**	1·63*	5·23	7·05*	11·45*	14·83 (7·49)	8·44 (3·08)	8·40 (71·33)	6·00	4·40
T3 Cotton unprotected+*aghani* 1986-87	17·77	58·93	7·07	11·10*	12·47**	4·10	4·83	11·05*	16·05*	11·04 (3·98)	7·38 (2·87)	9·20 (85·33)	7·33	6·93
T4 Cotton unprotected+*baisakhi* 1986-87	15·43	42 60	5·97	8·50**	12·10**	1·90*	2·07	5·87*	11·17*	7·15 (3·33)	7·86 (2·43)	9·20 (92·00)	5·67	4·30
T11 Pure cotton	15·03	64·43	7·87	17·73	25·57	7·50	8·07	15·43	21·14	9·75 (2·96)	9·36 (2·71)	11·73 (143·33)	8·33	13·67
C.D. at 5%	NS	NS	NS	4·59	4·40	3·70	NS	5·26	4·29	NS	NS	NS	NS	NS
C.D. at 1%	—	—	—	6·68	6·40	—	—	—	—	—	—	—	—	—

(i) *Data transformed into degrees ($P = \sin^2 \theta$: Figures in the parentheses are original values.
(ii) Data transformed into $\sqrt{n+1}$.

TABLE 17 — GROWTH, INSECT INCIDENCE AND YIELD IN OKRA UNDER PURE AND INTER CROP CONDITION

Treatment	Plant height (cms) taken during			No. of leaves per plant during		No. of flower/bud per plant during		Dry matter accumulation (g/mt) at		Per cent Fruit borer infestation*	Yield (g/plant)
	40 DAS	105 DAS	Matu-rity	40 DAS	60 DAS	40 DAS	60 DAS	Flow-ering	30 DAF		
T5 Okra protected +*aghani*	25·7	36·4	68·9	3·70	4·37*	2·17	1·33*	7·65*	12·01*	16·79 (8·43)	17·33
T6 Okra protected +*baisakhi*	24·2	44·0	57·0	5·06	4·97*	3·20	1·57*	9·68*	12·20	16·96 (8·59)	29·75
T7 Okra unprotected +*aghani*	24·0	34·0	60·7	4·33	4·60*	2·80	1 17*	10·55	14·00	21·48 (13·69)	16·83
T8 Okra unprotected +*baisakhi*	23·3	40·9	66·2	4·93	5·13*	2·93	1·45*	6·13*	10·20*	22·31 (15·56)	26·0 0
T12 Pure okra	21·9	44·7	72·8	5·23	7·67	3·10	3·23	13·26	18·30	20·30 (12·13)	37·25
C.D. at 5%	NS	×S	S	NS	2·37	NS	1·28	3·46	5·12	NS	NS
C.D. at 1%	—	—	—	—	NS	—	—	—	—	—	—

*Data transformed into degrees ($P = \sin^2$); figures in the parentheses are original values.

of cotton boll worms and sucking pests, okra fruit borer (spotted boll worms) and lac predators, parasite incidence on lac predator and boll worms and the yield of cotton, okra and lac.

Observations on okra and cotton are presented in Tables 16 and 17. Vegetative growth like leaf formation, plant height and total dry matter accumulation and the reproductive growth like square/bud and flower formation were suppressed in both cotton and okra at latter stages of development as a result of inter cropping. However, there was no appreciable difference among the treatment till 40 days stage.

Yields were also substantially reduced in the inter crop plot. Reduction was heavy in case of okra + *aghani* lac and cotton + *baisakhi* lac perhaps due to the fact that inoculation and other operations of respective lac crop coincided with the active fruit formation stage of okra and cotton respectively.

Regarding insect incidence in cotton it was found that jassid and thrips populations were slightly higher in pure cotton plots. Boll worm infestation was very low this year, the damage being mainly caused by spotted boll worm. The infestation was slightly lower in pure crop on green boll basis. Among the inter crop plots, chemically sprayed plots had higher infestation than the unsprayed plots indicating that natural enemies are quite active at the later stages of crop whereas this is not so in case of okra where spotted boll worm infestation started early in the month of September. In okra spotted boll worm incidence was higher in unprotected inter crops plot than the pure crop whereas protected inter crop plots had lower infestation than pure crops.

Regarding parasite incidence in boll worm, it was found that parasite population could not yet build up properly and was low during the season. *Bracon greeni* was the major parasite isolated from spotted boll worms collected from cotton as well as okra. *Tetrastichus* sp. and *Elasmus* sp. were the minor parasites isolated.

Data on the *aghani* lac is presented in Table 18. Pure *aghani* crop had slightly higher population of *Eublemma amabilis* in comparison to other treatments, whereas there

TABLE 18 — INCIDENCE OF LAC PREDATORS AND THEIR PARASITES AND YIELD OF *aghani* LAC

Treatment	Predator incidence*(i) (Total of 3 observations per 60 cm)		Per cent parasitization in *E. amabilis*	Yield (g/bush)
	E. amabilis	*H. pulverea*		
T_1 Cotton protected* *aghani*	12·01 (149·67)	9·63 (93·00)	3·01	79·65
T_3 Cotton unprotected + *aghani*	11·66 (138·67)	10·49 (114·00)	7·61*	61·05
T_5 Okra protected + *aghani*	12·53 (159·67)	11·36 (128·33)	1·91	72·57
T_7 Okra unprotected + *aghani*	13·28 (178·33)	8·78 (78·67)	8·27*	72·79
T_9 Pure *aghani*	14·05 (209·33)	11·08 (127·00)	1·91	59·33
C.D. at 5%	S	NS	4·40	NS
C.D. at 1%	—	—	NS	—

was no such indication in case of *Holcocera* incidence. Parasitization on *E. amabilis* and *H. pulverea* was very low during this season. *Bracon greeni* was the major parasite isolated from *E. amabilis* followed by *Elasmus claripennis*. Parasites isolated form *H. pulverea* were *A. tachardiae*, and *Pristomerus sulci* etc. Parasitization of *E. amabilis* was found to be lowest in the plots of pure *aghani* lac whereas incidence was significantly higher in both the unsprayed inter crop plots.

Regarding yield of lac it was found that pure *aghani* lac had slightly lower yield than inter crops.

Thus, it appears that there is a prospect of augmenting natural control of lac predators by inter cropping method. There was a significant increase in parasitization on lac predator *E. amabilis* resulting in reduction of predator incidence in *aghani* lac and finally enhancing the yield.

(B. B. Das, A. Bhattacharya and B. P. Singh)

Entom. 4.17 Survey of the Pathogenic Micro-organism and Their Effects on the Development of Lac Insects

The study was aimed at identifying the causal organisms responsible for diseases of the lac insect and their effect on lac production.

Initially only one experiment was taken up, " Assessment of losses of lac caused by bacterial and fungal pathogen ". Trials were laid out for *jethwi* 1986, *aghani* 1986-87 and *baisakhi* 1986-87 crops and conducted in randomized block design with 5 replications and following 4 treatments:

(1) Protection against the bacterial diseases by applying bactericide;

(2) Protection against the fungal diseases by applying fungicide;

(3) Protection against both bacterial and fungal diseases by applying mixture of bactericide and fungicide;

(4) Control — No protection.

Bactericide (0·01% Plantomycin) and fungicide (0·05% Bavistin or 0·18% Diethane M-45) were applied by dipping method as well as by spraying. The brood lacs were dipped for 30 min in the pesticide solution before inoculation and subsequently sprayed twice during 15 to 60 days after inoculation.

Yield data were collected after harvest. In *baisakhi* 1986-87 crops, initial mortality data were also recorded. Results are presented in Table 19.

In *jethwi* 1986 crop yield was significantly higher in fungicide treated plots either alone or in combination with bactericide whereas plots treated with bactericide alone had no difference with the control, indicating that there is about 39% avoidable loss due to fungal diseases. In *aghani* crop, though there was no significant difference among the treatments, both fungicide and bactericide treated plots had numerically higher yield over control

TABLE 19 — YIELD LOSS AND MORTALITY OF LAC INSECT DUE TO FUNGAL AND BACTERIAL PATHOGEN

Treatment	Yield of scraped lac (g/plant)		Per cent mortality(i)
	Jethwi 1986	*Aghani* 86-87	*Baisakhi* 1986-87
T_1 Protection against bacteria	16·05	30·25	30·95 (26·68)
T_2 Protection against fungus	21·70*	29·65	30·11 (25·34)
T_3 Protection against both	21·45*	23·00	34·02 (31·64)
T_4 Control	15·40	18·55	29·55 (25·05)
C.D. at 5%	5·89	NS	NS
C.D. at 1%	—	—	—

(i) Data transformed into degrees ($P = \sin^2 \theta$); Figures in the parentheses are original values.

indicating that bacterial diseases are also responsible for yield loss in *aghani* crop.

Baisakhi 1986-87 crop is in the field. Data on the initial mortality of lac nymphs indicate that there is no significant difference in initial mortality among the treatments.

A new lepidopterous insect predator was found to cause damage to the young nymphs during second week of November to the second week of December. Besides outright killing, they were responsible for causing heavy mortality of young nymphs. This predator attacked lac insects at random irrespective of the treatment. The insect was noticed during the same period in 1985-86 crop season.

Entom. 5 Studies on Germ Plasm of Lac Insects

Entom. 5.8 Collection, Maintenance and Evaluation of Genetic Stocks of Lac Insects

A total of twelve genetic stocks of *rangeeni* and *kusmi* lac insects of widely separated regions have been maintained. One *rangeeni* stock from Meghalaya has been included during the year in addition to six already reported earlier. Evaluation of 3 *rangeeni* and 4 *kusmi* strains was done for the past three years taking 10 females in a sample for yearly observations during *baisakhi* and *katki* seasons for *rangeeni* strain and *jethwi* and *aghani* crop seasons for *kusmi* strain. In addition to three parameters namely, the life period, fecundity and resin secretion as reported earlier, one more parameter, the relative resin dye level was also considered this year.

Results are presented in Table 20. Among three *rangeeni* stocks, Ludhiana stock was found best for highest fecundity and resin production during *baisakhi* crop season and it produced lightest colour under lowest rearing period during *katki* season.

Among four *kusmi* stocks, Orissa crimson stock was found best in producing lightest colour resin during both *jethwi* and *aghani* crop seasons and having shortest rearing period, highest fecundity and resin secretion during *aghani* crop season only.

TABLE 20 — AVERAGE REARING PERIOD, NUMBER OF LARVAE PRODUCED PER FEMALE, RESIN SECRETION AND RESIN DYE LEVEL OF THE DIFFERENT STOCKS

Stock	Rearing season	Rearing period (days)	No. of larvae produced/ female	Resin secreted/ female (mg)	Relative resin dye level (optical density) at 450 nm
(1) Kundri	*Baisakhi*	254	256·15	10·96	83
(2) Umaria (M.P.)	do	248	272·1	11·61	83
(3) Ludhiana (Punjab)	do	255	303·2	11·77	74
(1) Kundri (Bihar)	*Katki*	115	332·75	7·68	81
(2) Umaria	do	115	273·5	7·84	69·6
(3) Ludhiana	do	106	230·4	6·66	87
(1) Orissa Crimson	*Jethwi*	153	207·6	7·5	90·3
(2) Dharamjaigarh (M.P.), Early, maturing	do	141	293·6	10·2	8·16
(3) Dharamjaigarh (M.P.), Late maturing	do	153	322·0	11·2	81·2
(4) Namkum (Ranchi)	do	147	296·2	15·1	72·4
(1) Orissa Crimson	*Aghani*	204	298·5	20·6	85·5
(2) Dharamjaigarh (M.P.), Early maturing	do	206	248·5	16·9	80·2
(3) Dharamjaigarh (M.P.), Late maturing	do	209	227·4	13·7	79·1
(4) Namkum (Ranchi)	do	228	209·5	19·2	76·6

Rangeeni stocks collected from Bangalore last year was grown on *Moghania macrophylla* as well as on *Shorea talura* which produced only the male progeny and was ultimately lost thus leaving only 11 stocks in total.

Ludhiana stock behaved in slightly different way during *baisakhi* 1985-86 producing few white mutants. These white mutants were reared separately but all died before emergence.

(S. K. Jaipuriar)

Entom. 5.11 Cytotaxonomy of lac insects

Cytological investigations on chromosome number and behaviour of Assam lac insects were reported earlier.

In the present investigation, following the "Giemsa air drying technique", the chromosomal behaviour during spermatogenesis was studied in respect of Assam lac insect which is claimed to be a separate species, based on morphological characters only (Varshney, 1976). Spermatogenesis involves two successive divisions. The first division is equational in which both euchromatic and heterochromatic sexes divide and separate out equationally. During the second division which is reductional, the chromosomes of each group segregate once again into two sets: euchromatic and heterochromatic sets with the suppression of cytoplasmic division.

This results in the formation of binucleate spermatids in each group. As in other lecanoids, the four products of meiosis form a tetranucleate stage. The heterochromatic sets do not take part in sperm formation and degenerate, while the euchromatic sets developed into sperms.

It was found that the Assam lac insect also follow the same pattern of chromosome behaviour as in *K. lacca* (Kerr). Thus, Assam lac insects do not differ at least on chromosome behaviour and appears to be the same as *K. lacca* (Kerr).

(S. K. Jaipuriar)

B. DIVISION OF INSECT GENETICS AND BREEDING

Introduction

With the increasingly greater emphasis now being laid on breeding better lac insects, a Division of Genetics was created under the charge of a S-3 Scientist who has hitherto been engaged in genetical studies of lac insect. A new research programme laying emphasis on breeding for quality and productivity has been drawn out and being implemented.

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES IN PROGRESS

Insect. Gent. 1. Lac Insect Genetics

Insect. Gent. 1.1 (Old No. 1.5.10) Studies on Sex Determination in Lac Insects

Studies made earlier (A.R.: 1983 and 1985) provided no evidence of genetic effect on sex ratio. It was observed that certain plant species such as *arhar* (*Cajanus cajan*) when used as a lac host showed unusually high proportion of male lac insects. Thus, an experiment was carried out to study the host effect on sex ratio using a wild stock of lac insect collected from Nongpoh, Meghalaya. The host species namely, *arhar* and *bhalia* used as lac hosts in the north-eastern region for lac cultivation and a lac host of the major lac growing areas were included in the experiment. The test insects were reared on potted plants by setting up their cultures in November 1985 under cover of a muslin cloth sleeve cage to check parasitic and predatory activity. The sex ratio was scored at the time of sexual maturity. Five cultures were raised on each host species.

It was found that the proportion of male was unusually high in general. However, the mean percentage of male differed significantly between the host species used. It was 72 per cent on *bhalia*, 82 per cent on *arhar* and 98 per cent on *ber* showing that the sex ratio is influenced by the host use.

(N. S. Chauhan)

Insect Gent. 1.2 Survey of Genetic Variation in Lac Insects

This is a new item of investigation taken up during the year under report to study genetic variation in the biological and resin characteristics of lac insects.

Insect Gent. 1.2.1 Study of crosses

With a view to examine the possibility of obtaining superior recombinant lac insects, an F_1 progeny of a cross made earlier between the local yellow *rangeeni* females and Orissa *kusmi* crimson males was used to raise the F_2 and F_3 generations. Females were drawn at random from the F_2 generation to establish fifty lines which are being maintained for evaluation.

It was reported earlier that the Meghalaya lac insect failed to provide a live progeny in crosses with those of widely separated regions (A.R.: 1985). Reciprocal crosses made during the year under report confirmed that this lac insect is reproductively isolated from those of other widely separated regions (Bihar, Orissa and Punjab).

(N. S. Chauhan)

Insect Gent. 1.2.2 Study of intra and inter-population variation in the Biological and resin characteristics

Preliminary observations made on the mature lac cells collected during May-June 1986 indicated that the melting point of lac of the Meghalaya lac insect was higher by about 10°C as compared to that of the local insect. Hence an experiment was taken up to study the intra and interpopulation variation in the melting point of lac of different lac insects. To start with cultures of lac insects collected from Tamar (Ranchi district) and Kundri (Palamau district), Bihar and Nongpoh, Meghalaya were set up on potted *bhalia* plants during October-November.

The settlement behaviour of lac insects collected from Kundri, Bihar and Nongpoh, Meghalaya was studied on potted *bhalia* plants during October-November. Each progeny, derived from single female was allowed to settle on 20 cm shoot and those from mass (used in excess of requirement) on 30 cm shoot. The density of larval settlement was measured by counting the number of larvae settled per sq. cm at three sites chosen at random on each shoot in the case of mass inoculations. The inter-insect distance was calculated by choosing pairs at random and measuring their midpoint distance in individual and mass progenies. The data are presented in Tables 21 and 22.

It can be seen (Table 21) that the number of first instar larvae settled per unit area is about 30 per cent more in case of Meghalaya lac insect. The variation in the density of settlement is also much less in the case of Meghalaya lac insect. General observations have shown that the Meghalaya lac insect settles in clear-cut patches as distinct from Kundri where the settlement is more diffused.

TABLE 21 — DENSITY OF SETTLEMENT OF LAC LARVAE ON POTTED *bhalia* PLANTS

Origin	N	No. of plants	No. of larvae/sq. cm (Mean ±S.E.)
Kundri, Bihar (*rangeeni*)	15	5	173·3±7·4
Nongpoh, Meghalaya	15	5	226·9±3·6

N, denotes total sample size.

TABLE 22 — INTER-INSECT DISTANCE OF THE LAC LARVAE ON POTTED *bhalia* PLANTS

Origin	Progeny derived from	N	No. of plants	*MIID ±S.E. (mm)
Kundri Bihar (*rangeeni*)	Single female	75	3	0·95±0·039
	Mass of female	75	5	0·77±0·032
Nongpoh Meghalaya	Single female	75	3	0·65±0·016
	Mass of female	75	5	0·65±0·018

*MIID: Mean inter-insect distance; N, denotes total sample size.

The mean inter-insect distance (MIID) is significantly different in the single and mass progenies in the case of Kundri lac insect whereas no such difference was observed in case of the Meghalaya insect suggesting no crowding effect. Kundri lac insect is also more variable for the inter-insect distance than the Meghalaya insect. The lesser MIID in Meghalaya lac insect compared to Kundri lac insect is consistent with the higher density of settlement in the former (Table 22).

Inter plant differences were not found significant for the parameters studied. However, it was significant (P = 0·05) where single progenies of Kundri lac insects were involved.

(R. Ramani)

Insect Gent. 2 Lac Insect Breeding

Insect Gent. 2.1 (Old Project No. 1.5.3 revived) Mutation Studies in Lac Insects

This investigation which remained in abeyance from 1979 was again taken up to study spontaneous and induced mutations in lac insects with a view to obtain desirable mutants particularly for evolving a strain producing the much needed dye-free lac.

The progenies derived from the new colour forms discovered last year were inbred and the resulting progenies reared. Some of these progenies included the new colour forms after one generation of full-sib mating suggesting that colour differences are genetic.

