INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA

Annual Report
1978

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI
1982

CONTENTS

1. DIRECTOR'S INTRODUCTION

A brief historical introduction

The Indian Lac Research Institute, Ranchi, which was established in 1925, continued to function under the administrative control of the Indian Council of Agricultural Research, New Delhi w.e.f. April 1, 1966. The Institute is located at Namkum, about nine kilometers east of Ranchi. Out of a total area of about 49 ha, nearly 35 ha are being used as plantation for cultivation experiments. Areas/trees have been taken on long term lease for outstation experiments.

Objectives

The objectives of the Institute are:

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

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

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

Organizational set-up

The Institute consists of five Divisions, namely, Entomology, Agronomy and Plant Genetics, Chemistry, Technology, and Extension. The Institute Library adjoins the Entomology Division. Besides these, the Institute has Administrative, Audit and Accounts, Artist-cum-photography, and Mechanical Sections. The Institute maintains one Regional Field Research Station at Dharamjaigarh (M.P.) and also runs one Operational Research Project in a group of four villages in Ranchi District to demonstrate the package of practices for improving the production of lac on area basis.

The overall administrative and technical supervision of the Institute is done by the Director. The Divisions of Entomology and Chemistry are headed by their respective Head of Division, while the remaining Divisions are under the charge of their respective seniormost scientist.

Research Highlights

Entomology

A positive correlation is found to exist between the incidence of lac predators and the density of lac insects. This has helped to devise a cultural method for minimising predatory losses.

Genetical studies have provided evidence of considerable hybrid vigour in lac insects.

Agronomy and Plant Genetics

The possibility of growing tuber and rhizome crops as intercrops in the mixed plantation of *bhalia* and *galwang* without affecting the growth of host plants has been established. The propagation of *kusum* through air layering with the help of growth regulators has been found successful.

Chemistry

A new aldehydic acid has been isolated from lac and some of its structural characteristics have been established. It has been assigned a molecular formula $C_{15}H_{18}O_3$ tentatively.

Urethane coatings from shellac having improved properties in respect of flexibility, adhesion and resistance to chemicals and solvents have been developed by first preparing shellac based polyesters through chain extension and subsequently reacting these polyesters with 2:4 toluene diisocyanate to yield polyurethanes.

Marked improvement in the flexibility, dielectric strength and heat resistance of shellac varnishes has been noticed by the addition of dimethyl phthalate. The plasticized shellac films are found to be resistant to heat upto 100°C (Shellac 70°C) and pass the test for flexibility as per IS: 352 (1973).

Technology

A thermoplastic adhesive composition from a mixture of shellac and synthetic monomer in the ratio of 60:40 respectively has been developed and found satisfactory for fixing sunmica (decorative laminates) on table tops and jointing wood to wood surface.

Library

The number of books and bound volumes of journals accessioned during the period was 304. This brought the total number of books and volumes of journals in the library to 16,815. One hundred fifty-two periodicals were subscribed in addition to a few received in exchange or as gift. Some miscellaneous publications and reports were also received.

The library also maintains an adequate stock of books and reprints of articles published by the Institute and by the erstwhile Indian Lac Cess Committee for sale/distribution to those interested.

Visitors

The Institute has always been a regular attraction to most visitors to Ranchi, particularly scientists and technologists. During the period under report also, it received the usual complement of visitors including students and trainees from different colleges and institutions, officials, delegates and other distinguished persons. These included, among others, the following:

1. Mr Jina Bulur, Namor University, Belgium.
2. Dr T. N. Ananthakrishnan, Director, Zoological Survey of India, Calcutta.
3. Prof. C. B. Misra, Head of Dept. of Mechanical Engineering, B.I.T., Mesra, Ranchi.
4. Sri R. C. Khanna, Deputy Chairman, State Planning Board, Bihar.

5. Sri A. K. Biswas, I.A.S., Jt. Secretary to Govt. of Bihar, Dept. of Forests.
6. Mr M. Lenzen Nichel, B.P. 825, Kinshasa I, Zaire.
7. Mr Lim Riban Court, B.P. 825, Kinshasa I, Zaire.
8. Mr T. C. A. Srinivasaramanujam, Principal Secretary, Forest, Welfare and R. D. Dept., Bihar.
9. Dr A. K. Choudhuri, Reader, Indian Association for the Cultivation of Sciences, Calcutta-32.
10. Mrs P. P. Trivedi, Agriculture Production Commissioner, Assam.
11. Sri T. H. Nirmal, Assistant Director-General, Indian Council of Agricultural Research, New Delhi.
12. Dr F. W. Colder, Canadian Adviser, Hyderabad.
13. Dr T. F. Shaxson, British Team Leader, Indore.
14. Maj.-Gen. P. Basu Roy, DDMS, Eastern Command, Calcutta.
15. Brig. B. P. Samanta, Command Hospital, Calcutta.

Training and Advisory Services

The Institute provides two training courses of six months' duration each on (i) Improved methods of lac cultivation and (ii) Industrial uses of lac. The training is given to the deputees of Central and State Governments and Industrial Undertakings. In addition, short term training on specific lines is also arranged on request. The Institute also provides technical assistance to all those interested in cultivation, processing, grading and utilization of lac.

Research Collaboration Overseas and with Other Institutions

The Institute has always been taking advantage of technical know-how and facilities available in other Institutions/Universities for the furtherance of its objectives, in particular for the evaluation of the 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.

Finance

The Institute is being wholly financed by the Indian Council of Agricultural Research. The budget estimates of the Institute for the year 1978-79 amounted to Rs 26·38 lakhs for Non-Plan and Rs 10 lakhs for Plan Scheme. The actual expenditure during the year was Rs 23·53 lakhs and Rs 7·52 lakhs under Non-Plan and Plan respectively. In addition, an amount of Rs 0.47 lakh was spent under Operational Research Project and Rs 0·09 lakh under A.P. Cess Scheme on " Cultivation of *kusmi* lac on *bhalia* and *galwang* in mixed plantation at Chandwa ".

2. PROGRESS OF RESEARCH

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

1.1 Lac Cultivation Studies

1.1.2 Studies to evolve a suitable method for producing lac on *bhalia* (*Moghania macrophylla*) regularly during both the seasons (at Hesal)

Bhalia (*Moghania macrophylla*) possesses several attractive features as a lac-host but it is unable to sustain the summer crop. A study was, therefore, taken up to examine whether an *ari* (immature) or a partial summer crop is possible with crop inoculation on 12-month-old shoots in January-February using varying amounts of broodlac. The study was started in 1971 initially with 5 cultivation practices, to which 2 more practices were added in 1973. These 7 practices, each tried on 5 bushes with 10 replications in a randomized block design, are as under:

Treatment	*Brood rate/bush*	*Harvesting*
A	400 g	The crop is harvested completely as *ari* in the following May
B	200 g	Partial harvesting as *ari* in May and complete harvesting in January-February next
C	100 g	As in treatment B
D	50 g	Harvesting completely in January-February next
E	400 g	Harvesting completely on crop maturity in June-July
F	100 g	As in treatment C with foliar spray of 1% urea at weekly intervals for one month after the appearance of the new flush of leaves
G	50 g	As in treatment D with foliar spray of urea as in treatment F

The results obtained from the 7 cultivation practices in 5 combined *jethwi-cum-aghani* crops from 1973 onwards are consolidated in Table 1. It is seen that the cultivation practice involving the inoculation of bushes at the rate of 50 g per bush and harvesting the crop completely a year later in January-February next gave the best performance. The application of foliar spray of urea did not help in increasing the lac yield.

(R. S. Gokulpure and R. C. Maurya)

TABLE 1 — EVOLUTION OF CULTIVATION SCHEDULES ON *bhalia* (*Moghania macrophylla*) AT HESAL

Treatments	Crops	No. of bushes	Brood used		Yield obtained		Crop ratio*
			Lac stick kg	Stick lac kg	Lac stick kg	Stick lac kg	
A	*Jethwi* 1973-*cum-aghani* 1973-74	50	20·00	4·42	37·85	2·16	1 : 0·48
	Jethwi 1974-*cum-aghani* 1974-75	25	10·00	3·66	18·42	1·64	1 : 0·44
	Jethwi 1975-*cum-aghani* 1975-76	50	20·00	8·35	31·48	1·88	1 : 0·23
	Jethwi 1976-*cum-aghani* 1976-77	50	20·00	9·45	34·80	3·85	1 : 0·40
	Jethwi 1977-*cum-aghani* 1977-78	50	20·00	8·28	32·88	2·19	1 : 0·26
	Mean		18·00	6·83	31·08	2·34	1 : 0·34
B	*Jethwi* 1973-*cum-aghani* 1973-74	50	10·00	2·77	26·55	2·03	1 : 0·73
	Jethwi 1974-*cum-aghani* 1974-75	25	5·00	1·77	16·52	1·23	1 : 0·69
	Jethwi 1975-*cum-aghani* 1975-76	50	10·00	3·95	26·15	1·06	1 : 0·27
	Jethwi 1976-*cum-aghani* 1976-77	50	10·00	4·99	25·51	4·95	1 : 0·99
	Jethwi 1977-*cum-aghani* 1977-78	50	10·00	4·19	5·37	0·27	1 : 0·06
	Mean		9·00	3·52	20·02	1·91	1 : 0·54
C	*Jethwi* 1973-*cum-aghani* 1973-74	50	5·00	1·70	18·17	1·72	1 : 1·01
	Jethwi 1974-*cum-aghani* 1974-75	25	2·50	0·99	11·58	0·91	1 : 0·91
	Jethwi 1975-*cum-aghani* 1975-76	50	5·00	2·12	17·32	0·78	1 : 0·36
	Jethwi 1976-*cum-aghani* 1976-77	50	5·00	2·20	28·67	5·35	1 : 2·42
	Jethwi 1977-*cum-aghani* 1977-78	50	5·00	2·01	11·46	0·62	1 : 0·37
	Mean		4·50	1·80	17·44	1·87	1 : 1·04
D	*Jethwi* 1973-*cum-aghani* 1973-74	50	2·50	0·79	23·70	1·26	1 : 1·58
	Jethwi 1974-*cum-aghani* 1974-75	25	1·25	0·45	6·46	0·54	1 : 1·20
	Jethwi 1975-*cum-aghani* 1975-76	50	2·50	0·90	7·30	0·20	1 : 0·22
	Jethwi 1976-*cum-aghani* 1976-77	50	2·50	1·29	24·10	4·50	1 : 3·49
	Jethwi 1977-*cum-aghani* 1977-78	50	2·50	1·20	6·65	0·36	1 : 0·30
	Mean		2·25	0·93	13·64	1·37	1 : 1·47
E	*Jethwi* 1973-*cum-aghani* 1973-74	50	20·00	3·37	34·76	2·56	1 : 0·76
	Jethwi 1974-*cum-aghani* 1974-75	25	10·00	4·01	15·19	1·36	1 : 0·34
	Jethwi 1975-*cum-aghani* 1975-76	50	20·00	7·98	28·60	2·08	1 : 0·26
	Jethwi 1976-*cum-aghani* 1976-77	50	20·00	9·90	34·70	4·72	1 : 0·47
	Jethwi 1977-*cum-aghani* 1977-78	50	20·00	8·54	22·10	1·95	1 : 0·23
	Mean		18·00	6·76	27·07	2·53	1 : 0·37
F	*Jethwi* 1973-*cum-aghani* 1973-74	50	5·00	1·01	23·21	1·01	1 : 1·00
	Jethwi 1974-*cum-aghani* 1974-75	25	2·50	0·77	10·97	0·93	1 : 1·20
	Jethwi 1975-*cum-aghani* 1975-76	50	5·00	2·01	10·76	0·27	1 : 0·13
	Jethwi 1976-*cum-aghani* 1976-77	50	5·00	2·49	21·65	3·83	1 : 1·54
	Jethwi 1977-*cum-aghani* 1977-78	50	5·00	2·10	4·00	0·19	1 : 0·09
	Mean		4·50	1·67	14·12	1·24	1 : 0·74
G	*Jethwi* 1973-*cum-aghani* 1973-74	50	2·50	1·04	17·30	1·07	1 : 1·03
	Jethwi 1974-*cum-aghani* 1974-75	25	1·25	0·53	9·92	0·96	1 : 1·82
	Jethwi 1975-*cum-aghani* 1975-76	50	2·50	0·82	7·88	0·27	1 : 0·33
	Jethwi 1976-*cum-aghani* 1976-77	50	2·50	1·40	21·30	3·40	1 2:42
	Jethwi 1977-*cum-aghani* 1977-78	50	2·50	1·20	7·75	0·34	1 : 0·28
	Mean		2·25	0·99	12·83	1·21	1 : 1·22

*Crop ratio refers to the ratio of brood lac used to yield in terms of sticklac.

(b) RESEARCHES ON HAND

1.1 Lac Cultivation Studies

1.1.2 Studies to evolve a suitable method for producing lac on *bhalia* (*Moghania macrophylla*) regularly during both the seasons (at Amjharia)

This experiment was continued as per the lay out reported earlier (A.R., 1974-76) with 5 bushes under each treatment and six replications. Inoculations were made on 12-month-old shoots during January/February. The larval settlement was rather poor due to inferior quality of brood lac. The crop also suffered due to *Chrysopa* attack in March. Hand picking of the eggs and larvae was done to check *Chrysopa* damage. The crop data are set out in Table 2.

It will be seen that the crop, in general, was rather poor. However, of the brood rates tried, lowest brood rate applied (B_1) gave the maximum yield. Of the cultural practices, T_5 proved to be superior to others and as a result of interaction between the brood rate and cultural practice, B_1T_5 came out to be the best.

TABLE 2 — CROP PERFORMANCE UNDER DIFFERENT CULTIVATION PRACTICES TRIED ON *bhalia* (*Moghania macrophylla*) AT AMJHARIA

Crop — *Jethwi* 1977-*cum-Aghani* 1977-78

Cultural practice \ Brood rate:	Stick lac yield (kg)/crop ratio			
	B_1	B_2	B_3	Mean
T_1	2.110 1 : 1·18	2.810 1 : 0·89	3.000 1 : 0·58	2.640 1 : 0·88
T_2	0.635 1 : 0·35	1.235 1 : 0·36	1.235 1 : 0·25	1.035 1 : 0·32
T_3	0.940 1 : 0·47	1.100 1 : 0·32	1.205 1 : 0·25	1.082 1 : 0·35
T_4	2.140 1 : 1·21	2.920 1 : 0·86	3.110 1 : 0·64	2.723 1 : 0·90
T_5	2.830 1 : 1·55	2.480 1 : 0·84	3.580 1 : 0·71	2.963 1 : 1·03
Mean	1.731 1 : 0·93	2.109 1 : 0·65	2.426 1 : 0·49	

(R. S. Gokulpure and P. Sen)

1.1.3 Evolution of a schedule for *rangeeni* lac cultivation on *galwang* and *ber* in alternation

The experiment was continued as per the lay out reported earlier (A.R., 1974-76) with 2 bushes under each sub-plot treatment replicated 5 times, using *ber* and *galwang* for raising *katki* and *baisakhi* crops respectively. The crop performance was compared with that on the conventional *rangeeni* host,

palas, on which the *baisakhi* 1977-78 crop was a total failure and the crop ratio during *Katki* 1978 was 1:1.01.

The larval settlement on *galwang* in the *baisakhi* 1977-78 was satisfactory but heavy mortality followed at the time of sexual maturity. Further mortality due to an unknown reason rendered the crop a total failure.

The *katki* 1978 crop on *ber* was a poor one. From the data presented in Table 3, it is seen that maximum yield was obtained from medium brood rate (B_2); foliar application of urea (F_3) contributed slight increase in yield and as a result of interaction between the brood rate and fertilizer application, B_2F_2 came out to be the best.

TABLE 3 — CROP PERFORMANCE ON *ber* BUSHES DURING *katki* 1978 USING *galwang* BROOD LAC

Brood lac: / Fertilizer application	Stick lac yield (kg) crop ratio			
	B_1	B_2	B_3	Mean
F_1	0.695 1: 1·36	0.945 1: 1·39	0.955 1: 1·04	0·865 1: 1·26
F_2	0.475 1: 1·06	1.020 1: 1·50	0.575 1: 0·61	0.690 1: 1·06
F_3	0.560 1: 1·35	0.990 1: 1·37	0.929 1: 1·01	0.826 1: 1.28
Mean	0.577 1: 1·26	0.985 1: 1·42	0.820 1: 0·89	

(P. Sen and R. S. Gokulpure)

1.1.5 Finding out alternate hosts for *kusmi/rangeeni* strains of lac insect under field conditions and conducting cultivation on them

Three plant species, namely, *putri* (*Croton oblongifolius*), *baryari* (*Desmodium pulchellum*) and *gorai* (*Milletia extensa*) were studied.

Gorai and the monoecious variety of *putri* produced satisfactory *jethwi* 1978 crop whereas the *aghani* 1978-79 crop was satisfactory on *gorai* and *baryari*. The crop data are furnished in Table 4. The *katki* crop was satisfactory only on *baryari*.

(R. S. Gokulpure, P. Sen and S. K. Saha)

1.2 Physiological Studies on Lac Insects and Associated Insects

1.2.1 (b) Nutritional requirements of the predators, *Eublemma amabilis* and *Holcocera pulverea* and evolution of a suitable artificial diet

Artificial diets were formulated incorporating three fractions isolated from the lac insect, viz., total lipoidal matter, total amino acids and precipitated proteins with peptone, glycogen, galactose, vitamins of B group, Wesson's salt and distilled water. Agar shreds were added to obtain the desired texture.

TABLE 4 — CROP DATA FOR LAC CULTIVATION TRIALS ON *putri*, *baryari* AND *gorai*

Host	No. of bushes	Broodlac used (kg)		Yield (kg)						Brood used to yield ratio	
				Lac stick			Stick lac				
		Lac stick	Stick lac	Broodlac	Rejected lac	Total	Broodlac	Rejected lac	Total	Lac stick	Stick lac
				Jethwi 1978							
Putri	25	5	2·100	7·200	11·00	18·200	1·600	2·300	3·900	1 : 3·64	1 : 1·85
Gorai	25	3·5	0·950	6·400	3·800	10·200	1·850	0·400	2·250	1 : 2·91	1 : 2·36
				Aghani 1978-79							
Putri	18	3·5	1·450	0·500	—	0·500	0·200	—	0·200	1 : 0·42	1 : 0·40
Baryari	15	0·6	0·150	—	0·800	0·800	—	0·225	0·225	1 : 1·33	1 : 1·50
Gorai	1	0·2	0·100	0·500	—	0·500	0·200	—	0·200	1 : 2·50	1 : 2·00

The compositions tried were as follows:

(A) 1 — Peptone 0·5 g, 2 — Precipitated proteins 2·5 g, 3 — Glucogen 0·004 g, 4 — Galactose 0·08 g, 5 — Vitamins 18·75 mg, 6 — Lipoidal matter 0·02 g, 7 — Total free aminoacids 0·004 g, 8 — Wesson's salt 0·002 g, 9 — Agar shreds 4 g, 10 — Distilled water 100 ml.

(B) Same as (A) but 2 and 7 deleted.

(C) Same as (A) but 6 and 7 deleted.

(D) Same as (A) but 2 and 6 deleted.

The *p*H of the diet was adjusted to 6·5-6·7 using KOH.

The insects were maintained at 27°C ± 2°C and 65-70 per cent R.H. (maintained by using 35 per cent aqueous KOH solution) throughout the experiment. Field collected pupae of *E. amabilis* were kept in cages to allow adults to emerge, mate and lay eggs. Ten newly hatched larvae were released on each diet with three replications.

The larvae did not survive beyond seven days on any of the diets tried though they apparently fed on the diets as revealed by the presence of excreta produced. This short survival could be due to the absence of a phagostimulant in the diet.

Studies are being planned for the extraction of possible phagostimulant from the lac insect.

The total lipoidal matter in lac insects was estimated again for confirmation. Resin and wax free homogenates of lac insects were extracted with chloroform: methanol (2:1 v/v) using Soxhlet apparatus. The extract was allowed to evaporate and then dried over fused calcium chloride in a desiccator for 48 hr. The dried fatty matter was estimated gravimetrically. The experiment was repeated thrice.

The crawling larvae contain approximately 1·1656 mg and nearly mature insects approximately 3·3326 mg of lipoidal matter per g body weight. These results agree well with those obtained earlier.

(A. K. Sen, T. P. S. Teotia and A. H. Naqvi)

1.2.2 Evolution of a suitable synthetic diet for artificial rearing of lac insects

An attempt was made to improve the agar-shred slants using soft wax in concentration of 0·5 and 1 per cent in 3 per cent agar agar preparation. These were steam sterilised. Sorbic acid (0·15 per cent) was added as a preservative.

The lac larvae released on the above preparation failed to settle. The few larvae which settled did not survive for more than fifteen days.

