INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA


# Annual Report
# 1981 & 82

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI
1985

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# 1. DIRECTOR'S INTRODUCTION

## A brief historical introduction

The Indian Lac Research Institute, Ranchi which was set up 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 9 km east of Ranchi. Out of a total area of 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 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 Divisions, while the remaining Divisions are under the charge of their respective senior most scientists.

## Research Highlights

### Entomology Division

Among the notable results of the Entomology Division, mention may be made of: (i) scanning electron microscopic studies undertaken for the first time on the Indian lac insect, *Kerria lacca* (Kerr) to provide further knowledge in the

ultrastructural details of the epidermal glands of the female, (ii) confirmatory results obtained for the key mortality stages and factors governing the field populations of the *rangeeni* lac insects, (iii) effective control of the lac predators, *Chrysopa* spp. with the use of BHC and chlordane under field trials, (iv) insecticidal screening trials which have shown some to be safe to lac insects for their possible use against their pests, (v) the sex ratio study suggested that major gene effects could possibly be involved for the occurrence of all male progency and (vi) cytological studies have confirmed a Lecanoid system of chromosome behaviour in *K. lacca.*

**Agronomy and Plant Genetics Division**

The lac yield per unit area was maximum from double hedge system followed by single-hedge system of planting the lac host *bhalia* (*Moghania macrophylla*).

Of the 17 varieties of pigeonpea (*arhar*) tried as lac hosts, '*Bahar*' gave the maximum lac yeld. In general, pigeonpea varieties, better suited to raising lac, gave less yield of grain.

*Baisakhi* (summer) lac (*ari*) and Tasar crops could be taken on the same set of *ber* (*Ziziphus mauritiana*) bushes.

**Chemistry Division**

An ester composed of C-38 straight chain acid and C-36 straight chain alcohol was isolated for the first time from lac wax.

A cyclic ether, having musk like odour was prepared from aleuritic acid, the major component of lac resin.

Varnishes obtained by dissolving the reaction products of shellac and epoxy resin (70:30) and shellac and phenolic resin (50:50) in appropriate solvents could satisfactorily be used as air-drying insulating varinishes. The dielectric strength of these varnishes was found to be 1·1 and 1·2 kV/mil respectively.

For effective control of *parthenium* and other weeds in the soil, a heterogeneous reaction system using benzene, a cheap solvent, was developed for preparing slow release chemically combined lac based weedicides.

An improved baking type insulating varnish based on lac (DL) and double boiled linseed oil has been developed. This varnish possesses very good drying characteristics and high breakdown strength of the order of 2·1 kV/mil and can be used for coating of coils of electric motors and transformers.

**Technology Division**

Genteel was found to be the best synthetic detergent for washing sticklac without reducing its yield thereby improving the overall economics.

A process for utilization of waste mica for the preparation of flexible insulating sheets/boards has been developed.

**Library**

The number of books and bound volumes of journals accessioned during the year 1981 and 1982 was 108 and 212 respectively. This brought the total number

of books and volumes of journals in the library to 17,737. Two hundred fifty 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.

**Study Tour of Members of Parliament**

A team of nine Members of Parliament visited this Institute from 10 to 12 January 1981 under the leadership of Sri Ranavir Singh, M.P., to make a spot study of the research activities carried out by the Institute. The delegation also discussed matters pertaining to problems of lac Industry and cultivators' interests. The M.P.'s visited a few lac industries in the vicinity of Ranchi. Sri Ranavir Singh (Team Leader) and other participating M.P.'s conveyed their appreciation of the good work being done by the Institute vide DirectorGeneral [D.O.No. PR/3 (1)/80 dated February 2, 1981].

**Visit of Second Sub-committee of Committee of Parliament on Official Language**

A committee of Members of Parliament representing the Second Sub-committee of Parliament of Official Language visited this Institute and other Govt. offices of Ranchi from July 3 to July 5, 1981 to assess the progress on the use of Hindi Language in day-to-day official work. Dr T. P. S. Teotia, Director of the Institute was the coordinator for this purpose. The Parliamentary committee appreciated the progress made by the Institute in the use of Hindi Language in day-to-day official work. However, the committee made a number of suggestions and recommendations to be adopted in future for further increase in the use of Hindi Language.

**Study Report of Quinquennial Review Team (Q.R.T.)**

The Director-General I.C.A.R. constituted a Q.R.T. vide office order No. F. 11(14)/81-CDN-II dated August 14, 1981 to (i) examine and identify the research achievements of the Institute during the past 5 years, (ii) examine the objective, scope and relevance of the research programmes and budget allocations of the Institute for the next 5 years in relation to overall national plans and policies, (iii), examine the present research programmes whether they are in keeping with the objectives and mandate of the Institute, (iv) examine the policies, strategies and procedures adopted by the Institute and the systems in arriving at these decisions in particular the effectiveness of working of the Staff Research Council, (v) examine the kinds of linkages established with the utilimate users of research results, (vi) examine whether any changes in the organizational set up are called for and to examine constraints which may be hindering Institute in achieving of its objectives.

The members of the Q.R.T. were as follows:

1. Prof. S. C. Mandal — Chairman
   Emeritus Scientist
2. Dr C. K Atal, Director — Member
   R.R.L. Jammu

3. Dr T. N. Ananthakrishnan — Member
   Director, Loyola College, Madras
4. Dr R. C. Badami — Member
   Emeritus Scientist, Dharwar University
5. Dr N. Panda — Member
   Dean of Research, Orissa University of Agr. and Techn., Bhubaneswar
6. Dr T. P. S. Teotia — Convenor
   Director, I.L.R.I., Ranchi

The Chairman and the members of Q.R.T. visited the Institute laboratories, Plantation and field areas several times during February 1981-December 1982 and held detailed discussions with the staff members of all categories in terms of references mentioned above.

The Q.R.T. submitted its report in February 1983.

**The Institute Staff Joint Council**

The Institute Staff Joint Council (IJC) constituted vide office letter LR-A/317/79; 10 August, 1979 with the object of finding solution of various problems concerning welfare of the staff members continued to function smoothly. The eighth and an emergency meeting of the Council were held in April and October 1981 respectively. Consequently with the expiry of the term of the I.J.C., it was reconstituted w.e.f. 4 September 1982. Out of the fourteen members of the Council including Director as the Chairman, six members were nominated from official side whereas seven members were elected by various categories of staff members to represent Staff side. Ninth meeting of the I.J.C, was held in October, 1982.

**The Institute Grievance Cell**

Consequent upon the expiry of the term of the previous "Grievance Cell" in April 1981, it was reconstituted vide letter No. LR-A/346/81: 16 and 27 June 1981. Out of Seven members of the Cell, three members were nominated by the Director including Administrative Officier and Audits Accounts Officer while the third nominee was made by the Chairman of the Council. The remaining four members were nominated by the Staff side of IJC. Besides this, the Cell has one non-member secretary. The new Grievance Cell started functioning w.e.f. 22 September 1981. The object of the Cell is to provide an apparatus in the Institutional frame work that will (i) provide a forum for employees to ventilate their personal grievances relating to official matter, (ii) impart a degree of objectivity and fair play in the consideration of such grievances and (iii) ensure prompt consideration and decision thereon.

**The Institute Management Committee**

Consequent upon the expiry of the previous Management Committee, it was reconstituted and its first meeting was held on 30 Junuary 1981. The committee recommended the restructuring of the supervisory Staff of the Administrative Section for consideration by ICAR. Besides this, it made suggestions to implement a number of research activities for the improvement of lac cultivation on various lac hosts.

Another meeting of the committee was held on 15 October 1981. The committee recommended the enhancement of divisional contingent advance from Rs 200 to Rs 500 with annual ceiling of Rs 5000 and enhancement of the power of the Divisional Head to sanction purchase of a single item from Rs 100 to Rs 250. The committee also recommended enhancement of the amount of office imprest to Rs 5000.

**The Institute Technical Committee for Processing and Editing Annual Reports**

The Institute Technical committee was reconstituted vide office letter No. LR-A/291/81: 22 June 1981 to process and edit the Annual Reports of the Institute. The committee consists of six members including Chairman, Member-Secretary and members representing various Divisions. The committee was assigned the task of clearing the backlog of Annual Reports from 1973 onwards by holding frequent meetings. The Committee took up the processing and editing of Annual Reports for the year 1973, 1974-76 (combined), 1977 and 1978 and these reports were published during the period under report.

**Training and Advisory Services**

The Institute provides two courses of training of six month duration each on: (i) Improved methods of lac cultivation and (ii) Industrial uses of lac. The training is usually given to 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 taken advantage of International Technical cooperation schemes to provide specialized knowledge to its employees as well as to exchange technical know-how with foreign delegates. Accordingly seven scientists of the Institute have so far been provided advanced training in various disciplines under Colombo Plan. A delegation of three Vietnamese Scientists, sponsored by F.A.O., visited this Institute during October 1982 to study lac cultivation, pest control and export promotion, etc. The delegation was shown round the Institute Plantation and Entomology Division and held discussions with the various scientists individually and in groups.

The Institute has always sought to take advantage of technical know-how and facilities available in other Institutions 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 Committees of the Indian Standards Institution.