(N. S. Chauhan)

PLANT SCIENCES DIVISION

(a) RESEARCH COMPLETED

Pl. Sc. 1.2 Management of *Bhalia* (*Moghania macrophylla*) for Lac Cultivation

Expt. 1: *Effect of planting systems and fertilizers on plant growth and lac yield*

Bhalia (*Moghania macrophylla*) is a quick growing shrub and can be raised on plantaion basis for systematic lac cultivation. Accordingly an experiment was initiated in 1978 to study the effect of planting systems and fertilizers on plant growth and lac yield.

The experiment was laid out in split plot design with four replications. The planting systems viz. regular (square), quincunx, single hedge and double hedge system as main plot treatment and fertilizers namely, N (20 g urea) and P (40 g SSP) alone and in combination as normal (20 g urea+40 g SSP) and double normal (40 g urea+80 g SSP) doses per plant as sub plot treatment were tried for *aghani* lac crop.

Plant growth characters viz. plant height, number of tillers and total shoot length as recorded prior to lac inoculation in July for raising *aghani* crop showed that systems of planting had no adverse effect on the above characters. Double hedge system accommodating large number of plants gave 47·1, 44·9 and 20·7 per cent more stick lac yield than square, quincunx and single hedge system respectively (Fig. 2). In respect of fertilizer treatments given initially at the time of planting, the combination of N (urea) and P (S.S.P.) showed marked influence on plant growth attributes. Both normal and double normal doses were statistically at par and superior to other doses. At later stage, the effect became nonsignificant with respect to the plant growth attributes and stick lac yield over the pooled years. However, normal dose of N+P produced 36·5 and 33·6% respectively more sticklac yield than nitrogen applied alone (Fig. 2). The finding would

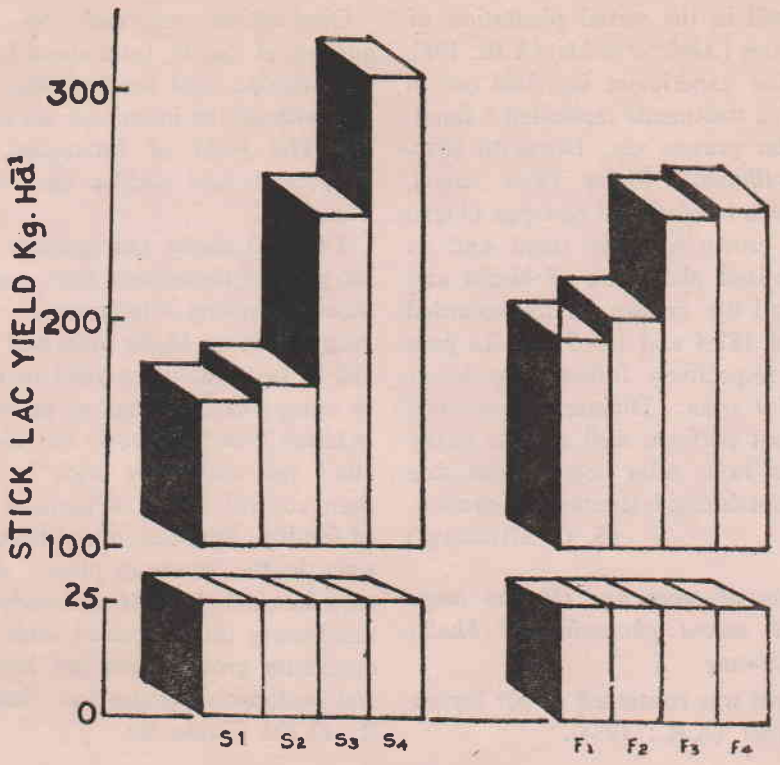


Fig. 2

help to increase productivity per unit area by accommodating larger number of plants in double hedge system of planting and application of N and P in combination at normal dose and also to provide enough space for inter-cropping. However, *bhalia* bushes exploited every year for lac cultivation need further application of fertilizers for better growth and stick lac yield.

(B. P. Singh and B. K. Purkayastha)

(b) RESEARCHES ON HAND

Pl. Sc. 1 Propagation and Management of Lac Host Plants

Expt. 2: *Weed management in bhalia nursery*

It was reported that out of the total weed population, grassy weeds were dominant. Among the various herbicides tried, pendimethaline and oxadiazon were highly effective in controlling weeds in *bhalia* nursery. During the period under report, the experiment was continued as per the layout reported earlier (A.R.: 1985). The results confirmed the dominance of grassy weeds as recorded from the weed count (88·6% of total weed population) and dry weight. Among the various herbicides tried, the pre-emergence application of oxadiazon (0·5 kg ai/ha) was found to be the most effective in controlling weeds. The plots with severe weed infestation produced lanky *bhalia* plants than those receiving weed control measures.

(B. P. Singh)

Pl. Sc. 1.3 Integration of Lac Cultivation with General Agriculture under Dry Farming

Expt. 1: *Effect of intercropping of fodder grasses and legume in mixed plantation of bhalia and galwang*

The experiment which was kept in abeyance was re-started and modified in the light of previous results that perennial grasses did

not perform well in the mixed plantation of *bhalia* and *galwang* (*Albizzia lucida*) (A.R.: 1981 and 1982). The experiment was laid out in R.B.D. with nine treatments replicated 3 times.

Annual fodder grasses viz., Dinanath (*Permisetum pedicellatum*), Maize (*Zea mays*), Jowar. (*Sorghum bicolor*) and cow pea (*Vigna sinensis*) were grown as pure stand and as intercrops in mixed plantation of *bhalia* and *galwang*. Of all the grasses, maize recorded highest yield of 187·4 and 185·5 q/ha in pure and intercrop respectively followed by jowar 173·6 and 171·9 q/ha. Dinanath grass and cow pea did not perform well due to heavy and continuous rains after sowing and due to insufficient rain during later stages of growth.

(S. C. Srivastava)

Expt. 2: *Raising of tuber and rhizome crops in the mixed plantation of bhalia and galwang*

The experiment was continued as per layout reported last year (A.R.: 1985).

Observation recorded on plant height, number of shoots, total shoot length per bush and sticklac yield for both the lac hosts with and without the intercrops are shown in Table 23. The yield of intercrops, return from these crops and sticklac have been shown in Table 24.

Table 23 shows that growth attributes and lac yield of these hosts have marked improvement by growing of intercrops. *Aghani* 1985-86 crop grown on *bhalia* bush had on an average 165·70 per cent more yield in intercrop plots in comparison to that of control. Similarly in *jethwi* 1986 crop grown on *galwang* produced 108·1 per cent more stick lac in intercrops than control. This is perhaps due to effect of fertilizer application and interculture operations in the intercrop plots. *Aghani* 1986-87 crop inoculated on *M. macrophylla* were quite satisfactory till the period under report. The maximum gross return per hectare from lac and colocacia+ginger as intercrops was Rs 12,203 (Table 24).

TABLE 23 — EFFECT OF INTERCROP ON THE GROWTH ATTRIBUTES AND STICKLAC YIELD

Treatments	*Bhalia* (*Aghani* 1985-86)				*Galwang* (*Jethwi* 1986)			
	Plant height (cm)	Shoots per bush	Total shoot length per bush (cm)	Sticklac yield (Q/ha)	Plant height (cm)	Shoots per bush	Total shoot length per bush (m)	Sticklac yield (Q/ha)
Control (No intercrop)	1·47	4	4·00	1·39	1·13	24	8·02	1·23
Colococia	1·63	5	6·01	3·77	1·38	25	11·03	2·12
Sweet Potato	1·64	7	6·26	4·25	1·29	34	14·40	2·32
Ginger	1·65	6	6·25	3·61	1·35	39	12·83	2·50
Turmeric	1·63	6	6·04	3·19	1·27	29	12·27	2·54
Colococia + Ginger	1·80	5	5·21	4·25	1·28	28	13·12	2·90
Colococia + Turmeric	1·85	5	6·44	3·42	1·24	26	12·88	2·37
Sweet Potato + Ginger	1·63	5	5·23	3·49	1·40	29	15·97	2·77
Sweet Potato + Turmeric	1·56	6	5·72	3·15	1·31	34	12·25	2·75
Sweet Potato + Ginger + Turmeric	1·71	5	6·05	4·11	1·26	31	12·29	2·76
C.D. at 5%	NS	NS	NS	1·76	0·11	5	4·16	0·69

TABLE 24 — YIELD AND ECONOMICS OF INTERCROPING WITH LAC HOSTS *bhalia* AND *galwang* DURING 1986

Treatment	Yield of intercrops (Q/ha)				Combined sticklac yield (q/ha)	Return from intercrops (Rs/ha)	Return from sticklac (Rs/ha)	Total gross return (Rs/ha)
	Colocacia	Sweet Potato	Ginger	Turmeric				
Control (No intercrop)					2·62		2620·00	2620·00
Colocacia	30·36				5·89	4554·00	5890·00	10,444·00
Sweet Potato		28·21			6·57	2821·00	6570·00	9391·00
Ginger			7·90		6·11	3950·00	6110·00	10,060·00
Turmeric				10·35	5·73	3105·00	5730·00	8835·00
Colocacia + Ginger	28·92		1·43		7·15	5053·00	7150·00	12,203·00
Colocacia + Turmeric	29·28			3·03	5·79	5301·00	5790·00	11,991·00
Sweet Potato + Ginger		29·82	1·07		6·26	3517·00	6260·00	9777·00
Sweet Potato + Turmeric		26·25		2·67	5·90	3426·00	5900·00	9326·00
Sweet Potato + Ginger+Turmeric		27·50	2·50	0·54	6·87	3770·00	6870·00	10,640·00

Rate: per quintal: Colocacia Rs 150.00, Sweet potato Rs 100.00, Ginger Rs 500.00, Turmeric Rs 300.00, and Sticklac Rs 1000.00.

(B. P. Singh)

Pl. Sc. 1.8 Utilization of *ber* for Lac, Tasar and Fruits

Baisakhi ari (1985-86) lac crop could not be raised due to nonavailability of brood lac. The DFLS of *daba* tasar silk worms procured form Central, Tasar Research Institute, Ranchi during July were allowed to hatch in the laboratory and were reared for 72 hr and then mounted on *ber* bushes in the field as per the layout reported earlier (A.R.: 1978). Plant growth attributes like height, number of shoots and plant spread (N-S and E-W) were recorded prior to tasar mounting and the data showed no significant differences among the treatments. Most of the tasar

TABLE 25 — PLANT ATTITUDES OF *ber* AT THE TIME OF LAC INOCULATION

Treatment	Height/Plant (m)	Girth/Plant (cm)	Shoot/Plant (No.)	Plant (E-W) (m)	Spread (N-S) (m)
T_1 (Lac)	2·77	3·60	9·33	2·03	2·10
T_2 (Tasar)	2·89	3·36	10·58	2·20	2·19
T_3 (Ber fruit)	2·94	3·65	10·50	2·02	2·07
T_4 (Lac + Tasar)	2·48	3·15	9·25	1·89	2·01
T_5 (Lac + *Ber* fruit)	2·95	5·91	9·25	2·08	2·03
T_6 (Tasar + *Ber* fruit)	2·91	3·85	12·16	2·12	2·36
T_7 (Lac + Tasar + *Ber* fruit)	3·04	3·81	9·91	2·35	2·30
C.D. at 5%	NS	NS	NS	NS	1·13

larvae were found lost and hence no systematic data could be obtained. Tasar cocoons were harvested during Nov. 1986. ERR (Effective rate of rearing) was 28·72%, 24·66%, 19·69% and 16·84% with T_2 (tasar crop), T_4 (lac + tasar), T_6 (tasar + *ber* fruit) and T_7 (lac + tasar+fruit) respectively. Plant growth attributes of *ber* bushes were again recorded prior to lac inoculation in November and no significant differences were observed among the treatments suggesting no adverse effect on plant attributes due to tasar rearing (Table 25). *Ber* bushes were inoculated with *rangeeni* brood lac during November as per layout of the experiment. The insects were growing well till the period under report.

(P. Kumar)

Pl. Sc. 1.9 Standardization of Agroforestry Practices for Raising High Lac Yielding *Kusum* through Air Layering

The air-layers transplanted (93 nos.) in earthen pots during December 1985 died except three, perhaps due to late planting.

During the year, 1200 air-layers from 15 proven *kusum* trees Broodlac Farm at Hessel were prepared during June-July 1986 with the use of mixture of IAA+IBA (100 ppm) aqueous solution alongwith lanolin paste. *Sphagnum* moss was used for covering. Only 758 air layers were found callusing/rooting. These were detached from the trees and transplanted in the field as well as in earthen pots. Among them 117 were found surviving (15·4%) till the period under report.

(S. C. Srivastava)

Pl. Sc. 1.10 Study and Assessment of Economics of Cultivation of *Kusmi* Lac on Bushes of *Moghania macrophylla* and *Albizzia lucida* in Mixed Plantation

Bhalia bushes were inoculated in the month of July 1986 (*aghani* 1986-87 crop). The progress of the lac crop has been quite satisfactory in spite of damage done by predators at earlier stage. The crop will be harvested during Jan.-Feb. 1987 season. *Galwang* plants coppiced for second time in July 1986, put forth shoots showing satisfactory growth till the end of Dec. 1986.

(B. K. Purkayastha)

Pl. Sc. 2.2 Selection for Better Performance of *Bhalia* as a Lac Host for *Kusmi* Strain of Lac Insects (Dropped)

Pl. Sc. 2.3 Evaluation and Improvement of *Arhar* Varieties/Oultivars for Lac Yield as well as Pulse Production

Baisakhi 1985-86 and *Jethwi* 1986 crop raised on *arhar* varieties showed very poor lac yield suggesting that the local lac insect is not performing well on any *arhar* variety.

Five *arhar* plants were inoculated with *rangeeni* brood lac collected from Meghalaya region. These insects showed very good growth on this lac host species. However, the lac crop was damaged at a later stage by the predators.

Another set of plants with the *arhar* varieties tried earlier were raised in RBD with five replications. Five plants from each variety/cultivars were inoculated in Nov. 1986 with *rangeeni* lac. Observations on various plant growth attributes like plant height, number of primary branches, length of branches and stem girth were recorded prior to lac inoculation. The plant growth characters were found to vary with the varieties. One spray of thiodan was given just after the *phunki* removal to protect the crop with predators.

Germplasm lines of *arhar* were also maintained in a separate plot and 5 plants from each line were inoculated with *rangeeni* brood lac to evaluate these lines. Plant growth attributes were also recorded prior to lac inoculation. The data showed significant variations in plant growth attributes with different lines.

(P. Kumar)

Pl. Sc. 2.4 Mutation Studies on *Arhar* in Relation to Lac and Pulse Production (Dropped)

Pl. Sc. 2.6 Survey of Genetic Variation in Lac Potential of Host Plants

Expt. 1: *Survey of genetic variation in galwang (A. lucida)*

The trial for raising *galwang* plants through stem cuttings from 20 parent plants with the use of IBA+IPA (100 ppm) aqueous solution was repeated during the year under report. The percentage of survival was very poor.

(S. C. Srivastava)

Expt. 2: *Survey of genetic variation in bhalia (Moghania macrophylla)*

Twenty-two cm long stem cuttings from 20 *bhalia* bushes were randomly selected in field and these cuttings were treated with mixture of NAA+IPA (50 ppm) for 24 hr during June 1986. The survival percentage varied from 56·25 to 96·15% (Table 26). The plants thus, raised were transplanted in the field during last week of August under RBD with four replications. The plants were growing satisfactorily.

(P. Kumar)

TABLE 26 — SURVIVAL PERCENTAGE OF PLANTS RAISED FROM SHOOT CUTTINGS OF *bhalia*

Sl No.	Shoot cuttings planted (No.)	Survival (%)
1	45	88·88
2	52	96·15
3	48	85·41
4	44	93·18
5	46	71·73
6	44	70·45
7	32	87·5
8	44	70·45
9	60	86·66
10	60	65·0
11	56	75·0
12	60	76·6
13	155	89·09
14	85	65·88
15	80	56·25
16	36	66·66
17	52	61·53
18	44	73·54
19	54	85·18
20	48	83·33

(c) RESEARCHES CONTEMPLATED

(1) Agricultural utilization of lac mud as organic manure.
(2) Survey, collection, maintenance, evaluation and characterization of lac host species.

CHEMISTRY DIVISION

Introduction

The research work in the Chemistry Division is aimed at developing new avenues for greater utilization of shellac and its constituents. The research carried out during the year under report include the isolation of a major constituent acid (jalaric) and degradation products from lac, synthesis of pheromones, juvenile hormones, heterocyclic molecules from aleuritic acid, formulation of paint composition for wood patterns, primer compositions for ferrous metals and strippable compositions for metal surfaces; film properties of lac modified with polyisocyanates and styrenated lac oil combinations, slow release weedicide formulations based on lac and 2,4-D and on the use of lac as adjuvant in pesticide formulations. Interaction of lac dye and its sodium salts with DNA has also been studied. Work has been initiated to study the tracking property of lac based insulating varnishes.

(a) RESEARCHES COMPLETED

Chem. 4.3 Studies on Shellac Paints for Wood Patterns

A large quantity of pattern paints are used for painting wood patterns in steel foundries.

These paints are mostly based on synthetic resins, some of which are imported. The present study was undertaken to develop a satisfactory composition of pattern paint which may be used as a substitute to costly paints presently used in foundries.

A number of varnish compositions were prepared by dissolving dewaxed lac in different solvents. These varnishes were then modified with butylated melamine resin (MF resin) and pigmented with titanium dioxide. Homogeneous paints were obtained which possessed good flow, levelling and drying characteristics On application by brush they produced hard, smooth, adherent and glossy films on wooden surface. These films became tackfree within 5-7 min and acquired sufficient hardness for rubbing and repainting within 15 min. It was, however, observed that paint compositions containing low boiling solvents such as methanol, acetone and ethyl acetate left some brush marks on the surface. The best finish was obtained from the paint composition containing spirit as the main solvent. Film properties of this composition were studied in detail. Air dried films showed good hiding and possessed a gloss of 68·70% of standard black glass. Scratch hardness of the film was found to be 900 g. These films passed flexibility (1/4″ mandrel) and resistance to water, toluene, white spirit and dilute acid. Suitability of the paint for actual use in foundries was studied by placing a painted wooden panel in contact with moist sand for 24 hr. The painted surface did not show any sign of sticking nor showed any deterioration in the film gloss indicating good resistance to the action of wet sand.

Pattern paints based on dewaxed lac-MF resin-nitrocellulose (NC)-dewaxed lac-ethyl cellulose as binders

Further experiments were carried out to prepare pattern paints based on dewaxed lac-M/F resin-NC and dewaxed lac-ethyl cellulose as binders. Uniform paint compositions were obtained which could be applied by brush to produce hard, smooth, adherent and glossy films. These films showed good resistance to water. It was observed that the paint composition based on dewaxed lac-M/F resin-NC gave almost similar performance to that obtained earlier from the paint composition based on dewaxed lac-M/F resin binder excepting that this composition could also be applied by spraying.