The lac larvae were also reared on agar agar substrate developed earlier. The maximum survival observed was for a period of 61 days during *jethwi* 1978 season, 53 days during *katki* 1978 and 125 days during *aghani* 1978-79. These larvae, however, failed to moult. During the *katki* 1978 and *aghani* 1978-79 seasons, growth of lac larvae was better than in the other seasons as could be seen by the heavy secretion of waxy filaments and honey dew but the resin secretion was poor compared to insects reared on natural hosts.

(A. H. Naqvi and T. P. S. Teotia)

1.2.3 Studies on the role of micro-organisms present in the lac insect

The lac insects were reared on *bhalia* plants and also on artificial diets and attempts were made to eliminate the micro-organisms harboured by these insects by using 0·25 per cent chloromycetin and terramycin as foliar spray in the case of insects reared on *bhalia* plants and by incorporating these antibiotics in the diet for those reared on artificial diet.

Foliar application of the antibiotics was found to have no effect on the micro-organisms harboured by the lac insects, but lac insects fed on artificial diets containing antibiotics did not survive for more than 72 hr.

(A. H. Naqvi)

1.2.4 Studies on sex attraction in the major lepidopterous predators of lac

Abdominal tips of 2-day-old virgin females were extracted with cold methylene chloride. This extract was then mixed with acetone : methylene chloride (1 : 10 v/v) at −20°C. The precipitated fats were then filtered out. The filtrate when evaporated yielded a yellow oily substance which attracted the adults of the lepidopterous predators of lac. The amount of crude pheromone so obtained was less than 5 mg. Studies were planned on the chemical nature of this pheromone.

(T. P. S. Teotia, A. K. Sen and A. H. Naqvi)

1.3 Ecological Studies on Lac Insects and Associated Insects

1.3.2 Effect of host density and age of host on the incidence of predators in different crop seasons

The objective and technical programme of the study have been reported earlier (A.R., 1974-76). During the period under report, studies were made on crops raised on *palas* during the *katki* 1978 and *baisakhi* 1978-79 seasons. The incidence of the two major predators was recorded at the time of (i) *phunki* removal, (ii) sexual maturity of lac insects and (iii) crop maturity. Similar studies with *kusmi* lac insects could not be made due to non-availability of brood lac. From the data given in Table 5, it will be seen that, in general,

TABLE 5 — INCIDENCE OF THE MAJOR PREDATORS (ALL STAGES) IN RELATION TO THE AGE AND DENSITY OF THE LAC INSECTS

Crop	Host	Rate of broodlac (kg)	At Phunki removal		At third moult		At crop maturity	
			Eublemma amabilis No.	*Holcocera pulverea* No.	*Eublemma amabilis* No.	*Holcocera pulverea* No.	*Eublemma amabilis* No.	*Holcocera pulverea* No.
Katki 1978	*Palas*	0·125	19	—	24	4	7	3
		0·250	53	8	11	3	10	9
		0·500	49	14	19	1	13	8
		1·000	63	11	19	3	17	13
Baisakhi 1978-79	*Palas*	0·125	65	4	6	0	72	141
		0·250	68	4	21	10	83	128
		0·500	121	12	61	8	170	193
		1·000	190	33	53	14	176	157

there has been an increase in the incidence of the predators with the increase in the density of lac insects.

(B. P. Mehra and B. N. Sah)

1.3.3 To study the bioecological aspects of *Pristomerus sulci*, an endoparasite of *Holcocera pulverea*, a predator of lac insect

This parasite could be got mated under laboratory confinement only after the adults were in dark for some time and released in the battery jars in the male : female ratios of 1:3, 2:1 and 3:1. This confirms the observations made earlier.

(M. L. Bhagat and B. P. Mehra)

1.3.4 To study the effect of insecticidal control of the major lac predators on the vital economic attributes of lac insect and on its associated fauna

The objective and the technical programme of the study have been reported earlier (A.R., 1974-76). Data collected from crops raised on *bhalia* during *baisakhi* 1977-78, *katki* 1978, *baisakhi* 1978-79, *jethwi* 1978 and *aghani* 1978-79 are presented in Table 6.

It is seen from the table that the control schedule using endosulfan and *Bacillus thuringiensis* does not affect the survival, rearing period, sex-ratio, cell weight and resin dye level of lac insects. However, the treated females were found to be more fecund than the untreated ones, for which no ready explanation can be offered.

(B. P. Mehra and B. N. Sah)

1.3.5 Studies taken up at the Regional Field Research Station, Dharamjaigarh

The progress made under the various studies conducted at this station is reported below:

(a) Evolution of a suitable technique for culturing lac on *kusum* under local conditions.

The objective and technical programme have been detailed earlier (A.R., 1973).

Further data obtained during the period under report showed that the crops obtained under the different cultivation schedules were too poor to allow any generalization.

(b) To investigate the indigenous plant species for use as alternative *kusmi* host.

One tree each of *dumar* (*Ficus racemosa*) and *jhera* (*Ficus* sp.) were inoculated for *jethwi* 1978 crop. None, however, produced a crop.

(c) Introduction of quick growing *kusmi* hosts.

Experiments could not be conducted as all *bhalia* bushes raised for this study died during the period under report.

(d) To study the inimical and beneficial insects associated with *kusmi* lac insect.

TABLE 6 — EFFECT OF INSECTICIDAL CONTROL OF PREDATORS ON THE VITAL AND ECONOMIC ATTRIBUTES OF THE LAC INSECT

Crop season	Treatment	Effect on lac insects									
		Average per cent survival after		Average rearing period (days)		Average per cent males			Average weight of mature female cell (mg)	Average fecundity (No. of larvae per female)	Average dye level (optical density/mg/ resin)
		I spray (combination/ endosulfan) spray	II spray (combination spray)	Males	Females	Alate	Apterous	Total			
Baisakhi 1977-78	insecticide spray	80·52	*	128·72	208·38	0	19·19	19·19	6·1	289·0	0·013078
	Water spray	77·44	*	128·70	205·19	0·34	22·90	23·24	7·5	140·8	0·009240
Jethwi 1978	Insecticide spray	86·11	*	60·30	159·61	2·82	17·37	20·19	6·6	295·5	0·014191
	Water spray	65·38	*	60·34	160·35	0·42	18·14	18·56	6·6	173·2	0·012535
Katki 1978	Insecticide spray	72·47	*	46·62	115·60	0	15·99	15·99	6·7	201·0	0·023750
	Water spray	75·00	*	46·23	112·14	0	12·23	12·23	9·0	148·4	0·027959
Aghani 1978-79	Insecticide spray	80·67	†	64·86	228·43	0	18·80	18·80	12·7	310·3	0·014251
	Water spray	72·13	†	64·83	228·33	0	18·30	18·30	11·98	247·2	0·013347
Baisakhi 1978-79	Insecticide spray	83·48	*	127·20	N.A.	3·70	32·27	35·97	N.A.	N.A.	N.A.
	Water spray	80·66	*	126·61	N.A.	5·33	30·25	35·58	N.A.	N.A.	N.A.

N.A. Data not available since insects died during the post-mating period.
*Not applicable since second spraying is not recommended.
†Second spraying was due but could not be given.

TABLE 7 — EFFECT OF VARIOUS CONTROL SCHEDULES ON THE LAC CROP YIELDS AND PRED

Code	Treatment			Brood lac used per tree (kg)		Average lac yield/			
	Insecticide	Concentration (%)	No. of sprays	Lac sticks	Stick lac	Lac stick			
						Brood lac	Rejected lac	Total	
A	Endosulfan	0·05	2	0·300	0·064	0·700	0·940	1·640	
B	do	0·05	3	0·300	0·064	0·550	1·200	1·750	
C	do	0·075	2	0·300	0·064	0·700	1·266	1·966	
D	do	0·075	3	0·300	0·063	1·050	2·813	3·530	
E	do	0·01	2	0·300	0·066	1·287	0·837	2·125	
F	do	0·1	3	0·300	0·065	0·662	1·737	2·400	
G	Cryolite	0·1	2	0·300	0·064	0·800	1·740	2·540	
H	do	0·1	3	0·300	0·065	0·527	1·512	2·037	
I	Endosulfan + Thuricide	0·05	2	0·300	0·062	0·150	0·950	1·100	
J	do	0·05	3	0·300	0·065	0·787	1·887	2·675	
K	do	0·1	2	0·300	0·063	0·290	1·050	1·340	
L	do	0·1	3	0·300	0·056	0·850	1·816	2·666	
M	Water		2	0·300	0·059	0·237	0·663	0·900	
N	do		3	0·300	0·067	0·563	1·037	1·600	
O	No treatment (control)		—	0·300	0·066	0·400	1·175	1·575	
P	do		—	0·300	0·049	0·166	0·433	0·600	
	Mean			0·300	0·060	0·341	0·827	1·169	

ATOR POPULATION IN *baisakhi* 1977-78-*cum-katki* 1978 CROP ON *Palas* AT LOTA FARM

tree (kg)			Brood used to yield ratios		Average No. of predators per 100 g sticklac during October 1978			Percent suppression of the predators during October 1978
	Stick lac							
Brood lac	Rejected lac	Total	Broodlac stick	Stick lac	*Eublemma amabilis*	*Holcocera pulverea*	Total	
0·113	0·117	0·230	1 : 2·33	1 : 3·59	6·25	5·0	11·25	65·145
0·110	0·171	0·274	1 : 1·83	1 : 4·28	6·83	8·54	15·38	52·35
0·151	0·085	0·235	1 : 2·33	1 : 3·65	9·13	6·72	15·86	50·87
0·222	0·280	0·502	1 : 3·50	1 : 7·96	3·12	7·17	10·29	68·12
0·245	0·079	0·324	1 : 4·29	1 : 4·90	9·66	9·66	19·15	40·675
0·118	0·129	0·247	1 : 2·20	1 : 3·80	5·07	9·77	14·84	54·03
0·174	0·170	0·344	1 : 2·66	1 : 5·37	12·97	13·74	26·71	17·25
0·089	0·143	0·232	1 : 1·75	1 : 3·56	10·28	9·55	19·27	40·30
0·030	0·076	0·106	1 : 0·50	1 : 1·70	1·79	5·39	7·18	77·76
0·168	0·199	0·367	1 : 2·62	1 : 5·64	11·71	13·28	25·00	22·55
0·102	0·112	0·214	1 : 0·96	1 : 3·39	14·73	10·71	25·44	21·19
0·223	0·165	0·389	1 : 2·83	1 : 6·94	12·76	7·76	20·53	36·40
0·041	0·062	0·103	1 : 0·79	1 : 1·74	20·47	16·47	36·94	—
0·119	0·083	0·202	1 : 1·88	1 : 3·01	11·35	21·48	32·83	—
0·066	0·117	0·183	1 : 1·33	1 : 2·77	12·20	14·02	26·22	—
0·029	0·046	0·075	1 : 0·55	1 : 1·53	19·82	13·33	33·15	—
0·064	0·077	0·141	1 : 1·13	1 : 2·35	15·96	16·32	32·28	—

One kg of unselected *jethwi* 1978 lac was caged for recording the emergence of insects therefrom. The results are presented below:

Lac Insect Predators:	
E. amabilis	53
H. pulverea	124
Lac Insect Parasites:	
Tetrastichus purpureus	2
Tachardiaephagus tachardiae	2
Erencyrtus dewitzi	1
Insect Parasites of Lac Predators:	
Pristomerus sulci	11
Apanteles tachardiae	5
Apanteles fakhrulhajiae	4
Bracon greeni	3

(B. P. Mehra and J. M. Dasgupta)

1.4 Integrated Control of Enemies of Lac Insects

1.4.1 Field trials of envisaged integrated control schedules against the lac predators

(i) *Baisakhi* 1977-78 *cum-katki* 1978 crop on *palas* at Lota:

Sixteen control schedules (including 2 controls), as detailed in Table 6, were tried. Each treatment was carried out on crop raised on one *palas* tree replicated five times.

The inoculations were made on 7 October 1977. Only one spraying was given on all the experimental trees on 15 April 1978 during the *baisakhi* crop season, whereas either one or two sprayings were given during *katki* crop season on 23 August 1978 and 15 September 1978.

Data on suppression of predatory fauna were obtained by caging samples of broodlac at the rate of 200 g per replication collected at crop maturity.

From the results presented in Table 7 it is seen that 3 sprays of 0·075 per cent endosulfan gave best crop yields and also suppressed the predatory fauna to the extent of 68·12 per cent. The results have, however, presented an inconsistent trend with respect to concentration and number of sprays.

(ii) *Katki* 1978 crop on *bhalia* (*Moghania macrophylla*) at Amjharia

Katki 1978 crop was inoculated on 20 July 1978 on 90 bushes. There were six treatments, namely, EC, CE, EE, CC, BC and N. Treatment symbols stand as under:

E = 0·05% endosulfan B = 0·05% *Bacillus thuringiensis*,

C = combination spray of 0·05% endosulfan and 0·05% of *Bacillus thuringiensis*.

There were five replications with 3 bushes under each treatment under a randomized block design. A total of 2 sprays with insecticides in sequence as shown for each treatment were applied on 21 August 1978 and 21 September 1978 respectively. Data on yield and suppression of predators are presented in Table 8. It is seen that the best result with respect to lac yield was obtained

TABLE 8 — COMPARATIVE DATA ON CROP YIELD AND DEGREE OF SUPPRESSION OF PREDATORS UNDER INTEGRATED CONTROL SCHEDULES IN THE *katki* 1978 CROP ON *bhalia* AT AMJHARIA

Treatment	Broodlac used/ bush (g)		Yield/bush (g)		Brood used to yield ratio		Predators emerged/100 g sticklac			Per cent reduction		
	Lac stick	Stick lac	Lac stick	Stick lac	Lac stick	Stick lac	*E. amabilis*	*H. pulverea*	Total	*E. amabilis*	*H. pulverea*	Total
EC	100	17·8	94·6	9·2	1: 0·94	1: 0·52	2·2	0·7	2·9	68·5	41·6	64·6
CE	100	18·3	107·8	10·0	1: 1·08	1: 0·55	2·2	0·3	2·5	68·5	75·0	69·5
EE	100	18·4	100·6	8·1	1: 1·00	1: 0·44	0·9	0·1	1·0	87·1	91·6	87·8
CC	100	18·1	107·5	8·8	1: 1·07	1: 0·49	2·0	1·2	3·2	71·4	Nil	60·9
BC	100	18·1	73·6	4·9	1: 0·74	1: 0·27	1·4	0·2	1·6	80·0	83·3	80·4
N	100	18·0	110·3	6·8	1: 1·10	1: 0·38	7·0	1·2	8·2	—	—	—

under the schedule CE which suppressed the predatory population to the extent of 69·5 per cent.

(C. P. Malhotra, R. C. Mishra and T. P. S. Teotia)

1.4.2 Studies on evolving cultural control for the enemies of lac insect

The study was conducted at Kundri, as in the previous year, with brood lac maturing at different times and collected from 3 places within Bihar, viz., Chandwa, Malichak and Kundri. The inoculations were done with Chandwa brood on 9 October 1977 (C), Malichak brood on 15 October 1977 (M), and Kundri brood on 22 October 1977 (K), 29 October 1977 (KI) and 6 November 1977 (KL) on an unit of 5 trees each, replicated five times. There were thus a total of 125 trees under the study in a randomized block design.

Baisakhi 1977-78-*cum-katki* 1978 crop was harvested during the period (Table 9). Highest sticklac yield was recorded from inoculation made on 15 October 1977 with Malichak brood lac (M) and lowest from inoculation made on 9 October 1977 with Chandwa brood lac (C). The latter coincided with the general emergence at Kundri which started on 10 October 1977.

(C. P. Malhotra and R. C. Mishra)

1.4.7 Estimation of losses caused by the enemy insects of lac

The lac crops were protected by mechanical and chemical measures. Methods and procedures of the study have already been explained earlier (A.R., 1977). Cropwise details during the period under report are given below and data presented in Table 10.

(i) *Aghani* 1977-78 crop on *bhalia*

Avoidable pest losses under mechanical and chemical protection were assessed as 68·75 and 39·02 per cent, respectively. There was cent per cent inhibition of the enemies in mechanically protected crop, whereas reduction to the extent of 67·8 and 12·5 per cent of predators and harmful parasites, respectively, was recorded under chemical protection.

(ii) *Baisakhi* 1977-78 crop on *bhalia*

Avoidable pest losses based on mechanical and chemical protections were assessed as 38·63 and 10·00 per cent respectively. There was cent per cent inhibition of enemy insects in mechanically protected crop, whereas reduction to the extent of 63·0 and 19·2 per cent was recorded in predators and harmful parasites, respectively, under chemical protection.

(iii) *Katki* 1978 crop on *bhalia* and *palas*

On *bhalia* crop, avoidable pest losses based on mechanical and chemical protection were assessed as 66·67 and 63·04 per cent, respectively. Again there was cent per cent inhibition of enemy insects in mechanically protected crop, whereas 68·9 and 30·6 per cent reduction in the population of predators and harmful parasites, respectively, was noted under chemical protection. Avoidable pest losses on *palas* crop were assessed as 69·23 and 45·45 per cent, respectively, under mechanical and chemical protection, with 100 and 81·5 per cent reduction in population of predators and harmful parasites.

(C. P. Malhotra and S. G. Choudhary)

TABLE 9 — EFFECT OF VARYING THE DATES OF INOCULATION ON THE LAC CROP YIELD AND THE INCIDENCE OF LAC PREDATORS IN THE *baisakhi* 1977-78-*cum-katki* 1978 CROP ON *palas* AT KUNDRI FARM

Treatment/ Code	Brood lac used/tree (g)		Average lac yield/tree (kg)						Brood used to yield ratios		Incidence of predators					
			Lac stick			Stick lac					No. of predators/meter lac stick in April 1978			No. of predators/100 g stick lac in October 1978		
	Lac stick	Stick lac	Brood lac	Rejected lac	Total	Brood lac	rejected lac	Total	Brood lac stick	Stick lac	*Eublemma amabilis*	*Holcocera pulverea*	Total	*Eublemma amabilis*	*Holcocera pulverea*	Total
C	250	60	1·248	1·392	2·640	0·248	0·104	0·352	1:4·99	1:5·87	6·0	4·0	10·0	15·4	16·2	31·6
M	250	60	1·816	2·204	4·020	0·364	0·184	0·548	1:7·26	1:9·13	4·5	5·5	10·0	11·2	10·4	21·6
K	250	61	1·800	2·068	3·868	0·360	0·152	0·512	1:7·20	1:8·39	1·2	3·3	4·5	14·4	12·2	26·6
KI	250	70	1·368	1·480	2·848	0·268	0·152	0·420	1:5·47	1:6·00	3·8	4·3	8·1	12·0	17·5	29·5
KL	250	56	1·754	0·846	2·600	0·369	0·058	0·427	1:7·02	1:7·62	0·9	2·6	3·5	3·3	6·5	9·8

TABLE 10 — ESTIMATION OF LOSSES CAUSED BY THE ENEMY INSECTS OF LAC INSECT DURING VARIOUS CROP SEASONS (1977-78)

Crop	Host plant	Treatment	Number of samples	Total length of samples (cm)	Yield obtained (g)		Percentage avoidable loss in yield of stick lac	Emergence of enemy insects from samples				Percentage reduction of enemy insects			
					Lac stick	Stick lac		Predators			Parasites	Predators			Parasites
								E.a.	*H.p.*	Total		*E.a.*	*H.p.*	Total	
Aghani 1977-78	*Bhalia*	A	36	422	1620	480	68·75	Nil	Nil	Nil	Nil	100	100	100	100
		B	36	422	1050	246	39·02	5	4	9	84	66·6	69·2	67·8	12·5
		C	36	422	717	150	—	15	13	28	96	—	—	—	—
Baisakhi 1977-78	*Bhalia*	A	36	576	1322	88	38·63	Nil	Nil	Nil	Nil	100	100	100	100
		B	36	576	1009	60	10·00	5	12	17	63	75	53·8	63·0	19·2
		C	36	576	876	54	—	20	26	46	78	—	—	—	—
Katki 1978	*Bhalia*	A	25	402	900	51	66·67	Nil	Nil	Nl	Niil	100	100	100	100
		B	25	402	902	46	63·04	3	6	9	34	86·9	100	68·9	30·6
		C	25	402	85·8	17	—	23	6	29	49	—	—	—	—
	Palas	A	57	696	1875	234	69·23	Nil	Nil	Nil	Nil	100	100	100	100
		B	57	696	1566	132	45·45	3	3	6	21	98·0	100	96·1	81·5
		C	57	696	1164	72	—	152	3	155	114	—	—	—	—

A — Mechanical protection, B — Chemical protection, C — Control. *E.a.*— *Eubelmma amabilis*, *H.p.*— *Holcocera pulverea*.