**Finance**

The Institute is being wholly financed by the Indian Council of Agricultural Research. The revised budget estimates of the Institute for the years 1981-82 and 1982-83 amounted to Rs 35·95 and Rs 41·18 lakhs under non-plan and Rs 13·55

and Rs 15·45 under plan respectively. The actual expenditure was Rs 35·65 and Rs 43·41 lakhs under non-plan and Rs 16·51 and Rs 19·52 lakhs under plan respectively.

**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 high officials, delegates, trainees from Institutions and other distinguished persons. Some of them are listed below:

1. Sri Rana Vir Singh, M.P.
2. Sri George Joseph Mundakal, M.P.
3. Sri Jagdish Jani, M.P.
4. Sri Hukumdeo Narayan Yadav, M.P.
5. Sri B. Satyanarayan Reddy, M.P.
6. Sri Jagpal Singh, M.P.
7. Sri Laxman Mallick, M.P.
8. Sri Daulat Ram Saran, M.P.
9. Sri Prof. A. K. Mehta, M.P.
10. Sri Yogendra Sharma, M.P.
11. Sri Ramavatar Shastri M.P.
12. Sri Narsing Baitha, M.P.
13. Sri J. Singh Kartar, M.P.
14. Dr Nguyen Dx. Kham, Forest Research Institute, Hanoi, Vietnam.
15. Dr Vu Biet Linh, Director of Forest, Forest Research Institute, Hanoi, Vietnam.
16. Mrs Naghi Nghiem Thi Yen, Documentation Officer, Forest Research Institute, Hanoi, Vietnam.
17. H. W. Gallaund, Secy., U.S.S.I.A.; (United State Shellac Importers Association), 46, Caphenin's Drive, Islip, N.Y. 11751-U.S.A.
18. Mr C. W. Langham, British Council, New Delhi.
19. Dr M. Alam, Architect, World Bank, Washington, D.C.
20. Dr N. Sawhney, Hope Hospital, Salford, U.K.
21. Dr C. K. Atal, Director, R.R.L., Jammu.
22. Sri S. K. Mukherjee, Emeritus Scientist, I.C.A.R., New Delhi.
23. Dr R. C. Badami, Emeritus Scientist, Deptt. of Chemistry, Karnataka University.
24. Sri P. Singh, World Bank, Washington, D.C.
25. Dr R. S. Agarwal, Head, Division of Entomology, I.A.R.I., New Delhi-110 012
26. Dr J. M. Satpathy, Prof. and Head, Deptt. of Entomology, O.U.A., Bhubaneshwar.

27. Sri S. S. Teotia, Director, Horticulture, U.P., Lucknow.
28. Sri C. B. L. Saxena, Deputy Sec. Ministry of Parliament Affairs, Govt. of India, New Delhi.
29. Dr H. C. Shrivastava, Deputy Director, Ahemedabad Textile Industries Research Association.
30. Dr A. K. Sinha, Sr. Scientists Soil Science, All India Coordinated Research Project for Dryland Agriculture, Hyderabad.
31. Sri G. C. P. Sinha, Deputy Secretary, Bihar State Planning Board.
32. Sri M. C. Pathak, Officer A.F.D., Syndicate Bank, Delhi Zone, Lucknow Region.
33. Dr J. L. Tandon, Deptt. of Hindi, D.A.V. College, Kanpur.
34. Dr Kirti Singh, Dean, NDVAT, Faizabad, U.P.
35. Sri S. Mitra, Joint Director of Industries, West Bengal.
36. Sri M. Kumar, M.D., RIADA, Ranchi and Addl. Director (Industries), Ranchi.
37. Sri R. K. Rangan, Staff Reporter, The Times of India, Bombay.
38. Lt. Col. J. Seal, Military Hospital, Namkum, Ranchi.
39. Dr (Mrs) Raikhi, Civil Surgeon, Sangrur, Punjab.
40. Prof. S. C. Mandal, Emeritus Scientist, Chairman, Quinquennial Review Team.

# 2. PROGRESS OF RESEARCH

## A. ENTOMOLOGY DIVISION

### (a) RESEARCHES COMPLETED

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

This investigation was taken up with a view to find out a suitable method of lac cultivation on *kusum* (Schleichera oleosa) in Madhya Pradesh. Two new cultivation schedules have successfully been tried to improve upon the existing 4-coupe system developed earlier at this Institute. These involve the use of one-year-old (Treatment A) and two-year-old (Treatment B) shoots for artificial inoculation in January and July seasons and raising the succeeding crop through self inoculation for harvesting once in two crop seasons. The crop performance is compared with those of the standard 4-*coupe* system involving the use of one and a half year old shoots with artificial inoculation and complete harvesting in each crop season (Treatment C) and the villagers' practice of keeping the trees continuously under lac through partial harvest in each crop season (Treatment D).

The experiment was concluded with the harvest of *aghani* 1981-82 crop. The data are presented in Table 1. It will be seen from the table that the crops, in general, were rather poor, however the new cultivation practices tried did not show any significant improvement over the standard 4-*coupe* system.

(J. M. Dasgupta, B. P. Mehra, R. L. Tripathi and B. N. Sah)

TABLE 1 — CROP PERFORMANCE UNDER DIFFERENT CULTIVATION PRACTICES TRIED FOR *kusum* AT DHARAMJAIGARH (M.P.)

| Crop | Treatment | No. of crops raised | Brood used (kg) | | Yield (kg) | | Crop ratio* |
|---|---|---|---|---|---|---|---|
| | | | Lac stick | Sticklac | Lac stick | Sticklac | |
| | | | January-January cycle | | | | |
| *Jethwi*-cum-*aghani* Crops | A | 11 | 27·57 | 11·247 | 8·84 | 6·37 | 1:0·56 |
| | B | 7 | 33·99 | 12·33 | 6·76 | 8·72 | 1:0·71 |
| | C | 17 | 48·39 | 14·42 | 16·09 | 11·12 | 1:0·78 |
| | D | — | 32·02 | 10·30 | 3·74 | 4·41 | 1:0·43 |
| | | | July-July cycle | | | | |
| *Aghani*-cum-*jethwi* Crop | A | 7 | 27·157 | 6·43 | 8·51 | 5·65 | 1:0·87 |
| | B | 7 | 32·88 | 7·67 | 4·08 | 1·49 | 1:0·30 |
| | C | 18 | 48·70 | 14·30 | 15·90 | 10·40 | 1:0·72 |
| | D | — | 27·77 | 8·33 | 4·77 | 1·68 | 1:0·02 |

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

### 1.5.5 Cytological studies in lac insects

Earlier cytological studies of the Indian Lac insect *Kerria lacca* (Kerr) led to contradictory reports of its chromosome system. A reinvestigation was, therefore, undertaken to resolve this controversy through further cytological observatiions and radiation analysis. The findings are as follows:

#### Cytological observations

The embryos and the gut and malphigian tubules of the first, second and third instar larvae of the lac insects could be classified into two groups: (i) those having a prominent heterochromatic body in the Interphase nucleus and (ii) those without the heterochromatin in any nucleus. This, in the latter stages of these insects, could be related to their sex, the former with the male and the latter with the female. Cytologically, therefore, the lac insect could be differentiated into male or female depending upon the presence or absence of heterochromatic body in the Interphase nucleus. In the male insect, all the Metaphase plates showed the presence of one euchromatic and another heterochromatic sets of chromosomes whereas in the female, both the chromosome sets were euchromatic.

The diploid chromosome number was $2n = 18$ in both the sexes and a diffused centromeric activity was observed as also reported earlier. The nuclei of the malphigian tubules and the gut showed size variation and some of these appeared to be polyploid. Interestingly, in the polyploid nuclei the number of heterochromatic bodies was 2-3 which in relation to the number of euchromatic chromosomes appeared smaller.

Spermatogenesis also showed a typical lecanoid system, as meiosis in this insect also leads to a tetranucleate stage with two heterochromatic and two euchromatic nuclei and the sperms develop only around the euchromatic nuclei.

#### Radiation analysis

The males were X-irradiated at 1, 2, 4 and 6 kR in the pupal stage. The adults, on emergence, were each mated to a virgin female and the resulting progenies each reared separately and scored for the progeny size and sex ratio.

Although the X-irradiation resulted in considerably reduction of the size of progeny, the data for sex ratio did not show any consistent trend.

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

## (b) RESEARCHES ON HAND

### 1.1 Lac Cultivation Studies

### 1.1.8 Studies on the possibility of lac cultivation on *palas* and *khair* in alternation

*Khair* (*Acacia catechu*) is raised on a plantation basis by the Forest Department for *katha* production and is also a good lac host particularly for raising the rainy season crops (*katki* and *aghani*). Thus, lac cultivation trials were taken up in 1981 for using *khair* in alternation with the *rangeeni* host *palas* (*Butea monosperma*), the former for the *katki* crop and the latter for the *baisakhi*.