The performance of the other composition based on dewaxed lac-ethyl cellulose binder was also found to be similar to that of the paint composition based on dewaxed lac-M/F resin binder excepting that the gloss of the film in this case was inferior.

Pattern paints of different shades

Since smoothness and gloss of the film play an important role in pattern paints, further experiments were carried out with dewaxed lac-M/F resin as binder. Pattern paints of different shades were prepared to study the variation, if any, in the properties with the shade of the paint. It was observed that the gloss was the best in the case of black paint. However, no appreciable variation was noticed in other properties such as drying characteristics adhesion to wooden surface, hardness and resistance to water etc.

Pattern paints based on *bhatta* shellac and seedlac

Due to difficult supply position of dewaxed lac, experiments were carried out to prepare pattern paints based on *bhatta* shellac-M/F resin as binder. Uniform paint compositions were obtained which could also be applied by brush to produce hard, smooth, adherent and glossy films on wooden surface. These films showed good flexibility and possessed a gloss of 65% of standard black gloss. The scratch hardness of the film was found to be 1100 g. However, these films showed a

little inferior performance in regard to water resistance, compared to those obtained from the paint composition based on dewaxed lac-M/F resin binder.

With a view to reduce the cost of the paint, a few compositions based on seedlac-M/F resin binder were also prepared. The performance of these paints was found to be more or less similar to that obtained from the paint composition based on *bhatta* shellac-M/F resin binder.

Evaluation of pattern paints

Bigger lots of pattern paints based on *bhatta* shellac-M/F resin and seedlac-M/F resin binders were prepared and supplied to the Foundry Forge Plant of H.E.C., Ranchi for evalution. The report received from them indicates that both the composition served satisfactorily for painting wood patterns.

Conclusions

The study has resulted in the development of two pattern paint compositions which can be used for painting wood patterns in steel Foundries.

(Shravan Kumar and A. K. Dasgupta)

Chem. 4. Studies on Shellac Esters and Their Utilization

The present study was undertaken to prepare suitable shellac glycerol ester compositions which may find use as plasticizers in the surface coating formulations.

With a view to gain an insight into the mechanism of esterification reaction, studies were initiated on the reaction between aleuritic acid and glycerol under different conditions of time and temperature using various catalysts such as conc. sulphuric acid (1) borontrifluoride etherate and zinc dust. The reaction products were analysed by TLC and found to be a mixture of mono- di-, and triesters. The results are presented in the Tables 27 and 28.

The separation of mono-, di- and triglyceryl esters of aleuritic acid from their mixtures was successfully done by preparative TLC employing solvent systems viz. (i) chloroform: methanol: glacial acetic acid (90:10:2, v/v) and (ii) ethyl acetate: glacial acetic acid (100:1, v/v). The above esters could also be separated by column chromatography using eluents e.g. (i) benzene, (ii) benzene and diethyl ether (9:1) and (iii) diethyl ether. Esters, thus separated, were characterized as described below:

(a) Glyceryl monoaleuritate was obtained as a solid, m.p. 63-65°C IR (neat): 3380 cm (OH), 1728 cm (ester carbonyl). Its identity as glyceryl monoaleuritate was confirmed by comparison with authentic sample of monopalmitin (co-TLC).

(b) Glyceryl dialeuritate was obtained as a liquid IR (neat): 3380 cm^{-1} (OH), 1725 cm^{-1} (ester carbonyl). Its identity was confirmed by comparison with authentic sample of 1,3-dipalmitin (co-TLC).

(c) Glyceryl trialeuritate was obtained as a thick liquid. IR (neat): 3380 cm (OH), 1728 cm (ester carbonyl). Identity of this compound was also confirmed by comparison with authentic sample of tripalmitin (co-TLC).

Next, experiments were carried out to prepare these glyceryl esters separately. Glyceryl trialeuritate could be prepared by reacting methyl aleuritate with glycerol in the molar ratio of 1:1·5 at 180-200°C for 2 hr using conc. sulphuric acid (1) boron trifluoride-etherate as catalysts.

Glyceryl monoaleuritate was prepared by reacting equimolar proportion of both aleuritic acid and glycerol at 125 ± 5°C for 1 hr 15 min using zinc dust as catalyst.

Based on the above findings, esterification of shellac with glycerol was studied. It was observed that when shellac was reacted with glycerol in 3:1 molar ratio in the presence of BF_3-Et_2O (Boron trifluoride etherate) under reflux for 5 hr, shellac-glyceryl ester was formed to the extent of 60-65%. The product

TABLE 27 — PREPARATION OF GLYCERYL ESTERS OF ALEURITIC ACID

Sample No.	Reactants/Molar ratio		Time (hr)	Temp (°C)	Catalyst (5 p.c.) on the weight of aleuritic acid
	Glycerol	Aleuritic acid			
1	1	3	1·0	140±5	Conc. H_2SO_4
2	1	3	0·5	150±5	BF_3-Et_2O
3	1	3	2·5	210±5	Zinc dust
4	1	2	1·0	140±5	Conc. H_2SO_4
5	1	2	0·5	150±5	BF_3-Et_2O
6	1	2	2·5	210±5	Zinc dusr
7	1	1	1·0	140±5	Conc. H_2SO_4
8	1	1	0·5	150±5	BF_3-Et_2O
9	1	1	2·5	210±5	Zinc dust

TABLE 28 — CHROMATOGRAPHIC ANALYSIS OF GLYCERYL ESTERS OF ALEURITIC ACID

Sample nos. are in accordance to Table 1	Rf values					
	Solvent		System-A	Solvent		System-B
1	0·16	0·62	0·75	0·20	0·61	0·78
2	0·18	0·61	0·76	0·21	0·62	0·80
3	0·16	0·61	0·77	0·21	0·63	0·78
4	0·18	0·63	0·75	0·22	0·61	0·78
5	0·16	0·62	0·76	0·20	0·63	0·80
6	0·17	0·62	0·75	0·21	0·63	0·78
7	0·18	0·61	0·75	0·22	0·62	0·80
8	0·16	0·63	0·76	0·20	0·62	0·78
9	0·17	0·63	0·77	0·22	0·61	0·80
Aleuritic acid	0·26			0·33		
Glycerol	0·10			0·11		

Note: Solvent system-A — Chloroform: Methanol: Glacial acetic acid (90:10:2, v/v).
Solvent system-B — Ethyl acetate: Glacial acetic acid (100:1, v/v).

was then examined by TLC and found to be a mixture of mono-, di- and triglyceryl esters of shellac. From this mixture, a white crystalline compound m.p. 78-79°C was isolated by column chromatography. IR and mass spectral studies of this compound suggested it to be a triglyceryl ester of shellac.

Surface coating properties of the shellac-glyceryl ester in conjunction with Desmodur N were studied. It was observed that when the ester was reacted with Desmodur N (15%) the resultant product gave films which were uniform, non-tacky, hard, flexible and glossy. Both air dried as well as baked films showed good resistance to water.

Experiments were also carried out to assess the suitability of shellac ester as plasticizer in surface coating formulations. It was observed that incorporation of shellac ester into shellac spirit varnishes improved the adhesion and flexibility of the films. However, when shellac ester (10 g) was reacted with shellac

(90 g) at 105°C for one hour, a product was obtained which produced hard smooth, adherent and flexible films having improved resistance to water:

(i) Separation of glyceryl mono-, di- and trialeuritates has been achieved by preparative TLC and column chromatography.

(ii) Glyceryl mono- and trialeuritates have been synthesized.

(iii) Shellac-glyceryl ester has been found to serve as plasticizer in the shellac-based surface coating formulations.

(M. Mukherjee, R. N. Majee and S. Kumar)

Chem. 5.3 Combination of Lac with Weedicide for Slow Release

The study was undertaken to utilize lac and lac-mud alongwith 2,4-D for the development of a slow-release, selective and pre-emergent type of weedicide formulation for the control of *parthenium* and other weeds which pose serious threat to agricultural crops and environment.

Lac-2,4-D *combination*

Direct bonding of 2,4-D (active ingredient) with lac (matrix) was attempted through esterification reaction to obtain a slow-release weedicide system. Two approaches were made i.e.: (i) by bringing about a direct chemical combination between lac and 2,4-D and (ii) by reacting acid chloride of 2,4-D with lac.

(1) *Direct fusion method* — Shellac was first esterified with 2,4-D by direct fusion method and it was found that the combination takes place between shellac and 2,4-D in 1:1 and 1:2 molar proportions. The 1:1 product was found suitable for use in the powdered form.

(2) *Acid chloride method* — The acid chloride of 2,4-D was combined with shellac by adopting the following reaction systems:

(i) *Homogeneous reaction system* — The acid chloride of 2,4-D and shellac taken in 1:1, 1:2 and 1:3 molar proportions in dioxan and pyridine were heated under reflux for 3 hr. The reaction mixture was concentrated to about half its volume. Hexane was then added with vigorous stirring. The precipitate was collected through filtration and dried to obtain lac-2,4-D ester. It was found that lac-2,4-D ester formed in 1:1 and 1:2 molar proportions.

(ii) *Heterogeneous reaction system* — The benzene solution of acid chloride of 2,4-D reacted with shellac, suspended in benzene with pyridine in 1:1, 1:2 and 1:3 molar proportions. The resultant product was filtered, washed with benzene and dried. It was found that the lac-2,4-D ester formed in 1:1 and 1:2 molar proportions.

The difficulties experienced in preparing, handling and heating of viscous polymeric mass in the homogenous reaction were overcome by replacing dioxan with the cheaper solvent benzene.

Lac-mud-2,4-*D combination*

In order to utilize lac-mud, a waste of the lac processing industry, the following studies were undertaken:

(1) *Direct fusion method* — Attempts were made to combine 2,4-D with lac-mud, on the basis of resin content, but success was not achieved.

(2) *Acid chloride method* (*Heterogeneous reaction system*) — It was found possible to combine lac-mud with acid chloride of 2,4-D (1:1) by adopting the heterogeneous reaction system. The product was found suitable to be used in the powdered form.

Granular formulations

Studies were also made to prepare granular formulations of lac-2,4-D and lac-mud-2,4-D combination products. Various carriers were examined. Bentonite and soap stone were preferred due to their easy availability and economic viability. Blank granules were prepared using different binders and their order

of disintegration was determined. The hardness of water showed an effect on the disintegration of granules. The granules/micro tablets based on lac-mud-2,4-D could be prepared thereby minimizing the cost of the carrier. It was observed that PVA (polyvinyl alcohol) binder could be used for the slow dissolution of lac-mud and lac-2,4-D based granular formulations for aquatic weed control. Further, it was found that the wood and rubber (without filler) surfaces coated with lac-2,4-D (1:1) melt can be employed for the use as a slow-release floating material for the aquatic weed control.

Evaluation

Samples of lac-2,4-D ester formulations were prepared and sent for evaluation to different agricultural universities and institutions. Their findings are summarized below:

(1) RRL Jammu

Pre-emergent trials — The results of pre-emergent trials conducted with lac-2,4-D ester on growth response of barley (*H. vulgare* L.) and latjira (*A. aspera* L.) showed that barely seeds were comparatively resistant to the formulation. Lac-2,4-D becomes lethal at much lower dose (1200 ppm) and 2,4-D acid at higher concentration of 1600 ppm, whereas sodium salt of 2,4-D resulted some growth even at highest concentration of 2000 ppm.

Selective studies —The above weedicides proved effective at all doses (500-4000 ppm) against dicots and annual grasses.

Herbicides did not result in any morphological abnormalities during vegetative growth of the test plants (wheat) but with the emergence of inflorescence various types of abnormalities like, the formation of tubular leaves, incomplete beading, tweaked and bunched ears, besides reduced number of grains/ears was observed with the rise in the strength of concentration except of 500-1000 ppm of 2,4-D-lac and 2,4-D sodium salt and 500 ppm of 2,4-D acid. Moreover, the grain yield with the treatment of 2,4-D at 500 ppm was found to be enhanced by 11·81% and thus proved selective.

Soil residue studies — The soil residue studies indicated an increase of 8·33% with the treatment of 2,4-D-lac (4000 ppm) and 3·33-12·66% 2,4-D acid in (500-1000 ppm) in respect of growth of *bhindi* seedlings 50 days after sowing.

(2) FRI, Dehradun (Pre-emergent trials)

The efficacy of lac-2,4-D product tried as a pre-emergent type weedicide for *Albizzia lebek* was found at par with 2,4-D and 2,4-D sodium salt.

(3) CRRI, Cuttack (Pre-emergent trials)

The pre-emergent application of lac-2,4-D, 2,4-D sodium salt and 2,4-D acid at 0·40 kg ai/ha could not control the *Cyperus* weed as effectively as butachlor or thiobencorb.

(4) ILRI, Namkum (Germination trial)

The lac-2,4-D and lac mud-2,4-D combination products were found effective in controlling the germination of *parthenium* seeds revealing that these may work as pre-emergent type of slow-release weedicide.

Aquatic weed control

Preliminary tests on *water hyacinth* indicated the sustained release action of lac-2,4-D formulations in controlling this weed.

(5) G. B. Pant K.A.P.V.V., Pant Nagar

Pre-emergent trials — Studies on relative effect on lac 2,4-D and other herbicides treatments on population of problematic *parthenium* per plot at different stages of growth of wheat were carried out. It is reported that the best results were obtained when lac-2,4-D (a) 0·25 kg ai/ha as pre-emergent alongwith Isoproturon (a) 5·0 kg/ha after 32 days of sowing or Decomba (a) 0·072 kg/ha after

30 days of sowing used. Wheat was thus made free after 60 days of sowing. It was also reported that other herbicides such as Isoproturon, Dic mba, 2,4-D sodium, oxyfluorfen and Methabenthizwron etc. were not found effective.

(6) IARI, New Delhi

Release studies — Laboratory and pot culture experiment were conducted to study the release of the herbicides from lac-2,4-D formulation in water and soil. The amounts released were analysed chemically by HPLC technique. Approx. 31% of 2,4-D was released in water in 24 hr and 82% in soil in 28 days, thereby indicating the sustained release of the active ingredient from the formulation.

Bio-assay studies — The green-house bioassay with nine crops including wheat and *parthenium hysterophorus* grown in soil treated with the formulation indicated that the formulation extended the uptake from the soil and enhanced the biological activity.

Conclusion-target achieved — A slow-release selective and pre-emergent type chemically combined lac-2,4-D and lac mud-2,4-D weedicide formulation have been successfully developed and found effective in controlling *parthenium* and other weeds.

(B. C. Srivastava and S. C. Agarwal)

Chem. 5.4 Studies on the Use of Lac as Adjuvant in Pesticide Formulation

Studies were undertaken to adjudge the suitability of hydrolysed lac for use as adjuvant in pesticide formulations with a view to develop suitable lac-based sticker and emulsifier.

Shellac in aqueous and alcoholic medium was subjected to hydrolysis under different conditions and the characterstics of the product determined (A.R.: 1981 and 1982).

Water thinnable sticker formulations based on the above products were prepared using triethanolamine and liquor ammonia as solubilizing agent. With a view to ascertain the sticking characterstics of these formulations, a glass slide test was improvised and sliding characteristics were found out (A.R.: 1985).

Studies were made to determine the effect of modifiers on the properties of lac based stickers. It was found that shellac, sodium, CMC and casein in common solubilizing agent were suitable as modifier for lac-based stickers.

The lac-based formulations when applied on glass surface retained its stickiness for months together similar to that of commercial BASF (W. Germany) sticker formulations based on synthetics. The performance of lac-based stickers was also comparable to BASF stickers.

Lac-based emulsifier

Studies were made to find the possibility of preparing sulphonated lac-based emulsifier. Sulphonation of shellac was carried out by adopting the techniques of CLRI, Madras and SEPC, Calcutta. The solubility of the resultant products was studied in water, aq. ammonia. The product prepared by CLRI method was found dispersible in these solvents. IR spectrum showed the presence of sulphonic group in the sulphonated lac. Acid and hydroxyl values were appreciably lower than those of shellac. The product showed surface-active characteristics.

Studies were made to sulphonate aleuritic acid as well as its stearic acid ester.

Aleuritic acid was sulphonated with sulphuric acid in 1:1, 1:2 and 1:3 molar proportions by adopting the CLRI technique and the physico-chemical characteristics, TLC and IR of the resultant products were studied. These products did not show any surface active properties.

Aleuritic acid was esterified with stearic acid in 1:1, 1:2 and 1:3 molar proportions and sulphonated by adopting the CLRI method. Physico-chemical characteristics of the resultant products showed 1:1 molar proportion

to be superior over other proportions. The product (1:1) was water dispersible and showed surface active characteristics.

Lab-evaluation

The comparative foaming and emulsifying properties of the compositions were studied. It was found that these products produced considerable foam but were not up to the standard of commercial surfactants. However, foaming could be enhanced by the use of foam boosters. The sulphonated lac produced better emulsions with linseed oil and groundnut oil in comparison with castor oil. However, anionic commercial surfactants were found to produce much better emulsions with the above oils.

(B. C. Srivastava)

(b) RESEARCHES IN PROGRESS

Chem. 1 Chemistry of Lac/Constituents

Chem. 1.8 Biophysical Studies on the Interaction between Laccaic Acid and DNA

The results of the studies on the interaction of laccaic acid and its mono- and disodium salts with DNA in 0·001 M NaCl solution have been reported earlier (A.R.: 1985).

During the period under report, studies have been made on the binding of laccaic acid and its sodium salts in 0·01 and 0·1 M NaCl solution by spectrophotometric measurements. A bathochromic shift and hypochromism were observed in the spectra of both the dyes with increased binding of DNA. No isosbestic point was observed with laccaic acid. The number of binding sites available per nucleotide (n) for the dyes were calculated from the scatchard plots and these have been shown in Table 29. The values of n for the dyes obtained earlier in 0·001 M have also been included in the table for comparison. It may be seen from the table that the ionic strength of the medium did not seem to have any marked effect on the value of n i.e., the extent of binding of laccaic acid with DNA. These results suggest nonelectrostatic nature of binding of laccaic acid with DNA. Binding of monosodium salt of laccaic acid was, however, found to decrease with the increase in ionic strength (Table 29).

TABLE 29 — VALUE OF n CALCULATED FROM THE SCATCHARD PLOTS FOR LACCAIC ACID AND ITS SODIUM SALT AT DIFFERENT IONIC STRENGTHS

Ionic strength	Value of n	
M	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

Similar studies were also made with disodium salt of laccaic acid. No hypochromism was observed in the spectrum of the dye, instead a hyperchromism was observed together with red shift with increased addition of DNA,

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

Chem. 1.9 Thermal Polymerization of Lac; Studies on the Molecular Weight· Shape and Size

Nothing to report.