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

Two hormones, namely, Altosid and Altozar and a chitin inhibitor, namely, Diflubenzuron were obtained from U.S.A. A laboratory trial with the latter material revealed 100 per cent mortality of the pupae of the lac predator, *E. amabilis*, when sprayed with concentrations ranging from 0·05 to 1·0 per cent. A lower concentration, viz., 0·01 per cent, however, resulted in 86·6 per cent mortality and the survivors developed as abnormal adults.

The trial will be repeated with lower concentrations.

(C. P. Malhotra and Satya Vir)

1.5 Breeding and Genetical Studies on Lac Insects

1.5.2 Study of crosses of *rangeeni* and *kusmi* strains of lac insects

Crosses of kundri rangeeni females and local kusmi males

With a view to studying the performance of the hybrid female lac insects, the *rangeeni* lac insects of the kundri stock and *kusmi* of a local stock were reared during the rainy season in 1977 and the virgin females of the *rangeeni* strain were mated to the males of the *kusmi* strain. Since the rearing period of the two strains differs much particularly during the rainy season, the F_1 hybrid insects can be reared along with lac insects of only the maternal parent during the same rearing period. The resulting F_1 and F_2 hybrid insects were, therefore, reared alongwith those of the *rangeeni* parent and their females scored for the rearing period and resin secretion.

It will be seen from Table 11 that compared to the *rangeeni* parent, the resin secretion of F_1 hybrid females was considerably higher (43·7%) even

TABLE 11 — COMPARISON OF THE AVERAGE REARING PERIOD AND RESIN SECRETION OF THE F_1 AND F_2 FEMALES OF A CROSS OF KUNDRI *rangeeni* FEMALES AND LOCAL *kusmi* MALES WITH THOSE OF THE *rangeeni* PARENT

Particulars			Parent (*rangeeni*)	Cross bred	
				F_1	F_2
Dry season life cycle (October-November to June/July)	Total life period (days)	No. tested	54	20	—
		Range	260-276	217-227	
		Mean	270·3	223·0	
	Resin secretion per female (mg)	No. tested	20	20	—
		Range	5·2-12·3	7·6-16·7	—
		Mean	8·7	12·5	
		Per cent increase over *rangeeni* parent		43·7	
Rainy season life cycle (June/July to October/November)	Total life period (days)	No. tested	61		64
		Range	105-115		108-146
		Mean	110·6		117·2
	Resin secretion per female (mg)	No. tested	20		72
		Range	3·2-9·6		2·9-13·3
		Mean	6·8		8·3
		Per cent increase over *rangeeni* parent			22·1

though the rearing period was significantly shorter, providing evidence of considerable hybrid vigour in these insects. As expected, the F_2 females were highly variable and the F_1 superiority for resin secretion was found reduced by about half in the F_2 generation.

From the F_2 generation, 50 females were taken at random and their individual progenies are being maintained for performance evaluation.

Reciprocal crosses of an early maturing Dharamjaigarh kusmi and local rangeeni stocks of lac insects

The reciprocal F_1 hybrid progenies were maintained along with cultures of the parent stock during the rainy season. The females were scored for rearing period, fecundity and resin secretion.

The data set out in Table 12 provide further evidence of considerable hybrid vigour in lac insects. The reciprocal F_1 hybrid females, however, differ significantly in their performance and those with *kusmi* as the maternal parent showed better performance than even the superior *kusmi* parent. The F_2 progenies are being maintained for further studies.

Maintenance and evaluation of the advanced segregating progenies of crosses of rangeeni and kusmi strains

The advanced segregating progenies of the strain crosses were maintained. Some of these included females which maintained the *rangeeni* rearing period and produced apparently *kusmi* type lighter coloured resin. These females were collected and their progenies maintained for further studies.

(N. S. Chauhan and Jawahir Lal)

1.5.3 Mutation studies in lac insects

The third and fourth generation progenies of the X-irradiated lac insects were maintained. No variant lac insect, however, could be observed.

(N. S. Chauhan and S. K. Jaipuriar)

1.5.5 Cytological studies in lac insects

Cytological studies were continued to examine the chromosome behaviour in lac insect. For this, lac larvae were fixed in Bradley's carnoy solution. Squash preparations were made in acetocarmine.

It was observed that, in the male, the resting nuclei always contained a heteropycnotic residue in the somatic and germline tissues which was not present in the case of females. These heteropycnotic residues were observed from the early embryogeny of the male and were maintained till spermatogenesis. Further studies are in progress.

(T. P. S. Teotia, S. K. Jaipuriar and N. S. Chauhan)

1.5.7 Protein polymorphism and genetic heterozygosity in lac insect

To study the presence of tetrazolium oxidase, fully mature females were crushed in phosphate buffer *p*H 7, homogenised and centrifuged at 10,000 r.p.m. for 15 min. The supernatant was subjected to disc gel electrophoresis for 90 min at 300 V. The gels were then rimmed out and kept in a staining mixture of 0.005M $MgCl_2$, 0·001M D.P.N., 0.00043M NB-tetrazolium, 0.000163M

TABLE 12 — TOTAL LIFE PERIOD, FECUNDITY AND RESIN SECRETION OF THE FEMALE LAC INSECTS IN THE *rangeeni* AND *kusmi* STRAINS AND THEIR CROSSES DURING THE RAINY SEASON

Particulars of lac insects	Total life period (days)			No. of larvae produced per female				Resin secretion (mg) per female			
	No. tested	Range	Mean	No. tested	Range	Mean	Per cent increase over mid-parent value	No. tested	Range	Mean	Per cent increase over mid-parent value
I. *Parents*											
Ranchi *rangeeni* ♀	101	106-123	108·2	30	107-455	258·6	—	30	1·8-9·5	5·6	—
Dharamjaigarh *Kusmi* ♂	97	144-167	154·0	29	82-718	361·8	—	30	6·0-19·0	10·7	—
II. *Crosses*											
Ranchi *rangeeni* ♀ — Dharamjaigarh *kusmi* ♂	49	117-224	143·0	20	46-834	431·8	39·2	30	4·1-14·5	9·7	19·0
Dharamjaigarh *kusmi* ♀ — Ranchi *rangeeni* ♂	66	111-167	119·9	17	257-790	526·8	69·8	30	7·0-18·3	12·8	57·1

Phenazine methosulphate prepared shortly before use in 100 c.c. of phosphate buffer *p*H 9 under light. The gels were crushed in 1 per cent acetic acid.

Three achromatic bands appeared on the gel indicating the presence of the enzyme in three molecular forms. Tetrazolium oxidase is, thus, present in *kusmi* lac insect as a polymorphic protein.

(Y. D. Mishra, T. P. S. Teotia and N. S. Chauhan)

1.5.8 Collection maintenance and evaluation of genetic stocks of lac insects

A stock of *rangeeni* strain was collected from Meghalaya which was maintained along with those of the same strain collected earlier from Punjab, Delhi, Madhya Pradesh and Bihar. The stocks of *kusmi* strain maintained included those collected earlier from Tamilnadu, Orissa, Madhya Pradesh and Bihar. These stocks have shown interesting differences in their rearing period, host preference, resin productivity and resin quality as judged on the basis of dye-level.

During the course of breeding work with lac insects, a few colour variants were observed which were isolated and their individual progenies maintained.

A few cultures of a wild stock of *kusmi* strain and F_2 progeny from a cross of the *rangeeni* and *kusmi* strains were found to include only the male insects, for which no explanation is available at present.

The yellow mutant which has so far been observed in the *rangeeni* strain was also recorded as occurring in a wild stock of *kusmi* strain originating from Orissa.

The wild stock originating from Meghalaya showed a high proportion of winged males during rainy season generation. Their rearing period during the rainy season was longer than that of the *rangeeni* strain and these insects produced the darkest coloured lac resin.

(Jawahir Lal)

(c) RESEARCHES CONTEMPLATED

1. Studies on the population dynamics of *kusmi* strain of lac insects to ascertain the causes of *kusmi* crop failures.

2. Studies on sex determination in lac insects.

(d) OPERATIONAL RESEARCH PROJECT

In the project area, comprising of four villages in Ranchi district, 83 demonstrations of improved methods of lac cultivation (involving approximately 1000 *palas* and *ber* trees) were laid out with the *baisakhi* 1977-78 crop. The *ari* harvest data on *ber* trees have indicated that sticklac yield per tree obtained by the traditional method is nearly doubled with the improved technology. The data on brood lac crop are under compilation. Some farmers have also started following the improved practices on their own.

For improving the overall economy of the project area, other programmes were also taken up. A stipendiary artisan bee-keeping training of one-month duration was imparted to 28 villagers and standard bee-hives were provided

to them through the help of Bihar State Khadi Gramodyog Board. The modern crop production technology, appropriate for the area, was also demonstrated. Under this programme, 24 demonstrations of acid soil reclamation with Mussoriephos were undertaken and soyabean and hybrid maize were newly intsoduced in the area on these reclaimed plots. Demonstrations of dry farming technology for pady, *ragi*, groundnut, and maize+*arhar* were also given at two locations. An existing cooperative society in the area was revitalized with the enrolment of 74 villagers as new members. A villagers' forum meeting for exchange of ideas and extension education activities was organised once a month at three locations in the area. Guest teachers were arranged on different agricultural topics and seasonal training of farmers in the villages and at the Block headquarters was also arranged. The farmers were also taken round the Kisan Melas organized by the Ranchi Agricultural and Veterinary Colleges.

B. AGRONOMY AND PLANT GENETICS DIVISION

(a) RESEARCHES COMPLETED

2.4 Genetics and Breeding Studies

2.4.1 Cytotaxonomic and mutation studies on lac-host plants

Cytotaxonomic studies

The mitotic analysis in 13 varieties/cultivars of *Cajanus cajan* (*arhar*) showed that all the varieties had the same chromosome number (2n=22) but they differed in their chromosome morphology. The total chromatin length was maximum in var. NP 41 and minimum in Cult. *Ranchi*. SAT chromosomes were observed in varieties T-1, No. 148 and 7-S. On the basis of D^2 analysis the varieties were classified into seven distinct groups: Cluster A (Varieties PT 301, ILRI and 7-S), B (Varieties T-1 and C-11), C (Varieties NP 39 and NP 80), D (Cult. *Ranchi*), E (Var. NP-41, Cult. *Motihari* and Var. BR 60), F (Var. No. 148), and G (Cult. *Assam*).

The meiotic analysis of these varieties revealed that there was a formation of 11 regular bivalents in all the varieties/cultivars but they differed in the number of ring and rod bivalents per pollen mother cell and half chiasma per chromosome. The highest value for rod bivalents was recorded in var. T-1 and lowest in var. C-11 and that of half chiasma per chromosome in cult. *Motihari* and var. T-1. The inter- and intra-class correlations showed positive correlation in all the cases except in varieties 7-S and No. 148 and cultivars ILRI and *Assam* where negative correlation was noted. The maximum and minimum variance ratios were observed in varieties 7-S and C-11 respectively. From the above observations it appeared that the different varieties/cultivars of *C. cajan* had originated by the change in the nature of their chromosomes and genes. It was also apparent that the meiotic behaviour of the chromosomes is one of the determinant factors in establishing new varieties under the same species.

The karyotype study in *bhalia* (*Moghania macrophylla*), *bara salpan* (*M. chappar*), *palas* (*Butea monosperma*) and *takoli* (*Dalbergia lanceolaria*) showed

the diploid chromosome number as 2n=22, 22, 18 and 20 respectively. The total chromatin length was maximum in *takoli* and minimum in *bhalia*.

The meiotic analysis of *bhalia*, *bara salpan*, *palas* and *takoli* showed the bivalents per PMC as 11, 11, 9 and 10 respectively. The highest value for rod bivalents per PMC was in *bhalia* and lowest in *bara salpan*. The meiotic abnormality, such as, formation of bridges at anaphase I was observed in *bara salpan* only. Inter- and intra-class correlations showed positive correlation amongst all the plant species studied except in *takoli* where negative correlation was noted.

Besides the above study, mitotic analysis in some more lac-hosts, namely, rain tree (*Samanea saman*), *galwang* (*Albizzia lucida*), *siris* (*A. lebek*), *khair* (*Acacia catechu*) and *kastura* (*A. farnesiana*) was also carried out and the chromosome numbers were confirmed as 2n=26, 26, 26, 26 and 52 respectively.

Mutation Studies

Mutational studies were undertaken in two cultivars of *Cajanus cajan* (Cult. *Ranchi* and Cult. *Assam*) and two species of *Moghania* (*M. macrophylla* and *M. chappar*) after irradiating the seeds with gamma rays at doses varying from 5 to 40 kr. The seeds were sown in the field and the following observations were recorded in M_1 and M_2 generations.

(1) *Germination and survival* — The germination percentage decreased with the increase of doses. Stimulating effect was observed only at 5 kr in *C. cajan* Cult. *Ranchi* and *M. chappar* in M_1 generation. However, in M_2 generation, the germination percentage reached towards normalcy. The survival percentage at the two-leaf stage and at maturity also decreased with the increase of doses. The LD 50 values in both the cultivars of *C. cajan* and *M. chappar* were noted between 10 and 15 kr and in *M. macrophylla* between 23 and 30 kr.

(2) *Growth of the seedlings* — The root and shoot meristems measured for seven days at 24-hr interval showed a decreasing trend with the increase of doses. The stimulating effect was noted on root in *C. cajan* Cult. *Assam* at 5 and 10 kr and on shoot in *M. chappar* at 5 kr only. It was also observed that shoot suffered more than root.

(3) *Mitotic abnormalities and their elimination* — The chromosomal aberrations were noted in root and shoot meristems of irradiated material both at chromosome and chromatid level. The roots were carrying more aberrations than shoots. The elimination of the aberrations studied up to seven days at 24-hr interval in root and shoot meristems showed gradual decline in the number of bridges, fragments and micro-nuclei.

(4) *Meiotic abnormalities* — Various types of meiotic abnormalities, such as, multivalents, chains, rings, bridges and fragments in PMC in M_1 generation plants were recorded. There was an increase in the aberrations with the increase of doses. Formation of monads, diads and triads instead of tetrads was also noted.

(5) *Effect on plant attributes* — The plant height, number of primary branches, total shoot length, number of flowers, pods and seeds per plant were recorded in M_1 and M_2 generations. In M_1 generation these plant attributes showed a declining trend with the increase of doses. However, in M_2 generation they tended to reach towards normalcy at least at lower dose levels. At higher dose levels the declining trend still persisted.

(6) *Types of mutants* — Chlorophyll and morphological mutants were detected in M_2 generation.

Dealing with various aspects of mutational studies it was found that, amongst the two cultivars of *C. cajan*, Cult. *Ranchi* was more radiosensitive than Cult. *Assam* and, amongst the two *Moghania* species, *M. chappar* was more radiosensitive than *M. macrophylla*.

Artificial induction of polyploidy in bhalia (Moghania macrophylla)

The seedlings were treated with 0·125, 0·50 and 0·75 per cent colchicine and transplanted in earthen pots. Out of all the plants raised from the treated seedlings the plants raised from the seedlings treated with 0·50 per cent colchicine solution showed the signs of being polyploid. The morphological and cytological studies were made and compared with normal plants. The treated plant showed an increase in the size of leaf, stomata, flower, floral parts and pollen grains but decrease in plant height and number of branches as compared to the control plant. The cytological studies showed the meiotic configurations of 1 VI+4(O) III+1 II+5(O) II+3 I at metaphase I. On the basis of above results the treated plant was suspected to be triploid or mosaic.

(Pranaya Kumar)

2.3 Arboricultural Studies

2.3.1 Introduction of rain tree for lac cultivation

Expt. 2 — *Growing of rain tree into bushes*

The experiment was initiated in 1973 with split-plot design to examine the possibilities of training rain trees into bushes for cultivating lac on a plantation basis for increased and economical production of lac.

Under this experiment three different factors, namely, spacing, coppicing height and seasons of coppicing, were included. There were three spacings (S), viz., 1·8 m×1·8 m, 1·8 m×2·7 m and 1·8 m×3·6 m, three heights of coppicing (H), viz., 15 cm, 30 cm and 45 cm, and three months of coppicing (M), viz., March, May and July.

The plants were coppiced continuously in successive years at respective heights in different seasons as mentioned. Although the March coppicing of plants at 15 cm height had shown the best effect as compared to the other treatment combinations, the overall growth of plants within a period of 5 years was found very unsatisfactory. This was mostly due to the sprouting of fewer numbers of shoots following coppicing and poor development of such shoots resulting in drying up of top portion of shoots. The training of rain trees into bushes may not thus be considered an economical proposition for lac cultivation and the study is, therefore, concluded.

(B. K. Purkayastha and Moti Ram)

(b) RESEARCHES ON HAND

2.1 Lac Cultivation and Host Plant

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

Twenty promising varieties/cultivars of *arhar* (*Cajanus cajan*), namely, ICRISAT No. 4704, 7035, 7188, 6344, 7197, 6443, 6986, 3783, 7119, 8501,

Basant, AS-29, No. 3570, 2E, K35/6, T-21, Pant A1, *Assam*, UPAS 120 and Pant A3 were under field evaluation for lac yield and pulse production. The design adopted was randomised blocks in 3 replications with a plot size of 3·6×7·2 m. Sowing was done in the first week of June. Plants in one set were inoculated in October with *rangeeni* strain of lac insects for evaluating their performance for lac production while those in the other set were left uninoculated to compare the pulse yield on these plants with that on inoculated ones. Of all the varieties/cultivars under evaluation, the maximum inoculable space (total shoot length) was provided by cult. *Assam* but the linear space covered by the lac insects was more in ICRISAT ICP No. 6344 (Table 13). The lac crop was found surviving on all the varieties/cultivars.

TABLE 13 — SCREENING OF *arhar* VARIETIES FOR LAC YIELD AND PULSE PRODUCTION

(Mean values of various plant attributes and lac inoculation)

Sl No.	Variety	Plant height (m)	No. of primary branches/ plant	Total shoot length/plant (m)	Linear space covered by lac insects/ plant (m)
1	Assam	1·80	13·8	16·44	6·98
2	ICRISAT 7197	1·49	13·5	9·99	6·00
3	Pant A 1	1·50	14·1	10·39	4·66
4	ICRISAT 7188	1·61	15·6	10·94	6·25
5	ICRISAT 7119	1·38	12·9	7·64	5·84
6	AS-29	1·49	18·0	6·20	5·80
7	ICRISAT 6443	1·44	15·9	8·41	7·69
8	K 35/6	1·63	18·7	10·48	7·87
9	ICRISAT 6986	1·53	12·0	7·38	5·98
10	Basant	1·59	20·0	11·47	7·64
11	ICRISAT 6344	1·71	23·1	14·00	9·05
12	ICRISAT 7035	1·76	16·8	9·34	8·04
13	T-21	1·55	15·7	16·12	6·19
14	No. 3570	1·66	21·0	11·64	8·36
15	ICRISAT 3783	1·61	14·1	10·82	7·63
16	ICRISAT 4704	1·66	25·9	15·65	8·93
17	2 E	1·55	18·4	12·12	6·66
18	Pant A 3	0·80	9·8	1·90	1·25
19	UPAS 120	1·39	13·8	9·68	2·68
20	ICRISAT 8501	1·62	11·7	8·18	6·71

On the basis of available inoculable space (total shoot length) for the settlement of lac insect, Pant A_3 (an extra early maturing variety) was not found suitable for lac production.

(P. Kumar, B. P. Singh, S. C. Srivastava and R. S. Gokulpure)

2.1.2 Lac cultivation on *bhalia* (*M. macrophylla*)

Expt. 1 — *Effect of spacing, systems of planting and fertilizers on plant growth and lac yield*

The experiment was laid out afresh with some modifications in the planting systems and fertility levels by adopting split-plot design with 4 replications,

Four planting systems (main plot treatments), namely, regular (square), quincunx, single hedge and double hedge and four fertility levels (sub-plot treatments), namely, N (20 g urea) and P (40 g s.s.p.) alone and N and P in combination at normal (20 g urea and 40 g s.s.p.) and double normal doses (40 g urea and 80 g s.s.p.) were tried.

The different planting systems had no significant effect on the plant growth though maximum plant height and number of tillers per bush were recorded from the regular (square) system. The combination of urea and superphosphate showed marked influence on both plant height and number of tillers per bush. N and P in combination at both normal and double normal doses were found statistically at par and superior to other doses of fertilizers (Table 14).

TABLE 14 — EFFECT OF PLANTING SYSTEMS AND FERTILIZERS ON PLANT HEIGHT AND NUMBER OF TILLERS PER *bhalia* BUSH

System of planting	Plant height					Number of tillers/bush				
	Fertilizer					Fertilizer				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
Square	44·35	49·32	49·47	51·10	48·56	10·8	11·0	10·3	11·1	10·8
Quincunx	42·60	44·00	45·40	49·02	45·25	9·2	8·8	10·5	11·2	9·9
Single hedge	41·43	43·35	48·94	47·90	45·41	9·1	9·0	10·9	10·1	9·8
Double hedge	41·90	44·15	49·90	50·65	46·65	9·3	9·4	11·5	10·0	10·0
Mean	42·57	45·21	48·44	49·67	—	9·6	9·5	10·8	10·6	—
		System of planting		Fertilizer			System of planting		Fertilizer	
CD at 5%		N S		3·15			N S		0·52	
CD at 1%		N S		4·22			N S		1·05	

NS — Not significant.