*Katki* 1981

Fifty *khair* trees were pruned in April 1981 and inoculated in the following July to raise the *katki* crop using *palas* brood lac (63·8 kg). A set of 10 *palas* trees was also inoculated with *palas* brood lac (11·9 kg) for comparison. The crop was sprayed with Thiodan® (0·05 per cent) once at the time of *phunki* removal and again during the second week of September to check the predatory activity. The crop was harvested at maturity. The crop ratio (brood lac used to yield in terms of stickac) was 1:3·4 on *khair* as against 1:0·9 on *palas*. Thus, the crop performance was far better on *khair* than on *palas* in the *katki* 1981 season. It was also found that the female lac insect was more fecund (378 larvae per female) on *khair* than on *palas* (216 larvae per female).

*Baisakhi* 1981-82

The crop was raised on *palas* trees using the brood lac obtained from *khair*. Another set of *palas* trees was inoculated with *palas* brood lac for comparison. The brood rates tried were 0·25, 0·50, 0·75 and 1·0 kg/tree. The crop raised with *palas* broodlac totally failed whereas that raised with *khair* brood lac was also not satisfactory. The lac yield showed no improvement with the increase in brood rate.

*Katki* 1982

The crop was raised on *khair* with *khair* × *palas* broodlac using the brood rates tried earlier. A set of *palas* trees was also inoculated with *palas* brood lac for comparison. The crop was, however, poor.

(P. Sen and R. Ramani)

**1.2 Physiological Studies on Lac Insects and Associated Insects**

**1.2.1 Nutritional requirement of predators, *Eublemma amabilis* and *Holcocera pulverea* and evolution of a suitable artificial diet**

Kept in abeyance.

**1.2.2 Evolution of a suitable synthetic diet for artifical rearing of lac insects**

Kept in abeyance.

**1.2.3 Isolation and identification of micro-organisms present in the lac insect and determination of roles played by them in metabolism and resin secretion**

Kept in abeyance.

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

Kept in abeyance.

**1.2.5 Studies on some physiological aspects of lac insect in relation to host plants**

This study was taken up in 1981 to study the effect of the application of fertilisers to the host plants individually and in combination on the overall performance of lac insect.

The programme involved study of the growth and development of lac insects on *bhalia* plants raised in earthen pots by sowing or transplanting with the following fertilizer treatments:

| *Treatment* | *Fertilizer application* |
|---|---|
| A | Urea+phosphate+potash |
| B | Potash+phosphate |
| C | Phosphate |
| D | Control (no fertilizer) |

The lac insects were reared with the October inoculation, and twenty transplanted *bhalia* plants raised under the different treatments. They however, suffered heavy mortality within 4 weeks under Treatments B, C and D.

(A. H. Naqvi)

**1.2.6 Biochemical studies on lac insects to ascertain strain differences**

This investigation was taken up in 1981 to ascertain the biochemical differences between the *rangeeni* and *kusmi* strains of the lac insect, *Kerria lacca* (*Kerr*).

The lipoids were extracted from the lac insect crawlers (*rangeeni*) obtained from the *katki* 1981 broodlac by the Soxhlet extraction technique using methanol: chloroform (2:1 v/v), over water bath at 80-85°C for 1·5 hr.

The orange coloured extract was decolourised with activated charcoal and filtered. The residue was washed several times with the above solvent for complete extraction. The clear filtrate on cooling to 10-12°C for 12 hr gave a white precipitate (Part I) which was filtered out and retained for study. The filtrate was then evaporated on a water bath for removal of the solvents. The residual substance on cooling to 10-12°C yielded a semi solid sticky mass (Part II) and a light yellow oily liquid (Part III). The physical characteristics of the three fractions obtained as above are given in Table 2.

(A. K. Sen and R. Ramani)

TABLE 2 — PHYSICAL CHARACTERISTICS OF THE FRACTIONS OF THE LIPOIDS EXTRACTED FROM THE *rangeeni* LAC INSECT CRAWLERS

| Fr. No. | Appearance | Solubility | Melting point | Rf values in solvent systems | | |
|---|---|---|---|---|---|---|
| | | | | Trichloro-ethylene: chloroform: acetic acid 70: 28: 0·05 v/v | Chloroform: acetic acid 96: 4 v/v | Chloroform: methanol 97: 3 v/v |
| 1. | White precipitate waxy in nature | Soluble in ether, chloroform and benzene | 40°C | No movement | 0·87 | 0·86 |
| 2. | Dark yellow semi solid sticky substance at 20-25°C | Insoluble in above solvents | — | No movement | 0·82 | 0·75 |
| 3. | Light yellow oily liquid at room temp. but solid waxy crystals at 10-12°C | Soluble in above solvents | — | No movement | 0·84 | 0·78 |

### 1.2.7 Histophysiology of lac glands

The study was taken up in 1981 to gain knowledge of the physiological aspects of epidermal glands and biosynthetic pathways of their secretions using histochemical techniques.

Sections of the adult female lac insects, using paraffin as the embedding medium, were studied using different stains. Morphology of some of the non-resinous glands has been found to conform to the earlier findings whereas that of resin glands revealed additional subcellular structural features.

Preliminary investigation has confirmed the presence of alcohol-insoluble dorsal relic. Scanning electron microscopic study has shown that this secretion is not confined to the dorsal region as reported earlier but is found all over the body, although it is most conspicuous on the dorsal surface. Topographical studies of the adult female of *K. lacca* have shown the following features: (i) the dorsal spiracle remains at its base when the corresponding branchium is elongate; (ii) the broad rim of the branchial plate is interrupted at the point of its association with the dorsal spiracle and two bands of reticular patterns extend along either side of the dorsal spiracle in which the pores of the glands of caveara secretion are located; (iii) the crater of the branchial plate consists of numerous tiny pits in which branchial mass secreting cells open. The bigger 'dimples' lead to large cuticular ducts of branchial core secreting cells. The broad rim of the branchial plate contains some openings of irregular outline.

The anus is situated on top of a papilla at the centre of the anal ring. The pores of anal wax filament glands located on tiny papilliform processes showing interesting cuticular patterns are distributed amidst the circle of anal setae on the anal ring. The anal tubercle shows constrictions at two places one at the base and another at the middle thus dividing it into two segments. The penultimate segment bears the vulva ventrally. Cuticular plaits radiate from the vulva with numerous irregular folds between them.

The perivaginal pore clusters show a U-shaped distribution pattern around the base of the anal tubercle. Each cluster is composed of several locules, each of which appeas as a circular depression showing a flower-like pattern.

The openings of the resin secreting glands are simple, minute and do not involve any cuticular modification.

The six marginal pore clusters form a girdle around the insect dividing it into two aspects, the oral and the aboral. Each cluster is in the form of two semicircular strips of specialized cuticlar areas juxtaposed to form a W-like pattern. Large openings of the gland secreting stalked girdle fibres, arranged singly or in small groups, occur in this region in association with a complex net work of cuticular ridges into which the non-stalked girdle fibre secreting glands open (Fig. 1).

(R. Ramani)

### 1.2.8 Laccaic acid as a biological stain

The study was taken up in 1982 to find out the possible use of the water soluble lac dye, laccaic acid, as a biological stain.

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Fig. 1 — Scanning electron micrographs of adult female of *Kerria lacca* (Kerr.) [(a) Branchium showing the "dimples" and the openings of wax secreting glands on either side of the dorsal spiracle; (b) Branchial depression showing the openings of the waxy pencil secreting cells and branchial mass secreting cells; (c) Aboral aspect of the insect showing the dorsal spine and branchia; (d) Close-up view of the marginal pore clusters]