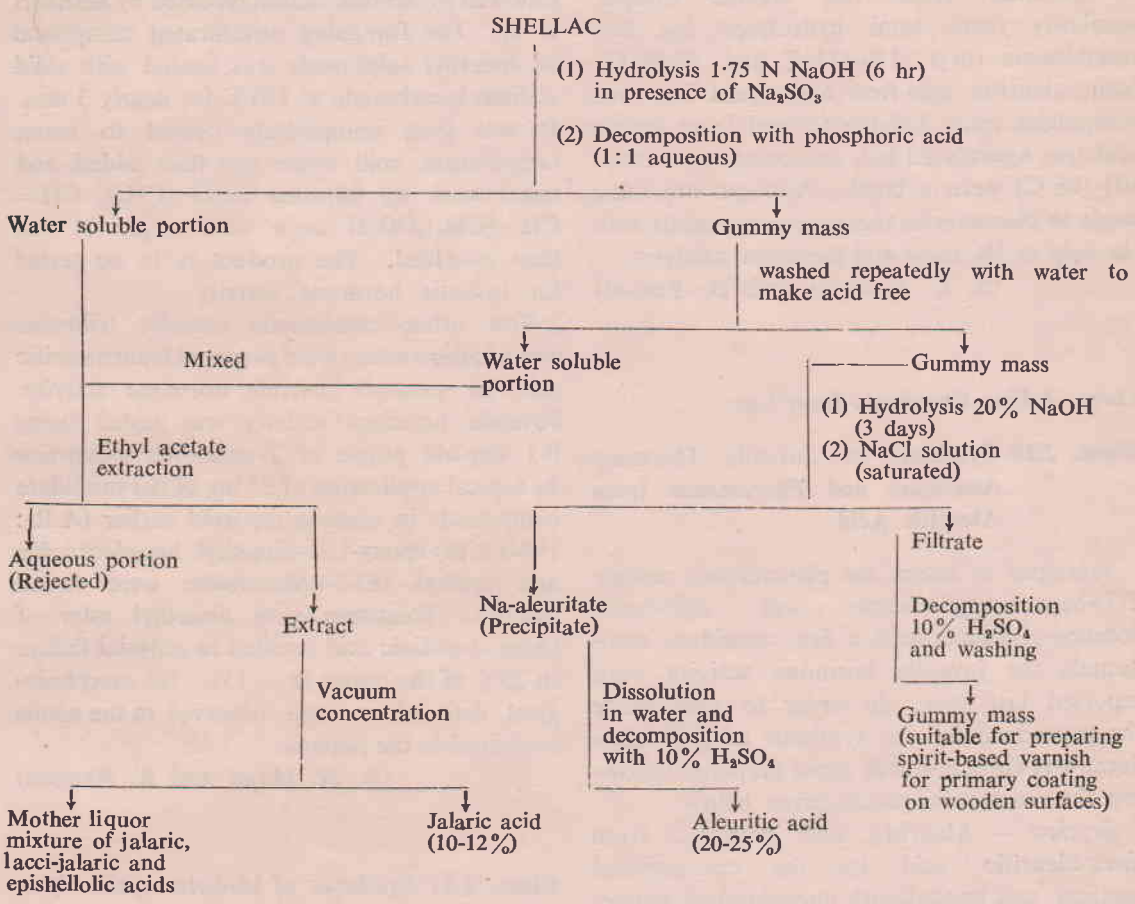
(A. Kumar)

Chem. 1.11 Isolation of Jalaric Acid from Lac: on Technical Scale and Its Utiliza, tion

Methods for the isolation of jalaric acid from shellac and aleuritic acid from the gummy mass left after separation of jalaric acid on technical scale were reported last year.

During the year, the jalaric acid in quantity (25 g) was prepared by adopting the method reported earlier so as to explore its utility as a

starting material in synthesis of some useful organic compounds like diketone, dilactone, triester and substituted coumarin derivatives. The gummy mass left after separation of jalaric acid, was conveniently utilized for the technical preparation of aleuritic acid was also found to be suitable for preparing varnish to be used for primary coating on wooden surfaces. The flow diagram of the total method is given in Fig. 3.



(Pure compounds can be obtained by column chromatography)

Fig. 3 — Flow diagram for isolation of jalaric and aleuritic acids from shellac

(N. Prasad and S. C. Agarwal)

Chem. 1.12 Degradation Studies on Lac

It was reported last year that oxidation reaction of aleuritic acid carried out with nitric acid (70%) resulted in three pure components having m.p. 127-128°, 115-116° and 117-118°C. Similar reaction carried out with jalaric acid yielded one component (m.p. 110-112°C). During the period under report, oxidation reactions of different samples of lac were carried out with nitric acid (70%). The products, thus, obtained from the different samples were

found to be mixture of several components by TLC examination. These were fractionated, refractionated through column chromatography and monitored by TLC.

After repeated crystallization however, only one pure component (m.p. 124-125°C) could be isolated from the shellac sample. Similarily from total hydrolysed lac, two components (m.p. 110-111°C and 96-98°C), from aleuritic acid-free hydrolysed lac, one component (m.p. 127-128°C) and from jalaric acid free hydrolysed lac, one component (m.p. 103-105°C) were is lated. Attempts are being made to characterize the pure compounds with the help of IR, mass and elemental analysis.

(S. C. Agarwal and N. Prasad)

Chem. 2 Fine Chemicals from Lac

Chem. 2.10 Synthesis of Juvenile Hormone Analogues and Pheromones from Aleuritic Acid

Syntheses of insect sex pheromones namely Z(7)-hexade-cenyl-acetate and Z(9)-hexadecene-l-yl-acetate and a few candidate compounds for juvenile hormone activity were reported last year. In order to standardize the procedure for the synthesis of Z(9)-hexadecen-l-yl acetate, it was again prepared following the reaction sequence given below:

Erythro — Aleuritic acid prepared from *threo*-aleuritic acid by the conventional method, was treated with phosphonium iodide/acetic acid followed by alkaline (alcoholic) hydrolysis of the resultant acetoxy acid. The product, 16-hydroxy-(Z)-9-hexadecenoic acid was converted to the corresponding tosyl derivative (oily product). It was then converted to iodo derivative with sodium iodide-dry acetone. Reduction of the foregoing iodo compound as its ester with LAH/THF yielded Z(9)-hexadecen-l-ol. To a solution of the foregoing compound in pyridine, acetic anhydride was added. The resulting solution was stirred for nearly 1 hr and left overnight at room-temperature. Usual work-up and removal of solvent gave Z(9)-hexadecene-l-yl-acetate.

Threo-aleuritic acid was converted into known trans-16-bromo-hexadec-9-enoic acid by the conventional method of bromination followed by debromination reported by Seshadri *et al.* The foregoing unsaturated compound in dimethyl sulphoxide was heated with solid sodium bicarbonate at 150°C for nearly 3 min. It was then immediately cooled to room temperature, cold water was then added and usual work up afforded CHO $(CH_2)_5$ CH= CH$-(CH_2)_7CO_2H$ as a semi solid. It was then esterified. The product is to be tested for juvenile hormone activity.

Few other compounds namely, tribromo and trichloro esters were prepared from aleuritic acid for possible juvenile hormone activity. Juvenile hormone activity was tested using 0-1 day-old pupae of *Trogoderma granarium* by topical application of 25 mg of the candidate compounds in acetone reported earlier (A.R.: 1984) 9(10)-epoxy-1,16-dimethyl hexadecanoate and methyl (E)-2-undecenoate were found inactive. Treatment with dimethyl ester of undec-2-endioic acid resulted in ecdysial failure in 20% of the pupae (n = 15). No morphological deformities were observed in the adults contained in the puparia.

(R. N. Majee and R. Ramani)

Chem. 2.11 Syntheses of bis-heterocyclic Compounds from Aleuritic Acid

Syntheses of oxadiazoles from azelaic and pimelic acids, obtained from periodate oxidation products of aleuritic acid, were reported earlier. During the period under report, synthesis of thiadiazole was carried out using suberic acid as starting material.

Thiadiazole from suberic acid

Suberic acid, m. 140-42°C, was esterified with methanol in the presence of conc. sul-

phuric acid on steam-bath for 6 hr. The dimethyl ester obtained as liquid was heated in methanol with hydrazide hydrate to afford the corresponding hydrazide as a solid, m.p. 186-88°C.

Methanolic solution of the above hydrazide (0·1 M) and phenyl isothiocyanate (0·21 M) were refluxed together for 3 hr and then cooled. The solid thiosemicarbazide was filtered, washed several times with water, dried and crystallized from alcohol, m.p. 176-78°C. The above thiosemicarbazide was then dissolved in ice cold conc. sulphuric acid. The resulting solution was kept at room temperature for 2 hr with occasional stirring and poured into crushed ice, diluted with water and filtered. The solid, thus, obtained was washed and recrystallized from alcohol. The resultant product was *bis*-(5-aryl amino-1,3,4-thiadiazol 2-yl) alkane, (m.p. 222-24°C).

Thiadiazoles from azelaic and pimelic acids

Aleuritic acid on periodate oxidation usual yielded azelaic acid aldehyde and neutral aldehyde, which on further oxidation with Jones reagent afforded azelaic and pimelic acids. The azelaic acid was converted into its dimethyl ester by esterification with methanol. The dimethyl ester on refluxing with hydrazide hydrate afforded the corresponding hydrazide as solid, m.p. 173-75°C.

Similarly hydrazide of pimelic acid was prepared, m.p. 164-66°C.

(R. N. Majee)

Chem. 3 Modification of Lac/Hydrolysed Lac and Their Utilization

Chem. 3.3(ii) Cation exhange resin from styrenated Lac

Kept in abeyance:

Chem. 3.6(ii) Modification of lac and hydrolysed lac with polyisocyanates

Last year lac-linseed oil and lac-castor oil combinations were treated with polyisocyanates and film properties of the resultant compositions were studied.

During the period under report, studies were made on the modification of shellac with polyisocyanates. Shellac solution (25%) in dioxan was prepared and treated with Desmodur N and Desmodur VL separately. Baked films obtained from Desmodur N (15% and 30%) showed good alkali, acid and water resistance. Both air-dried and baked films obtained from Desmodur VL (15%) with shellac showed good acid and water resistance but poor alkali resistance. For comparison, shellac was also treated with TDI (tolune diisocyanate) (20% and 30%) and the film properties of the resultant compositions were studied. Baked films with TDI (30%) showed good alkali, acid and water resistance. It can be inferred that Desmodur N is a better crosslinking agent than TDI as its lower proportion results in the formation of urethane with desirable properties.

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

Chem. 3.10 Addition Polymerization in Shellac

Kept in abeyance.

Chem. 3.11 Modification of Lac with Ethyl Cellulose

It was reported earlier (A.R.: 1984 and 1985) that the varnish compositions were prepared by modifying shellac with diflerent proportions of ethyl cellulose in denatured alcohol. The properties of the air-dried films of these compositions were found to be more or. less similar to those obtained from ethyl cellulose solution.

During the period under report, the performance of the air-dried films of the varnish compositions prepared earlier was re-examined. It was observed that the varnish composition containing 20% ethyl cellulose on the weight of shellac gave the best film performance especially in respect of gloss, flexibility and resistance to water, acetone and alcohol.

Performance of baked films of the said composition was also studied. All the compositions showed much improved performance in respect of water resistance. The films did not show any blushing or lifting when immersed in water for 24 hr. These films also passed the tests for flexibility, and resistance to acetone and alcohol. However both air-dried as well as baked films did not pass the test for impact resistance. In this case the best performance was obtained from the composition containing 20% ethyl cellulose on the weight of lac.

(A. K. Dasgupta)

Chem. 3.12 Modification of Lac Wax

The modification of lac wax with various calcium salts and with sodium bisulphite (5%) at 150°C has been reported earlier.

During the period under report, the commercial lac wax was modified with 2·5, 5, and 7·8% of sodium bisulphite following the same reaction conditions reported last year and physical characteristics such as m.p., penetration value and ash contents of the products so obtained were determined. The results were, however, inconsistent.

Next, lac wax was extracted from lac-mud and the wax so obtained was modified with sodium bisulphite at 150° and 200°C respectively. Physical characteristics such as penetration value and m.p. of the modified products were determined (Table 30).

It may be seen from the table that for an increase in either of the amount of sodium bisulphite or the temp. of reaction, an increase was obtained in m.p. and hardness of the resultant products.

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

TABLE 30 — PHYSICAL CHARACTERISTICS OF MODIFIED LAC WAX OBTAINED FROM LAC-MUD

Sample	Penetration value	M.P. (°C)
1. Wax from lac mud	5	77-78
2. Wax modified at 150°C with		
i) 2·5% sodium bisulphite	4	80-81
ii) 5·0% sodium bisulphite	2	81-82
iii) 7·5% sodium bisulphite	2	82-83
3. Wax modified at 200°C with		
i) 2·5% sodium bisulphite	3	82-83
ii) 5·0% sodium bisulphite	2	83-84
iii) 7·5% sodium bisulphite	2	84-85

Chem. 4 Use of Shellac and Modified Shellacs in Surface Coatings

Chem. 4.5 Studies on Anticorrosive Primers/ Paints for Use on Ferrous Metals

An anticorrosive primer composition based on *bhatta* shellac and double boiled linseed oil vehicle was prepared last year. During the year under report, film properties of this composition were studied but consistent results could not be obtained because the composition showed some gelling tendency. A modified composition of the primer was, therefore, prepared by pigmenting the above vehicle with red oxide of iron and other minor ingredients. This primer composition also showed good drying characteristics and produced smooth, uniform and adherent egg shell films on MS and tin panels. Both the air dried as well as baked films of the primer showed satisfactory flexibility and resistance to scratch test. However, in regard to water and corrosion resistance the baked films showed much improved performance. This composition, unlike the previous one, did not show any tendency to gelling up to 6 months.

(S. Kumar, M. Mukherjee and A. Rahman)

Chem. 4.6 Styrenation of Lac-oil Combinations

The films prepared from lac-linseed oil combination have been found to possess good flexibility but poor properties in respect of hardness and chemical resistance. The objective of the present study is to bring improvement in the hardness and chemical resistance.

Lac-linseed oil combination was prepared following the method developed earlier A.R.: 1985).

Purified styrene and lac-linseed oil combination in equal proportion were dissolved in xylene and reacted together under reflux for 20 hr using benzoyl peroxide (2·5%) as initiator. The film properties of the resultant product were then studied in respect of hardness and resistance towards water, acid and alkali. It was observed that air-dried as well as baked films possess good water and acid resistance but showed poor resistance towards alkali.

(P. M. Patil)

Chem. 6 Electrical Properties of Lac and Modified Lacs

Chem. 6.3 Study on the Tracking Resistance of Shellac-based Varnishes

The study has been initiated during the period under report with an objective to investigate the resistance to tracking of various shellac-based varnishes for use as antitracking insulating varnishes in the electrical industry. The knowledge gained from this study will be helpful to undertake modification of shellac for the said purpose.

Studies have been made on the formation of tracking i.e., slow formation of carbonized path due to the passage of electric current in the presence of NH_4CL solution on the surface of a solid insulating material coated with air-drying varnishes prepared from *bhatta* shellac and seedlac following IS: 8264-1976. The tracking index of the above varnishes were found to be 256 and 224 volts respectively. The comparatively lower value for seedlac appears to be due to the ionic impurities present in it.

(D. N. Goswami)

Adhoc Project: Studies on Lac based Igniter-cum-Fuel

The present study was undertaken with a view to develop a suitable igniter-cum-fuel which may be used by the Defence personnel for cooking food at high altitude.

The experiments carried out on the project have given very encouraging results. A solid igniter-cum-fuel based on *kiri* lac has been prepared which when ignited by a match stick catches fire and burns smoothly with a high fiame (5-6″) for 12-15 min. This igniter weighs about 60 g and is capable of boiling 3-4 cups of water in 7-10 min. It is sufficiently tough and does not break when falls from a height of 6-7′.

(S. Kumar)

(c) RESEARCHES CONTEMPLATED

(1) Studies on lac host plant-insect relationship.
(4) Studies on lac cation exchange resin as catalyst.
(3) Slow-release lac-urea formulation for animal nutrition.
(5) Studies on the modification of lac for use as high thermal class insulating varnishes.
(2) Modification of byproduct obtained during isolation of aleuritic acid from shellac for their utilization in surface coatings.

TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED

Tech. 1.7 Making of Shellac from *Kiri* without Use of Alcohol

Kiri, a byproduct of lac industry obtained during making of shellac from seedlac, contains lac varying from 40 to 55 per cent depending on sample to sample. The lac from *kiri* is at present extracted with alcohol, a costly solvent and not always easily available. So, some other method without use of alcohol has been searched for.

The experiments were carried out to extract lac from *kiri* in aqueous medium using different alkalies of various concentrations. It was observed that on extraction with sodium hydroxide or sodium carbonate, dark coloured products having no life and flow were obtained.

Reaction with sodium carbonate and sodium sulphite followed by the addition of sodium hydrosulphite improved the colour only. Both life and flow were improved but the same time acid value of the product was found higher when further treated with different concentrations of sodium hydroxide. Optimum reaction conditions were worked out which are given below:

The *kiri* is powdered to 10 mesh and dissolved in boiling water with sodium carbonate (8%) and sodium sulphite (4%) (on the weight of lac content) for one hr and filtered. The filtrate is then reacted with sodium hydroxide (2-3%) depending on the quality of *kiri* for 4 hr at 90°C. On cooling, the same amount of sodium hydrosulphite as that of hydroxide is added to it and allowed to react for 15 to 20 min. This is then diluted with water and precipitated with dilute H_2SO_4. The precipitated lac, washed free from sulphate ion is put into boiling water. The molten mass is then made into sheets. The product is more or less similar to that obtained from alcohol extraction process in respect of life, flow and acid value (Tables 30, 31).

The addition of 10 to 15 per cent of good quality of seedlac along with the *kiri* further increased the life and flow of the final product (Table 31).

TABLE 31

Sl No.	Medium of extraction	Raw material used	Life in min	Flow in min	Acid value
1.	Aqueous alkali	*Kiri*	19	16	91
2.	do	*Kiri* + seedlac 10 per cent	20	20	90
3.	do	*Kiri* + seedlac 15 per cent	22	20	90
4.	Alcohol	*Kiri*	20	17	85
5.	do	*Kiri* + seedlac 10 per cent	24	21	85
6.	do	*Kiri* + seedlac 15 per cent	25	22	84

The life and flow of the product remain unchanged during the storage up to six months and it remained alcohol soluble up to 12 months.

(A. K. Ghosh)

Tech. 3.1 Modified Lac (with Synthetic Monomers) as Adhesive

The project was aimed to develop adhesive compositions for wood to wood, wood to sunmica and wood to metal surfaces to extend the use of shellac.