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

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

Expt. 1 — *Effect of intercropping of perennial fodder grasses in mixed plantation of bhalia and galwang*

An experiment was laid out in randomized block design with four replications to determine the effect of raising fodder grasses as intercrops, in between the rows of *bhalia* and *galwang* bushes grown under mixed plantation technique, as also to ensure sustained production of lac.

As compared to the control (a plot with no grasses), *bhalia* and *galwang* bushes showed better growth response (Table 15) due to the indirect effect of fertilisers applied to the fodder grasses grown in the plots. Of the four species of grasses, namely, *Hybrid napier*, *Andropogon gayanus*, *Brachiara brizantha* and

TABLE 15 — EFFECT OF GROWING DIFFERENT GRASSES AS INTERCROP ON THE HEIGHT OF *bhalia* AND *galwang*

Treatments	Height of *bhalia* (cm)	Height of *galwang* (cm)
Control	93·25	87·4
Hybrid napier	149·45	122·4
Andropogan gayanus	100·20	139·3
Brachiara brizantha	130·95	141·1
Dinanath (*Pennisetum pedicellatum*)	139·25	176·4
CD at 5%	30·13	40·11
CD at 1%.	42·29	56·30

Dinanath (*Pennisetum pedicellatum*) grown in between them as intercrops, only *Dinanath* gave promising results with respect to fodder yield (523·7 q/ha), which was much higher than that from the other three species of grasses.

Expt. 2 — *Raising of tuber crops and rhizomes in mixed plantation of bhalia and galwang*

The experiment was laid out during this year under rainfed conditions in a 10×3 R.B. design to determine the effect of growing tuber crops and rhizomes as intercrops in between and within the rows of *bhalia* and *galwang* bushes during its early stage of growth, and also to find out the economic viability of producing such crops along with lac production on the bushes.

The growing of tuber crops (sweet potato and tapioca) and rhizome crops (ginger and turmeric) as intercrops did not show any adverse effect on the growth of plants, on the other hand, it resulted in satisfactory growth except with tapioca (Table 16).

Maximum increase in plant height was observed in both the lac-hosts when intercropped with sweet potato+ginger+turmeric, closely followed by sweet potato+turmeric. In regard to number of branches and total shoot length, however, inter cropping with sweet potato was best, followed by sweet potato+ginger+turmeric in the case of *bhalia*. The position was slightly different in the case of *galwang* in which the number of branches per bush was maximum when intercropped with turmeric, followed by sweet potato+ginger+turmeric. The effect on total shoot length was non-significant. The increase in the above cases might be owing to the indirect effect of fertilizers and cultural operations given to the crops. Tapioca with its spreading crown and thick foliage had an adverse effect on the growth of the lac-hosts.

The intercropping of sweet potato+ginger+turmeric within the mixed plantation of *bhalia* and *galwang* was found as the most profitable combination and gave a gross return of Rs 5688.00 per hectare.

(B. K. Purkayastha, B. P. Singh and Moti Ram)

TABLE 16 — EFFECT OF INTERCROPS ON THE GROWTH ATTRIBUTES OF LAC-HOSTS (*bhalia* AND *galwang*) AND ON GROSS INCOME (Rs/ha)

Sl No.	Treatment	*Bhalia* (*Moghania macrophylla*)			*Galwang* (*Albizzia lucida*)			Gross return from intercrops (Rs/ha)
		Plant height (cm)	Branches/ bush (No.)	Total shoot length/ bush (cm)	Plant height (cm)	Branches/ bush (No.)	Total shoot length/ bush (cm)	
1	Control	95·4	12·4	609	51·3	1·4	62	—
2	Tapioca	85·7	5·8	211	48·1	1·3	49	2,589·00
3	Sweet potato	125·9	21·0	1076	72·9	1·6	106	3,338·50
4	Tapioca + ginger	96·0	7·27	308	62·1	1·4	79	3,798·00
5	Tapioca + Turmeric	103·3	10·07	475	68·8	1·1	73	3,537·00
6	Sweet potato + Ginger	128·8	19·2	984	71·4	2·3	117	4,420·50
7	Sweet potato + Turmeric	131·3	18·0	939	82·2	2·9	152	5,498·00
8	Ginger	125·0	16·1	868	70·0	2·2	115	2,720·00
9	Turmeric	117·0	15·3	795	78·0	3·3	142	5,385·00
10	Sweet potato + Ginger + Termeric	133·2	20·4	1061	83·2	3·0	124	5,688·00
	CD at 5%	26·922	5·901	340	NS	1·428	NS	—
	CD at 1%	36·922	8·093	467	NS	NS	NS	—

2.3 Arboricultural Studies

2.3.2 Role of plant growth regulators on the growth of lac-host plants

Expt. 3 — *Effect of plant growth regulators on ber*

The experiment was laid out in replicated randomized block design. Two growth regulators, namely, NAA at 40, 80, 160, 320 ppm and GA at 20, 40, 80 100 ppm were tried. The data obtained (Table 17) suggest that NAA at 80 ppm

TABLE 17 — EFFECT OF PLANT GROWTH REGULATORS ON *ber*

Treatment	Plant height (cm)	Branches/plant (Nos)	Diameter of stem (cm)
NAA 40 ppm	156·00	1·83	1·50
NAA 80 ppm	160·00	3·00	1·93
NAA 160 ppm	152·66	3·00	1·73
NAA 320 ppm	144·16	2·66	1·50
$G.A_3$ 20 ppm	129·33	1·83	1·50
$G.A_3$ 40 ppm	140·33	1·83	1·43
$G.A_3$ 80 pm	144·66	1·83	1·50
$G.A_3$ 160 ppm	149·66	2·00	1·56
Control	110·56	1·83	1·03
CD at 5%	21·03	NS	NS

had the best effect on the growth characters, namely, plant height, number of branches and diameter of the stem and was found much superior to the control.

Expt. 4 — *Effect of gibberellic acid and growth regulators on the rain tree* (*Samanea saman*)

Gibberellic acid and two growth retardants, namely, MH and TIBA, in different concentrations, were used in the form of foliar spray for three successive periods and a set was kept as the control. The data (Table 18) was found statistically non-significant.

TABLE 18 — EFFECT OF GA_3 AND GROWTH RETARDANTS ON *raintree*

Treatment	Branches/plant Branches/ (No.)	Total shoot length/plant (cm)	Diameter of shoot (cm)
GA_3 20 ppm	11·77	28·36	0·61
GA_3 40 ppm	12·21	40·51	0·65
GA_3 80 ppm	8·88	31·44	0·59
TIBA 100 ppm	11·21	35·77	0·57
GA_3 200 ppm	11·88	35·66	0·64
GA_3 400 ppm	10·77	34·91	0·62
MH 100 ppm	13·10	33·77	0·66
MH 200 ppm	11·66	31·22	0·64
MH 400 ppm	8·88	25·96	0·47
Control	6·22	24·92	0·44
CD at 5%	NS	NS	NS

Expt. 5 — *Effect of GA* 3 *and urea on kusum* (*Schleichera oleosa*) *and palas* (*Butea monosperma*)

To find out the effect of GA 3 in combination with urea, as foliar spray, on the growth of shoots developed after pruning in *kusum* and *palas*, an experiment was laid out in randomized block design with three replications. On an examination of the data (Tables 19 and 20) of both *kusum* and *palas* was found best

TABLE 19 — EFFECT OF GA_3 AND UREA ON *kusum*

Treatment	Branches/plant (No.)	Length/plant (cm)	Diameter of shoot (cm)
GA_3 20 ppm	27·00	94·66	2·40
GA_3 40 ppm	34·30	100·90	2·00
GA_3 80 ppm	40·70	90·00	2·50
Urea 0·5%	21·00	74·80	2·13
Urea 1·0%	32·00	96·76	2·13
20 ppm+0·5%	22·00	74·20	2·20
20 ppm+1·0%	19·70	87·76	2·40
40 ppm+0·5%	12·70	89·90	2·13
40 ppm+1·0%	16·70	85·33	2·56
80 ppm+0·5%	20·00	85·10	2·26
80 ppm+1·0%	39·00	105·90	2·43
Control	11·30	69·51	1·81
CD at 5%	9·33	29·11	NS

TABLE 20 — EFFECT OF GA_3 AND UREA ON *Palas*

Treatment	Branches/bush (Nos.)	Shoot-length/ bush (cm)	Diameter of shoots (cm)
GA_3 20 ppm	6·00	72·18	1·12
GA_3 40 ppm	8·16	74·83	1·12
GA_3 80 ppm	10·00	79·27	1·10
Urea 0·5%	10·00	88·49	1·22
Urea 1·0%	10·83	68·66	1·05
20 ppm +0·5%	9·00	67·17	1·05
20 ppm +1·0%	6·66	42·10	1·22
40 ppm + 0·5%	7·33	78·77	1·26
40 ppm + 1·0%	10·66	84·28	1·21
80 ppm +0·5%	6·00	65·55	1·08
80 ppm + 1·0%	12·66	89·29	1·29
Control	6·00	63·60	1·14
CD at 5%	NS	NS	NS

with 80 ppm of GA3+1 per cent urea spray as compared to all other treatments. The percentage increase in shoot length over the control was 52·4 in *kusum* and 40·5 in *palas*.

(Moti Ram, B. K. Purkayastha and S. C. Srivastava)

2.3.3 Vegetative propagation of *kusum* (*Schleichera oleosa*)

With a view to obtaining *kusum* plants of proven value i.e. plants having high lac-yielding capacity, a trial was initiated in 1977 by adopting the following vegetative propagation methods:

(i) Air layering, (ii) Stem cutting, (iii) Cincturing. Of the methods tried, success was achieved through air layering with the help of growth regulators. The application of growth regulators influenced the rooting response wherein good callus formation and large number of root initials were observed but the control did not develop any roots at all. The highest rootage (66%) was observed with the application of IAA+IBA at 100 ppm. Only a few rooted air-layers were found surviving under field conditions after detachment from the mother plants.

(B. K. Purkayastha and Moti Ram)

2.4 Genetics and Breeding Studies

2.4.2 Possibility of interspecific crossing in *Moghania* species

With the object of synchronizing flowering times of the two *Moghania* species (*M. macrophylla* and *M. chappar*), for facilitating interspecific hybridization, an experiment has been initiated during the year through the following approaches:

(a) *Effect of different dates of sowing and growth regulators on flowering*

Seedlings of *bhalia* (*M. macrophylla*) raised from March to August and of *bara salpan* (*M. chappar*) raised from February to August have been transplanted in alternate rows into different combinations, for further observations.

(b) *Effect of NAA, pinching and topping on bhalia*

The experiment was carried out on the existing bushes in Split-Plot Design, replicated 3 times. The treatments were:

Main plot treatments: (i) Pinching of inflorescence
(ii) Topping of apical twigs

T_0= control
T_1= one topping
T_2= two toppings
T_3= three toppings
P_1= one pinching
P_2= two pinchings
P_3= three pinchings

Sub-plot treatments = spraying of NAA

H_0= control
H_1= 250 ppm
H_2= 500 ppm

Three sprayings of NAA at 250 and 500 ppm were given after 10 days of first topping at monthly intervals on each of the topping and pinching sets of plants.

The topping of apical twigs twice in July and August followed by NAA spray at 500 ppm resulted in slightly late flowering (20th Oct. to 25th Nov.) as compared to the control, (5th Sept. to 16th Oct.). The flowering time of *bhalia* thus could be coincided with the early flowering of *bara salpan* (25th Oct. to 6th Nov.).

A fresh set of *bhalia* plants was raised in June 1978 under split-plot design with 3 replications for further study.

(S. C. Srivastava, P. Kumar and Moti Ram)

2.4.3 Selection for better performance of *M. macophylla* as lac-host for *kusmi* strain of lac insects

Jethwi crop

The seeds collected from 21 parent *bhalia* plants from the *jethwi* 1977 crop on the basis of best and worst lac performers were sown in nursery beds during April and seedlings raised therefrom were transplanted in progeny rows. The plants are growing well.

Aghani crop

Similarly, seeds collected from 36 parent *bhalia* plants from the *aghani* 1977-78 crop were sown in nursery beds in April and the seedlings thereafter transplanted in progeny rows. The plants are growing well.

(P. Kumar, S. C. Srivastava and N. S. Chauhan)

(c) RESEARCHES CONTEMPLATED

Mutation studies on *arhar* in relation to lac yield as well as pulse production.

(d) INSTITUTE PLANTATION

General upkeep of the plantation was maintained as far as possible. Seedlings of various lac-host plants were raised for use in pots for laboratory experiments and for filling vacant pits.

A "Nutrition Garden" covering an area of 30 m×10 m was laid out in September, 1978 for growing winter vegetable crops. The vegetable crops grown were sold to the staff members of the Institute. During the period the low lying and water-logged marshy areas were developed for utilizing the plots for cultivation of paddy. The bushy lac-hosts, *A. lucida* and *M. macrophylla*, were grown on the raised bunds of these plots. The total return from the plantation through sale of vegetable and other experimental produce are Rs 6659.48.

(e) SCHEME ON CULTIVATION OF *KUSMI* LAC ON *BHALIA* AND *GALWANG* IN MIXED PLANTATION AT CHANDWA

The *aghani* 1977-78 lac-crop was harvested in February 1978 from 9000 *bhalia* bushes which were inoculated in July 1977. These bushes recorded a yield of 435 kg of brood lac and 286 kg of scraped lac. The settlement of lac insects was very good on these bushes, but thereafter the crop was badly affected due to the attack of predators, resulting in poor crop yield.

The growth of the *galwang* plants raised in 1976 and 1977 was far from satisfactory in comparison to the growth of the plants raised at Namkum plantation. As a result, these plants could not be coppiced for training them into suitable bushes.

Due to the non-availability of *kusmi* brood lac, *bhalia* bushes could not be inoculated in July 1978 for raising the *aghani* 1978-79 crop.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED

3.2.9 Modification of lac, its fractions and hydrolysed lac with sulphur

Dewaxed lac, *kusmi* lac and hydrolysed lac were reacted with sulphur by dry fusion at 150°C up to pregelation stage. It was found that 1·8, 3·5 and 3·7 per cent sulphur had gone into combination respectively. The amounts increased to 3·2, 3·8 and 4·2 per cent when an accelerator (MBT) was used. An examination of the sulphur modified products indicated drop in acid, hydroxyl and iodine values. The study was extended to the two fractions of lac, namely, soft and hard resins by carrying out the reaction under similar conditions. The results are brought out in Table 21.

The film properties of sulphur reacted lac did not show much improvement over those of plain lac. The product has been suggested for evaluation in rubber compounding and coating of urea.

(B. B. Khanna and Ashok Kumar)

TABLE 21 — PROPERTIES OF SULPHUR TREATED HARD AND SOFT RESINS OF LAC

Sl No.	Samples	Sulphur combined %	Acid value	Hydroxyl value	Iodine value
1	Hard resin	—	60·0	232·0	14·0
2	Hard resin +5% sulphur	1·6	56·0	223·0	8·2
3	Hard resin +5% sulphur + 1% accelerator	2·2	54·0	220·0	7·9
4	Soft resin	—	95·0	110·0	27·0
5	Soft resin +5% sulphur	2·4	89·0	105·0	21·1
6	Soft resin 5% sulphur + 1% accelerator	3·0	88·0	101·0	20·8

3.7.1 Study on the dielectric behaviour of natural resins

The dielectric relaxation data of the natural resin Manila copal, shellac and its constituents, obtained by Bhattacharya [*J. Sci. and Indus. Res.* **4**: 713, 1946 and *Indian J. Phys.*, **18**: 1, 97, 1944], were analysed by the Cole-Cole method for temperatures between 20° and 150°C. The dielectric behaviour of the above natural resins was found to be similar. Conformational rearrangement was found to take place above their melting temperatures. The functional groups present in hard and soft resins of lac appear to be responsible for the dielectric properties of shellac below and above its glass-transition and melting temperatures respectively.

During the course of this year, the dielectric relaxation data of (i) different mixtures of hard and soft resins of shellac, (ii) two modified shellac compositions viz., shellac-urea-formaldehyde (SUF) and shellac-melamine-formaldehyde (SMF) and (iii) two other natural resins, mastic and dammar, obtained by Bhattacharya [*Indian J. Phys.*, **18**: 116, 126, 159, 1944], were analysed by the same Cole-Cole method. The different parameters of a mixture of hard-soft resin (70:30) have been evaluated from the Cole-Cole method at two temp. 80° and 90°C (Table 22). These were found to be in close agreement with those of shellac. The analysis revealed that the dielectric properties of shellac can be satisfactorily explained by a mixture of hard-soft resin (70:30) which confirmed the proposition that lac is a physical mixture of these resins.

TABLE 22 — COMPARISON OF DIELECTRIC PARAMETERS OF SHELLAC AND A MIXTURE OF HARD-SOFT RESIN (70: 30) BY COLE-COLE METHOD

Temperature in °C	Sample	Static dielectric constant (ϵ_0)	High frequency dielectric constant ($\epsilon\infty$)	Dielectric increment ($\Delta\epsilon$)	Relaxation time in (τ) second	Distribution Parameter (α)
80	Shellac	8·13	4·48	3·65	$5{\cdot}5\times10^{-5}$	0·61
	Hard-soft resin mixture	7·98	4·5	3·48	$4{\cdot}39\times10^{-5}$	0·61
90	Shellac	7·85	4·74	3·11	$8{\cdot}74\times10^{-6}$	0·58
	Hard-soft resin mixture	7·72	4·64	3·08	$8{\cdot}26\times10^{-6}$	0·57

The dielectric behaviour of two modified shellac compositions SUF and SMF has been investigated between 30° and 100°C. The modified resins were found to be more polar compared to shellac. The glass-transition temperature (Tg) for both the modified resins was nearly same. Like shellac and other natural resins, both SUF and SMF exhibited multirelaxation processes below melting temperature (Tm) and only one process above Tm. The dielectric behaviour of both the modified resins was similar to those of shellac and other natural resins.

The same Cole-Cole method was then employed for two other natural resins viz., mastic and dammar at temp. between 20° and 150°C. Both the glass-transition (Tg) and melting temp. (Tm) of the resins were higher by 30°C compared to those of shellac. Like Manila copal, both the resins exhibited two overlapping Cole-Cole arcs and single relaxation process below and above their Tm respectively. Like other natural resins, both mastic and dammar exhibited marked decrease in dielectric increment, relaxation time and distribution parameter above Tm, which indicated conformational changes of the resin molecules above their Tm.

The Tg/Tm ratio of shellac, its constituents and fourteen other natural resins was studied. The results are shown in Table 23. The same was in the range of 0·87-0·95.

TABLE 23 — GLASS-TRANSITION AND MELTING TEMPERATURE OF NATURAL RESINS

Sl No.	Resin	Tg or softening point (°K)	Tm (°K)	Tg/Tm
1	Manila Copal	343	373	0·92
2	Mastic	345	376	0·92
3	Dammar	373	393	0·95
4	Shallac	313	343	0·91
	(a) Hard lac	323	353	0·92
	(b) Soft lac	283	313	0·90
5	Pontianac	360-408	408-434	0·88-0·94
6	Sandarac	373-403	408-423	0·91-0·95
7	Kauri	378	403	0·94
8	Congo	360	401	0·898
9	Manila Macassar	353-361	388-401	0·91-0·90
10	Manila Philippine	359	398	0·90
11	Manila Singapore	367	399	0·92
12	Batu East India			
	(a) Scraped	384-405	441-453	0·87-0·89
	(b) Dust	404	438	0·92
13	Pale East India Macassar			
	(a) Bold-Hiro	374-385	400-429	0·94-0·90
	(b) Dust-Hiro	389-395	420-429	0·94-0·90
14	Pale East India Singapore			
	(a) Bold	382-401	420-429	0·91-0·93
	(b) Dust	389	423	0·91
15	Accroides	348-358	383-407	0·91-0·88
		Average Tg/Tm= 0·9195		0·92

Note — The transition temperatures for the resins at Sl 5 to 15 were obtained from Barry, T. H., Drummond, A. A. and Morell, R. S. "The Chemistry of the Natural and Synthetic Resins", Ernest Benn Ltd, London, 1926.

(D. N. Goswami)

(b) RESEARCHES ON HAND

3.1 Fundamental Studies

3.1.1 Macrocyclic molecules from aleuritic acid

(i) *Synthesis of isoambrettolide*

The synthesis of isoambrettolide from *threo*-aleuritic acid has been reported earlier (A.R., 1974-76). To prepare it in quantity, *threo*-aleuritic acid (5 g) was converted to *trans*-16-hydroxy-hexa dec-9-enoic acid, m.p. 66-68°C (3·2 g) by the method developed earlier.