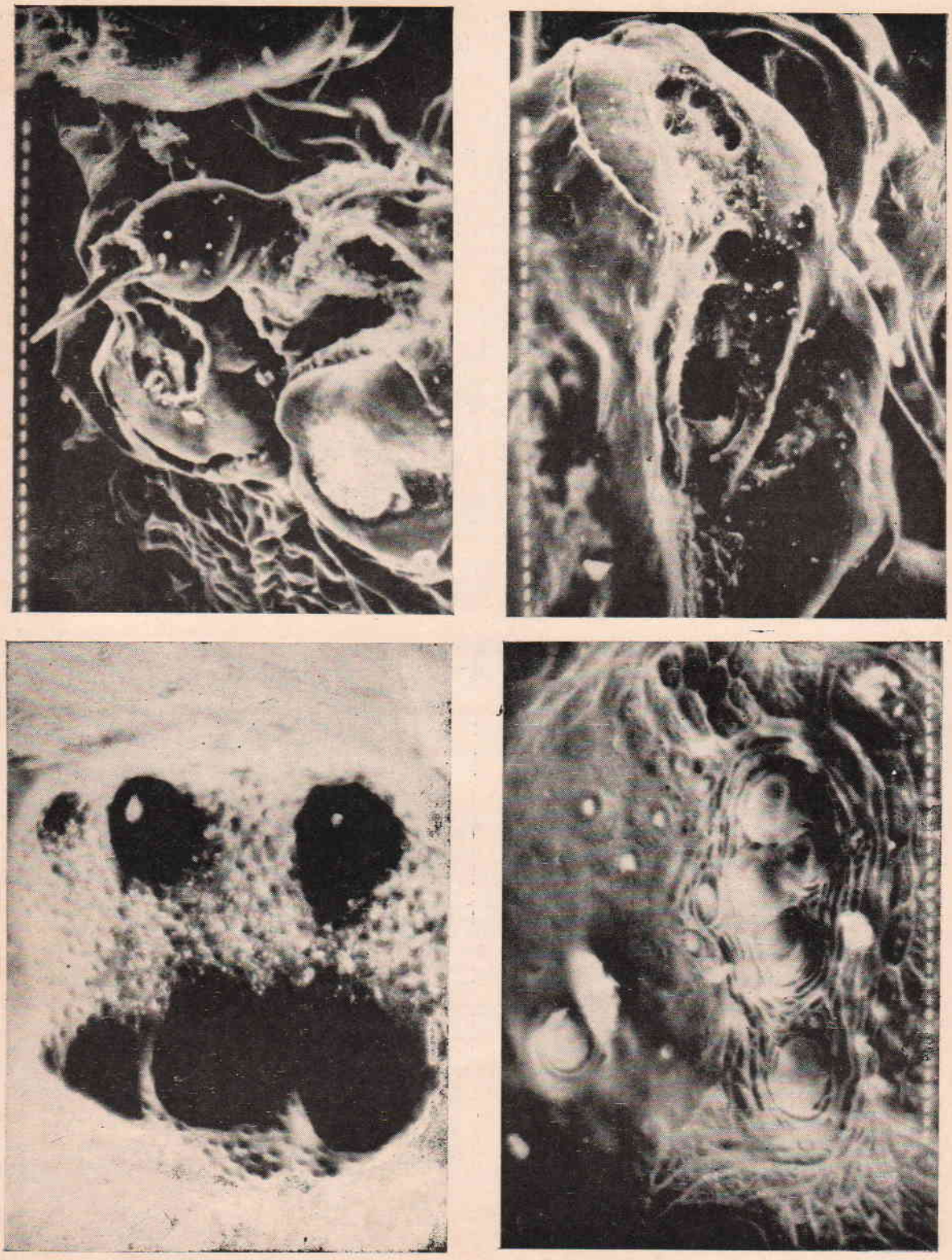

Fig. 1a-d

Several aqueous and alcoholic formulations of laccaic acid were prepared and tested on sections of the crop of the American cockroach, *Periplaneta americana*, human buccal smear and onion root tips as a nuclear stain. The results have been encouraging with the use of acidified alcoholic solution of lac dye post-chromed in iron alum.

Later, more satisfactory results were obtained with the formulation using aluminium as a probable chelating agent and aniline blue as a counter stain when tried on the tissues of the crop of the American cockroach. The nuclei were stained red and the cytoplasm light pink.

(R. Ramani)

## 1.3 Ecological Studies on Lac Insects and Associated Insects

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

The Regional Field Research Station at Dharamjaigarh (M.P.) continued to function during the period under report. The progress made under the various items of investigation is reported below:

(a) *Investigation on indigenous plant species for use as alternate hosts to supplement kusmi lac production in the region*

*Jethwi* 1981

Three trees each of *jhera* (*Ficus* sp.) and *dumar* were inoculated. Only a poor crop was obtained.

*Jethwi* 1982

This crop raised on two trees each of *sarai, sendha, dhaona, jhera* and *bargad* failed due to total mortality of the lac insects.

*Aghani* 1982-83

Two trees each of all the five species used during the *jethwi* 1982 were inoculated for raising the *aghani* 1982-83 crop. The crop failed on all the trees.

(b) *To study the performance of kusmi broodlac from different sources*

This investigation was taken up in 1981 to determine the relative performance of *kusmi* broodlac originating from different states at the field station. The experiment was laid out on a randomised block design with two *kusum* trees under each treatment and 5 replications. Lac cultivation is being carried out on the standard 4-*coupe* system.

*Aghani* 1981-82

This crop was raised using the brood lac obtained from three states. The results were as follows:

| *Source of brood* | *Brood lac used: Brood lac obtained* (lac sticks) | *Brood lac used: Total yield* (sticklac) |
|---|---|---|
| Bihar (Ranchi) | 1:0·216 | 1:0·56 |
| Orissa (Kalahandi) | 1:0·156 | 1:0·62 |
| Madhya Pradesh (Raigarh) | 1:0·330 | 1:0·79 |

*Jethwi* 1982

This crop was raised using brood lac collected from West Bengal (Purulia), Bihar (Ranchi), Madhya Pradesh (Raigarh) and Orissa (Kalahandi). The crops raised gave good yield and the crop performance was best with the brood lac of Madhya Pradesh:

| *Source of brood* | *Brood lac used: Brood lac obtained* (lac sticks) | *Brood lac used: Total yield* (sticklac) |
|---|---|---|
| Bihar (Ranchi) | 1:1·585 | 1:1·322 |
| Orissa (Kalahandi) | 1:0·068 | 1:0·058 |
| Madhya Pradesh (Raigarh) | 1:1·772 | 1:2·373 |
| West Bengal (Purulia) | 1:1·162 | 1:1·456 |

*Aghani* 1982-83

The brood lac could be obtained only from Bihar (Ranchi) and Madhya Pradesh (Raigarh). The crop was raised on 10 trees with brood lac from each state and harvested in December 1982. The crop data are being collected.

(B. N. Sah and J. M. Dasgupta)

**1.2.8 Studies on the factors affecting *rangeeni* lac insect population**

In order to study the population trend, key mortality factors and sampling considerations, preliminary sampling of field populations of *rangeeni* lac insects on *palas* was continued during the *baisakhi* 1980-81, *katki* 1981, *baisakhi* 1981-82 and *katki* 1982 crops as per the programme reported earlier (A.R.: 1979 and 1980). The apparent mortality data have shown that major mortality of these insects in both the crops takes place probably due to starvation in the crawler stage. Subsequently, this major mortality was recorded during the post metamorphic stage of the female due to both predation and parasitism in the *katki* and due to only predation in the *baisakhi* crop. A very small proportion of the insects was found to survive till the end of crop maturity.

Fungal mortality was observed in a few insects from second instar onwards. Efforts are being made to culture the fungus for identification and pathogenicity tests.

Studies made for sampling considerations showed that the lac insect population and their main mortalities were not affected in general by the canopy levels and the shoot portion except in the *baisakhi* 1981-82 crop in which a decreasing trend on the population size was noted from basal to apical portion before sexual maturity. However, inter-tree variation appeared to be significant.

(D. C. Srivastava)

**1.3.9 Studies on lac larval settlement and factors affecting it**

The experiment on potted *bhalia* plants using inclinations of 0°, 45°, 60° 75° and 90° from the ground level from east to west was continued with 5 plants under each. The total number of lac larvae settled and the shoot area covered were scored on each plant. The data collected during the *baisakhi* 1981-82 and 1982-83 crops indicated that the lac insect settlement was maximum on shoots inclined at

75°. The *baisakhi* crop raised under the field experiment on *palas* at Kundri as reported earlier (A.R. 1979 and 1980) was harvested as *ari* (immature) in May. The yield of sticklac was 5·3, 4·8 and 5·4 kg in the three groups of trees in which the shoots were tied facing upwards, facing downwards and undisturbed respectively.

(Y. D. Mishra)

### 1.3.10 Abundance of lac pests in relation to different agro-climatic situations and lac insects of different places

This investigation was taken up in 1982. Five locations of Chotanagpur, namely, Namkum, Khunti, Mako, Kundri and Malichak were selected. Fifteen *palas* trees were taken and divided into three groups. The *baisakhi* 1981-82 crop at maturity was sampled from these locations except Lota by collecting sample of these lac-bearing twigs from each tree. The samples of each group were then caged separately and the emergence therefrom of insect was recorded. The data on total number of lac insect parasitoids and predators are given in Table 3. The results show interesting locational differences in the abundance of lac insect parasitoids and predators.

The study was continued in the following *katki* 1982 crop. The samples were collected and caged at sexual maturity and crop maturity of the lac insects. The data are being collected.

(D. C. Srivastava)

TABLE 3 — ABUNDANCE OF THE INIMICAL INSECTS FROM MATURE LAC STICKS OF *baisakhi* 1981-82 CROP ON *palas* IN DIFFERENT LOCATIONS OF CHOTANAGPUR

| Location | Mean number per metre of lac stick | |
|---|---|---|
| | Predators | Parasitoids |
| Namkum | 43·93 | 19·77 |
| Khunti (Salga) | 39·93 | 12·66 |
| Kundri | 10·66 | 14·74 |
| Mako | 19·86 | 26·43 |
| Malichak | 6·66 | 1·79 |

## 1.4 Control of Enemies of Lac Insects

### 1.4.1.2 Field trials of integrated control schedules against the lac predators

This investigation was taken up in 1981, The study has been based on the conclusions of the projects 1.4.1 and 1.4.2. The experiment is being carried out in the *baisakhi*-cum-*katki* crop. It is laid out on a randomized block design at the Kundri lac orchard (Palamau) with the following treatments each tried on 50 *palas* trees with 3 replications.

| *Treatment* | *Pest control schedule* |
|---|---|
| A | Spraying of 0·05% Thiodan® in June-July. |
| B | Heavy inoculation of 1/5th of the total number of trees in October-November and another set of 1/5th of the trees in June-July along with normal inoculations of the remaining 3/5th trees. |
| C | Delaying of crop inoculation by 15 days. |
| AB | Raising of the crop as in Treatment B with spraying of 0·05% Thiodan(®) on the normally inoculated crop. |
| AC | Raising of crop as in Treatment C and spraying with Thiodan® as in Treatment A. |
| BC | Raising of crop on 2/5th of the total number of trees as in Treatment B and on the remaining 3/5th as in Treatment C. |
| ABC | Raising of crop on 2/5th of the total number of trees as in Treatment B and remaining 3/5 as in Treatment C with Treatment A. |
| *Control* | Raising of normally inoculated crop. |

The entire experimental area has been divided into 2 coupes each including more than 1200 *palas* trees. *Palas* trees (1200) were pruned in April 1982, of which 1080 trees were inoculated in Nov. 1982. The crop data will be collected in October-November 1983.