For this purpose, bleached lac was modified with synthetic monomers such as methylacrylate, ethylacrylate, methylmethacrylate, n-butylacrylate, iso-butylacrylate, styrene and vinylacetate in aqueous alkaline medium (triethanol amine/ammonia) using potassium permanganate as initiator.

Bleached lac solution (28%) in alkaline medium and monomers in varying proportions on the weight of bleached lac were taken in a three necked flask. Nitrogen gas was passed for 30 min with continuous stirring and potassium permanganate solution was added. The reaction was allowed to proceed at room temperature for 3·5 hr and thereafter it was refluxed for one hr. The resulting product was tested for adhesive properties on different surfaces.

The product obtained by using methyl or ethyl acrylate monomer and bleached lac triethanol amine in the ratio 50:50 gave the bond strength 0·14-0·15 ton/inch^2 over wood to wood surface. It further increased to 0·25 ton/inch^2 with the addition of hydrolysed lac (10% on the weight of bleached lac). The resulting emulsion was found to fix sunmica over wooden surfaces. The adhesion between the two surfaces was fairly good and the sunmica could not be pulled out by a knife after ageing for five days at room temperature. These compositions when applied over wood to mild steel surfaces gave bond strength of 0·32 ton/inch^2. The above experiments when carried out in ammonical medium, the

resulting product had poor bond strength and was thickened on storage.

In order to get better adhesive compositions, other monomers such as methylmethacrylate, n-butylacrylate, isobutylacrylate and styrene were tried adopting above technique but the products obtained were much inferior in respect of bond strength and fixing of sunmica over wooden surfaces as compared to methyl and ethylacrylate.

Since methyl and ethylacrylates are costlier monomers, vinylacetate and mixture of styrene and ethylacrylate were also tried. In case of vinylacetate, copolymerization was studied in different alkaline/acidic media such as ammonia, triethanolamine, borax, sodium carbonate and sodium bisulphite. It was found that co-polymerization could not be affected due to hydrolysis of the monomer. However, the mixture of styrene and ethylacrylate (1:3) gave bond strength equal to that of methyl/ethyl acrylate.

Bigger lots of the best composition (containing bleached lac methyl/ethylacrylate (50:50) and hydrolysed lac were prepared and applied over wooden surfaces. The sunmica of the size $2' \times 2'$ and $3' \times 1'$ were fixed to know the effect of weather and other factors. The surfaces were intact and no adverse effects such as swelling and delamination were noticed up to 3 years. These lots were also stored in a plastic container in order to see the storage stability and no adverse effect was observed up to one year.

The chemical combination taking place between bleached lac and methyl or ethyl acrylate was then investigated. For this purpose, the initiator $KMnO_3$ for maximum conversion of monomer into polymer was studied at room temp. for 3·5 hr and it was found that M/500 $KMnO_3$ was optimal.

When methyl-ethyl acrylates were polymerized with bleached lac in ratio 1:1 (w/w) at 31°C, maximum conversion was 85 and 63·8 per cent respectively. The acid values of the resulting products were found to be 46 and 27·6 respectively. Each sample (5 g) was extracted with toluene (200 ml) at room temperature for seven days and filtered. The residue was dried till constant weight which were 3·8 and 3·7 g respectively indicating that apparent graft copolymer formed were 27·9 and 10·7 per cent respectively. Since polyethyl acrylate and bleached lac are soluble in alcohol, separation of bleached lac was not possible. Hence, further studies for separation of true graft copolymer could not be carried out. However, apparent graft copolymer (1·5 gm) of methyl acrylate was kept in contact with methanol for seven days and residue 0·257 gm was obtained. This residue, however, did not completely dissolve in tolune-methanol mixture even on standing for more than 15 days.

Further, intrinsic viscosities of apparent graft copolymer of methyl and ethyl acrylates were determined in methanol-toluene (1:1) mixture at 30°C. The values obtained were 0·162 and 0·140 respectively against bleached lac 0·055, which supports that the monomer combines with bleached lac.

(P. C. Gupta, M. Islam and R. Prasad)

Tech. 3.4 Modified Hydrolysed Lac (with Epoxy Resin and Isocyanates) as Adhesives

Hydrolysed lac is widely used in adhesives as adhesion promoter and also as plasticizer. But it has a long curing time (5-6 hr at 150°C). The objective of the present work was to modify hydrolysed lac so as to reduce its long curing time and to make it cold setting for use as adhesives for porous and non-porous surfaces.

Experiments were carried out to introduce epoxy groups in total hydrolysed lac by reacting it with epichlorohydrin using different molecular ratios in aqueous alkaline medium. Experiments were also carried out to introduce epoxy groups in *total* hydrolysed lac by refluxing its solution (20%) in dioxan with sodium metal using different molar ratios (1:2, 1:3, 1:4) followed by refluxing of the

reaction product with epichlorohydrin (1:4 w/w) for 16 hr.

The end products, thus obtained, were soft, tacky and none of them could be air dried as such. In order to cure them at low temperature, these were treated with different amines and their mixtures e.g. triethanol amine, triethanol tetraamine and hexamethylene tetraamine etc. but none of them could be cured completely.

Adhesive property of *rebulac* (A.R.: 1970, 1982) was studied in aqueous medium adopting the standard procedure. The aqueous adhesive of *rebulac* which imparted a bond strength of 0·38 ton per sq. inch showed better properties on steel surfaces as compared to ordinary shellac and dewaxed lac (0·06 ton per sq. inch). On brass surfaces, the adhesive of rebulac imparted bond strength of 0·11 ton/sq inch while on copper surfaces, it was 0·40 ton/sq. inch. The aqueous dewaxed lac did not impart bond strength on brass surfaces but on copper surfaces it has shown bond strength of 0·08 ton/sq. inch. The optimum conditions of pressure, temperature and time of bonding the surface were found to be 3000 lb per sq. inch, 200°C and 45 min respectively. The bonds were found to be resistant to water, caustic soda (2%) solution, sulphuric acid (5%) solution, rectified and denatured spirits, methyl and butyl alcohols, acetone, benzene and toluene.

The adhesive property of aqueous *total* hydrolysed lac under the above conditions of pressure, temperature and time of bonding was studied. The bond strength on copper, steel and brass surfaces was found to be 0·23, 0·15 and 0·04 ton per sq. inch respectively.

The adhesive property of rebulac treated with different percentages of toluene diisocyanate (TDI) were also studied. The adhesive containing 30, 40 and 50 per cent of TDI were found to be suitable as cold setting adhesives for bonding wood to wood, wood to steel and steel to steel surfaces and the respective bond strength was 0·25, 0·30 and 0·32 ton per sq. inch. These bonds were resistant to water, caustic soda and sulphuric acid (5% solution of each), rectified and denatured spirits, acetone, benzene, toluene and dioxan. The formulations having pot life (215 to 280 min) showed remarkable improvement over the compositions obtained by treating shellac with T.D.I. which do not act as adhesive for metallic surface.

The *total* hydrolysed lac was also used in formulating cold-setting adhesive by treating it with 50 per cent TDI and a bond strength of 0·15 ton per sq. inch was obtained on steel surfaces.

The *total* hydrolysed lac was then modified by fusing at 150°C with 10 to 100 per cent of epoxy resin (epikote 1001) on its weight. The resulting products were hard and tough when 70-100% epoxy resin was used but with lower percentage of epoxy resin these were tacky. None of these end-products could be cured at room temperature as such or by treatment with amines. End products with lower (10 to 20) percentage of epoxy resin were completely soluble in aqueous ammonia and alcohol but those containing higher percentages of the epoxy resin were not completely soluble. However, these end products were soluble in a mixture of butanol and benzene (70 : 30, v/v).

The bond strength of these end-products showed decreasing tendency on steel surfaces with the increasing percentage of epoxy resin when the panels were bonded at 3000 lbs/sq. inch pressure for 45 min at 200°C. However, if the panels were bonded at a pressure of 2000 lbs per sq. inch for 1 hr at 150°C, the bond strength showed increasing tendency with the increase of the percentage of epoxy resin in the composition, and the bond strength of the end products containing 10 to 70 per cent of epoxy resin was found to vary from 0·14 to 0·29 ton per sq. inch.

Among the pressure sensitive adhesives, the formulation based on aqueous Rebulac showed excellent adhesive properties on metallic surfaces. On the other hand,

the cold setting adhesives obtained by treating Rebulac with T.D.I. had long pot life (215-280 min) and were highly suitable for bonding wood to wood, wood to steel and steel to steel surfaces. These adhesives also showed remarkable improvement over the compositions obtained by treating shellac with T.D.I. which do not act as adhesive for metallic surfaces.

(R. K. Banerjee and P. C. Gupta)

Tech. 4.2 Standarization and Pilot Plant Studies on Shellac Based Water Thinnable Red Oxide Primer

The object of the present study was to scale up the process for preparing water thinnable red oxide primer based on lac-linseed oil fatty acids-glycerine-red oxide formulation.

Linseed oil fatty acid (40 parts) was first heated to 130°C under stirring and powdered shellac (100 parts) was added in small lots. The temperature of melt was raised to 155 ±5°C and then glycerine (20 parts) was added. The melt was maintained at the same temperature (155-160°C) till the acid value dropped to 55·00, which took about 1·5 hr. A tendency of thickening of the product was observed at this stage. The heating was discontinued and the melt allowed to cool to about 100°C and dissolved in a small volume of methylated spirit (75 parts) to facilitate its subsequent dispersion in aqueous ammonia. This spirit solution was poured into ammoniacal water (350 parts, containing 8 parts ammonia, sp. gr. 0·888) with stirring to facilitate dissolution. It was then strained through a muslin cloth.

The vehicle, thus obtained, was ground to a pigment volume concentration of 35 per cent with red oxide of iron and small portions of talc (5%) for about 24 hr. The primer, thus obtained, had a viscosity of 28-29 sec in a B_4 Ford cup. The primer was applied on mild steel panels by brushing/spraying. The films dried in air very rapidly and hard film was obtained within 30 min. The baked film showed good adhesion to substrate and to finish coats such as nitrocellulose lacquer, oil, paints and synthetic enamels. Finish coat could be applied immediately after baking or after 24 hr air drying.

The hardness of the air dried and baked films were 0·80 and 1·5 kg respectively. Flexibility was good and passed the conical mandrel test (3 mm diameter). The baked films when immersed for 7 days in water, white spirit, kerosene, petrol and toluene remained unaffected.

The baked films also resisted salt droplet test (artificial sea water) without corrosion for 5 days.

A fresh sample of the primer prepared and stored in a polythene container for studying the self life. There had been no change in viscosity and its performance after one year storage.

(P. C. Gupta)

(b) RESEARCHES IN PROGRESS

Techn. 1. Improvement in the Processing Techniques

Techn. 1.6 (ii) Improvement in dewaxing and decolourizing techniques in solvent medium

The process of dewaxing was repeated with dilute alcohols of various concentrations. The results obtained confirmed the observations made last year i.e. dewaxing at room temperature (23-26°C) was optimum with 78-80 per cent alcohol, but below 18°C, 95-98 per cent alcohol was most suitable for dewaxing.

Different grades (commercial, L.R. and pure) of activated carbon were tried to decolourize lac (*kusmi* seedlac) by the method standardized earlier (A.R.: 1981 and 1982). The results are brought out in Table 32. It will be seen from the table that decolourization was most effective with activated carbon from E. Merck, Germany and shellac with

TABLE 32 — DECOLOURIZATION OF *kusmi* SEEDLAC WITH 20 PER CENT OF ACTIVATED CARBON OF DIFFERENT GRADES AND SOURCES

Sl No.	Grade and source of activated carbon	Yield of shellac (%)	Colour index
1.	Control (no activated carbon used)	83·7	11·0
2.	Commercial grade, Bengal Chemicals	80·6	1·2
3.	L.R. Grade, Sarabhai M. Chemicals	80·1	1·2
4.	E. Merck (India)	79·5	0·9
5.	Pure and dry, E. Merck (Germany)	78·9	0·7

colour index as low as 0·7 could be prepared but the fine carbon particles were very difficult to be separated by filtration from the decolourizing solution. On the other hand, the coarse particles of the commercial grade of activated carbon from Bengal Chemicals could be separated very easily by filtration, but decolorization was not so effective and shellac of colour index 1·2 could be prepared.

(R. K. Banerjee)

Techn. 2. Rubber-Shellac Combination

Techn. 2.1 Incorporation of modified lacs into Rubber

The effect of incorporation of mg-salt of lac into the blend of NR and SBR with EPC black and china clay white fillers was reported last year. During the period under report, the effect of incorporation of mg-salt of lac into the blend of NR and SBR with HAF black and aluminium silicate white fillers was studied (Table 33).

In case of HAF filler incorporation of 5-10 parts of mg salt of lac into the blend showed better performance in respect of tensile strength, tear resistance, hardness and abrasion resistance while in the case of aluminium silicate, improved performance in respect of modulus, tear resistance and hardness was obtained by the incorporation of 10 parts of mg salt of lac into the blend.

TABLE 33 — THE EFFECT OF INCORPORATION OF Mg-SALT OF LAC INTO THE BLEND OF 50 PARTS EACH OF NR AND SBR WITH FILLERS

(*Base mix*: *NR*, 50; *ZnO*, 4; *Stearic acid*, 1; *PBN*, 1; *Sulphur*, 2; *Accelerator*, 1)

Mg-salt of lac added per hundreds parts of the blend	Optimum time of cure (min)	Mooney No. ML 1+4 at 120°C	Scorch time (min-sec)	Modulus at 200% elongation (kg/cm²)	Elongation at break (%)	Tensile strength (kg/cm²)	Tear resistance (kg/cm²)	Shore A durometer hardness	Impact resilience (%)	Abrasion resistance index
FILLER HAF BLACK (40 PARTS/100 PARTS OF BLEND) ACC. CBS										
0	30	42	32-05	30·1	450	39·7	10·1	62	58·4	100
5	30	28	30-50	26·9	420	75·0	15·3	66	58·4	125
10	20	43	34-12	10·1	600	92·0	16·8	66	56·7	49·4
15	20	54	29-44	10·2	570	69·7	15·1	67	50·3	34·9
20	30	46	39-00	12·9	450	36·1	15·7	69	47·1	32·8
FILLER ALUMINIUM SILICATE (46·5 PARTS/100 PARTS OF THE BLEND) ACC. CBS										
0	20	45·0	6-18	11·3	570	56·3	17·6	63	63·5	—
5	20	45·0	7-13	14·1	550	37·5	17·3	64	58·4	—
10	20	41·0	11-44	16·4	600	42·3	20·0	65	58·4	—
15	20	36·5	13-07	16·1	550	40·2	18·2	—	51·9	—
20	20	27·0	14-03	14·4	470	34·1	14·7	68	48·7	—

(R. Singh)

Tech. 2.2 Electrical Properties of Rubber--Shellac Blends

The results of the study on the variation of dielectric constant, dissipation factor and dielectric loss (measured at 100 kH) due to incorporation of different proportions of shellac in the gumstocks of NR, SBR and their blends (50:50) and also in the filled (china clay) stocks of the blends at different periods of curing have been reported last year.

During the period under report, the variation of dielectric strength of the above blends was studied. The values of dielectric strengths are shown in Table 34. It may be seen that incorporation of shellac in the filled stocks of the blends resulted in slight decrease in the dielectric strength values. No marked change in the dielectric strength was observed for the stocks cured for a longer period of time. The values of dielectric strength of the filled stocks were found to be low compared to those of unfilled stocks reported earlier (A.R.: 1984).

Studies were also carried out on the variation of dielectric constant, dielectric loss and dissipation factor in the frequency range 100 HZ-100 kH for the blends of NR and SBR in the gumstock containing 0·15 and 20 parts of shellac per 100 parts of rubber at 30°C. The curing time was varied between 10 and 50 min. The dielectric loss-frequency profiles revealed existence of many relaxation processesl.

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

TABLE 34 — VARIATION OF DIELECTRIC STRENGTH OF DIFFERENT SHELLAC INCORPORATED BLENDS (50:50) OF NR AND SBR IN THE FILLED STOCK (CHINA CLAY), WITH CURING TIME

(*Base mix*: *NR*, 50; *SBR*, 50; *ZnO*, 4; *PBN*, 1; *stearic acid*, 1; *sulphur*, 2; *MBT*, 1; *china clay* 100)

Curing time in min	Dielectric strength (V/mil) of the blends of NR and SBR shellac content part per hundred parts of the blend				
	0	5	10	15	20
10	304	307	247	275	312
20	325	315	288	263	275
30	330	300	259	285	275
40	322	303	234	285	264
50	299	294	251	275	241

EXTENSION DIVISION

(a) PROJECTS COMPLETED

Nil

(b) PROJECT IN PROGRESS

OPERATIONAL RESEARCH PROJECT FOR MAXIMIZING 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 operational area comprising of four backward tribal villages, namely, Barguttu, Hardag, Koenjari and Saheda of Ranchi district.

(A) INSECT CULTURE PROGRAMME

(a) LAC CULTURE

Trial-cum-demonstrations of improved methods of lac cultivation on *palas*, *ber* and *kusum* trees belonging to the cultivators were continued. Necessary inputs were supplied where needed and improved implements were loaned for seasonal use.

Rangeeni sticklac coupe — Baisakhi 1985-86 *ari* (immature) sticklac was harvested from a set of 7 *ber* trees of 6 farmers during May 1986. The trees of this set were inoculated with the broodlac supplied *as subsidy*, at an average rate of 2·27 kg/tree during October/November 1986. An average yield of 3·643 kg sticklac/tree was obtained as against 0·580 kg recorded from the trees cultivated following traditional method. Thus, an average yield increase of 528 per cent was demonstrated.

Another set of 122 *ber* trees of 27 farmers which was inoculated with the farmer's own broodlac at an average rate of 2·27 kg/tree was also harvested and an average sticklac yield of 0·935 kg/tree only was recorded, in this case, mainly due to comparatively less efficient selection of broodlac used for crop inoculations. Here, an average increase of 61·0 per cent was recorded over the traditionally operated trees.

Rangeeni broodlac coupe — Baisakhi 1985-86 cum *katki* 1986 crop was harvested from 22 *palas* trees during October 1986. These trees were inoculated with an average brood rate of 6·603 kg/tree during October 1985 after pruning them during April 1985. Average broodlac yield of 1·4 kg/tree and 0·550 kg/tree was recorded from the sets inoculated with and without synthetic net containers respectively as against 0·375 kg/tree recorded from the traditionally operated trees. Thus, an average increase of 273 per cent was demonstrated with the use of synthetic net containers.

Caging observations on 5 samples, one metre each, collected at 3 intervals per crop revealed suppression of predator population at all stages due to the use of synthetic net containers. The data are summarized in Table 35.