The unsaturated acid (1.0 g) was then cyclised with *p*-toluene sulphonic acid, and the polyester depolymerized with $MgCl_2$ (anhydrous) to yield isoambrettolide (0·9 g).

(ii) *Synthesis of exaltone*

The synthesis of exaltone from *threo*-aleuritic acid has been reported earlier (A.R., 1974-76). To prepare it in quantity, *threo*-aleuritic acid (5 g) was converted to *threo*-9,10-dihydroxy hexadecane-1,16-dioic acid (3.5 g), m.p. 124-126°C. which was then converted to *trans*-Δ^9-hexadecane-1,16-dioic acid (1.2 g), m.p. 93-95°C.

IR: 970 cm^{-1} (*trans* HC=CH)

Other steps of the synthesis are being carried out.

(iii) *Synthesis of cyclic ether*

Attempts were made to synthesize macrocyclic ethers and to find their utility in the field of perfumery. By adopting the usual procedure, *threo*-aleuritic acid (5·0 g) was converted to *trans*-16-hydroxy-hexadec-9-enoic acid (3·2 g). Its methyl ester was prepared using boron-trifluoride-etherate in methanol. The product was reduced to dihydroxy compound with $NaBH_4$/methanol. It was then cyclized with *p*-toluenesulphonic acid to afford a liquid product which was purified over neutral alumina. It reduced ammonical silver nitrate solution on heating suggesting a cyclic ether. Further identification of the compound is in progress.

(R. N. Majee)

3.1.2 Detailed study on lac wax

Isolation of one pure component having m.p. 80-81°C and R_f value 0·76 (solvent system: trichloroethylene: chloroform: acetic acid: 70: 28: 0·5 v/v) from alcohol soluble wax fraction (at 40°C) was reported last year. The IR spectrum has shown it to be a hydrocarbon. This component was isolated up to 100 mg.

From the same wax fraction i.e., soluble at 40°C, another pure component R_f value 0·67, m.p. 68-71°C was also isolated by repeated crystallization from ethyl acetate. Its nature is under investigation.

Conversion of alcohol to hydrocarbons

(a) The alcohol (m.p. 83-84°C) obtained from petroleum ether-insoluble fraction of wax (A.R., 1977) was converted to its hydrocarbon by boiling it with hydroiodic acid and red phosphorus. It has m.p. 66-67°C and R_f value 0·70.

The IR spectrum showed it to be a hydrocarbon.

(b) Similarly the alcohol (m.p. 82-83°C), obtained from the hydrolysis of the ester (m.p. 93-94°) as reported last year, was also converted to its corresponding hydrocarbon. Its m.p. and R_f values are 71-72°C and 0·72 respectively.

Isolation of free acids from lac wax

Free acids from lac wax were isolated as follows:

The lac wax was treated with hot saturated solution of sodium bicarbonate for 30 min. and filtered. The filtrate was dried and the dried mass was extracted with chloroform. The insoluble mass, thus obtained, was digested with dil. sulphuric acid, filtered, washed and dried. It was subsequently crystallized from chloroform. Its m.p. was found to be 70-73°C, yield 14·5 per cent.

Further characterization is under progress.

(K. M. Prasad)

3.1.4 Separation and study of components of lac resin

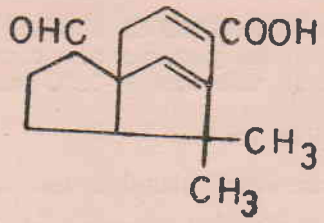
Isolation and identification of constituent acids from hard resin fractions B-2 and B-3 have been reported previously. The remaining fractions A, B-1 and C have been studied, adopting the methods already reported.

Fraction A — This fraction was partially hydrolysed with sodium hydroxide to get a water soluble and a gummy mass. The water soluble portion was repeatedly extracted with ethyl acetate and the extract on concentration afforded pure sample of jalaric acid (m.p. 168-170°C). The mother liquor left over, was evaporated to dryness to get a resinous mass. Its TLC revealed it to be a mixture of jalaric, *lacci*-jalaric, shellolic and *epi*-shellolic acids. Attempts to isolate these acids in pure form by extraction with chloroform or by column chromatography were, however, unsuccessful.

The gummy mass was treated with caustic soda (20 per cent) and the precipitated sodium aleuritate, after filtration, was decomposed to give pure aleuritic acid. The filtrate, left after the separation of aleuritic acid, was extracted with ether and the extract after concentration yielded a solid residue, melting at 76-78°C. It was confirmed as 10,16-dihydroxy hexadecanoic acid on the basis of its mixed melting point, TLC behaviour and IR spectrum. After separating the above two acids, the mother liquor was then treated to get barium salt which after decomposition and fractionation by column gave pure samples of butolic and *w*-hydroxy hexadecanoic acids.

Fractions B-1 and C

These fractions were also studied in a similar manner and pure samples of jalaric, *lacci*-jalaric, aleuritic and butolic acids were isolated. In addition to these, pure sample of an acid (liquid mass) having aldehydic nature was also isolated from fraction C similar to fraction B-3 (reported earlier). On comparison of its properties, viz., acid value, molecular weight, melting point of 2:4 DNPH (114-115°C), IR and UV analyses, with known aldehydic acids — jalaric and *lacci*-jalaric, a tentative structure (molecular formula $C_{15}H_{18}O_3$ mol. wt. 246) has been assigned for this new acid.



This tentative structure is subject to confirmation by further chemical and spectroscopic evidences which are in progress.

This study has so far resulted in the isolation and identification of nearly 80 per cent of the constituent acids of hard resin. The various acids and their proportions in hard resin are listed in Table 24.

TABLE 24 — APPROXIMATE COMPOSITION OF HARD RESIN

Sl No.	Component acid	Percentage
1	Saturated straight chain non-hydroxy acids	1·30
2	Aleuritic acid	29·40
3	Butolic acid	5·20
4	ω-hydroxyhexadecanoic acid	3·90
5	10.16-dihdroxyhexadecanoic acid	1·70
6	Jalaric acid	25·75
7	*Lacci*-jalaric acid	1·45
8	New aldehydic acid	0·90
9	Shellolic acid	9·60
10	Epi-shellolic acid	
11	Other terpenic components	
12	Unidentified	20·80

3.1.5 Estimation of shellac in presence of other resins

A spectronic absorption method for estimating lac in terms of aldehydic acids (jalaric and *lacci*-jalaric) was reported last year. In order to confirm the reproducibility of the method, it was tried with some more samples of lac when it was found to work satisfactorily.

The above method was also applied to other natural resins, such as, rosin, gamboge, benzoin, kauri, pontianac and dragone but none of these indicated the presence of any water-soluble aldehydic acid.

Work is in progress to apply this method for estimating lac in mixture of other natural resins.

(B. B. Khanna and N. Prasad)

3.1.6 Correlation of the properties of seed lac and shellac with age

Determination of the age of seedlac and shellac is an outstanding and as yet unsolved problem of the lac industry. As is well known, on storage, there is a gradual fall in the properties of lac due to slow polymerization, the extent of

which may depend on a number of factors such as the type, place of origin, time of harvesting of lac and its storage conditions.

A detailed study of physical, chemical and physico-chemical properties of various types of stored lac at intervals of six months using modern and conventional techniques was, therefore, taken up.

During the period under report, genuine fresh *ber* sticklac (*baisakhi*) was procured from Barguttu area (Ranchi District) and converted into seedlac and shellac. Various properties, such as, moisture, colour, life under heat, flow, hot and cold alcohol-insolubles, intrinsic viscosity, rate of filtration and dielectric strength of both seedlac and shellac were determined. The shellac obtained was also examined through IR, UV and TLC (Table 25).

The seedlac and shellac are being stored at room temperature and all the above mentioned properties will be determined periodically to study the effect of storage. Also sticklac of various types are being collected for the study.

(B. B. Khanna, S. K. Saha, A. K. Ghosh, D. N. Goswami, N. Prasad and R. N. Das)

3.2 Modification of Shellac/Constituents

3.2.2 Ion exchange resin from shellac

To substitute resorcinol, which is very costly, with cashewnut-shell-liquid (CNSL) for lowering the cost of the cation exchange resin developed from shellac, the following experiments were performed:

(i) Shellac and CNSL were heated together at 120°C for 2-3 hr when a resinous product was obtained which was dissalved in *n*-butanol and toluene (1 : 1) and, thereafter sulphonated. Next day, it was salted out with sodium chloride solution (30 per cent) and washed with water. Sodium hydroxide (30 per cent) was then added to neutralise it to *p*H 7. This product was treated with *p*-formaldehyde in batches after heating on a steam bath but this did not result in gel formation.

(ii) Sulphonated shellac and CNSL were dissolved either in water or spirit and *p*-formaldehyde added and heating carried out. However, no resinification was observed.

(iii) Thereafter, shellac and CNCL were sulphonated separately. The two were taken in sodium hydroxide solution (10 per cent) and *p*-formaldehyde added as before but no gel formation was noticed.

(iv) Sulphonated shellac was dissolved in sodium hydroxide solution (10 per cent) and CNSL added in various proportions. Formaldehyde solution (150 ml) was, thereafter, added and the mass heated on a steam bath for one hr and kept overnight at room temp. It was observed that only 1·5 and 2 parts CNSL on the wt. of sulphonated lac gave a hard brown fine resin of irregular shape. Some of the properties of these resins are given in Table 26.

The effect of adding ammonium chloride as catalyst to get a high capacity resin is under progress.

(A. Rahman and B. B. Khanna)

TABLE 25 — PROPERTIES OF SEEDLAC AND SHELLAC

Type of lac	Period of storage	Moisture (%)	Colour	Life under heat (min)	Flow (mm)	Cold alcohol insolubles (%)	Hot alcohol insolubles (%)	Rate of filtration (ml/20 min)	Intrinsic viscosity	I.R.	U.V.	T.L.C.	Dielectric strength (kV/mil)
Ber													
Seed lac	Initial	2·5	13	60	44	7·43	3·04	93·5	0·051	—	—	—	1·17
Shellac from above seedlac	Initial	2·0	12	60	68	5·07	0·99	91·0	0·031	Absorption at 1710 cm^{-1} (carboxyl) and 3250 cm^{-1} (hydroxyl)	Peak at 223 mμ	*	1·34

*Three spots, Rf values 0.19, 0.62 and 0.90 (solvent system: ethylacetate: aceticacid, 100: 1 v/v).

TABLE 26 — PROPERTIES OF SHELLAC-CNSL BASED ION EXCHANGE RESIN

Sulphonated lac: CNSL	Yield (%)	Cation exchange capacity meq/g dry resin	Colour throw	Moisture (%)
1: 1·5	48	2·50	Nil	6·50
1: 2	20	1·85	Nil	5·25

3.2.4 Creation of unsaturation in aleuritic acid and its addition polymerization

Last year allyl-aleuritate was polymerised in benzene using benzoyl peroxide at 84°C for 4 hr under inert atmosphere of nitrogen.

This year allyl aleuritate, aleurityl cinnamate and aleurityl crotonate were polymerized at 80°C for 6 hr in benzene (thiophene free) and rectified spirit separately under inert atmosphere of nitrogen using recrystallized benzoyl peroxide (1 per cent) as initiator.

A difficulty was experienced to separate out the polymer as both monomer and polymer were soluble in the solvents used. The method of fractional precipitation was adopted to overcome this difficulty. The polymers were obtained as the first fractions and their acid and iodine values were nil.

(A. Kumar and M. K. Misra)

3.2.7 Polyesters from aleuritic acid

Last year several attempts were made to block the vicinal hydroxyls of 9,10-dihydroxy hexadecane-1,16-dioic acid but were unsuccessful. This year replacement of hydroxyl groups has been carried out. The details of the methods are described below:

9,10-dihydroxy hexadecane-1,16-dioic acid was heated on a water bath with phosphonium iodide in acetic acid medium for 2 hr. It was then extracted with ether. After removal of ether, the product was refluxed with methanolic potassium hydroxide solution for 3 hr on a water bath. After cooling, it was acidified when a solid product was obtained which was recrystallized from ethyl acetate to give 9-hexadecane-1,16-dioic acid, m.p. 95-97°C. The yield was 26·0 per cent. It was dissolved in ethyl acetate, palladium-carbon catalyst was added and hydrogen passed through the solution for 8 hr. The mass was filtered and evaporation of the filtrate afforded a solid product which on recrystallization from ethyl acetate gave hexadecanedioic acid, m.p. 119-121°C.

(A. Kumar and R. N. Das)

3.2.8 Modification of lac and hydrolysed lac with glycols and dicarboxylic acids

The solubility behaviour of shellac-based polyesters prepared last year was determined in different solvents and mixture of solvents with a view to find a suitable solvent medium for treating these polyesters with diisocynate. All the polyesters were found soluble in cold methyl ethyl ketone and methyl isobutyl ketone but none of the non-hydroxy solvents or mixture of solvents was found to completely dissolve the shellac-based diethylene glycol polyesters.

Modified shellac-based polyurethanes were, thereafter, prepared by treating shellac-based ethylene glycol polyesters in methyl ethyl ketone with different proportions of toluene-diisocynate. Clear, non-tacky, smooth and glossy films could be obtained from these compositions. After allowing to stand at room temp. for one week, the films were tested for resistance to water, HCl (1 per cent) and NaoH (1 per cent) and for flexibility. A set of films on glass slides and tin panels was also baked at 150°C for 30 min and tested.

All the polyurethane coatings were found to have good flexibility. However, the composition prepared by two step process from shellac-ethylene glycol-adipic acid (10 per cent) was found to have good resistance towards water and HCl (1 per cent). Taking into consideration pot life, the optimum proportion of diisocynate for obtaining polyurethanes was 30 per cent on the wt. of the polyester. A marked improvement in the properties of the films was noticed on baking.

(B. B. Khanna and K. N. Rao)

3.3 Use of Shellac and Modified Shellac in Surface Coatings

3.3.3 Studies on lac-oil combinations and their utilization

Experiments carried out last year with lac-double boiled linseed oil varnishes containing drier showed good drying characteristics, high breakdown voltage and suitability as a baking type insulating varnish.

During this year, it was found that the films retained the necessary flexibility, smoothness and uniformity even after baking at 100°C for one hr or at 150°C for 30 min.

These films were tested for various properties (Table 27) according to ISS: 350.

TABLE 27 — PROPERTIES OF INSULATING VARNISH (BAKING TYPE)

Sl No.	Characteristics	I.S.S. 350 requirements	Results obtained
1	Drying time	Not more than 4 hr	30 min at 100°C
2	Finish	Smooth, uniform, glossy	Smooth, uniform, semi-glossy
3	Volatile matter (by wt.)	50%	55%
4	Thermo-setting properties	To pass the test	Passed
5	Electrical strength kV/mil at (a) 27°C	1·38	2·1
	(b) 90°C	1·0	1·71
6	Electrical strength (v/mil) after immersion in water	375	187
7	Compatibility with the thinner	To pass the test	Passed
8	Resistance to transformer oil	do	do
9	Behaviour on enamelled wire	do	do

It may be seen that the sample of the varnish, though it gave a comparatively lower value of the BDS (as compared to the values obtained earlier), passed most of the tests prescribed for the baking type insulating varnish. The cause of lowering of BDS was investigated by varying the conditions of preparation of the varnish and also by using fresh lots of lac and oil. It was observed that these conditions seem to play an important role for affecting BDS.

The effects of duration and temperature of baking of the films of lac-oil varnish were also examined and the results are given below:

Sl No.	Time of baking hr	Baking temperature °C	BDS kV/mil.
1	1·5	100	1·93
2	2·0	100	1·95
3	0·5	150	1·78
4	1·5	150	1·61

It may be seen that both the above factors affect the BDS.

A fresh sample of the varnish was prepared and supplied to a local consumer for its evaluation. It is reported that this varnish was applied to an electric motor (2 h.p.) fitted in a compressor and no trouble has been experienced by them so far.

Suitability of this varnish for other end uses was also studied. The baked films of the varnish were found to possess good resistance to mineral oil (mobil oil) and ageing characteristics (100 hr at 100°C) but showed some deterioration in the BDS when tested after exposure to humid conditions (50 per cent R.H. for 72 hr).

The results obtained so far indicate that lac-double boiled linseed oil varnishes may be used as baking type insulating varnish for coating of coils of electric motor etc. in conditions which are not very humid.

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

3.3.6 Shellac based paint/primer for the gas holders of gobar-gas plants

Lac-linseed oil-toluene diisocynate composition was prepared a number of times and mild steel panels coated with it. The coated panels were dipped in gobar-slurry in the laboratory for studying the effect of immersion. Bristles formation was noticed after two months or so, though this composition had withstood immersion up to one year without showing signs of damage last year.

This unsatisfactory performance may be due to improper preparation of the surface of mild steel panels or humid atmospheric conditions at the time of application of the paint on the panels. Some more experiments are being undertaken in this connection.

A gas holder of the gobar-gas plant has been got fabricated and steps are being taken to erect the plant for trying the composition on the actual gas holder.

(S. K. M. Tripathi and B. B. Khanna)

3.3.7 Shellac paints for wooden patterns

The study has been initiated to develop a composition of shellac paint as a substitute for the costly pattern enamels used for painting wooden patterns in steel foundries.

A number of compositions were prepared by using shellac melamineformaldehyde resin (binder), titanium dioxide (hiding pigment) and dibutyl phthalate

(plasticizer). In all cases, homogeneous paints could be obtained which when applied by brush produced hard, smooth and glossy films on wooden surface. These films became tack-free within 5 min and acquired sufficient hardness for rubbing and repainting within 15 min. It was, however, observed that paint compositions containing very low boiling solvents such as methanol, acetone, methyl acetate left some brush marks on the surface. The best finish was obtained using solvent mixture of spirit, butanol and toluene. The compositions were, thereafter, studied for their film properties. Air dried films showed good gloss, hiding power, resistance to scratch and abrasion and showed no deterioration when brought into contact with water, dilute acids and solvents such as toluene, white spirit and alcohol (50 per cent).

Suitability of these paints for actual use in foundries was studied by placing the painted wooden surface in contact with the wet sand and, even after 24 hr, the painted surface did not show any sign of sticking or deterioration in the film gloss indicating resistance to the action of wet sand.

(S. Kumar and A. K. Dasgupta)

3.4 Use of Lac for Encapsulation

3.4.1 Coating of insecticides/pesticides with lac

Bacillus thuringiensis Berliner — a microbial insecticide has been encapsulated by adopting the phase separation technique developed earlier and the encapsulated material is under evaluation.

(S. Kumar, B. C. Srivastava and C. P. Malhotra)

3.4.2 Physico-chemical studies on lac for encapsulation

Last year, physico-chemical properties of solutions and hydrosol of DL shellac were studied. This year the study has been extended to *bhatta* shellac.

Hydrosols of *bhatta* shellac from 5 to 15 per cent w/v aqueous ammoniacal and spirit solutions have been prepared by the dialysis and condensation methods respectively. Their physico-chemical properties, namely, resin concentration, relative viscosity and density, *p*H and the nature of charge have been studied (Tables 28 and 29). It has been noted that wax also dialyses along with the resin. The study revealed that hydrosols of *bhatta* and dewaxed shellac are suitable for encapsulation through phase separation.

Experiments have also been conducted to study the rate of dialysis of DL and *bhatta* shellac solutions. Changes in concentration, *p*H and volume with time have been determined. It has been observed that osmosis also takes place along with dialysis which affects the concentration. On the basis of above experiments, a new method for determining the optimum time of completion of dialysis for preparing shellac hydrosol has been found out which is based on determining the abrupt change either in *p*H or concentration or volume of the dialysate taking place after third day. This finding agrees with the previous qualitative method already reported.