(S. G. Choudhary)

### 1.4.3 Relative toxicity of newer synthetic insecticides and plant poisons to predators and parasites vis-a-vis lac insect

### 1.4.3(i) Screening of the insecticides for their safety to the lac insects and toxicity to the lac predators

*Baisakhi* 1980-81 *crop on bhalia* (*Moghania macrophylla*) *at Amjharia*

Ten insecticides, namely, Dimecron (Phosphamidon), Padan (Cartap hydrochloride), Evisect (Thiocyclam hydrogen oxalate), dipterex, methoxychlor, sevin, quinalphos, dimethoate, sumithion and sumicidine in various concertrations were tried with three bushes in each treatment. Tween 80 at 0·05 per cent concentration was used as an emulsifier. Insecticides causing corrected percentage mortalities up to 15 per cent have been taken as safe. Padan, Dimecron, methoxychlor proved completely safe to the lac insect at the times of *phunki* removal and sexual maturity whereas Evisect, dipterex and sevin were safe upto 4-week-stage. Quinalphos and dimethoate were safe to 18-week-old lac insect and not to 4-week-old one (Tables 4a and 4b).

TABLE 4(a)— SCREENING OF INSECTICIDES

Crop: *Baisakhi* 1980-81
Date of inoculation: 24 October 1980
Date of *phunki* removal: 15 November 1980
Date of spraying: 7 December 1980 (22-44 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 201 | 26·86 | — |
| | 0·0125 | 278 | 29·60 | — |
| | 0·025 | 257 | 17·30 | — |
| Dimecron | 0·00625 | 253 | 23·69 | — |
| | 0·0125 | 253 | 8·33 | — |
| | 0·025 | 257 | 17·30 | — |
| Methoxychlor | 0·0125 | 259 | 18·00 | — |
| | 0·025 | 222 | 16·48 | — |
| | 0·05 | 230 | 19·28 | — |
| Diptrex | 0·00625 | 250 | 23·36 | — |
| | 0·0125 | 247 | 22·07 | — |
| | 0·025 | 242 | 23·73 | — |
| Evisect | 0·00625 | 263 | 22·96 | — |
| | 0·0125 | 213 | 17·69 | — |
| | 0·025 | 244 | 22·42 | — |
| Sevin | 0·025 | 278 | 17·55 | — |
| | 0·05 | 288 | 28·42 | — |
| | 0·1 | 247 | 35·29 | 9·02 |
| Quinalphos | 0·0125 | 169 | 31·30 | 3·41 |
| | 0·025 | 234 | 42·94 | 19·78 |
| | 0·05 | 217 | 54·66 | 36·25 |
| Dimethoate | 0·00625 | 252 | 30·19 | 1·85 |
| | 0·0125 | 307 | 40·25 | 15·99 |
| | 0·025 | 274 | 73·96 | 63·39 |
| Sumicidin | 0·00625 | 212 | 21·12 | — |
| | 0·0125 | 276 | 20·56 | — |
| | 0·025 | 252 | 75·20 | 65·13 |
| Sumithion | 0·00625 | 213 | 34·18 | 7·46 |
| | 0·0125 | 236 | 47·88 | 26·72 |
| | 0·025 | 343 | 50·55 | 30·47 |
| Emulsified water control | 0·05 | 875 | 28·87 | — |

TABLE 4(b)— SCREENING OF INSECTICIDES

Crop: *Baisakhi* 1980-81
Date of inoculation: 24 October 1980
Date of *phunki* removal: 15 November 1980
Date of spraying: 9 March 1981 (114-136 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 116 | 75·96 | — |
| | 0·0125 | 99 | 80·36 | 4·38 |
| | 0·025 | 91 | 78·26 | — |
| Dimecron | 0·00625 | 103 | 62·30 | — |
| | 0·0125 | 131 | 71·66 | — |
| | 0·025 | 83 | 61·22 | — |
| Methoxychlor | 0·0125 | 90 | 62·91 | — |
| | 0·025 | 100 | 78·46 | — |
| | 0·05 | 82 | 70·90 | — |
| Dipterex | 0·00625 | 63 | 85·72 | — |
| | 0·0125 | 95 | 75·22 | — |
| | 0·025 | 103 | 73·73 | — |
| Evisect | 0·00625 | 101 | 89·77 | 50·01 |
| | 0·0125 | 108 | 88·28 | 42·94 |
| | 0·025 | 123 | 77·97 | — |
| Sevin | 0·025 | 111 | 84·06 | 22·39 |
| | 0·05 | 124 | 86·69 | 35·19 |
| | 0·1 | 98 | 65·28 | — |
| Quinalphos | 0·0125 | 138 | 79·72 | — |
| | 0·025 | 97 | 81·70 | 10·90 |
| | 0·05 | 95 | 68·75 | — |
| Dimethoate | 0·00625 | 102 | 64·95 | — |
| | 0·0125 | 105 | 59·81 | — |
| | 0·025 | 110 | 72·93 | — |
| Sumicidin | 0·00625 | 157 | 76·39 | — |
| | 0·0125 | 106 | 51·41 | — |
| | 0·025 | 106 | 71·79 | — |
| Sumithion | 0·00625 | 131 | 82·19 | 13·29 |
| | 0·0125 | 122 | 83·76 | 20·93 |
| | 0·025 | 134 | 77·00 | — |
| Emulsified water control | 0·05 | 292 | 79·46 | — |

*Jethwi* 1981 *crop*

Of the ten insecticides screened, none was found safe up to 4-week-old lac nymphs whereas Dimecron was safe to 29-51 days old lac nymphs (Tables 4c and 4d).

TABLE 4(c) — SCREENING OF INSECTICIDES

Crop: *Jethwi* 1981
Date of inoculation: 4 February 1981
Date of *phunki* removal: 25 February 1981
Date of spraying: 8 March 1981 (12-33 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 250 | 71·91 | 11·72 |
| | 0·0125 | 245 | 63·11 | — |
| | 0·025 | 250 | 63·33 | — |
| Dimecron | 0·00625 | 238 | 78·39 | 32·08 |
| | 0·0125 | 344 | 77·29 | 28·62 |
| | 0·025 | 252 | 62·65 | — |
| Methoxychlor | 0·0125 | 200 | 70·81 | 8·26 |
| | 0·025 | 236 | 75·32 | 22·43 |
| | 0·025 | 224 | 65·38 | — |
| Dipterex | 0·00625 | 262 | 61·26 | — |
| | 0·0125 | 226 | 53·03 | — |
| | 0·025 | 243 | 89·79 | 67·91 |
| Evisect | 0·00625 | 209 | 76·48 | 26·08 |
| | 0·0125 | 226 | 53·03 | — |
| | 0·025 | 217 | 70·77 | 8·13 |
| Sevin | 0·025 | 274 | 69·98 | 5·65 |
| | 0·05 | 180 | 67·14 | — |
| | 0·1 | 231 | 84·15 | 50·18 |
| Quinalphos | 0·0125 | 259 | 89·44 | 66·81 |
| | 0·025 | 222 | 86·43 | 57·35 |
| | 0·05 | 207 | 89·68 | 67·56 |
| Dimethoate | 0·00625 | 222 | 76·18 | 25·14 |
| | 0·0125 | 189 | 75·50 | 23·00 |
| | 0·025 | 224 | 89·78 | 67·88 |
| Sumicidin | 0·00625 | 210 | 80·25 | 37·93 |
| | 0·0125 | 277 | 93·04 | 78·12 |
| | 0·025 | 195 | 98·55 | 95·44 |
| Sumithion | 0·00625 | 229 | 91·08 | 71·96 |
| | 0·0125 | 225 | 93·36 | 79·13 |
| | 0·025 | 180 | 84·54 | 51·41 |
| Emulsified water control | 0·05 | 588 | 68·18 | — |