TABLE 35 — PREDATOR SUPPRESSION DUE TO THE USE OF SYNTHETIC NET CONTAINERS FOR CROP INOCULATION

Crop	State	Average suppression (%)		
		Eublemma amabilis	*Holcocera pulverea*	*Chrysopa* spp.
Baisakhi 1985-86	*Phunki* removal	71·1	76·9	100·0
	Sexual maturity	88·3	100·0	25·1
	Maturity	100·0	100·0	0
Self inoculated	*Phunki* removal	0	0	0
Katki 1986	Sexual maturity	61·7	79·1	40·0
	Maturity	57·8	77·1	0

Adoption level survey

Survey was conducted at the end of the period under report to ascertain the level of adoption of the improved technologies of lac production by the lac cultivators (71 nos.) through personal contact. The entire package was not adopted by the farmers due to the constraints described in the previous reports. Individual technologies, however, were adopted as per the details given in Table 36.

TABLE 36 — ADOPTION OF LAC PRODUCTION TECHNOLOGIES BY THE CULTIVATORS

Technology component	Adoption level (%)			
	Full	Partial	Convinced	Total
Pruning of *Ber*	34·4	13 9	13·9	62·2
Pruning of *Palas*	10·1	24·5	19·1	53·7
Broodlac selection	21·4	19·1	07·8	48·2
Broodlac bundling	20·0	21·5	07·7	49·2
Inoculation using net container synthetic	8·2	27·4	04·7	40·4
Spraying of insecticides	4·2	16·7	11·4	32·2
Coupe system	3·8	05·7	14·1	23·7

(b) APICULTURE

Follow up and support service was continued and by the end of the year, the area had 76 beekeepers owning 218 beehives. Out of these, 32 keepers possessed 91 bee colonies in the beginning of the year. After accounting for the 46 catches and 38 desertions of the bee colonies, the number of colonies rose up to 99 owned by 39 keepers by the end of the year and production of honey was 384 kg from 91 colonies owned by 34 beekeepers. As a marketing support the sale of honey in clean bottles was arranged at the rate of Rs 30 per kg providing a cash income of Rs 307.00 per beekeeper.

(B) CROP PRODUCTION PROGRAMME

(a) AGRICULTURAL CROPS

Farmers having irrigation facilities were encouraged to grow wheat crop during *rabi* season. Nine farmers continued growing wheat and average yields of timely and late sown trials (after paddy harvest) were recorded to be 23·0 and 7·50 q/ha respectively. The average gross income from this source was Rs 670 per farmer.

(b) HORTICULTURAL CROPS AND AGROFORESTRY

Seedling of *ber* (160), *galwang* (175) and *subabul* (75) raised at the Institute plantation were distributed amongst the farmers of the area.

In addition, grafts of *orange* (4) and *mosambi* (1) were purchased on behalf of the farmers from Birsa Agricultural University, Ranchi for raising gardens by the members of the Krishi Vikas Club.

(C) ANIMAL HUSBANDRY PROGRAMME

(a) SWINE HUSBANDRY

Two keepers continued to maintain hybrid (Yorkshire × Local) stock and 3 farrowings were recorded during the month of April, yielding 12 piglets (average 4, range 3 to 6). High mortality amongst the piglets was recorded, five died during April/May and six during September/October due to improper housing and inadequate feeding of nursing mothers/weaners. One farmer earned Rs 1480 through slaughter and disposal of 3 animals. By the end of the year, three sows and three boars were surviving in the area.

(b) DAIRYING

Out of the two crossbred heifers and 4 bullocks surviving in the area, 2 bullocks died due to disease and one pregnant cow died at the time of delivery. Out of the two local cows, one was sold for Rs 600 only. Thus, by the end of the period under report only one crossbred heifer and 2 crossbred bullocks were surviving. One local cow and one 15 month old local bullock were also surviving. No milk yield was recorded.

(c) GOAT KEEPING

The sole surviving black Bengal kid was reported lost due to lifting by wild animals and only the black Bengal mother survived till the end of the year without any economic contribution. The goat keeping has not shown any promise till now.

(D) EXTENSION EDUCATION PROGRAMME

A limited number of Farmers forum meetings were conducted and discussions on the new technologies, constraints and the needs of the farmers were held.

Krishi Vikas Club activities were also continued and technical literature printed/reproduced at the Institute and collected from various sources was distributed and contents explained.

(R. C. Mishra and J. Lal)

3. EXTENSION ACTIVITIES

1. Large scale cultivation of lac at Kundri

The division continued to render technical guidance to the Forest Department, Bihar in running their Lac Farm at Kundri (Palamau District) consisting of nearly 40,000 *palas* trees. Various seasonal operations were carried out in the farm during May, July, August and October-November under the direct supervision and guidance of the division. A total of 22,000 trees in coupe A and C were pruned/*ari* harvested in May yielding 51·30 Q sticklac. Partial harvesting from 486 trees during July/August yielded 2·72 Q broodlac. During October/November, a record yield of 306·53 Q broodlac was obtained from 15,000 trees. From this, 115·0 Q was utilized for inoculating 25,000 trees of coupe A and C and 2·0 Q was sold by the Forest Department. Besides, 45 Q broodlac was distributed free to 845 SC/ST families as a part of the development programme of the Forest Department. On scraping the remaining broodlac as well as the *phunki* lac stick, 22·33 sticklac was obtained. The entire operation involved an expenditure of Rs 51874.00 only and a net profit of Rs 463542.00 is expected.

Improved management practices have resulted in considerable increase in the productivity of the farm in recent years as is evident from the following table:

Years	Average production (per year)	
	Sticklac (tonnes)	Broodlac (tonnes)
1945-54	4706	1492
1955-64	13,247	7566
1965-74	5428	3411
1975-84	7432	4656
1985-86	19,979	6242 (average of 2 years)

2. Technical advisory services

The division attended 214 queries related to lac farming, manufacture of lac and lac products, availability of raw materials and machineries, schemes of various sizes on lac based industries etc. received from all over the country and abroad. Consultancy services were provided to visiting industrialists, entrepreneurs, extension workers and government functioneries. Technical assistance was also provided to lac growers for the forecast of larval emergence and causes of insect mortality. During the year, reports for 34 crop samples were issued by the Division. At the request of the Directorate of Lac Development, Ranchi, their *kusmi* broodlac farm at Hesadih was visited to investigate the causes of crop failure. The farmers in the region were interviewed in order to obtain information on the topic and the reasons of the crop failure were identified. Schemes and project reports on lac based industries were prepared for the benefit of new entrepreneurs and the processes for manufacture of bleached lac, sealing wax, gasket shellac and hydrolysed lac were demonstrated to entrepreneurs. The following ad-hoc research problems were also attended:

(a) Comparative study of lac stick shelling methods for small farmers.

A study was made for the performance of a number of manually operated lac stick shellers suitable for use in unmechanized farming operations. Laboratory analysis of samples obtained from traditional hand method and small rotary shellers developed by Birsa Agricultural University, Ranchi was carried and characteristics of the product determined for comparison.

(b) To study the industrial parameters of lac resin obtained from different source, origin and generation.

During the period, 15 samples were obtained and analysed for yield, flow, life, colour, rate of filtration, wax and acid value.

3. Publicity

Exhibition stalls were put up in 3 Kisan Melas organized by Divyayan Krishi Vigyan Kendra, Ranchi on 27-28 January and Birsa Agricultural University, Ranchi on 7-9 February and on 3-4 October. A programme for TV on 'Lakh ke Shatru Keere aur Unke Roktham' was arranged and a script for a TV film on ILRI was submitted. Information sheets for press release were compiled which received wide coverage. Important publicity was achieved through the presentation of a tableau on lac during the Republic Day functions of the Government of Bihar at Ranchi for which all material assistance was provided to the State Government.

4. Testing and standardization activities

The division provided testing facilities for lac and lac products for the benefit of manufactureres and Government Organization on payment of nominal fees. During the year, 68 samples of seedlac, shellac and other lac based products were received and in all 276 tests were carried out.

The division also contributed to the standardization activities of Indian Standards Institution through drafting and scrutiny of standards, evolving test methods and evaluation and extension of existing methods.

5. Training

The following training courses were organized by the division:

(i) Three regular certificate courses on "Improved methods of Lac Cultivation".

(ii) One-month short course training two senior level FAO fellows from Vietnam, namely, Mr Phan Dinh Thanh, Director of the Special Forest Products Research Division and Mr Hoang Hoai, National Director of Project, Ministry of Forestry, Vietanam.

Certificates were awarded to five successful candidates under the course in "Improved methods of Lac Cultivation". For all the above training programmes, the division contributed by developing course schedules, selecting candidates, developing instructional resources and evaluation of candidates.

The division continued to extend its support to the educational activities of the Divyayan Krishi Vigyan Kendra, Ranchi and during the year, fourteen lectures on lac culture by the Institute experts were arranged for three batches of their grass root level trainees. Besides, on-farm training for 25 farmers of Ranchi, Palamau and Singhbhum districts of Bihar was organized at the R. K. Mission farm, Maheshpur, Ranchi.

A project was started with the cooperation of Forest Department of Bihar with an aim to educate farmers in scientific lac cultivation. A group of 850 SC/ST families (traditional lac cultivators) belonging to the villages Vishrampur; Sna, Khapia, Anran, Kundri, Satbarva, Chianki, Kauria, Saahad, Manatu and Ramsagar of Palamau District were identified for training and assistance during the year. The programme is centred on the training of the participating families in improved techniques of lac cultivation, free broodlac supply and supervision spread over several seasons. During the year, 4536·5 kg of broodlac was distributed free among these families.

6. Visitors

The division attended 573 visitors including five batches of farmers, one batch of State Forest Service trainees and five batches of school/college students. Films/slides shows were arranged for those who came in a group.

4. PAPERS PUBLISHED

The Institute publishes its research findidgs in leading scientific and technical journals. In addition, a few books and one monograph have also been published. The total number of publications as on 31st December 1986 are given below:

Papers published

1.	Bulletins	
	(i) Chemical	165
	(ii) Entomological	107
2.	Technical Notes	30
3.	Research Notes	
	(i) Chemical	85
	(ii) Entomological	52
4.	Miscellaneous Technical Publication	
	(i) Chemical	14
	(ii) Entomological	48
5.	Books and Monographs	15
6.	Pamphlets and Leaflets	35

A complete list of the Institute's publication together with those of a sister organization, the erstwhile London Shellac Research Bureau is supplied on request by the Librarian of the Institute.

RESEARCH PAPERS PUBLISHED IN 1986

Entomology Division

Srivastava, D. C. and Chauhan, N. S. (1986) " On the Sex ratio of the lac associated insects ". *Entomon*, **11**(4), 245-46.

Plant Sciences Division

Kumar, P., Sinha, S. S. N. and Chauhan, N. S. (1985), The effect of gamma rays on germination and survival in two cultivars of *Cajanus cajan* and two species of *Moghania*. *Legume Res.* **8**(2), 98-100.

Kumar, P and Sinha, S. S. N. (1985), Gamma rays induced mitotic abnormalities and their elimination in root and shoot cells of two cultivars of *Cajanus cajan* Linn (Milli sp.) and two species of *Moghania*. *Genet. Iber* **37**, 183-190.

Srivastava, D. C. and Kumar, P. (1985), Sex ratio of the Indian Lac insect on pigeon pea. *Legume Res.* **8**(2), 101-102.

Kumar, P. (1986), Polyembroyony in *Acacia farnesiana*. *Indian Forester*, **11** 2(8), 742.

Chemistry Division

Agarwal, S. C. and Srivastava, B. C. (1986), Utilization of aleuritic acid free-gummy hydrolysed lac in shellac-jointing gasket compound. *Res. & Ind.*, **31**(3), 244-46.

Khanna, B. B., Saha, S. K., Goswami, D. N., Ghosh, A. K., Patil, P. M. and Prasad, N. (1986), The physico-chemical properties of seedlac and shellac on ageing. *J. Paint & Resin* **56** (3), 37-41.

Technology Division

Gupta, P. C. (1986), The adhesive properties of shellac modified with toluene diisocynate. *J. Oil Col. Chem. Assoc.*, **69**(2), 43-44.

Gupta, P. C., Bhattacharya, P. R. and Misra, G. S. (1986), Molecular weight-intrinsic viscocity relationship of *trans*-16-hydroxy-9-enoate hexadecenoic acid polyester. *Die. Angew, Makro Chemie*, **104**, 167-173.

Singh, R. and Khanna, B. B. (1986), Zinc salt of lac as a compounding ingredient of a blend of natural and styren butadiene. Proc. International conference on rubber and rubber like materials held at Jamshedpur, 6-8 November.

5. RESEARCH COORDINATION AND MONITORING SECTION

The Research Coordination and Monitoring Section received a new zeal for its various activities under the leadership of Institute new Director. The salient features of the activities held during 1986 are as under:

1. Research monitoring

The research progress on about 51 projects was periodically monitored by a committee comprising of Director as chairman, senior scientists of six divisions as members and technical officer as member-secretary. In this way, many bottle-necks were discovered to improve the research efficiency and needful action was initiated to modify the projects/ programmes. Emphasis was laid upon to every scientist of the divisions of Entomology, Plant Sciences and Insect Genetics to develop viable lac cultivation technology for the cultivator and of the divisions of Chemistry and Technology, to develop lac products/processes for the industry. In addition to these periodic meetings, the SRC (Staff Research Council) meetings were also held and the proceedings of these meetings were prepared and circulated. The concept of accountability was emphasized in these meetings. The research accomplishments of research projects were compiled in bookform in the " Mile stone proformae " and sent to Director-General, ICAR, New Delhi.

2. Research reports

Important research findings were regularly compiled into various reports namely, fortnightly, monthly and quarterly reports for union cabinet Ministry and Director-General ICAR, Regional Committee report, DARE report.

INSTITUTE ANNUAL REPORT COMMITTEE

A separate committee constituted for scrutinizing and editing the Institute Annual Report continued to function during 1986 to clear the back log of the Institute Annual Reports. During the period, the Member-Secretary convened forty-five meetings of the committee which scrutinized and edited the Annual Reports for the year 1984 and 1985. The said reports, after editing and compilation were sent to local press for printing.

3. Other Activities

The RC and M Cell plays active role in organizing various scientific and technical meetings/seminars/symposia etc. and in supplying general information about the Institute activities to various agencies. The section maintains research project files and manpower data whenever required by ICAR, NAARM and Dept. of Science and Technology. The section also works to keep a liason between the Institute Administration and Scientists in matters pertaining to research work and infrastructure facilities.

The papers submitted by the scientists for publication in different scientific and technical periodicals are also processed and communicated to the concerned journals.

6. CONFERENCES/SYMPOSIA/SEMINARS ATTENDED BY ILRI SCIENTISTS

The following scientists of ILRI, Ranchi attended the important conferences/symposia organized at various places in India.

1. Dr S. K. Saha, Head, Extension Division and Dr A. Pandey, S-1, attended a symposium on "Modernisation of lac industry organised by CSSI, Govt. of West Bengal at Purulia during March 24-25, 1986.

2. Sri Radha Singh, S-1, attended an International Conference on rubber and rubber like materials held at Tatanagar during November 6-8, 1986 and the scientist presented a paper entitled: "Zinc salt of lac as compounding ingredient of a blend of NR and SBR rubbers".

INSTITUTE SEMINARS

Prof. Dr R. P. Kapil who joined this Institute as Director on 1st April 1986, stressed the need for holding Institute Seminar talks on every Saturday so as to create appropriate platform to the scientists to present their research activities and exchange the views to plan new dimensions of research. The seminar talks organized during April-Dec. 1986 are given in Table 37.

TABLE 37 — INSTITUTE SEMINAR, TALKS HELD DURING APRIL TO DECEMBER. 1986

Date	Name of speaker	Topic	Name of reviewers
21.5.86	Sri N. S. Chauhan Head, Insect Genetics Division	Current state of our knowledge on genetics and breeding of lac insects	—
22.5.86	Dr A. Kumar, S-2	Polymer chemistry of lac	
2.6.86	Sri B. P. Singh, S-2	Role of intercroping under recent trend of lac cultivation	—
20.6.86	Dr David L. Pearson Associate Professor of Biology, Pennseylvania State University	Plant hervivore interaction	—
21.6.86	Dr P. C. Gupta Head, Tech. Division	Adhesives and shellac	—
28.6.86	Dr A. Pandey, S-1	Electro-deposition of shellac	—
5.7.86	Sri B. N. Sah, S-1	Factors affecting lac insect and lac culture	—
19.7.86	Sri Shravan Kumar Head, Chem. Division	Uses of lac and modified lacs in surface coatings	Dr B. B. Khanna
26.7.87	Sri R. K. Banerjee, S-1	Hydrolysed lac—its modifications and uses	Sri Shravan Kumar Dr B. C. Srivastava
2.8.86	Dr S. K. Saha Head, Extn Division	Age dependent characteristics of lac resin	Dr B. B. Khanna Dr P. C. Gupta
28.8.86	Sri A. H. Naqvi, S-2	Nutrition of lac insect with special reference to synthetic diet	Sri B. B. Das
30.8.86	Dr S. C. Agarwal, S-3	An up-to-date knowledge on the chemistry of lac	Dr A. Kumar Dr D. N. Goswami
6.9.86	Dr P. Kumar Head, Plant Sci. Division	Vegetative propagation of lac host plants	Sri B. K. Purkaystha Sri S. C. Srivastava
20.9.86	Sri Radha Singh, S-1	Zinc salt of lac as a compounding ingredient in a blend of natural and styrene-butadiene rubber	Dr B. B. Khanna Dr A. Kumar

—Continued

TABLE 37 — INSTITUTE SEMINAR, TALKS HELD DURING APRIL TO DECEMBER. 1986 — *Contd*

Date	Name of speaker	Topic	Name of reviewers
3.10.86	Sri R. P. Tiwari (Librarian)	Agricultural information services in ICAR	—
4.10.86	Sri B. B. Das Head, Ento. Division	Present status of entomological research on lac and future strategy	Sri N. S. Chauhan Sri R. C. Mishra
27.10.86	Dr S. N. Bhadani University Professor, Deptt. of Chem., Ranchi University	Cellulose based polymer liquid crystals	—
14.11.86	Dr D. N. Goswami, S-2	DNA-dye interaction binding of laccaic acid with DNA	Dr S. K. Saha Dr A. Kumar
6.12.86	Dr N. Prasad, S-2	Use of chromatographic techniques on isolation and identification of constituents of lac resin	Dr S. C. Agarwal

TABLE 38 — SPECIAL SEMINAR ON " PERSPECTIVES IN LAC RESEARCH AND ITS FUTUROLOGY " HELD ON 11-12 DECEMBER 1986

LAC/BROODLAC PRODUCTION TECHNOLOGY

Speaker	Title
Sri N. S. Chauhan, Head, Division of Genetics	Genetics and breeding approaches for improving lac insect productivity
Sri A. H. Naqvi, S-2	Cultivation techniques
Sri R. C. Misra, S-2	Research needs in lac production entomology and a peep into the future
Sri S. G. Choudhary, S-1	Pest control technology for improving lac productivity
Dr A. K. Sen, S-1	Extension of lac cultivation in India
Sri B. N. Sah, S-1	Role of ecological factors influencing lac production technology

LAC PRODUCTS AND PROCESS TECHNOLOGY

Dr B. B. Khanna, S-4	Need to scale up products/processes at pilot plan level
Sri Shravan Kumar, Head, Division of Chemistry	Prospective areas in lac utilization — A survey
Dr S. K. Saha, Head, Extension Division	Problems in transfer of lac based industrial technologies
Dr S. C. Agarwal, S-3	Lac industry — a viable proposition
Dr P. C. Gupta, Head, Division of Technology	Role of lac in adhesives
Dr A. Kumar, S-2	Future of lac in polymers
Dr N. Prasad, S-2	Measures to push up lac based products/processes
Dr R. N. Majee, S-2	Potentials of aleuritic acid in various fields
Dr B. C. Srivastava, S-2	Futurology of lac in the science of controlled release
Dr T. Bhowmik, Retired Scientist and Technical Adviser, SEPC, Calcutta	A vision in the future of lac industry

At the end of the year, a special seminar on "Perspectives in Lac Research and Its Futurology" was organized at the Institute during December 11-12, 1986 for active rethinking in each area of research on production of lac and its products for future diversification of lac research consequently revamping of the research programme of the Institute for the year 1987 leading to greater viability and prosperity of the lac industry. The details of this seminar are shown in Table 38.