(S. Kumar and B. C. Srivastava)

TABLE 28 — PHYSICO-CHEMICAL CHARACTERISTICS OF AQUEOUS BHATTA DL SHELLAC SOLUTION AND HYDROSOLS

Sl No.	Characteristics	Aqueous solutions of Bhatta shellac			Hydrosols of Bhatta shellac prepared by dialysis method			Hydrosols of Bhatta shellac prepared by condensation method		
		I	II	III	I	II	III	I	II	III
1	Appearance	Hazy, wax floats on top on standing	Hazy, wax floats on top on standing	Hazy, wax floats on top on standing	Transparent, very slight hazy in reflected light	Transparent, very slight hazy in reflected light	Transparent, very slight hazy in reflected light	Milky and opaque	Milky and opaque	Milky and opaque
2	Resin concentration (% w/v)	4·82	9·24	13·10	3·25	4·02	5·49	0·25	0·31	0·5
3	Concentration of ammonia (x in N)	0·52	0·49	0·49	0·025	0·018	0·019	—	—	—
4	Sp. conductivity (m hos at 30°C)	$7·89\times10^{-3}$	$1·37\times10^{-2}$	$1·45\times10^{-2}$	$9·02\times10^{-4}$	$12·63\times10^{-4}$	$12·63\times10^{-4}$	$1·62\times10^{-4}$	$1·66\times10^{-4}$	$1·34\times10^{-4}$
5	*p*H	9·8	9·2	9·3	7·3	7·2	7·2	4·2	4·5	4·5
6	Relative density (30°C)	1·007	1·015	1·021	1·015	1·017	1·017	1·001	1·002	1·002
7	Relative visocity (30°C)	1·09	1·37	1·67	1·20	1·25	1·30	1·01	1·01	1·02
8	Nature of charge	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative
9	Reversibility	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible

TABLE 29 — PHYSICO-CHEMICAL CHARACTERISTICS OF AQUEOUS DL SHELLAC SOLUTIONS AND HYDROSOLS

Sl No.	Characteristics	Aqueous solutions of DL shellac			Hydrosols of DL shellac prepared by dialysis method			Hydrosols of DL shellac prepared by condensation method		
		I	II	III	I	II	III	I	II	III
1	Appearance	Clean	Clean	Clean	Transparent	Transparent	Transparent	Milky and opaque	Milky and opaque	Milky and opaque
2	Concentration (% w/v)	4·81	9·55	15·34	3·20	4·10	5·60	0·24	0·32	0·49
3	Concentration of ammonia (in N)	0·52	0·49	0·49	0·028	0·019	0·019	—	—	—
4	Specific conductivity (m hos at 30°C)	$7·89\times10^{-3}$	$1·37\times10^{-2}$	$1·52\times10^{-2}$	$9·02\times10^{-}$	$12·63\times10^{-4}$	$12·63\times10^{-4}$	$1·62\times10^{-4}$	$1·66\times10^{-4}$	$1·34\times10^{-4}$
5	*p*H	9·9	9·2	9·2	7·4	7·3	7·3	4·1	4·5	4·4
6	Relative density (30°C)	1·007	1·016	1·026	1·014	1·017	1·020	1·001	1·001	1·002
7	Relative viscosity (30°C)	1·07	1·38	1·70	1·20	1·20	1·31	1·01	1·01	1·02
8	Nature of charge	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative	Negative
9	Reversibility	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible	Reversible

3.5 Use of Shellac in Rocket Fuel

Experiments were continued to develop a suitable binder by reacting hydrolysed lac with a thermosetting resin (phenolic resin) under different conditions of temp. and time. The resultant products obtained in most of the cases were in fluid state and appeared suitable for cold blending. It was observed that when the product was cured as such, it did not become hard even after prolonged heating at 100°C but when the curing was done in the presence of a catalyst and an accelerator, it solidified in 10-15 hr and gave a tough product.

Suitability of these modified binders in conjunction with the oxidizer and other ingredients was, thereafter, studied. It was observed that the modified composition ingredients did not give a pourable mass when mixed with the above even when heated up to 80°C.

Solid propellants were, therefore, made by mixing at 60°C and curing the composition in the mould at 100°C for 24 hr. These propellants burnt vigorously with a good flame leaving no ash. However, these did not have the desired flexibility.

Experiments were then carried out to assess the suitability of shellac propellants (developed so far) for firing.

A tubular charge, having inhibitive coating around it, was cast and cured. This charge was then burnt progressively in the isolated rocket chamber to study the nozzle effect. A PVC propellant was also burnt under similar conditions. It was observed that the shellac propellant (150 g charge) burnt more vigorously and with a greater force than the PVC propellant.

(S. Kumar and A. K. Dasgupta)

3.7 Electrical Properties of Lac and Modified Lacs

3.7.2 Effect of plasticizers on the electrical properties of shellac

The effect of the addition of tricresyl phosphate (TCP) on the dielectric strength of dewaxed lemon shellac varnish (air-drying) was reported last year. This year, the effect of some more plasticisers viz., dibutyl phthalate (DBP), dimethyl phthalate (DMP), dioctyl phthalate (DOP) and castor oil (C. oil) has been investigated as per IS: 352-1973. An increase in the dielectric strength was observed in all the cases (Table 30). For DBP, DMP and C. oil, maximum increase in the dielectric strength was obtained when 20 per cent of these plasticizers (on the wt. of shellac) was added to shellac varnish (25 per cent w/w). A higher value of dielectric strength (1·5 kV/mil) was obtained when 25-30 per cent DOP was added to shellac varnish. It will be seen from the table that the dielectric strength of shellac-TCP varnish is the highest. Although the dielectric strength of shellac-DMP composition was low, it showed resistance to transformer oil. The DOP-shellac composition also exhibited resistance to transformer oil but the flexibility of the films prepared from this varnish was very poor.

The dielectric strengths of films prepared from different plasticized shellac varnishes were also measured after immersion in water. The values obtained were very low (125 V/mil) thus showing their poor resistance to water.

(D. N. Goswami)

TABLE 30 — CHARACTERISTICS OF PLASTICIZED SHELLAC VARNISHES (AIR-DRYING)

(*Plasticizer*-20% *on the weight of shellac*)

Varnish	Finish	Drying time (min)	Electrical strength in air at 27°C (kV/mil)	Compatibility with the thinner	Resistance to transformer oil	Behaviour of varnish on enamelled wire	Test for flexibility (minimum mandrel size 1/8″)	Clarity
Plain shellac (sh)	Smooth, glossy, uniform	30	1·0	P	F	P	F	Clear
Sh-TCP	do	60	2·0	P	F	P	P	Clear
Sh-DBP	do	60	1·7	P	F	P	P	Clear
Sh-DMP	do	60	1·7	P	P	P	P	Clear
Sh-DOP	do	30	1·4	P	P	P	F	Turbid
Sh-Coil	do	60	1·6	P	F	P	F	Turbid

P=Passes; F=Fails.

3.7.3 Curing behaviour of shellac-synthetic resin composites by dielectric measurements

The work was initiated to develop a convenient and quick method, based on measurements of electrical parameters, for the determination of cure-time of shellac-synthetic resin compositions.

The curing behaviour of different shellac and butylated-melamine formaldehyde resin compositions was studied at room temp. The solutions of the two resins (25 per cent w/w) were prepared in a mixture of butyl alcohol and freshly distilled commercial denatured spirit (1 : 1). Different compositions, e.g., SMF 82 (80 per cent shellac, 20 per cent melamine resin by wt.) and likewise SMF 64 and SMF 46 were prepared. The curing between the reactive groups of the two resins was studied by the measurement of capacitance and dissipation factor (tan δ) of the varnishes at 100 kHz with time using a General Radio capacitance bridge.

The variation of different dielectric parameters with time was investigated. The dielectric constant, dielectric loss and dissipation factor of the blends showed a marked decrease during the first 3-4 days indicating that curing takes place within this period. The curing was found to be complete (as revealed from decrease in different parameters) within 24 hr at a slightly higher temp. (40°C).

(D. N. Goswami and S. Kumar)

Ad-hoc Research

Isolation of aleuritic acid in increased yield from lac

Aleuritic acid can serve as a starting material for the production of synthetic perfumes, adhesives and other fine chemicals. It is one of the major components of shellac and is believed to be present to the tune of 35-40 per cent. However,

it is usually obtained to the extent of only 18-20 per cent by the conventional methods and as such is quite costly. If the acid could be obtained in higher yield, its cost will be reduced.

To begin with, the methods developed by two old schools of studies have been tried. The first method is of Delhi University and consists of passing hydrogen chloride gas through a solution of shellac in glacial acetic acid followed by alkaline hydrolysis, while the second method developed at this Institute consists of modified alkaline hydrolysis in presence of sodium sulphite.

Since passing of hydrogen chloride gas in shellac solution is difficult and gives poor yield of *erythro*-aleuritic acid, it was thought worthwhile to modify this method. As such, shellac was directly treated with concentrated hydrochloric acid in the presence of organic solvents, such as, dioxane, pyridine and glacial acetic acid, followed by alkaline hydrolysis. *Erythro*-aleuritic acid (m.p. 123-124°C) was obtained in acetic acid medium but the yield was poor (10-15 per cent).

The preliminary studies carried out by the second method of alkaline hydrolysis yielded *threo*-aleuritic acid to the tune of 25 per cent. However, to increase the yield further, the method is being modified. The gummy mass, left after separating crude *threo*-aleuritic acid (m.p. 90-92°C) in the mother liquor, was treated in the manner as already described in the first method of acid treatment, followed by alkaline hydrolysis. A solid compound (m.p. 103-104°C) was obtained which appears to be aleuritic acid.

(S. C. Agarwal)

(c) RESEARCHES CONTEMPLATED

(1) Improvement in the method of isolating aleuritic acid from lac for maximizing its recovery
(2) Spectrophotometric studies on lac
(3) Studies on shellac esters and their utilisation
(4) Slow release chemically combined lac-based weedicides
(5) To prepare a standard for lac dye for use as a food colour.

D. TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES ON HAND

4.1 Improvement in the Processing Techniques

4.1.1 Manufacture of shellac and dewaxed lac in aqueous medium

Preparation and properties of both regular and dewaxed lac in aqueous medium on semi-pilot scale were reported last year. The dewaxed lac obtained by this process was evaluated by using it in different shellac formulations, such as, preparation of water-soluble lac, insulating varnish and etch primer. It was found that the performance of water soluble lac and insulating varnish, thus ob-

tained, was comparable with those prepared from conventional shellac/dewaxed lac. However, in case of etch primer the product gelled.

(A. K. Ghosh, S. K. Saha and A. Pandey)

4.1.5 Effect of drying seedlac in sun and shade

Normally, washed seedlac takes 24 hr for drying in the shade. The same can be achieved quickly by sun drying. In order to know the effect of sundrying for different periods, washed seedlacs were exposed to sun for 1, 2 and 3 hr. The alcoholic solutions (10 per cent) of these seedlacs were matched against the red, blue and Yellow slides of the Lovibond Tintometer. It was observed that red colour of the sun dried samples during the first hour of exposure, increased by 0·1-0·3 unit as compared to those dried in shade. During the second hour of drying in sun, no further change in red colour was observed in some seedlac samples while in others the change was up to 0·2 units. In the third hour of drying further increase in red colour varied between 0·1 and 0·4 units. However, no change was observed in yellow colour. As regards colour index, in sun, the colour index was same as observed after drying in shade while after 2 hour of drying marginal change of one unit was seen in some samples. However, the colour index increased by up to 2 units on drying for 3 hr (Table 31).

(A. K. Ghosh and R. K. Banerjee)

4.1.6 Improvement in dewaxing technique in aqueous medium

It was reported last year that immediate cooling of hot aqueous extract of lac improves the rate of filtration and quick removal of wax. The effect of cooling at various temperatures has now been studied in detail. The hot extract of lac was immediately cooled to 30°, 20° and 10°C by addition of ice and filtered through drill cloth. The wax content of the products was found to be 1·78, 0·26 and 0·14 per cent respectively. As IS specification lays down wax content less than 0·2 per cent for dewaxed lac, cooling to 10°C was found optimum. Next, the behaviour of different filter aids namely, paper pulp, fuller's earth, hyflo supercel and cellulose powder on the wax content of the product has been studied by incorporating them in different proportions in the cooled solution. The results are given in Table 32.

From the results given in Table 32 it would be seen that 7·5 per cent filter aid is optimum. However, in case of fuller's earch, fine particles were observed to pass through cloth bag, while with paper pulp it might be difficult to work in filter press due to its enormous swelling. Therefore, the working of cellulose powder is being studied on a semi-pilot scale.

(A. K. Ghosh)

4.1.7 Washing of sticklac with synthetic detergents

Preliminary experiments have shown that washing of sticklac with some commercially available synthetic detergents, namely, Det, Gnat, Key and Genteel (0·1 per cent on the weight of sticklac) improved the yield of seedlac by 2-8 per cent as compared to the one washed conventionally with washing soda.

(R. k. Banerjee and A. K. Ghosh)

TABLE 31 — COLOUR ANALYSIS OF SEEDLAC DRIED IN SUN AND SHADE

Sl No.	Seedlac	Method of drying	Duration (hr)	Colour Index	Colour analysis by Lovibond Tintometer		
					Red	Yellow	Blue
		Sun	3	15	6·1	24	—
			2	15	6·0	24	—
1	*Rangeeni*, Oct. 1976		1	14	5·9	24	—
	(*Palas*, Namkum)	Shade	24	14	5.7	24	—
		Sun	3	19	6·4	25	—
			2	18	6·3	25	—
2	*Kusmi*, Jan. 1977		1	18	6·2	25	—
	(*Kusmi*; Namkum)	Shade	24	18	6.0	25	—
		Sun	3	22	9·3	20	—
			2	20	9·1	20	—
3	*Rangeeni*, June 1977		1	20	9·1	20	—
	(*Palas*; Daltonganj)	shade	24	20	8·8	20	—
		Sun	3	12	5·4	24	—
			2	12	5·2	24	—
4	*Kusmi*, Jan. 1978		1	12	5·2	24	—
	(*Kusmi*; Namkum)	Shade	24	12	5.0	24	—
		Sun	3	22	9·2	22	—
			2	21	2·1	22	—
5	*Rangeeni*, Jan. 1977		1	20	8·9	22	—
	(*Ber*; Namkum)	Shade	24	20	8·7	22	—
		Sun	3	26	12·0	24	—
			2	25	11·8	24	—
6	*Rangeeni*, June 1976		1	24	11·7	24	—
	(*Palas*; Daltonganj)	Shade	24	24	11·5	24	—
		Sun	3	14	6·0	20	—
			2	14	5·8	20	—
7	*Kusmi*, Jan. 1978		1	13	5·8	20	—
	(*Kusmi*; Daltonganj)	Shade	24	13	5·6	20	—
		Sun	3	21	8·2	22	—
			2	20	8·0	22	—
8	*Rangeeni*, Jan. 1977		1	20	7·9	22	—
	(*Ber*; Namkum)	Shade	24	20	7·8	22	—
		Sun	3	16	6·9	20	—
			2	15	6·5	20	—
9	*Kusmi*, July 1977		1	15	6·5	20	—
	(*Kusmi*; Silli)	Shade	24	15	6·4	20	—

TABLE 32 — EFFECT OF VARIOUS FILTER AIDS ON THE WAX CONTENT

Sl No.	Filter aid used	(%)	Wax content (%)
1	Paper pulp	5·0	0·21
		7·5	0·12
		10·0	0·12
2	Fuller's earth	5·0	0·19
		7·5	0·11
		10·0	0·11
3	Hyflo supercel	5·0	0·28
		7·5	0·22
		10·0	0·19
4	Cellulose powder	5·0	0·21
		7·5	0·13
		10·0	0·12

4.2 Rubber-Shellac Combinations

4.2.1 Effect of incorporation of modified lacs into rubber

Black Filler

Last year, the effect of the incorporation of shellac into a blend of 50 parts each of NR and SBR was studied with EPC and HAF black fillers. The effect of the incorporation of zinc salt of lac into the blend has now been studied with the same fillers. It is seen from Table 33 that Mooney number showed

TABLE 33 — EFFECT OF THE INCORPORATION OF ZINC SALT OF LAC ON THE PROPERTIES OF BLEND OF NATURAL (NR) AND STYRENE BUTADIENE RUBBERS (SBR) USING EASY PROCESSING CHANNEL (EPC) AND HIGH ABRASION FURNACE (HAF) BLACK AS FILLERS

(Base mix: NR, 50; SBR, 50; ZnO, 4; stearic acid, 1; PBN, 1; sulphur, 2; and accelerator, 1)

Zn-salt of lac added per 100 parts of blend	Optimum time of cure at 140°C (min.)	Mooney No.	Scorch time (min-sec)	Modulus at 200% elongation (kg/cm²)	Ultimate elongation (%)	Tensile strength (kg/cm²)	Tear resistance (kg/cm)	Hardness (shore A)
			FILLER *EPC* (70 PARTS/100 PARTS BLEND), ACCELERATOR, *MBT*					
0	40	34·0	26-21	16·3	650	61·1	26·1	48
5	40	31·5	17-38	14·9	700	67·0	30·0	59
10	30	30·0	19-35	10·6	750	63·7	24·3	54
15	60	28·5	18-35	18·8	620	65·7	25·3	64
			FILLER *HAF* (40 PARTS/100 PARTS OF BLEND), ACCEEERATOR, *CBS*					
0	40	42·0	19-07	42·2	450	133·3	38·1	62
5	20	34·5	14-08	39·2	540	117·1	41·5	64
10	40	32·5	15-12	39·8	480	108·3	30·3	65
15	30	23·5	15-15	39·8	450	96·9	29·6	66

a de rease on its incorporation indicating a plasticizing effect. Tensile strength slightly increased with all the concentrations of zinc salt of lac with EPC black filler. Tear resistance increased slightly with 5 parts of zinc salt of lac per hundred parts of the blend with both the fillers. Hardness increased with all the concentrations of zinc salt of lac with both the fillers.

White Filler

The effect of the incorporation of shellac and zinc salt of lac into a blend of 50 parts each of NR and SBR has been studied with china clay and aluminium silicate as fillers. It is seen from Table 34 that optimum time of cure is almost constant but increased at higher concentration using china clay as fillter in both shellac/zinc salt of lac. The same observation has been noted with zinc salt of lac when aluminium silicate was used as the filler. Scorch time increased at all the concentrations of the resin with both the fillers which is a welcome feature and the increase was more in zinc salt of lac. Modulus increased with all the concentrations of the resin with china clay as the filler but with aluminium

TABLE 34 — EFFECT OF THE INCORPORATION OF SHELLAC AND ZINC SALT OF LAC ON THE PROPERTIES OF A BLEND OF NR AND SBR USING CHINA CLAY AND ALUMINIUM SILICATE AS FILLERS

(Base mix: NR, 50; SBR, 50; ZnO, 4; stearic acid, 1; PBN, 1; sulphur, 2; accelerator, 1)

Zn salt of lac added per 100 parts of blend	Optimum time of cure at 140°C (min)	Mooney No.	Scorch time (min-sec)	Modulus at 200% elongation (kg/cm²)	Ultimate elongation (%)	Tensile strength (kg/cm²)	Tear resistance (kg/cm)	Hardness (shore A)
FILLER CHINA CLAY (100 PARTS/100 PARTS OF BLEND), SHELLAC, ACCELERATOR MBT								
0	30	29·5	11-12·5	7·1	800	66·6	13·3	54
5	30	32·0	11-08	7·6	720	57·3	13·2	54
10	30	30·0	14-39	8·3	750	58·2	16·3	58
15	40	30·5	16-50	9·9	750	59·7	15·3	60
FILLER CHINA CLAY (100 PARTS/100 PARTS BLEND), Zn SALT OF LAC, ACCELERATOR MBT								
5	40	36·5	16-08	7·4	770	65·9	15·7	57
10	40	37·0	18-15	8·0	750	65·7	17·1	58
15	40	32·5	21-26	7·7	760	57·2	17·1	58
20	50	33·5	22-45	11·0	700	57·1	16·0	60
FILLER ALUMINIUM SILICATE (46·5 PARTS/100 PARTS BLEND), SHELLAC, ACCELERATOR CBS								
0	30	31·5	19-43	15·0	600	73·6	17·4	60
5	30	24·0	19-42	15·4	650	75·4	17·7	62
10	30	26·0	23-22	18·8	580	64·2	24·5	64
15	30	28·0	26-05	14·7	700	71·7	24·6	64
20	30	24·0	30-41	11·8	720	64·7	21·8	64
FILLER ALUMINIUM SILICATE (46·5 PARTS/100 PARTS BLEND), Zn SALT OF LAC, ACCELERATOR CBS								
5	30	22·0	17-53	13·9	670	75·6	23·4	66
10	30	26·0	20-00	12·5	700	67·5	19·1	58
15	40	29·0	30-19	12·5	700	62·8	19.5	60
20	50	32·0	35-15	15·3	650	60·8	19·1	62

silicate increase was noted only up to 5-10 parts of shellac. Ultimate elongation decreased when china clay was used as a filler with both the resins, but using aluminium silicate as the filler, it increased with both the resins. Tensile strength increased when 5 parts of either of the resins was incorporated into the blend using aluminium silicate as the filler while in remaining cases it showed decrease. Tear resistance increased with both the resins. The increase was more in case of shellac than zinc salt of lac when aluminium silicate was the filler. Hardness also increased with the incorporation of these resins.