TABLE 4(d)— SCREENING OF INSECTICIDES

Crop: *Jethwi* 1981
Date of inoculation: 16 January 1981
Date of *phunki* removal: 7 February 1981
Date of spraying: 8 March 1981 (29-51 days old lac symphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 294 | 68·58 | — |
| | 0·0125 | 275 | 68·18 | — |
| | 0·025 | 338 | 79·69 | 27·17 |
| Dimecron | 0·00625 | 353 | 58·90 | — |
| | 0·0125 | 359 | 69·18 | — |
| | 0·025 | 316 | 69·43 | — |
| Methoxychlor | 0·0125 | 333 | 80·97 | 31·76 |
| | 0·025 | 318 | 76·83 | 16·92 |
| | 0·05 | 268 | 77·55 | 19·50 |
| Dipterex | 0·00625 | 242 | 70·62 | — |
| | 0·0125 | 250 | 67·57 | — |
| | 0·025 | 236 | 77·50 | 19·32 |
| Evisect | 0·00625 | 244 | 76·62 | 16·17 |
| | 0·0125 | 238 | 67·82 | — |
| | 0·025 | 256 | 71·40 | — |
| Sevin | 0·025 | 314 | 63·02 | — |
| | 0·05 | 321 | 78·06 | 21·33 |
| | 0·1 | 314 | 79·75 | 27·39 |
| Quinalphos | 0·0125 | 281 | 84·50 | 44·42 |
| | 0·025 | 242 | 70·27 | — |
| | 0·05 | 203 | 86·49 | 51·55 |
| Dimethoate | 0·00625 | 227 | 78·23 | 21·94 |
| | 0·0125 | 220 | 78·28 | 22·12 |
| | 0·025 | 196 | 82·95 | 38·86 |
| Sumicidin | 0·00625 | 242 | 85·90 | 49·44 |
| | 0·0125 | 255 | 86·69 | 52·27 |
| | 0·025 | 240 | 91·38 | 69·09 |
| Sumithion | 0·00625 | 259 | 80·82 | 31·22 |
| | 0·0125 | 234 | 67·25 | — |
| | 0·025 | 261 | 77·26 | 18·46 |
| Emulsified water control | 0·05 | 888 | 72·11 | — |

*Katki* 1981 *crop*

Dimecron, Padan, quinalphos, dipterex, Evisect and methoxychlor were found completely safe to 4-week-old lac nymphs (Table 4e).

TABLE 4(e)— SCREENING OF INSECTICIDES

Crop: *Katki* 1981
Date of inoculation: 21 July 1981
Date of *phunki* removal: 4 August 1981
Date of spraying: 27 August 1981 (23-37 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 216 | 46·30 | — |
| | 0·0125 | 180 | 40·56 | — |
| | 0·025 | 255 | 47·85 | — |
| Dimecron | 0·00625 | 242 | 38·43 | — |
| | 0·0125 | 248 | 42·34 | — |
| | 0·025 | 220 | 58·64 | 4·74 |
| Methoxychlor | 0·0125 | 220 | 60·00 | 7·87 |
| | 0·025 | 230 | 50·44 | — |
| | 0·05 | 190 | 61·58 | 11·51 |
| Dipterex | 0·00625 | 188 | 40·96 | — |
| | 0·0125 | 207 | 37·69 | — |
| | 0·025 | 206 | 39·81 | — |
| Evisect | 0·00625 | 190 | 39·48 | — |
| | 0·0125 | 217 | 51·16 | — |
| | 0·025 | 183 | 42·08 | — |
| Sevin | 0·025 | 198 | 68·69 | 27·89 |
| | 0·05 | 182 | 47·26 | — |
| | 0·1 | 190 | 50·52 | — |
| Quinalphos | 0·0125 | 198 | 48·49 | — |
| | 0·025 | 202 | 49·51 | — |
| | 0·05 | 223 | 57·40 | 1·88 |
| Dimethoate | 0·00625 | 200 | 69·50 | 29·75 |
| | 0·0125 | 216 | 71·30 | 33·90 |
| | 0·025 | 280 | 92·50 | 82·72 |
| Sumicidin | 0·00625 | 218 | 69·73 | 30·28 |
| | 0·0125 | 230 | 63·92 | 16·90 |
| | 0·025 | 206 | 70·39 | 31·80 |
| Sumithion | 0·00625 | 260 | 68·41 | 27·24 |
| | 0·0125 | 172 | 58·73 | 4·95 |
| | 0·025 | 186 | 70·44 | 31·92 |
| Emulsified water control | 0·05 | 608 | 56·58 | — |

*Aghani* 1981-82 *crop*

Padan, dipterex, methoxychlor, sevin and Evisect proved completely safe to lac insect at the times of *phunki* removal whereas sevin, methoxychlor, Padan, dipterex, Evisect, quinalphos, dimethoate and sumithion at the time of sexual maturity (Tables 4f and 4g).

TABLE 4(f)— SCREENING OF INSECTICIDES

Crop: *Aghani* 1980-81
Date of inoculation: 25 June 1981
Date of *phunki* removal: 16 July 1981
Date of spraying: 13 August 1981 (28-49 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 160 | 55·63 | — |
| | 0·0125 | 147 | 63·64 | 6·14 |
| | 0·025 | 157 | 47·78 | — |
| Dimecron | 0·00625 | 190 | 78·77 | 47·47 |
| | 0·0125 | 195 | 62·42 | 2·81 |
| | 0·025 | 165 | 32·73 | — |
| Methoxychlor | 0·0125 | 182 | 54·40 | — |
| | 0·025 | 127 | 52·76 | — |
| | 0·05 | 122 | 50·00 | — |
| Dipterex | 0·00625 | 144 | 37·50 | — |
| | 0·0125 | 154 | 66·24 | 13·24 |
| | 0·025 | 140 | 34·29 | — |
| Evisect | 0·00625 | 166 | 44·58 | — |
| | 0·0125 | 133 | 55·64 | — |
| | 0·025 | 145 | 62·07 | 1·85 |
| Sevin | 0·025 | 164 | 41·47 | — |
| | 0·05 | 215 | 51·63 | — |
| | 0·1 | 184 | 51·64 | — |
| Quinalphos | 0·0125 | 183 | 47·55 | — |
| | 0·025 | 170 | 57·06 | — |
| | 0·05 | 213 | 46·48 | — |
| Dimethoate | 0·00625 | 167 | 62·17 | 2·13 |
| | 0·0125 | 160 | 53·75 | — |
| | 0·025 | 177 | 58·20 | — |
| Sumicidin | 0·00625 | 170 | 56·48 | — |
| | 0·0125 | 148 | 45·95 | — |
| | 0·025 | 150 | 80·00 | 50·83 |
| Sumithion | 0·00625 | 147 | 32·66 | — |
| | 0·0125 | 124 | 44·36 | — |
| | 0·025 | 140 | 47·15 | — |
| Emulsified water control | 0·05 | 246 | 61·39 | — |

TABLE 4(g)— SCREENING OF INSECTICIDES

Crop: *Aghani* 1981-82
Date of inoculation: 25 June 1981
Date of *phunki* removal: 16 July 1981
Date of spraying: 23 July 1981 (8-29 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 250 | 35·20 | — |
| | 0·0125 | 257 | 49·03 | — |
| | 0·025 | 223 | 36·78 | — |
| Dimecron | 0·00625 | 288 | 60·07 | 23·15 |
| | 0·0125 | 273 | 65·21 | 31·32 |
| | 0·025 | 285 | 55·44 | 12·04 |
| Methoxychlor | 0·0125 | 300 | 48·67 | — |
| | 0·025 | 250 | 49·60 | — |
| | 0·05 | 230 | 49·57 | — |
| Dipterex | 0·00625 | 252 | 50·00 | 1·30 |
| | 0·0125 | 270 | 42·97 | — |
| | 0·025 | 307 | 45·28 | — |
| Evisect | 0·00625 | 245 | — | — |
| | 0·0125 | 254 | 49·22 | — |
| | 0·025 | 273 | 52·75 | 6·73 |
| Sevin | 0·025 | 256 | 55·47 | 12·10 |
| | 0·05 | 214 | 45·46 | — |
| | 0·1 | 238 | 54·63 | 10·44 |
| Quinalphos | 0·0125 | 284 | 62·33 | 25·64 |
| | 0·025 | 222 | 40·10 | — |
| | 0·05 | 210 | 50·96 | 3·19 |
| Dimethoate | 0·00625 | 246 | 45·94 | — |
| | 0·0125 | 232 | 50·00 | 1·30 |
| | 0·025 | 205 | 77·08 | 54·75 |
| Sumicidin | 0·00625 | 272 | 53·31 | 7·83 |
| | 0·0125 | 254 | 48·04 | — |
| | 0·025 | 270 | 61·86 | 24·71 |
| Sumithion | 0·00625 | 193 | 24·88 | — |
| | 0·0125 | 246 | 58·95 | 18·96 |
| | 0·025 | 262 | 68·63 | 38·07 |
| Emulsified water control | 0i05 | 377 | 49·34 | — |

*Baisakhi* 1981-82 *crop*

Of the ten insecticides screened, only seven namely, Evisect, dipterex, Dimecron, Padan, methoxychlor, sevin and quinalphos were found safe to 16-day-old lac nymphs (Table 4h).