Conclusion

Considering the deliberations in the above seminar, the following aspects are suggested for future researches:

LAC/BROODLAC PRODUCTION TECHNOLOGY

*Precise evolution of the relative host potential of the plant species used for rearing lac insect for their judicious use to raise the lac production.

*Proper identification of good lac hosts and intensive studies to grow lac on plantation basis.

*The lac insect — host plant interactions need deeper probing for understanding the nutritional and secretional physiology of lac insects.

*Selection of high yielding pest resistant stocks and early maturing insects.

*Criteria for classification of good and healthy broodlac.

*Study of reproductive biology and optimum requirement of male population for raising the production of lac.

*Precise information is needed for the pest status of the various inimical insects and for their interactions for improving pest management. Working out causes of lac insects mortality and intensive control measures; for pest and predators.

*Little is known about lac insect ecology which merits attention.

*Survey of genetic variation through intra and interstock variation, study of crosses and analysis of inbred lines.

*Evaluation of lines derived from crosses of genetically divergent stocks for screening superior insects.

*Application of hybrid vigour for improved lac productivity.

*Quality improvement through mutation breeding.

*Motivating the people for growing more lac by the use of technologies development.

*Fixation of a standard price of lac by the Government.

LAC PRODUCTS AND PROCESS TECHNOLOGY

*Pilot plant scaling up of the products/processes already developed.

*Need to carry out researches in the field of: (i) Printing inks, (ii) Electronic industry, (iii) Anticorrosive primers, (iv) Fire resistant paints, (v) Insulating varnishes having high thermal resistance, (vi) Pharmaceuticals and other related products.

*Survey and analysis of the lac consuming industries.

*Drawing up guide lines on national policies for promotion of lac based industries.

*Drawing up Indian standards for shellac based products for quality control measures.

*Establishment of effective programmes/schemes of active research-industry cooperation.

7. AUXILIARY SUPPORTING SERVICES

INSTITUTE PLANTATION

General management and upkeep of the plantation including maintenance of roads, paths, hedges and fencing were carried out during the year. Hoeing, weeding and mulching operations for the young host plants in different plots were done on the same pattern as in previous seasons. Effective improvement and proper management of host plants through agro-forestry practices were adopted in all the plots. Dinanath grass was grown in between the rows of *khair* host trees for suppressing the weeds therein as well as to improve the condition of lac host trees by way of green manuring and cultural operations.

Seedlings of various species of lac host plants namely, *palas*, *ber*, *kusum*, *bhalia*, *galwang* and other minor hosts were raised in the nursery beds for filling up the gaps in respective plots and for use in the pots for laboratory experiments.

A road (2·5 m wide) along the fence line covering plot nos. 55, 56, 57, and 59 was got constructed to facilitate the guarding more effectively. Unwanted and obnoxous weeds like *Lantana camera* and *Stachyterphteta indica* were uprooted in the plot nos. 2, 6, 7 comprising of *Sal*, *Khair* and *ghont* trees respectively and thereafter hoeing operations through tractor were carried out.

Paddy (*Sita*) was grown in the low-lying fallow land covering an area of one hectare and an yield of 19·8 Q was obtained. In addition, vegetable crops like peas, cabbage, cauliflower and tomato were also grown in the nursery area and sold to the staff members.

A small plot in the nursery area was developed as landscaping Unit to grow various flowering and foliage plants in order to beautify the Institute campus and also to put on sale the extra ones. About one thousand rose cuttings (*wild variety*) were planted in the nursery beds with a view to raise *named* varieties of rose plants through bud grafting.

The total return from the plantation through sale of paddy, grasses, pruned woods, vegetable crops was Rs 4787.70.

LIBRARY AND DOCUMENTATION CENTRE

The Institute Library continued to provide the essential library services to the Scientists and Technical Staff of the Institute but in addition a good number of scholars, professors and other research workers from sister research institutions, Birla Institute of Technology, Ranchi, University of Ranchi. Birsa Agricultural University, Kanke (Ranchi), University of Bihar, Muzaffarpur, Magadh University, Bodhgaya and Patna University made use of it.

The holdings of the library grew rapidly during the period under report. Total 170 documents pertaining to Biological Sciences and Chemistry were added to library.

Library also extends the services of the, electrophotocopier to the research scholars/ workers of other organization on payment.

Main emphasis was given on the procurement of internationally reputed Research and Technical Journals (both Indian and Foreign), Proceedings of National and International conferences, Annual Reports, Standard specifications, Photocopies and Patents pertaining to Agriculture and Allied fields, with a view to feed the scientists all necessary information.

In addition to books and Journals, Photocopies/Microfilms, IS-specifications and patents

were procured from the Documentation Centres in the field of Science and Technology.

A large number of News-letters and few periodicals were also received during the year from various reputed organizations (both national and International) on Exchange/Complimentary basis which has become an additional asset to the library.

LITERATURE HOLDINGS AND UTILIZATION AS ON DECEMBER 1986

(i) No. of Books and Bound Volumes accessioned during the year	125
(ii) Currently subscribed periodicals	160
(iii) Total no. of holdings of Books and periodicals	18,495
(iv) Total membership (Borrowers)	107
(v) Number of readers visited the Library	1810
(vi) Publications issued during the year	1550
(vii) Publications consulted during the year	8000

Information retrieval

In order to provide the research workers latest information in the field of their research, library has started building up the Bibliographical reference cards to store the published information for further dissemination in Card Form.

Library spent a total sum of Rs 1·93 lakh for purchase of books and Journals. A sum of Rs 6000 was spent for the binding of loose periodicals and books.

WORKSHOP-CUM-MAINTENANCE CENTRE

The Institute has a Maintenance and Workshop centre which is responsible for the maintenance of water, electricity and gas supply lines to the laboratories and also maintain water and electricity supply to the campus including staff quarters and farm. The workshop unit is moderately equipped with lathe machine, drilling machines, grinders, gas and electric welding equipments, carpentry unit, gas plant, power generators etc. Apart from general maintenance work, the centre also undertakes minor repairs and fabrication of laboratory and farm equipments. The centre is presently under the charge of a Technical Officer who is looking after the work of this centre in addition to his own duties. However, a post of Maintenance Engineer, T-6 has already been sanctioned for this centre and it is likely to be filled up soon. The centre is provided with four Technicians and a number of skilled workers.

ARTIST-CUM-PHOTOGRAPHY UNIT

The Institute has an Artist-cum-photography unit manned with one fine art Artist (T-5), on Commercial Artist (T-4) and a Photographer (T-2). The unit is moderately equipped with all the required facilities and is playing active role in scientific as well as in publicity works. The unit is engaged in preparing the charts, badges, certificates, maps, display boards etc. The salient features of the work done this year by the unit include preparation of Institute emblem (black and white and multicoloured), badges, flags, certificate for Eastern Zone ICAR Sports, various charts for exhibitions and different maps besides preparation of transparencies (about 200 nos.) for a booklet.

MEDICAL CENTRE

The Institute provides day-to-day medical facilities to its employees. The medical unit has a strength of one physician (part time), one Stockman-cum-Pharmacist, one Dispensary attendant and one (part time) Clerk. During the year 1986, a total of 4452 patients con-

sulted the Authorized Medical Attendant (AMA) attending the ILRI Dispensary. Nearly 24 patients were examined at their residences by the AMA. Cases needing specialized treatment were referred to the Medical Institute of repute. Eighty-three such patients were referred for specialist consultation. A total of 1122 medical bills were submitted by the staff members for the reimbursement of the cost of medicines.

DISTINGUISHED VISITORS DURING 1986

1. Sri Mugenyi Gershom
   Kawanda Research Station
   P.O. Box 7065
   Kampala (Uganda)

2. Sri Michal Madalinski, Poland

3. Sri Odile Reboul
   53me 5 Mace 45,000
   Olliar (France)

4. Sri Pascale Maillaro
   Ban Foch
   Senlis (France)

5. Sri M. H. Penning
   Kalkhof Gmbh Peteson
   Gaisnie alke Co.
   6500 Mainl (F. R. Germany)

6. Dr C. B. S. Rajput
   Professor and Head, Department of Horticulture
   Banaras Hindu University, Varanasi

7. Sri V. R. Sachdeo
   Major General

8. Sri M. C. Suvarna
   Regional Development Commissioner
   Ranchi

9. Dr B. P. Gurmehta
   Chairman, Hindi and Haryani Sanskrit Department
   Haryana Agricultural University
   Hissar-125004

10. Dr Inder Sahai
    Reader
    Department of Anthropology
    Lucknow University
    Lucknow

8. LIST OF APPROVED RESEARCH PROJECTS FOR 1987

Project No.	Title of the Project	Name of the Investigators	Year of start	Date of completion
	DIVISION OF ENTOMOLOGY			
	(1) Improvements in lac cultivation techniques			
Entom. 1.9	To evolve suitable management practices for brood and stick lac production in the light of recent findings	Sri Y. D. Misra, S-1 Sri S. G. Choudhary, S-1 Sri M. L. Bhagat, S-1	1987	1992
	(2) Physiology of lac insect and associated insects			
Entom. 2.5	Analysis of physiological factors causing lac insect preference for host plants	Sri A. H. Naqvi, S-2 Dr B. P. Singh, S-2	1981	1987
Entom. 2.6	Biochemical studies on the lac insect to ascertain strain differences	Dr A. K. Sen, S-1	1981	1988
Entom. 2.9	Determination of physical and biochemical bases of insect host preference	Sri A. H. Naqvi, S-2 Dr A. K. Sen, S-1	1987	1990
Entom. 2.10	Studies on the factors influencing growth and development in the sexually reproducing female insect	Dr A. K. Sen, S-1 Sri A. H. Naqvi, S-2 Sri Y. D. Misra, S-1	1987	1992
	(3) Ecology of lac insect and associated insects			
Entom. 3.5	Ecological studies taken up at Dharamjaigarh, M.P.	Sri B. N. Sah, S-1		
Sub. Proj. 1	To study the relative performance of *kusum* broodlac from different sources (States) at Khadgaon		1981	1988
Sub. Proj. 2	To study the relative abundance of parasites and predators in different regions of M.P. in different crops of *kusum*		1981	1987
Sub. Proj. 3	To study the relative abundance of parasites and predators in different regions of M.P. in different crops on *palas*		1986	1990

Project No.	Title of the Project	Name of the Investigators	Year of start	Date of completion
Entom. 3.6	Population dynamics of *kusmi* strain of lac insect to ascertain the causes of *kusmi* crop failures (First phase)	Sri B. N. Sah, S-1 Sri M. L. Bhagat, S-1	1979	1987
Entom. 3.8	Factors affecting *rangeeni* lac insect population clubbed with 1.3.10		1986	1990
	4. Control of enemies of lac insect			
Entom. 4.3	Effect of insecticides on the lac insect, *kerria lacca* (kerr) and the associated fauna		1986	1990
Sub. Proj. 1	Screening of insecticides for their safety to the lac insects and toxicity to the lac predators	Sri S. G. Choudhary, S-1		
Sub. Proj. 2	Screening of plant poisons for their safety to the lac insect and toxicity to the lac predators	Sri A. Bhattacharya, S-1		
Sub. Proj. 3	Effect of insecticides (safer to lac insect) against harmful parasites of lac inseet	Sri S. G. Choudhary, S-1		
Sub. Proj. 4	Effect of insecticides (safer to lac insect) against beneficial parasites of lac insects	Sri Y. D. Misra, S-1		
Sub. Proj. 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		
Sub. Proj. 6	Hormoligatory effect of the insecticides on the lac insects	Sri S. G. Choudhary, S-1 Dr A. K. Sen, S-1		
Sub. Proj. 7	Treatment of broodlac with selective insecticide	Sri A. Bhattacharya, S-1 Sri S. G. Choudhary, S-1		
Entom. 4.9	Studies on application of hormones and pheromones for the control of major lac predators	Sri A. Bhattacharya, S-1	1984	1988
Entom. 4.13	Studies on the economic threshold of *Eublemma amabilis* and *Holcocera pulverea* infesting lac crop	Sri S. G. Choudhary, S-1	1981	1987
Entom. 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
Entom. 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

Project No.	Title of the Project	Name of the Investigators	Year of start	Date of completion
	(5) Studies on germ plasm bank of lac insects			
Entom. 5.8	Studies on germplasm collection, conservation and characterization of indigenous exotic lac insect	Dr S. K. Jaipuriar, S-1 (w.e.f. 1982) Prof Dr R. P. Kapil, Director (w.e.f. 1987)	1976	1989
Entom. 5.11	Studies on chromosomal behaviour of lac insect strains	Dr S. K. Jaipuriar, S-1	1981	1987
	DIVISION OF INSECT GENETICS AND BREEDING			
Insect Gent. 1.1	Studies on sex determination in lac insects	Sri N. S. Chauhan, S-3	1980	1987
Insect Gent. 1.2	Survey of genetic variation in lac insects	Sri R. Ramani, S-2 Sri K. K. Sharma, S-1	1986	1988
Insect Gent. 2.1	Mutation studies in lac insects	Sri N. S. Chauhan, S-3	1986	1989
	DIVISION OF PLANT SCIENCES			
	(1) Propagation and management of lac host plants			
Plant Sci. 1.2	Management of *Bhalia* for lac cultivation	Dr B. P. Singh, S-2	1975	1987
Plant Sci. 1.3	Integration of lac cultivation with general agriculture under dry farming conditions	Dr B. P. Singh, S-2 Sri S. C. Srivastava, S-1	1978	1993
Plant Sci. 1.6	Agricultural utilization of lac mud as organic manure	Dr B. P. Singh, S-2	1981	1992
Plant Sci. 1.9	Standardization of forestry practices for raising high yielding *kusum* through air-layering	Sri S. C. Srivastava, S-1	1980	1990
	(2) Genetics and breeding of lac host plants			
Plant Sci. 2.3	Evaluation and improvement of *arhar* varieties for lac yield as well as pulse production	Dr P. Kumar, S-2 Sri S. C. Srivastava, S-1	1978	1988
Plant Sci. 2.6	Survey of genetic variation in lac potential of host plants	Sri S. C. Srivastava, S-1 Sri Y. D. Misra, S-1 Dr P. Kumar, S-2	1985	1990
Plant Sci. 2.7	Survey, collection, maintenance, evaluation and characterization of lac hosts	Dr P. Kumar, S-2	1987	1992
	DIVISION OF CHEMISTRY			
	(1) Chemistry of lac/constituents			
Chem. 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

Project No.	Title of the Project	Name of the Investigators	Year of start	Date of completion
Chem. 1.9	Thermal polymerization of lac-studies on the molecular weight, shape and size	Dr A. Kumar, S-2	1983	1988
Chem. 1.11	Isolation of jalaric acid from lac on technical scale and its utilization in syntheses	Dr N. Prasad, S-2 Dr S. C. Agarwal, S-3	1983	1988
Chem. 1.12	Degradation studies on lac	Dr S. C. Agarwal, S-3 Dr N. Prasad, S-2	1983	1989
	(2) Fine chemicals from lac			
Chem. 2.10	Synthesis of Pheromone and Juvenile hormone analogues from aleuritic acid	Dr R. N. Majee, S-2 Sri R. Ramani, S-2	1982	1988
Chem. 2.11	Synthesis of bis-heterocyclic compounds from aleuritic acid	Dr R. N. Majee, S-2	1985	1989
	(3) Modifications of shellac/constituents and their utilization			
Chem. 3.6	Modification of lac/hydrolysed lac with (ii) Polyisocyanates	Dr B. B. Khanna, S-4- Sri P. M. Patil, S-1	1983	1987
Chem. 3.11	Modification of lac with ethyl cellulose	Sri A. K. Dasgupta, S-1	1983	1987
Chem. 3.12	Modification of lac wax	Dr K. M. Prasad, S-1 Dr B. B. Khanna, S-4	1984	1988
Chem. 3.13	Studies on lac based cation-exchange resin as catalyst	Dr B. C. Srivastava, S-1	1987	1989
	(4) Use of shellac and modified shellac in surface coating			
Chem. 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
Chem. 4.6	Styrenation of lac-oil combinations	Dr B. B. Khanna, S-4 Sri P. M. Patil, S-1	1986	1988
Chem. 4.7	Modification of byproduct obtained during the preparation of aleuritic acid and its use in surface coatings	Sri A. K. Dasgupta, S-1	1987	1990
	(5) Use of lac for encapsulation and controlled release			
Chem. 5.5	Slow-release lac urea formulation for animal feed	Dr B. C. Srivastava, S-1	1987	1989
	(6) Electrical properties of lac and modified lacs			
Chem. 6.3	Study on the tracking resistance of shellac based varnishes	Dr D. N. Goswami, S-2	1986	1989
Chem. 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	1991

Project No.	Title of the Project	Name of the Investigators	Year of start	Date of completion
	(7) Studies on biochemical aspects of insect host plant relationship			
Chem. 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-2 Dr A. K. Sen, S-1 Dr K. M. Prasad, S-1 Sri P. C. Sircar, S-1	1987	1992
	DIVISION OF TECHNOLOGY			
	(1) Improvement in the processing techniques			
Techno. 1.6 (ii)	Improvements in dewaxing and decolourising technique in solvent medium	Sri R. K. Banerjee, S-1	1980	1987
Techno. 1.8	To study the industrial parameters affecting the preparation of bleached lac	Sri R. K. Banerjee, S-1	1987	1991
	(2) Rubber-shellac combinations			
Techno. 2.1	Incorporation of modified lacs rubber	Sri R. Singh, S-1 Dr B. B. Khanna, S-4	1973	1987
Techno. 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
	(3) Use of lac in adhesives			
Techno. 3.5	Modified lac (with synthetic resins) as adhesives	Dr P. C. Gupta, S-2	1987	1990
Techno. 3.6	Use of lac byproducts for making coal blocks	Dr P. C. Gupta, S-2	1987	1990
	(4) Use of lac in printing inks			
Techno. 5.1	Development of printing inks based on lac/modified lac	Dr A. Pandey, S-1	1987	1992
	DIVISION OF EXTENSION			
Ext. 1	Training and advisory service			
Ext. 2	Lab. to Land Programme			
Ext. 3	Technical Information Service			
Ext. 4	Operational Research Project for Maximising lac production in Chotanagpur area			

Note: The scientists listed at Sl No. 1 against each project would act as a Project Leader (Principal Investigator).