(R. Singh and B. B. Khanna)

4.3 Use of Lac in Adhesives

4.3.1 Modified lac as adhesive

(A) The study was undertaken to examine the suitability of shellac as an adhesive for wood to wood surface. The dewaxed lemon shellac solution in different proportions in spirit (w/w) was prepared and applied on a teak wood panel (1′×6″) over one sq. inch area with the help of glass rod. A second pannel of the same size coated in the same manner was kept above it such that the coated portions of the two panels were superimposed. They were clamped and allowed to stand at room temperature for 24 hr. When the clamp was removed after aging for seven days at room temperature, the bond strength was determined by Hounsfield tensometer. For each reading average of five sets was taken (Table 35). There was variation in adhesive strength with different concentrations of shellac. From the table it is evident that shellac: spirit (40:60) is optimum and the bond strength is 0·083 ton/sq. inch. Further experiments on incorporation of adhesion promoters, namely, maleic acid, urea and hydrolysed lac were carried

TABLE 35 — ADHESIVE STRENGTH OF DEWAXED SHELLAC WITH AND WITHOUT ADHESION PROMOTERS/FILLERS

Sl No.	Dewaxed shellac : spirit	Adhesion promoters-fillers (%)	Average bond strength (tons/sq in.)
1	30: 70	—	0·075
	40: 60	—	0·083
	50: 50	—	0·080
2	40: 60	Maleic acid(2)	0·10
	40: 60	Maleic acid(4)	0·12
3	40: 60	Urea(5)	0·14
4	40: 60	Hydrolysed lac(5)	0·18
	40: 60	Hydrolysed lac(10)	0·22
	40: 60	Hydrolysed lac(20)	0·21
	40: 60	Hydrolysed lac(30)	0·22
5	40: 60	Carbon black(5)	0·15
	40: 60	Barytes (5)	0·12
	40: 60	Titanox (5)	0·11
6	40:60	Meleic acid(4)+carbon black (5)	0·21
	40: 60	Hydrolysed lac(10)+carbon black(5)	0·23

out with this composition when an increase in adhesive strength was noticed. The addition of maleic acid (4·0%), urea (5·0%) and hydrolysed lac (10·0%) as promoters in the optimum composition resulted in further increase in bond strength (0·12, 0·14 and 0·22 ton/sq. inch, respectively). The increase is about three times in case of hydrolysed lac as compared to plain shellac. Further increase in hydrolysed lac did not show any improvement. The effect of fillers, with and without promoters, namely, carbon black, barytes and titanox was also studied and an increase in the bond strength was noticed. In order to increase further bond strength of the composition, the combinations of a mixture of maleic acid+carbon black and hydrolysed lac+carbon black were studied. The results obtained by these compositions showed practically no improvement as compared to the composition containing hydrolysed lac.

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

(B) The above composition based on dewaxed shellac in alcoholic medium with 10 per cent hydrolysed lac and 5 per cent carbon black, although suitable for wood to wood surface, was not found effective for fixing sunmica to wood. Hence an investigation was taken up to examine the possibility in aqueous medium. Since aqueous solution of lac was found to have very little adhesive strength on wood to wood surface (0·04 ton/sq. ineh.), it was modified in aqueous alkaline medium (triethanolamine) with vinyl monomers, viz., ethyl and methyl acrylate using potassium permanganate as an initiater in inert atmosphere. Several compositions by varying the concentrations of monomers were prepared and bond strength determined. It was found that 40 parts monomer (ethyl or methyl acrylate) and 60 parts dewaxed decolourised shellac was optimum which had a bond strength of 0·21-0·23 ton/sq. inch. over wood to wood surface. This composition was found fairly satisfactory for fixing sunmica over wood or plywood surfaces.

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

4.3.2 Heat and water proof decorative laminates

It was reported earlier that when the decorative paper for top layers was coated with shellac-melamine resin combination and kraft paper for bottom layers with shellac urea combination, the resulting board had poor alkali, iodine and silver nitrate resistance. To improve these properties, decorative laminated boards were made by coating the top layers with lac solution modified with isocyanate. The boards came out without sticking to plates and were quite tough and hard, but were not resistant to alkali, iodine and silver nitrate solution as per IS specification.

(P. K. Ghosh, P. C. Gupta and M. Islam)

4.5 Utilization of Waste Mica

The moulded sheets/boards when pressed with a composition comprising of shellac, dimethylol, urea and calcined mica in a hydraulic press for 3 min resulted in a better product in respect of impact strength as compared to previous products. The optimum quantity of dimethylol urea in the composition was found to be 15 per cent on the weight of shellac. This product also withstood mechanical operations like sawing, drilling, punching, etc.

(P. K. Ghosh)

Ad-hoc Research

Studies on cold setting sealing wax

Based on shellac butyl ester, pigment (titanium dioxide), ethylcellulose, and volatile solvents (ether and methylacetate), a cold setting sealing wax in the form of paste has been prepared. On application, the embossing may be made after one min. which sets after 5 min. The seals are elastic and passed the tests as per IS: 868 (1956). The sealing wax, thus prepared, when stored in a collapsible tube showed no change in performance so far up to 3 months.

(P. C. Gupta)

E. EXTENSION DIVISION

(a) RESEARCHES COMPLETED

3.2.6 Copolymerization of shellac with vinyl monomers

With a view to overcoming inherent drawbacks of shellac, copolymerization of shellac was studied with vinyl monomers such as ethyl acrylate (EA), methyl methacrylate (MMA) in aqueous alkaline medium and MMA and acrylamide in non-aqueous medium (dioxane) using potassium permanganate and ceric ammonium nitrate as redox initiators respectively.

In aqueous medium, the optimum amount of EA and MMA for surface coating properties was found to be thirty per cent on the weight of shellac. Two compositions, viz. an aqueous varnish and an emulsion paint were formulated. The former was suitable for wooden surface as a French Polish. The adhesion of the varnish was, however, poor in ammoniacal solution but was improved by the addition of triethanolamine (10% on the weight of shellac). The performance of the emulsion paint was satisfactory over cement surface for six months. In non-aqueous medium, the maximum amount of MMA which appeared to have combined with shellac was found to be twenty per cent and the product was insoluble in common solvents of shellac except glacial acetic acid. The reaction product of acrylamide (shellac-acrylamide 1:1 w/w) when treated with water in order to remove homopolymer and monomer, formed an emulsion which could not be broken by the addition of acetic acid, suggesting that shellac has combined with acrylamide.

(P. C. Gupta, P. R. Bhattacharya and S. K. Saha)

(b) RESEARCHES ON HAND

5.2 Development of Shellac Bond Powder

The bond powder used by the Micanite industry possesses peculiar characteristics like a fairly good heat polymerization time but poor flow. Since ordinary shellac powder is not expected to give such properties, a modified shellac obtained by precipitating an alkaline seedlac solution with dil. H_2SO_4 was used. The precipitated lac showed a slightly reduced heat polymerization time but considerably reduced flow. The heat polymerization time and flow of the product was, however, adjusted by adding rosin and proper mixing. A series of experiments

were carried out to determine the correct percentage of rosin to be added in order that the product meets the desired specification. The optimum percentage of rosin to be added was found to be 20-25 per cent (w/w). Twenty kg of the bond powder was prepared and sent to M/s Bharat Heavy Electricals Ltd., Bhopal for shop trial. The report is awaited.

(S. K. Saha and B. P. Banerjee)

(c) RESEARCHES CONTEMPLATED

(i) Effect of storage on sticklac.

(ii) Commercial feasibility studies on storage of sticklac and seedlac (sponsored research).

3. EXTENSION

The principal extension activities carried out by the Extension Division were as follows:

(i) Large scale cultivation of lac at Kundri
(ii) Technical service and Development work
(iii) Publicity
(iv) Testing of lac and lac products
(v) Training
(vi) Production and sale of special shellacs in the Production unit

(i) *Large scale cultivation of lac at Kundri*

Technical guidance was continued to be rendered to the Forest Department, Bihar in running their lac farm at Kundri (Daltonganj) consisting of nearly 40,000 *palas* trees. Various operations were carried out on 36,890 trees of both the coupes. A total quantity of 2598 kg *ari* scraped lac and 9122 kg brood lac was obtained out of which 1040 kg brood lac was sold and the rest was used for inoculating 14,885 *palas* trees of coupe 'A'. The operations involved an expenditure of Rs 11,215 approximately. The sale proceeds are likely to exceed the investment and a net profit of nearly Rs 1500-2000 is expected.

(ii) *Teclnical services and development vork*

The division continued to maintain close touch with various development agencies interested in lac. The senior scientist of the division, who is also a member of the Industrial Promotion Group set up by the Ranchi Industrial Area Development Authority attended several meetings and held discussions with Govt. officials and representatives of the industries on various aspects of lac development. Two scientists of the division also participated in the Erntepreneurs' meet at Ranchi organised by the Industry Department, Bihar.

The division also attended all technical enquiries received from various Government Organizations, private Institutions and individuals interested in shellac and shellac-based compositions. Technical notes, schemes and samples of lac-based products were sent whenever asked for. Some of the important activities are listed below:

(i) A sample of metal lacquer was supplied to the Manager (R and D), Calico, Baroda for use as a protective varnish for metal wares.

(ii) The Automotive Engineering Wing, Electrical and Mechanical Engineering School, Baroda approached this Institute for a suitable material to be used in sealing the joints and insulating electrical terminals immersed in water. A sample of Cable Dressing Compound was supplied which has been found effective on the basis of preliminary trials. Further samples have been sent to them for their extensive trials.

(iii) Technical information about lac coated urea was supplied to several organisations.

(iv) Technical notes and schemes on the manufacture of sealing wax, bleached lac, shellac varnish, Melfolac, water soluble lac, etc. were supplied to Govt. organizations and private parties on request.

(v) A paint manufacturing unit has been supplied with samples and details about the manufacture of shellac Wash Primer.

(vi) At the request of a private party, an improved shellac based varnish (baking type) with specific drying time and viscosity was developed and the same has been found satisfactory by M/s Bharat Heavy Electricals Ltd., Bhopal.

(vii) Samples of shellac and lac dye were sent to several organizations.

(viii) A sample of shellac-based binder for sand moulds was supplied to M/s Allied Resins Pvt. Ltd., Calcutta for evaluation.

(ix) Several entrepreneurs were advised regarding shellac and shellac-based industries.

(x) A request was received from the State Trading Corporation of India, Calcutta for studying the problems related to the deterioration of the stock of seedlac in their air-conditioned godown at Calcutta. Samples of seedlac received from them were examined and necessary experiments were also conducted to ascertain the extent of deterioration and probable causes for the same. The findings along with the observations were passed on to S.T.C.

(xi) Efforts were made to establish contacts with different Agro-Service Centres in lac growing States. A handout is being prepared for distribution to these centres.

(xii) A total of 53 crop samples were examined for forecasting the dates of larval emergence and ascertaining the causes of mortality etc. and reports were sent to the concerned parties.

(*iii*) *Publicity*

The Institute participated in the following Exhibitions:

(a) Purulia District Exhibition held at Purulia from 23rd February to 4th March, 1978 and

(b) Rabi and Kharif Kisan Melas held at Ranchi Agricultural College, Ranchi, during February and September, 1978 respectively.

Samples of lac and lac products and charts were also sent for display at the museums of (i) Sir Sorabji Banker's Training College, Bombay and (ii) N. N. College of Agriculture, Gujarat Agricultural University, Navsari.

(*iv*) *Testing of lac and lac products*

A total number of 184 samples of seedlac, shellac and sealing wax were received from Government Organizations and private industries and in all 483 tests were carried out.

(*v*) *Training*

A private candidate received a fortnight's training in analysis and testing of lac.

Two private candidates successfully completed their training in the regular six months course (Oct. 1977-March 1978 session) on " Improved Methods of Lac Cultivation ".

Another batch of four candidates including three nominees of the department of Agriculture, Govt. of Uttar Pradesh, who were admitted to the April-September, 1978 course on " Improved Methods of Lac Cultivation ", completed the course successfully. Three more candidates were admitted to the October 1978-March 1979 course for training on the above subject.

Besides above, two new short term courses, namely, (i) Farmers' Training Course of 8-day duration and (ii) Entrepreneurs' training course of 3-month duration were introduced during the period.

In the Farmers' Training course 17 farmers from eight villages of Bihar and West Bengal were trained in lac cultivation practices. In the Entrepreneurs' training course, 7 entrepreneurs out of whom 6 were sponsored by the Directorate of Cottage and Small Scale Industries, Govt. of West Bengal and one by the Bihar State Cooperative Lac Marketing Federation, Ranchi, were provided training in uses of lac.

(*vi*) *Production Unit*

The unit continued to function as usual. The following items were manufactured and sold to the interested parties:

Sl No.	Material	Quantity (kg)	Value (Rs)
1	DXO-grade water-soluble lac	119·00	3570.00
2	DXG-grade water-soluble lac	82·00	1689.20
3	ASK-grade shellac	150·00	1275.00
	Total	351·00	6,534.02

4. PAPERS PUBLISHED

Publications and Patents

Publications

The Institute publishes its research findings 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 1978 is as below:

1. Bulletins	
(i) Chemical	149
(ii) Entomological	90
2. Technical notes	30
3. Research notes	
(i) Chemical	85
(ii) Entomological	52
4. Miscellaneous technical publications	
(i) Physico-chemical	14
(ii) Entomological	48
5. Books and Monographs	14
6. Pamphlets and leaflets	24

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

List of papers published during the year 1978

Sl No.	Authors	Title of paper	Name of Journal
		A. ENTOMOLOGY DIVISION	
1.	P. Sen and R. S. Gokulpure	*Sthenias madurae* Boppe, a new pest of *bhalia, Moghania macrophylla* (Wild) O. KTZE-	*Indian J. Ent.* **40**(4): 442-443.
2.	S. N. Mukherjee and N. S. Chauhan	Record of a new host for *Oligonychas coffeae* (Nietner)	*Curr. Sci.*, **47**(11): 396.
		B. AGRONOMY AND PLANT GENETICS DIVISION	
1.	Sinha, S. S. N. and Kumar, P.	Meiotic analysis in four lac hosts plants	*J. Cytol. Genet.*, **13**, 82-86.
		C. CHEMISTRY DIVISION	
1.	Rao, K. N. and Khanna, B. B.	Modified shellac based polyurethane coatings	*Res. and Ind.*, **23**, 215-218.
2.	Chatterjee, J. N. and Khanna, B. B.	Lac Industry, utilization and future	*Golden Jubilee Brochure, Instt. of Chemists, India*, 33-38.
3.	Srivastava, B. C.	Recent advances in analytical methods of lac	*Proc. Instt. of Chemists (India)*, **50**(4), 100.
		D. TECHNOLOGY DIVISION	
1.	Prasad, R. and Sengupta, S. C.	Identification of shellac	*J. Oil. Col. Chem. Assoc.*, **61**, 49-51.

5. SUMMARY

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

1.1.2 (*at Hesal*) — The possibility of utilizing *bhalia* as a lac host for raising the summer crop (*jethwi*) was explored trying seven cultivation practices. Of these the practice involving inoculation of bushes @ 50 g per bush in January/ February and harvesting the crop completely a year later has given the best performance. The application of foliar spray of urea did not help in improving the lac yield.

(b) RESEARCHES ON HAND

1.1.2 (*at Amjharia*) —)*Jethwi* 1977-cum-*aghani* 1977-78 crop was raised on *bhalia* bushes with varying brood rates and cultural practices. The crop performance has been best under the treatment B_1T_5.

1.1.3 The *baisakhi* 1977-78 crop raised on *galwang* has been a total failure.

The *katki* 1978 crop raised on *ber* using *galwang* brood lac was poor. However, the crop performance has been best under the treatment B_2F_3.

1.1.5 The *jethwi* 1978 crop was satisfactory on *gorai* and *putri*, the *aghani* 1978-79 crop on *gorai* and *baryari* and the *katki* 1978 only on *baryari*.

1.2.1 The first instar larvae of the lac predator *Eublemma amabilis* were reared on different artificial diets but they did not survive for more than a week on any of these diets.

The total lipidal matter of lac insect has been estimated.

1.2.2 Efforts made to improve the agar-agar substrate for artificial rearing of lac insect did not meet with the desired success. The maximum period of survival of lac insect reared on the agar-agar substrate developed earlier was 61 days during *jethwi* 1978, 53 days during *katki* 1978 and 125 days during *aghani* 1978-79 season.

1.2.3 The foliar application of antibiotics was not found to kill the micro-organisms harboured by the lac insect. However, the lac insects fed on artificial diets containing antibiotics did not survive for more than 72 hr.

1.2.4 The sex pheromone extracted with cold methylene chloride from the virgin females of the lac predator *Eublemma amabilis*, was found to attract the males of this predator.

1.3.2 The effect of density and age of the lac insect on the incidence of lac predators has been studied in the *katki* 1978 and *baisakhi* 1978-79 crops. It has been found that, in general, there has been an increase in the incidence of lac predators with increase in the density of lac insects.

1.3.3 A technique has been developed to induce mating of *P. sulci* for laboratory rearing of the parasite.

1.3.4 The control schedule involving the use of endosulfan and *Bacillus thuringiensis* has not been found to adversely affect the economic qualities of lac insect. On the other hand an increase in the fecundity of treated females was observed.

1.3.5 Investigations were continued at the Regional Field Research Station, Dharamjaigarh (M.P.) to supplement *kusmi* lac production in the region.

1.4.1 The field trials of integrated control schedules against the lac predators were continued in the *baisakhi* 1977-78-cum-*katki* 1978 crop on *palas* at Lota. Best results were obtained with three sprays of 0·075 per cent endosulfan.

These trials were also continued in *katki* 1978 crop on *bhalia* at Amjharia. The best result for lac yield was obtained under the schedule CE which suppressed the predatory population to the extent of 69·5 per cent.

1.4.2 The simple cultural method is being evolved for the control of lac pests by varying the time of crop inoculation.

1.4.7 Avoidable losses due to inimical insects of lac were estimated under mechanical and chemical protection in the *aghani* 1977-78 crop on *bhalia* and *palas*.

1.4.9 Studies have been initiated with two hormones and one chitin inhibitor for the control of major lac predators.

1.5.2 Study of crosses have provided evidence of considerable hybrid vigour in lac insects. A number of lines derived from the strain crosses are being maintained for performance evaluation.

1.5.3 X-irradiation of lac insects has not provided any variant for study of mutants in these insects.

1.5.5 Cytological studies of lac insect have shown that, in the male, the resting nuclei always contain a heteropycnotic residue in the somatic and germline tissues right from the early embryogeny of the male.

1.5.7 The presence of tetrazolium oxidase was detected in the fully mature females of *kusmi* lac insects and it was found to occur in three molecular forms.

1.5.8 Four stocks each of *rangeeni* and *kusmi* lac insects, collected earlier were maintained. A stock of *rangeeni* lac insect was obtained from Meghalaya. These stocks were found to differ in their economic qualities.

During the breeding work with lac insects, some interesting observations have been made. These included (i) occurrence of a few new colour variants (ii) presence of only male insects in a few cultures of a wild stock and of the F_3 of the strain crosses; (iii) first record of the occurrence of yellow mutant in the *kusmi* strain and (iv) unusual occurrence of winged males in the rainy season generation of a wild stock, originating from Meghalaya.

Operational Research Project

Eighty three demonstrations were given for improved methods of lac cultivation. The crop yield was almost twice as that of the traditional method. Beekeeping was encouraged by imparting training to the farmers and providing them with the bee hives. Twenty-four demonstrations were given for soil reclamation

with Mussorie Phos. Demonstrations were also given for the agricultural crops. The farmers were educated through group discussions, meetings and by arranging visits to Kisan Melas.

B. AGRONOMY AND PLANT GENETICS DIVISION

(a) RESEARCHES COMPLETED

2.4.1 Mitotic and meiotic analyses in thirteen varieties/cultivars of *Cajanus cajan* were completed and their systematic positions on the basis of cytology were established. Similar studies on *bhalia*, *bara salpan*, *palas* and *takoli* were also carried out. Karyotypes of some more lac-hosts, namely, rain tree, *galwang*, *siris*, *khair* and *kastura* have been studied.

Mutational studies undertaken on two cultivars of *C. cajan* (cult. *Ranchi* and Cult. *Assam*) and two species of *Moghania* (*M. macrophylla* and *M. chappar*), through irradiation of seeds with gamma rays at various doses, have shown that Cult. *Ranchi* and *M. chappar* were more radiosensitive than Cult. *Assam* and *M. macrophylla* respectively.

Polyploidy could be induced in a plant of *bhalia* by treating the seedlings with 0·5 per cent colchicine solution.

2.4.2 The training of rain trees into bushes is not found to be an economical proposition for lac cultivation.

(b) RESEARCHES ON HAND

2.1.1 Of the 20 varieties/cultivars of *arhar* under evaluation for lac and pulse yield, the maximum inoculable space (total shoot length) was provided by Cult. *Asam* but the linear space covered by the lac insects was more in ICRISAT ICP No. 6344.

2.1.2 The different systems of planting had no significant effect on plant growth but the levels of fertilizers showed marked influence on both plant height and number of tillers.

2.1.3(a) The growth response of *bhalia* and *galwang* bushes was better in plots where grasses were grown as intercrops than in the control plot (without grasses). *Dinanath* grass gave promising result with respect to fodder yield (523·7 q/ha).