TABLE 4(h)— SCREENING OF INSECTICIDES

Crop: *Baisakhi* 1981-82
Date of inoculation: 18 October 1981
Date of *phunki* removal: 3 November 1981
Date of spraying: 11 November 1981 (8-24 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 358 | 25·98 | — |
| | 0·0125 | 384 | 20·32 | — |
| | 0·025 | 355 | 17·16 | — |
| Dimecron | 0·00625 | 360 | 24·73 | — |
| | 0·0125 | 447 | 15·44 | — |
| | 0·025 | 322 | 20·81 | — |
| Methoxychlor | 0·0125 | 388 | 33·73 | 9·59 |
| | 0·025 | 392 | 30·62 | 5·34 |
| | 0·05 | 465 | 23·23 | — |
| Dipterex | 0·00625 | 411 | 26·77 | — |
| | 0·0125 | 354 | 16·67 | — |
| | 0·025 | 270 | 30·00 | 4·50 |
| Evisect | 0·00625 | 326 | 21·17 | — |
| | 0·0125 | 284 | 21·13 | — |
| | 0·025 | 345 | 13·63 | — |
| Sevin | 0·025 | 321 | 28·35 | 2·25 |
| | 0·05 | 420 | 30·72 | 5·62 |
| | 0·1 | 359 | 24·24 | — |
| Quinalphos | 0·0125 | 406 | 35·72 | 12·30 |
| | 0·025 | 367 | 28·07 | 1·86 |
| | 0·05 | 452 | 29·43 | 3·72 |
| Dimethoate | 0·00625 | 391 | 33·51 | 9·29 |
| | 0·0125 | 345 | 34·50 | 10·64 |
| | 0·025 | 416 | 51·06 | 33·23 |
| Sumicidin | 0·00625 | 366 | 37·16 | 14·27 |
| | 0·0125 | 334 | 47·91 | 28·93 |
| | 0·025 | 402 | 64·80 | 51·99 |
| Sumithion | 0·00625 | 341 | 27·28 | — |
| | 0·0125 | 329 | 38·00 | 15·41 |
| | 0·025 | 360 | 40·84 | 19·29 |
| Emulsified water control | 0·05 | 335 | 26·70 | — |

In another experiment all the above insecticides in concentrations ranging from 0·00625 to 0·025 per cent were sprayed on about 5-month-old lac crop and all proved safe (Table 4i).

TABLE 4(i)—SCREENING OF INSECTICIDES

Crop: *Baisakhi* 1981-82
Date of inoculation: 18 October 1981
Date of *phunki* removal: 3 November 1981
Date of spraying: 31 March 1982 (148-165 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 73 | 5·48 | — |
| | 0·0125 | 60 | 26·67 | 1·93 |
| | 0·025 | 78 | 23·08 | — |
| Dimecron | 0·00625 | 98 | 32·66 | 9·94 |
| | 0·0125 | 100 | 25·00 | — |
| | 0·025 | 99 | 8·09 | — |
| Methoxychlor | 0·00625 | 89 | 7·87 | — |
| | 0·0125 | 91 | 9·90 | — |
| | 0·025 | 92 | 28·27 | 4·07 |
| Dipterex | 0·00625 | 94 | 7·60 | — |
| | 0·0125 | 97 | 7·22 | — |
| | 0·025 | 68 | 8·83 | — |
| Evisect | 0·00625 | 85 | 28·24 | 4·03 |
| | 0·0125 | 78 | 8·98 | — |
| | 0·025 | 69 | 24·64 | — |
| Sevin | 0·00625 | 80 | 26·25 | 1·37 |
| | 0·0125 | 94 | 15·96 | — |
| | 0·025 | 79 | 6·33 | — |
| Quinalphos | 0·00625 | 78 | 2·57 | — |
| | 0·0125 | 79 | 20·26 | — |
| | 0·025 | 102 | 36·28 | 14·79 |
| Dimethoate | 0·00625 | 87 | 8·05 | — |
| | 0·0125 | 100 | 29·00 | 5·05 |
| | 0·025 | 80 | 22·50 | — |
| Emulsified water control | 0·5 | 119 | 25·22 | — |

*Jethwi* 1982 *crop*

In this crop, all the ten insecticides except dimethoate & methoxychlor at a concentration of 0·0125 per cent were found safe to one-month-old lac nymphs (Table 4i).

TABLE 4(j)— SCREENING OF INSECTICIDES

Crop: *Jethwi* 1982
Date of inoculation: 13 February 1982
Date of *phunki* removal: 10 March 1982
Date of spraying: 31 March 1982 (21-47 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 96 | 42·71 | — |
| | 0·0125 | 105 | 67·04 | 8·33 |
| | 0·025 | 133 | 25·57 | — |
| Dimecron | 0·00625 | 95 | 56·25 | — |
| | 0·0125 | 198 | 43·44 | — |
| | 0·025 | 106 | 60·00 | — |
| Methoxychlor | 0·00625 | 76 | 45·72 | — |
| | 0·0125 | 96 | 68·75 | 13·00 |
| | 0·025 | 97 | 44·31 | — |
| Dipterex | 0·00625 | 105 | 52·39 | — |
| | 0·0125 | 110 | 44·78 | — |
| | 0·025 | 92 | 36·54 | — |
| Evisect | 0·00625 | 151 | 50·00 | — |
| | 0·0125 | 140 | 30·00 | — |
| | 0·025 | 96 | 40·63 | — |
| Sevin | 0·00625 | 116 | 47·20 | — |
| | 0·0125 | 116 | 64·66 | — |
| | 0·025 | 118 | 56·78 | — |
| Quinalphos | 0·00625 | 107 | 43·93 | — |
| | 0·0125 | 60 | 38·47 | — |
| | 0·025 | 118 | 56·17 | — |
| Dimethoate | 0·00625 | 138 | 54·35 | — |
| | 0·0125 | 153 | 76·67 | 34·34 |
| | 0·025 | 132 | 44·70 | — |
| Emulsified water control | 0·5 | 153 | 64·62 | — |

*Aghani* 1982-83 *crop*

In this crop and in the *katki* 1982 only eight insecticides were under experimentation, since the safety of sumithion and sumicidine was found doubtful in the earlier studies, those were deleted (Table 4k).

In the *aghani* crop, the insecticides, methoxychlor, sevin, dimecron and dipterex were safe whereas the lowest concentration (0·00625%) of Padan, Evisect and dimethoate and the highest of quinalphos (0·025%) were comparatively toxic (Table 4k).

TABLE 4(k)— SCREENING OF INSECTICIDES

Crop: *Aghani* 1982-83
Date of inoculation: 18 July 1982
Date of *phunki* removal: 30 July 1982
Date of spraying: 19 August 1982 (20-33 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 304 | 78·83 | 30·4 |
| | 0·0125 | 300 | 60·08 | — |
| | 0·025 | 345 | 71·23 | 5·4 |
| Dimecron | 0·00625 | 335 | 71·87 | 7·52 |
| | 0·0125 | 336 | 70·00 | 1·38 |
| | 0·025 | 350 | 63·20 | — |
| Methoxychlor | 0·00625 | 313 | 69·33 | — |
| | 0·0125 | 297 | 61·62 | — |
| | 0·025 | 318 | 69·39 | — |
| Dipterex | 0·00625 | 363 | 65·29 | — |
| | 0·0125 | 293 | 51·88 | — |
| | 0·025 | 318 | 52·97 | — |
| Evisect | 0·00625 | 366 | 76·83 | 23·83 |
| | 0·0125 | 297 | 47·14 | — |
| | 0·025 | 298 | 68·62 | — |
| Sevin | 0·00625 | 342 | 71·84 | 7·42 |
| | 0·0125 | 312 | 61·60 | — |
| | 0·025 | 360 | 61·67 | — |
| Quinalphos | 0·00625 | 331 | 67·98 | — |
| | 0·0125 | 379 | 65·14 | — |
| | 0·025 | 343 | 77·74 | 26·82 |
| Dimethoate | 0·00625 | 262 | 84·14 | 47·86 |
| | 0·0125 | 303 | 63·54 | — |
| | 0·025 | 322 | 72·96 | 11·11 |
| Emulsified water control | 0·5 | 355 | 69·58 | — |

*Katki* 1982 *crop*

Of the eight insecticides tried, seven except dimethoate were found safe to one-month-old lac nymphs whereas five, namely, Dimecron, Padan, Evisect, dipterex and methoxychlor were safe to two-month-old lac nymphs (Tables 4l and 4m).

A new insecticide, namely, Ripcord (cypermethrin) was screened against lac insect, under potted plant conditions but was found to be highly toxic to the lac nymphs and, therefore, has not been included in regular trials.