9. ADMINISTRATIVE ACTIVITIES

The Institute Management Committee

The Institute Management Committee which was reconstituted in March 1986 held its 13th Meeting on 8th November 1986. Besides Director and nominated scientists of this Institute, Sri Karam Jit Singh, non-official member and Dr A. Alam, Assistant Director General, ICAR, New Delhi attended the meeting. The following items on the agenda were discussed and decisions taken there on:

(i) Confirmation of the proceedings of the 12th meeting;

(ii) Review of action taken on the recommendations of the 12th meeting of the Management Committee;

(iii) Budget sanctioned and Revised Budget estimates, expenditure up to October, 1986 in respect of plan and non-plan;

(iv) Proceedings of the meetings of the IJC and action taken thereon;

(v) Proceeding of the meeting to the Grievance Cell and action taken thereon;

(vi) Review of the progress of the research programme;

(vii) Any other item-proposal of Secretary IJC (staff side) regarding Rules of allotment of quarters.

The Institute Joint Staff Council

Three meetings of the Institute Joint Staff Council (IJC) were held on 18th Feb., 19th May and 25th July, 1986 respectively. The following decisions were taken:

(i) While making recruitment for Driver, a condition shall be made in the appointment letter that he has to stay in the campus;

(ii) To approach officials of State Bank of India, Ranchi for opening a branch at Namkum;

(iii) To prepare and circulate the seniority list every year for administrative staff members;

(iv) The Administrative Officer will present a report every fortnight to the Director regarding pending works.

The Institute Grievance Cell

During the year, two meetings of the Institute Grievance cell were held and personal grievances of the staff members were considered.

ICAR Estern Zone Sports

The ICAR Eastern Zone Sports were successfully organized by this Institute during October 1986, Six ICAR Institutes of Eastern Zone participated in the sports. Sri B. K. Sinha Deputy Commissioner, Ranchi inaugarated the sports and Sri M. C. Subarno, Regional Development Commissioner, Ranchi delivered the valedictory address of the function and distributed the prizes to the participating players and teams.

10. ILRI STAFF

Administration

1. Prof Dr R. P. Kapil, M.Sc. Ph.D. (Allahabad), Ph.D. (Lyon), Director
2. Sri S. N. Sharma, B.A., Administrative Officer
3. Sri R. K. Singh, M.A.B.L., Assistant Administrative officer
4. Sri B. S. Mishra, M.A., S.A.S., Accounts Officer
5. Sri P. K. Choudhury, B.Com., Superintendent-I
6. Sri H. S. Munda, Matric, Superintendent-II

Chemistry Division

1. Dr B. B. Khanna, M.Sc., Ph.D. (Punjab), Scientist, S-4
2. Sri Shravan Kumar, M.Sc. (Agra), Head, Division of Chemistry
3. Dr S. C. Agarwal, M.Sc., Ph.D. (Aligarh), Scientist, S-3
4. Dr A. Kumar, M.Sc. (Bihar), Ph.D. (Jadavpur), Scientist, S-2
5. Dr D. N. Goswami, D.Sc., Ph.D. (Calcutta), Scientist, S-2
6. Dr N. Prasad, M.Sc., Ph.D. (Ranchi), Scientist, S-2
7. Dr R. N. Majee, M.Sc., Ph.D. (Ranchi), Scientist, S-2
8. Sri A. K. Dasgupta, M.Sc. (Patna), Scientist, S-1
9. Dr B. C. Srivastava, A.I.C. (Calcutta), Ph.D. (Ranchi), S-2
10. Dr K. M. Prasad, M.Sc. (Bihar), Ph.D. (Ranchi), Scientist, S-1
11. Dr M. Mukherjee, A.I.C. (Calcutta), Ph.D. (Ranchi), Scientist, S-1
12. Sri P. M. Patil, M.Sc. (Poona), Scientist, S-1
13. Sri P. C. Sircar, M.Sc. (Lucknow), Scientist, S-1
14. Sri I. Rajendran, M.Sc. (Madurai Kamraj), Scientist, S-1
15. Sri K. K. Sharma, M.Sc., M.Phil. (Delhi), Scientist, S-1
16. Miss Mukta Joardar, M.Sc. (Calcutta), Scientist, S-1
17. Sri A. Rahman, B.Sc., T-5

Entomology Division

1. Sri B. B. Das, M.Sc. (Kalyani), Head, Division of Entomology
2. Sri A. H. Naqvi, M.Sc. (Aligarh), Scientist, S-2
3. Sri S. G. Choudhury, M.Sc. (Patna), Scientist, S-1
4. Dr A. K. Sen, M.Sc. (Bihar), Ph.D. (Calcutta), Scientist, S-1
5. Sri B. N. Sah, M.Sc. (Bhagalpur), Scientist, S-1
6. Dr S. K. Jaipuriar, M.Sc., Ph.D. (Ranchi), Scientist, S-1
7. Sri A. Bhattacharyya, M.Sc. (Ranchi), Scientist, S-1
8. Sri Y. D. Misra, M.Sc. (Ranchi), Scientist, S-1
10. Sri M. L. Bhagat, M.Sc. (Ranchi), Scientist, S-1
10. Sri A. K. Jaiswal, M.Sc. (Allahabad), Scientist, S-1
11. Miss P. Chandrika, M.Sc., M.Phil. (Calicut), Scientist, S-1
12. Miss P. Rani George, M.Sc., M.Phil. (Calicut), Scientist, S-1
13. Sri M. K. Choudhary, I.Sc., T-5
14. Sri R. L. Singh, Diploma in Fine Arts, Senior Artist (T-5)

Extension Division

1. Dr S. K. Saha, M.Sc., Ph.D. (Calcutta), Head, Division of Extension
2. Sri R. C. Misra, M.Sc. Agriculture (Agra), Scientist, S-2

3. Dr A. Pandey, M.Sc., Ph.D. (Ranchi), Scientist, S-1
4. Sri Jawahir Lal, M.Sc. (Ranchi), Scientist, S-1
5. Dr R. K. Suri, M.Sc. (Meerut), Ph.D. (Kumaon), Lac Information Officer, (T-6)
6. Sri R. C. Maurya, B.Sc. (T-5)

Insect Genetics Division

1. Sri N. S. Chauhan, M.Sc. Agriculture (Agra), M.Sc. Animal Genetics (Edinburgh), Head, Division of Insect Genetics
2. Sri R. Ramani, M.Sc. (Madras), Scientist, S-2
3. Sri K. K. Sharma, M.Sc. (Kurukshetra), Scientist, S-1

Plant Sciences Division

1. Dr P. Kumar, M.Sc. (Agra), Ph.D. (Ranchi), Head, Division of Plant Sciences
2. Dr B. P. Singh, M.Sc., Ph.D. (Ranchi), Scientist, S-2
3. Sri S. C. Srivastava, M.Sc. (Ranchi), Scientist, S-1

Technology Division

1. Dr P. C. Gupta, M.Sc. (Allahabad), Ph.D. (Ranchi), Head, Division of Technology
2. Sri R. K. Banerjee, M.Sc. (Lucknow), Scientist, S-1
3. Sri Radha Singh, M.Sc. (Ranchi), Scientist, S-1
4. Sri A. K. Ghosh, B.Sc., Junior Technologist, T-6
5. Sri B. P. Banerjee, B.Sc., T-5
6. Sri M. Islam, B.Sc., T-5
7. Sri Ramesh Prasad, B.Sc., T-5

Research Coordination and Monitoring Cell

1. Sri S. K. M. Tripathi, B.Sc., Technical Officer, T-7
2. Sri P. Sen, B.Sc., T-5

Farm Section

1. Sri B. K. Purkayastha, B.Sc., Farm Superintendent, T-7

Library and Documentation Section

1. Sri R. P. Tiwari, B.Sc., B.Lib., Senior Library Assistant, T-5

Medical Section

1. Dr S. S. Sahay, Authoriszd Medical Attendant (Part Time)

Appointments during 1986

(a) *Scientific*

1. Prof Dr R. P. Kapil, Dean, Post-Graduate Studies, Haryana Agriculture University, Hissar appointed as Director, ILRI, Ranchi w.e.f. 1.4.1986
2. Sri P. C. Sircar, Scientist, S-1 — Organic Chemistry
3. Sri I. Rajendran, Scientist, S-1 — do
4. Sri K. K. Sharma, Scientist, S-1 — do
5. Miss Mukta Joardar, Scientist, S-1 — do

6. Miss P. Chandrika, Scientist, S-1	Zoology
7. Miss P. Rani George, Scientist, S-1	do
8. Sri A. K. Jaiswal, Scientist, S-1	do
9. Sri K. K. Sharma, Scientist, S-1	do

(b) *Technical*

1. Dr R. K. Suri, Lac Information Officer, T-6 (on deputation from F.R.I., Dehradun)

(c) *Administrative*

1. Sri B. S. Misra, Accounts Officer (on deputation from Defence Accounts Department)

Resignation/Termination etc.

1. Sri R.P. Singh, Scientist, S-1 (Plant Physiology), Services terminated

Total Number of Employees

Class of Posts		No. of Posts sanctioned	No. of Employees in position	No. of SC Employees	No. of ST Employees
Scientific Posts					
Scientist-S		24	Nil	Nil	Nil
Scientist, S-1		22	26	1	Nil
Scientist, S-2		10	10	Nil	Nil
Scientist, S-3		4	6	2	Nil
	Total	60	42	3	Nil
Technical Posts					
Category I		46	43	5	10
Category II		36	29	1	2
Category III		4	3	Nil	Nil
	Total	86	75	6	12
Administrative Posts					
Administrative Officer		1	1	Nill	Nil
Asstt. Admn. Officer		1	1	Nil	Nil
Accounts Officer		1	1	Nil	Nil
Hindi Officer		1	Vacant	Nil	Nil
Superintendant		3	2	Nil	1
Senior Stenographer		1	1	1	Nil
Assistants		8	8	1	1
Senior Clerk		13	13	Nil	2
Junior Clerk		17	14	1	3
Junior Stenographer		4	4	1	1
	Total	50	45	4	8
Auxiliary Posts					
Class I		2	1	1	Nil
Class II		1	Vacant	Nil	Nil
Class III		11	5	Nil	3
	Total	14	6	6	3

Class of Posts	No. of Posts sanctioned	No. of Employees in position	No. of SC Employees	No. of ST Employees
Supporting except Safaiwala				
Supporting I	63	51	5	21
Supporting II	43	31	1	15
Supporting III	16	13	3	05
Supporting IV	9	5	Nil	01
Total	131	100	9	42
Safaiwala				
Supporting I	1	1	1	—
Supporting II	2	2	2	—
Supporting III	2	2	2	—
Total	5	5	5	

11. BUDGET

STATEMENT OF RECEIPTS AND EXPENDITURE IN RESPECT OF INDIAN LAC RESEARCH INSTITUTE, NAMKUM, RANCHI FOR THE YEAR 1986

Non-plan

A. RECEIPTS	Rs
(i) Grants received from ICAR 77,70,189.41 under different heads including opening balance and cash in hand	
(ii) Sale proceeds under different heads	61,000.00
(iii) Any other item (sports)	8000.00
Total	78,39,189.41
B. EXPENDITURE	
(i) Salary, T.A. and L.S.P.C. etc.	70,66,000.00
(ii) Library books, periodicals etc.	1,38,483.33
(iii) Works	7623.11
(iv) Other Misc. expenditure	3,18,000.00
	75,30,106.44

Plan

A. RECEIPTS	Rs
(i) Grants received from ICAR	20,85,000.00
B. EXPENDITURE	
(i) Expansion of ILRI	14,89,000.00
(ii) Purchase of equipments	2,29,000.00
(iii) Cost of chemicals and other consumable stores	50,000.00
(iv) Other Misc. expenditure	23,000,00
	17,91,000.00

12. ABBREVIATIONS/ACRONYMS

AR	= Annual Report	m.p.	= melting point
aq.	= Aqueous	MS	= Mild steel
BF_2-Et_2O	= Boron triftuoride etherate	ml	= mililitre
Co-TLC	= Comparative thin layer chromatography	Mg	= Magnesium
		NAARM	= National Academy of Agricultural Research Management, Hyderabad
C.D.	= Critical difference		
Conc.	= Concentrated		
CLRI	= Central Leather Research Institute	NC	= Nitrocellulose
		NR	= Natural Rubber
DFLS	= Diseased free layings	NH_4Cl	= Ammonium Chloride
DNA	= Deoxy ribonucleic acid	NaCl	= Sodium Chloride
DARE	= Department of Agricultural Research Education	NS	= Not significant
		PLC	= Preparative Layer Chromatography
DHS	= Double Hedge System		
ERR	= Effective Rate of Rearing	PVA	= Poly Vinyl Alcohol
EPC	= Essay Processing Channel	RC and M-Cell	= Research Coordination and Monitoring Cell
G.P.B.	= Germ Plasm Bank		
ha	= hectare	RRL	= Regional Research Laboratory
HEC	= Heavy Engineering Corporation		
		RFRS	= Regional Field Research Station
H_2SO_4	= Sulphuric acid		
HAF	= High Abrasion Furnace	RBD	= Randomised Block Design
IARI	= Indian Agricultural Research Institute	SHS	= Single Hedge System
		SPD	= Split Plot Design
ILRI	= Indian Lac Research Institute	SBR	= Styrene-butadiene rubber
		SRC	= Staff Research Council
IR	= Infra Red Spectroscopic values	TLC	= Thin Layer Chromatography
		Temp.	= Temperature
$KMnO_4$	= Potassium permanganate	TDI	= Tolune di-isocynate
LAH	= Lithium Aluminium Hydride	THF	= Tetra Hydro Furan
MIID	= Mean inter-insect distance	v/v	= Volume by volume
MF resin =	= Melamin formaldehyde resin	w/w	= Weight by weight

13. LIST OF COLLOQUIAL WORDS AND THEIR DEFINITIONS

Ari: The lac crop harvested few weeks before larval emergence is called *ari*.

Aghani: The crop obtained from *kusmi* host in Jan-Feb. is called *aghani*.

Bleached lac: The product obtained from seedlac/shellac through bleaching with chlorine.

Baisakhi: The crop harvested during June-July from *rangeeni* host is called *baisakhi*.

Bhatta shellac: Shellac prepared through *bhatta* (a simple mud-oven) process.

Broodlac: Lac bearings twigs containing mature gravid females ready for larval emergence.

Bathochromic shift: Red shift (shift towards higher wavelength).

Crawlers: The tiny red lac nymph when start crawling on the trees is called *crawler*.

Dewaxed lac: The wax-free lac.

Daba: A variety of Tasar cocoons.

DL-shellac: A commercial name for wax-free hand-made shellac.

Honey dew: The rejected material passed out by the insect during life-cycle.

Hydrolysed lac: The product (65 to 70%) obtained as a water-insoluble soft acidic mass on saponification of shellac with alkali and treatment of the resulting solution with acid.

Hyperchromism: Decrease in optical density.

Jethwi: The crop obtained from *kusumi* host in June-July is called *jethwi*.

Katki: The crop maturing and collected in Oct.-Nov. from *rangeeni* hosts is called *katki*.

Kiri: A by-product which remains accumulated inside the bag during the preparation of *bhatta*-shellac.

Kusumi strain: The insect growing mostly on *kusum* host and passing through two generations of equal span of life in a year.

Lac larvae/lac nymphs: The tiny red insect measuring 0·5 mm in length emerging from the mature female cell.

Lac stick: Lac encrustation with host shoots.

Lac-mud: Lac factory sludge obtained as a waste during sticklac/seedlac processing.

Modified Hydrolysed lac: The product obtained through modification of hydrolysed lac.

Phunki: Used brood lac after the larval emergence is over.

Rebulac: Rebuilt lac.

Rangeeni strain: The insect growing on hosts other than *kusumi* hosts.

Seedlac: A semi-refined product obtained from sticklac after water and soda washings.

Shellac: A further refined product obtained from seedlac.

Sulphonated lac: Sulphuric-acid-treated lac.

Sticklac: Lac encrustation separated from twigs either by hand or by an instrument

Total Hydrolysed lac: The product obtained in cent per cent yield through hydrolysis of shellac with alcoholic alkali and treatment of resulting solution (i) with equivalent amount of alcoholic solution of sulphuric acid or (ii) by passing over cation exchange column.

14. METEOROLOGICAL REPORT FOR THE YEAR 1986

The average meteorological data for each month were as follows:

Months	Means baro-metric pressure (mm)	Mean maximum tempera-ture (°C)	Mean minimum tempera-ture (°C)	Mean dry bulb tempera-ture (°C)	Mean wet bulb tempera-ture (°C)	Mean humidity (%)	Total rainfall (mm)	Highest maximum temp. (°C)	Lowest minimum tempera-ture (°C)
January	708·68	24·67	6·76	16·0	13·9	79·45	14·6	28·0	3·3
February	708·33	26·21	12·08	18·46	15·96	77·60	22·2	31·5	8·8
March	705·87	32·83	16·24	26·20	20·93	62·41	9·5	38·5	11·1
April	702·93	37·26	20·66	30·56	24·8	62·63	40·4	40·5	16·1
May	701·12	35·79	21·39	29·20	25·4	73·80	97·8	40·0	18·8
June	695·57	34·23	23·45	29·1	26·25	80·96	192·8	42·0	21·1
July	697·28	29·03	22·44	25·29	23·98	89·87	254·6	34·0	20·0
August	698·26	26·67	22·43	25·80	24·22	87·74	219·0	32·5	21·1
September	700·98	30·0	21·83	25·65	24·06	88·2	169·6	34·0	19·4
October	705·17	29·3	17·85	24·17	21·87	81·2	104·2	33 5	12·7
November	706·94	27·93	14·5	22·15	19·9	80·53	80·53	30·0	11·1
December	708·98	23·75	10·95	17·22	15·69	85·58	64·9	28·5	6·6

The highest maximum temperature recorded was 40°C on 20th April and Lowest minimum temperature on 6th January 1986. The total rainfall during the year was 1239·4 mm of which the monsoon/June-September rainfall was 836·0 mm. The rainfall during the year was lower than that of 1985 (1985-1473·2 mm). There was hail storm on 24th April 1986 during the year.