(b) There was no adverse effect on the growth of *bhalia* and *galwang* bushes when tuber (sweet potato and tapioca) and rhizome (ginger and turmeric) crops were grown as intercrops. The intercropping of sweet potato+ginger+turmeric was found as the most profitable combination.

2.3.2(a) Growth regulators, namely, NAA and GA applied on *ber* plants at different concentrations showed that NAA at 80 ppm had the best effect on plant growth.

(b) Foliar spray of 80 ppm GA3+1 per cent urea on *kusum* and *palas* after pruning resulted in 52·4 and 40·5 per cent increase in shoot length over the control.

2.3.3 Of the three vegetative propagation methods tried on *kusum*, namely, air layering, stem cutting and cincturing, success was achieved through air layering with the help of growth regulators.

2.4.2(a) *Bhalia* and *bara salpan* seedlings raised during different periods were transplanted to study the effect of sowing dates and growth regulators on flower initiation.

(b) The topping of apical twigs of *bhalia* in July and August followed by NAA spray at 500 ppm resulted in a slightly late flowering which could be coincided with the early flowering of *bara salpan.*

2.4.3 *Bhalia* plants raised in progeny rows from seeds of parent plants, selected on the basis of best and worst lac yielders, are growing well.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED

3.2.9 Various types of lac and their fractions, namely, hard and soft resins were reacted with sulphur by dry fusion at 150°C up to pregelation stage. It was found that sulphur combined to the extent of 1·6-3·7 per cent. The amount increased slightly (by 0·3 to 1·4 per cent) when an accelerator was used. An examination of the sulphur modified products indicated a drop in acid, hydroxyl and iodine values.

3.7.1 The relaxation data of natural resins, namely, Manila copal, mastic, dammar, shellac and its constituents, and two modified shellac compositions, namely, shellac-melamine formaldehyde and shellac-urea-formaldehyde, obtained by Bhattacharya, were analysed by the Cole-Cole method for temperatures between 20° and 150°C. The dielectric behaviour of all these resins was found similar. All of them exhibited single and multi-relaxation processes above and below melting temperatures respectively. The study suggested conformational rearrangement of the resin molecules above their melting temperatures.

The functional groups present in hard and soft resins appear to be responsible for the dielectric properties of shellac below and above its glass-transition and melting temperatures respectively. It has been further confirmed from the dielectric studies that shellac is a physical mixture of its hard and soft fractions.

The ratio between the glass-transition and melting temperatures of fifteen natural resins including shellac was found to be within the range 0·87-0·95.

(b) RESEARCHES ON HAND

3.1.1 Attempts have been made to synthesize isoambrettolide and exaltone from aleuritic acid in quantity.

Work has been initiated to synthesize macrocyclic ethers from aleuritic acid for their utility in the field of perfumery.

3.1.2 Two pure components have been isolated from alcohol-soluble wax fraction C. The first appeared to be a hydrocarbon by IR spectrum, whereas the nature of the second component is under investigation.

The two alcohols isolated previously have been converted into their corresponding hydrocarbons.

Free acids (14·5%) present in lac wax have been isolated.

3.1.4 The hard resin fraction A, B-1 and C on further study gave pure samples of jalaric, *lacci*-jalaric, aleuritic, butolic, *w*-hydroxyhexadecanoic and 10,16-dihydroxyhexadecanoic acids. In addition to these, a pure sample of new aldehydic acid, similarly obtained from fraction B-3 previously, was also isolated from fraction C. On the basis of some chemical and spectronic evidences, a tentative structure has been assigned to the new acid which is subject to confirmation by other evidences.

Up-to-date, nearly 80 per cent of the components from hard resin have been isolated and identified.

3.1.5 The reproducibility of the spectronic method of estimating lac in terms of aldehydic acid was tested with more samples of lac and found to work well.

3.1.6 With a view to correlating the properties of seedlac and shellac with age, genuine *ber* sticklac (*baisakhi*) was converted into seedlac and shellac and their physical, chemical and physico-chemical properties determined.

The shellac, thus obtained, was also examined through I.R., U.V and T.L.C. These characteristics will be studied periodically to study the effect on storage.

3.2.2 Attempts were made to substitute resorcinol, a costly material, with cashewnut-shell-liquid (CNSL) to lower the cost of production of the cation exchange resin from shellac.

Shellac and CNSL were treated by different methods using *p*-formaldehyde or formaldehyde in alkaline medium. CNSL (1·5 or 2 parts on the weight of sulphonated lac) gave hard, brown, fine resin of irregular shape. The properties of these resins were studied.

3.2.4 Alkyl aleuritate, aleurityl crotonate and aleurityl cinnamate were polymerized using benzoyl peroxide as the initiator. The polymers, so obtained, were white solids whose acid and iodine values were nil.

3.2.7 Hexadecanedioic acid, the basic material for polymerization was successfully prepared from Δ^6-hexadecene-1,16-dioic acid. The polymerization of hexadecanedioic acid with ethyleneglycol will now be taken up.

3.2.8 Shellac based polyurethane coating having good flexibility and resistance to water and acid have been developed by reacting shellac-based polyesters with 2:4 toluene-diisocynate.

3.3.3 Lac-linseed oil double boiled varnishes prepared earlier have been studied in greater detail to assess their suitability as baking type insulating varnish for coating of coils of electric motors etc. The results obtained satisfied most of the requirements of ISS/350 for baking type insulating varnishes. Commercial trial made by a local consumer has also given encouraging results, indicating its suitability for the said purpose.

3.3.6 Mild steel panels coated with lac-linseed oil-toluene diisocyanate composition, on immersion in gobar-slurry in the laboratory, were found to have been affected after 2 months as against one year observed previously. The possible reasons for this are being looked into.

A gas holder for the gobar-gas plant has been got fabricated for the above studies.

3.3.7 A study has been initiated with a view to developing a composition of shellac paint as a substitute for costly pattern enamels used in steel foundries. A few compositions have been prepared which possess good drying characteristics, hiding power and produce highly adherent and glossy films which resist the action of water and wet sand.

3.4.1 A microbial insecticide, based on *Bacillus thuringiensis*, has been encapsulated with the help of phase separation technique and the material is under evaluation.

3.4.2 Hydrosols of *bhatta* shellac have been prepared by the dialysis and condensation methods and their physico-chemical properties studied. Ordinary and dewaxed shellac can be used for preparing the hydrosols for encapsulation by phase separation method. Shellac hydrosol has shown reversibility phenomenon, further signifying its suitability for *p*H-coacervation.

A new method of significance for determining the optimum time of dialysis for preparing shellac-hydrosol to be used for encapsulation has been found which is based on determining the abrupt change in *p*H or concentration or volume of the dialysate.

3.5 Experiments have been carried out to impart flexibility in shellac propellants by modifying hydrolysed lac with a phenolic resin under different conditions of time and temperature. The binder so obtained produced propellants which burnt smoothly and vigorously, leaving no ash but did not possess the desired flexibility. It has been found that shellac propellant burnt smoothly and with a greater force than PVC propellant.

3.7.2 The effect of some plasticizers on the dielectric strength of dewaxed lemon shellac varnish (air drying) has been investigated. The dielectric strength in air (27°C) of the shellac-TCP and shellac-DMP compositions were found to be 2·0 and 1·7 kV/mil respectively compared to that of plain shellac (1·0 kV/mil). The former composition failed for resistance to transformer oil, while the latter passed the test.

3.7.3 Studies have been made on the curing behaviour of different compositions of shellac and butylated-melamine formaldehyde resin by the measurement of various dielectric parameters with time. A marked decrease in dielectric constant, dielectric loss and dissipation factor was noticed within first 4 days of their blending, thereby indicating that curing takes place within this period.

Ad-hoc Research

Attempts have been made to isolate aleuritic acid in higher yield from shellac. Preliminary studies have indicated that modified method of alkaline hydrolysis of shellac in presence of sodium sulphite yields 25 per cent crude *threo*-aleuritic acid. The gummy mass left in the mother liquor has shown promise to further improve the yield of aleuritic acid when acid treatment followed by alkaline hydrolysis is carried out.

D. TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES ON HAND

4.1.1 The performance of water soluble lac and insulating varnish prepared from dewaxed lac manufactured in aqueous medium was comparable with those prepared from conventional shellac/dewaxed lac.

4.1.5 The effect of drying of seedlacs in sun and in shade has been studied. The red colour of seed lac increased by 0·1-0·4 unit upon exposure to sun for 1-3 hr.

4.1.6 The immediate cooling of hot aqueous extract of lac at 10°C and subsequent filtration in presence of 7·5 per cent filter aid reduced the wax content of dewaxed lac considerably.

4.1.7 Washing of sticklac with commercially available synthetic detergents improved the yield of seed lac by 2-8 per cent.

4.2.1 Zinc salt of lac when incorporated into a blend of 50 parts each of NR and SBR in presence of black fillers improved the mechanical properties. The study was extended using white fillers, namely, china clay and aluminium silicate. The mechanical properties were found comparatively better with zinc salt of lac.

4.3.1 Adhesive property of dewaxed shellac in alcoholic medium, with and without promoters and fillers, was studied on teak wood surface. It was found that incorporation of hydrolysed lac (10 per cent) in the optimum composition increased the bond strength from 0·083 to 0·22 ton/sq. inch.

A composition based on 60 parts dewaxed decolourised shellac in aqueous medium and 40 parts monomer (ethyl or methyl acrylate) had a bond strength of 0·21-0·23 ton/sq inch and was found satisfactory for fixing sunmica over wood or plywood surfaces.

4.3.2 To improve the surface resistance of the decorative laminated boards, shellac modified with diisocyanate was used, but it also did not give the desired results.

4.5 The moulded sheets/boards made with dimethylol urea, shellac and calcined mica resulted in an improved product.

Ad-hoc Research

A cold setting sealing wax based on shellac, butyl ester, ethyl cellulose, pigment and volatile solvents passed the tests as per IS: 868 (1956).

E. EXTENSION DIVISION

(a) RESEARCHES COMPLETED

3.2.6 Two satisfactory compositions, viz. an aqueous varnish and an emulsion paint were prepared when shellac was copolymerised with EA and MMA in aqueous alkaline medium in presence of potassium permanganate as an initiator. Ceric ammonium nitrate has shown promise as an initiator for reacting shellac with MMA and acrylamide in non-aqueous medium.

(b) RESEARCHES ON HAND

5.2 A modified shellac obtained by precipitating an alkaline seedlac solution with dilute sulphuric acid was used in the preparation of shellac bond powder. The desired flow and heat polymerisation time were achieved by the addition of 20-25 per cent of rosin. A 20 kg sample has been sent to M/s Bharat Heavy Electricals Ltd., Bhopal for shop trial.

6. METEOROLOGICAL REPORT FOR THE YEAR 1978

The average meteorological data for each month were as follows:

Month	Mean barometric pressure mm	Mean maximum temperature °C	Mean minimum temperature °C	Mean dry bulb temperature °C	Mean wet bulb temperature °C	Mean humidity %	Mean sunshine hr/day	Total rainfall mm temperature °C	Highest maximum	Lowest minimum temperature °C
January	710·67	22·90	7·14	18·17	12·9	53·54	7·60	11·9	28·0	3·3
February	710·47	24·93	10·89	20·52	15·00	55·12	6·80	45·1	29·0	4·4
March	707·08	29·09	13·92	24·45	17·08	47·45	8·25	97·2	33·0	10·0
April	704·91	35·65	19·33	30·98	20·35	36·78	8·71	12·3	39·5	15·5
May	699·40	39·54	23·56	33·14	23·27	44·27	8·70	70·3	43·5	19·4
June	697·72	37·16	23·82	29·68	24·20	66·38	4·64	364·4	42·0	21·1
July	699·06	29·73	22·61	26·54	24·30	83·30	3·70	232·8	32·0	21·6
August	698·39	29·21	22·68	26·17	24·58	87·96	3·92	360·3	31·5	21·1
September	701·53	28·41	22·05	25·03	23·34	87·18	4·45	335·6	31·5	20·0
October	705·98	28·66	18·16	25·90	21·59	68·61	6·19	58·3	31·0	14·4
November	708·53	28·54	14·61	24·65	18·12	52·95	7·16	10·0	32·0	11·1
December	710·89	24·22	8·40	19·27	14·16	56·20	7·20	21·9	26·6	4·4

The highest maximm temperature recorded was 43·5°C on 21st May and lowest minimum temperature 3·3°C on 4th Januaıy. The total rainfall during the year ammounted 1620·1 mm, of which the monsoon (June-Sept.) rainfall was 1293·1 mm. The rainfall during the year was lower than that of 1977 (1977-1637·0 mm). There were hail storms on 19th and 21st April.

LIST OF PERSONNEL

Sl. No.	Name of the post	Staff in position as on 31-12-78
1.	Director	Dr. T. P. S. Teotia
	Division of Entomology	
2.	Head	Dr. R. L. Tripathi
3.	Scientist S-3 (Agricultural Entomology)	Sri N. S. Chauhan
4.	Scientist S-2 (Agri. Ento.)	1. Dr. B. P. Mehra 2. Dr. C. P. Malhotra 3. Sri A. H. Naqvi
5.	Scientist S-1 (Agri. Ento.)	1. Sri R. S. Gokulpure 2. Sri S. G. Choudhary 3. Sri A. K. Sen 4. Sri B. N. Sah 5. Dr. D. C. Srivastava 6. Dr. Satyavir 7. Sri S. K. Jaipuriar 8. Sri A. Bhattacharya 9. Sri R. Ramani
6.	Scientist S (Agri. Ento.)	1. Sri Y. D. Mishra 2. Sri M. L. Bhagat 3. Sri Jawahir Lal
7.	Senior Technical Asstt.	1. Sri J. M. Dasgupta 2. Sri M. K. Chowdhury
8.	Technical Assitt. (TII-3)	1. Sri A. K. Sahay 2. Sri H. Bhangra 3. Sri L. C. C. Nath Sahadeo 4. Sri K. U. S. Sinha 5. Sri R. N. Vaidya (w.e.f. 30.5.78)
9.	Senior Artist (T-4)	Sri R. L. Singh
10.	Jr. Artist-cum-Photographer (T-1)	Sri R. P. Srivastava
11.	Laboratory Technician (T-2)	1. Sri B. B. Chakravorty 2. Sri G. M. Borkar 3. Sri Ajmer Hussain
12.	Field Technician (T-2)	1. Sri R. S. Maliya 2. Sri K. C. Jain 3. Sri H. R. Munda 4. Sri S. N. Sharma 5. Sri S. S. Prasad 6. Sri R. D. Pathak
13.	Field Technician (T-1)	1. Sri H. N. Shukla 2. Sri Jiwan Lal
14.	Insect Collection Tender (T-1)	Sri Ram Lochan Ram
15.	Field Plantation and Store Asstt. (T-1)	Sri Munna Lal Ravidas

16.	Laboratory Technician (T-1)	1. Sri S. K. Chatterjee 2. Smt. Santoshi Minz 3. Sri Bhola Ram 4. Sri Ghanshyam Das

Agronomy and Plant Genetics Division

1.	Agronomist	Vacant
2.	Jr. Arboriculturist	Vacant
3.	Scientist S-1 (Plant Genetics)	Dr. P. Kumar
4.	Scientist S-1 (Plant Breeding)	Sri S. C. Srivastava
5.	Scientist S-1 (Horticulture)	Dr. Moti Ram
6.	Scientist S-1 (Agronomy)	Sri B. P. Singh
7.	Laboratory Technician (T-2)	Sri D. D. Prasad
8.	Field Technician (T-1)	Sri Jagarnath Oraon

Chemistry Division

1.	Head	Dr. B. B. Khanna
2.	Scientist S-3	Sri Shravan Kumar
3.	Scientist S-2	1. Dr. S. C. Agarwal 2. Dr. A. Kumar
4.	Scientist S-1	1. Sri A. K. Dasgupta 2. Dr. D. N. Goswami 3. Sri B. C. Srivastava 4. Sri K. Mohan 5. Sri N. Prasad 6. Sri R. N. Majee
5.	Scientist 'S'	1. Sri A. Rahman 2. Sri R. N. Das 3. Sri K. M. Prasad 4. Sri M. Mukherjee 5. Sri P. M. Patil
6.	Technical Asstt. (T-II-3)	1. Sri N. K. Dey 2. Sri M. K. Mishra 3. Sri T. K. Saha 4. Sri M. Ekka 5. Sri D. D. Singh
7.	Laboratory Technician (T-2)	1. Sri U. Sahay 2. Sri B. P. Keshri
8.	Glass Blower	Vacant
9.	Laboratory Technician (T-1)	1. Sri P. B. Sen 2. Sri G. Mishra 3. Sri R. P. Sahu

Technology Division

1.	Technologist (S-2)	Dr. P. C. Gupta
2.	Jr. Technologist (Processing S-1)	Sri A. K Ghosh
3.	Jr. Technologist (Factory S-1)	Sri P. K. Ghosh
4.	Scientist (S)	1. Sri R. K. Banerjee 2. Sri Radha Singh

5.	Senior Tech. Asstt. (T-4)	1. Sri M. Islam 2. Sri B. P. Banerjee 3. Sri R. Prasad
6.	Technical Asstt (T-II-3)	Sri K. K. Prasad
7.	Laboratory Technician (T-2)	1. Sri N. Minz 2. Sri M. K. Singh
8.	Laboratory Technician (T-1)	Sri Tulsi Ram

Extension Division

1.	Scientist S-2 (Shellac Utilization)	Dr. S. K. Saha
2.	Scientist S-1 (Shellac Utilization)	Dr. A. Arya
3.	Asstt. Scientist (Processing S-1)	Dr. A. Pandey
4.	Scientist S-1 (Agri. Ento.) (Lac cultivation)	Sri R. C. Mishra
5.	Senior Analyst (T-5)	Sri L. C. Mishra
6.	Sr. Technical Asstt. (T-4)	Sri R. C. Maurya
7.	Commercial Artist (T-II-3)	Sri P. Das
8.	Technical Asstt. (T-II-3)	1. Sri K. M. Sinha 2. Sri Deepak Ghosh 3. Sri Jagdish Singh
9.	Laboratory Technician (T-2)	1. Sri D. Runda 2. Sri B. P. Ghosh
10.	Museum Assistant (T-2)	Vacant

Administrative Section

1.	Sr. Administrative Officer	Sri K. K. Mustaufi (expired on 28.2.78)
2.	Asstt. Administrative Officer	Sri S. K. Sircar — retired on 28.2.78 Sri S. N. Sharma (from 29-2-78)
3.	Superintendent	1. Sri S. N. Prasad 2. Sri R. K. Singh
4.	Assistants	1. Sri P. K. Choudhury 2. Sri D. P. Sengupta 3. Sri H. S. Munda 4. Sri R. P. Singh 5. Sri Musafir Singh 6. Sri Enamul Haque
5.	Senior Stenographer	Sri R. Rabidas
6.	Senior Clerk	1. Sri D. N. Mahto 2. Md. Samiullah 3. Sri A. K. Chowdhury 4. Sri Elias Tirkey 5. Sri A. Haue 6. Sri S. K. P. Keshri 7. Sri R. B. Singh 8. Smt. Sati Guha 9. Sri K. N. Sinha 10. Sri K. D. Pandey 11. Sri S. Ram 12. Sri D. Ram

7.	Junior Stenographer	1. Sri Sant Kumar 2. Sri A. K. Sinha
8.	Pharmacist	Sri Chandreswar Pandey
9.	Jr. Clerk	1. Sri K. L. Choudhury 2. Sri R. K. Upadhaya 3. Sri Budhan Ram 4. Sri A. K. Lal 5. Md. Mubarak 6. Sri N. Topno 7. Sri V. Ram 8. Sri E. Gari 9. Sri J. P. Srivastava

Audit and Accounts Section

1.	Assistant Accounts Officer	Sri Jagmohan Singh

Project File and Technical Cell

1.	Jr. Technical Officer, T-6	Sri S. K. M. Tripathi
2.	Sr. Technical Assistant, T-4	Sri P. Sen

Library

1.	Senior Library Asstt. (T-4)	Sri R. P. Tiwari

Maintenance and Workshop Unit

1.	Chief Mechanic (T-II-3)	Sri K. N. Sinha
2.	Assistant Mechanic (T-2)	Sri S. K. Bhaduri
3.	Instrument Maker (T-2)	Sri M. Kujur
4.	Turner (T-1)	Sri A. S. Manoranjan
5.	Driver for vehicle (T-1)	1. Sri J. Ram 2. Sri Bandhan Runda

Institute Plantation

1.	Farm Superintendent	Sri B. K. Purkayastha
2.	Jr. Field Asstt. (T-2)	1. Sri G. Lakra 2. Md. Ali Ansari
3.	Labour Supervisor	Sri Mohar Sahu
4.	Tractor Driver	Sri Markus Surin

Mixed Plantation Scheme at Chandwa

1.	Field Farm Technician (T-2)	Sri R. C. Singh

PRINTED AT THE CATHOLIC PRESS, RANCHI