(C. P. Malhotra)

TABLE 4(I)— SCREENING OF INSECTICIDES

Crop: *Katki* 1982
Date of inoculation: 30 June 1982
Date of *phunki* removal: 18 July 1982
Date of spraying: 8 September 1982 (52-71 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padan | 0·00625 | 55 | 34·55 | 12·04 |
| | 0·0125 | 42 | 19·05 | — |
| | 0·025 | 47 | 27·66 | 2·78 |
| Dimecron | 0·00625 | 53 | 24·53 | — |
| | 0·0125 | 48 | 29·17 | 4·81 |
| | 0·025 | 41 | 31·71 | 8·22 |
| Methoxychlor | 0·00625 | 46 | 17·40 | — |
| | 0·0125 | 68 | 30·89 | 7·12 |
| | 0·025 | 51 | 23·53 | — |
| Dipterex | 0·00625 | 66 | 19·70 | — |
| | 0·0125 | 52 | 23·08 | — |
| | 0·025 | 53 | 33·97 | 11·26 |
| Evisect | 0·00625 | 48 | 25·00 | — |
| | 0·0125 | 44 | 20·46 | — |
| | 0·025 | 58 | 27·59 | 2·06 |
| Sevin | 0·00625 | 60 | 26·67 | 1·45 |
| | 0·0125 | 67 | 35·83 | 13·76 |
| | 0·025 | 70 | 40·00 | 19·36 |
| Quinalphos | 0·00625 | 59 | 33·90 | 16·11 |
| | 0·0125 | 59 | 49·16 | 31·67 |
| | 0·025 | 67 | 55·23 | 39·83 |
| Dimethoate | 0·00625 | 62 | 41·36 | 21·19 |
| | 0·0125 | 47 | 48·98 | 31·43 |
| | 0·025 | 53 | 32·08 | 8·72 |
| Emulsified water control | 0·5 | 43 | 25·59 | — |

TABLE 4(m)— SCREENING OF INSECTICIDES

Crop: *Katki* 1982
Date of inoculation: 9 July 1982
Date of *phunki* removal: 29 July 1982
Date of spraying: 18 August 1982 (20-41 days old lac nymphs)

| Insecticides and their concentrations | | No. of lac nymphs under observation | Percentage mortality | Corrected per cent mortality |
|---|---|---|---|---|
| Padans | 0·00625 | 209 | 68·27 | 13·23 |
| | 0·0125 | 224 | 60·27 | — |
| | 0·025 | 307 | 59·79 | — |
| Dimecron | 0·00625 | 313 | 41·22 | — |
| | 0·0125 | 278 | 59·18 | — |
| | 0·025 | 273 | 61·54 | — |
| Methoxychlor | 0·00625 | 225 | 53·89 | — |
| | 0·0125 | 294 | 59·49 | — |
| | 0·025 | 255 | 53·73 | — |
| Dipterex | 0·00625 | 259 | 68·65 | 14·27 |
| | 0·0125 | 278 | 53·96 | — |
| | 0·025 | 272 | 43·00 | — |
| Evisect | 0·00625 | 270 | 53·24 | — |
| | 0·0125 | 274 | 59·11 | — |
| | 0·025 | 261 | 63·99 | 1·53 |
| Sevin | 0·00625 | 333 | 54·06 | — |
| | 0·0125 | 276 | 53·99 | — |
| | 0·025 | 288 | 55·91 | — |
| Quinalphos | 0·00625 | 346 | 45·09 | — |
| | 0·0125 | 247 | 48·07 | — |
| | 0·025 | 289 | 60·90 | — |
| Dimethoate | 0·00625 | 266 | 65·04 | 4·40 |
| | 0·0125 | 214 | 70·10 | 18·23 |
| | 0·025 | 240 | 75·45 | 32·85 |
| Emulsified water control | 0·5 | 217 | 63·43 | — |

### 1.4.3(ii) Screening of plant poisons for their safety to the lac insect and toxicity to the lac predators

Petroleum ether extracts of the rhizomes of *Acorus calamus* (*Vasambhu*), drupes of *Melia azederach* (*dharek* or *bakain*) and leaves of *Vitex negundo* (sindwar) were taken and their emulsions prepared using Tween 80 as the emulsifer. Three concentrations ranging from 0·1 to 0·4 per cent and 0·05 to 0·2 per cent were sprayed on about 3-week-old lac nymphs of *baisakhi* 1981-82 and *baisakhi* 1982-83 crops respectively, grown on potted plants of *bhalia*.

Results revealed (Tables 5a and 5b) that 0·05 and 0·1% concentrations were found safe. Concentrations lower than these would be tried in future.

(A. Bhattacharya & C. P. Malhotra)

TABLE 5(a) — EFFECT OF VARIOUS PLANT POISONS ON THE LAC INSECT DURING *baisakhi* 1981-1982

| Crop | Plant poisons and their concentrations | No. of lac nymphs under observation | Per cent mortality | Corrected per cent mortality |
|---|---|---|---|---|
| | | *Acorus calamus* | | |
| *Baisakhi* 1981-82 | 0·1 | 337 | 12·38 | 2·795 |
| | 0·2 | 247 | 20·64 | 11·959 |
| | 0·4 | 264 | 27·89 | 20·002 |
| | Control | 304 | 9·86 | — |
| | | *Melia azederach* | | |
| | 0·1 | 355 | 13·48 | 5·225 |
| | 0·2 | 393 | 17·11 | 9·201 |
| | 0·4 | 298 | 23·09 | 15·751 |
| | Control | 412 | 8·71 | — |
| | | *Vitex negundo* | | |
| | 0·1 | 326 | 12·63 | 1·198 |
| | 0·2 | 386 | 16·84 | 5·959 |
| | 0·4 | 388 | 28·52 | 19·167 |
| | Control | 311 | 11·57 | — |

TABLE 5(b)— EFFECT OF VARIOUS PLANT POISONS ON THE LAC INSECT DURING *baisakhi* 1982-1983

| Crop | Plant poisons and their concentrations | No. of lac nymphs under observation | Per cent mortality | Corrected per cent mortality |
|---|---|---|---|---|
| | | *Acorus calamus* | | |
| *Baisakhi* 1982-83 | 0·05 | 350 | 26·571 | 6·204 |
| | 0·1 | 452 | 29·203 | 9·566 |
| | 0·2 | 361 | 38·504 | 21·466 |
| | Control | 352 | 21·714 | — |
| | | *Melia azederach* | | |
| | 0·05 | 308 | 17·532 | Nil |
| | 0·1 | 313 | 23·961 | 6·808 |
| | 0·2 | 336 | 49·107 | 36·413 |
| | Control | 364 | 18·406 | — |
| | | *Vitex negundo* | | |
| | 0·05 | 352 | 28·409 | 3·557 |
| | 0·1 | 473 | 39·746 | 19·641 |
| | 0·2 | 420 | 39·523 | 19·209 |
| | Control | 350 | 25·143 | — |

### 1.4.3.3 Effect of insecticides (safer to lac insect) against harmful parasites of lac insect

The insecticides safe, to lac insects, BHC, Sevin, Thiodan, Lindane and chlordane were tried against *Tetrastichus purpureus*; BHC, Sevin, Thiodan and Lindane against *Tachardiaephagus* tachardiae tachardiae; and BHC, Thiodan and chlordane against *Coccophagus tschirchii*, all at five concentratons ranging from 0.00625 to 0.1 per cent. The data are presented in Table 6(a), (b) and (c). BHC was the most toxic against all the three parasites.

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

TABLE 6(a)— COMPARATIVE EFFICACY OF INSECTICIDES AGAINST *Tetrastichus purpureus*

| Treatment | Concentration | Percentage mortality at different intervals (in hours) | | | |
|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 |
| BHC | 0·00625 | 13·3 | 21·6 | 66·6 | 86·6 |
| | 0·00125 | 15·0 | 26·6 | 83·3 | 88·6 |
| | 0·025 | 21·6 | 46·6 | 96·6 | 10·0 |
| | 0·05 | 46·6 | 50 | 100 | 100 |
| | 0·1 | 50 | 63·3 | 100 | 100 |
| Sevin | 0·00625 | 10·0 | 20·0 | 61·6 | 73·3 |
| | 0·0125 | 13·3 | 25·0 | 71·6 | 83·3 |
| | 0·025 | 18·3 | 43·3 | 80·0 | 85·0 |
| | 0·05 | 40·0 | 46·6 | 93·3 | 95·0 |
| | 0·1 | 46·6 | 53·3 | 96·6 | 100·0 |
| Thiodan | 0·00625 | 10·0 | 13·3 | 50·0 | 66·6 |
| | 0·0125 | 10·0 | 20·0 | 66·6 | 75·0 |
| | 0·025 | 15·0 | 36·6 | 75·0 | 78·3 |
| | 0·05 | 33·3 | 40·0 | 80·0 | 90·0 |
| | 0·1 | 36·6 | 53·3 | 88·3 | 93·3 |
| Lindane | 0·00625 | 10·0 | 10·0 | 46·6 | 53·3 |
| | 0·0125 | 13·3 | 13·3 | 58·3 | 60·0 |
| | 0·025 | 13·3 | 21·3 | 66·6 | 73·3 |
| | 0·05 | 20·0 | 36·6 | 73·3 | 80·0 |
| | 0·1 | 31·3 | 43·3 | 73·3 | 80·0 |
| Chlordane | 0·00625 | 10·0 | 10·0 | 50·0 | 60·0 |
| | 0·0125 | 10·0 | 13·3 | 60·0 | 72·3 |
| | 0·025 | 13·3 | 26·6 | 73·3 | 78·3 |
| | 0·05 | 23·3 | 36·6 | 75·0 | 83·3 |
| | 0·1 | 33·3 | 46·6 | 83·3 | 88·3 |
| Control | — | — | 6·6 | 6·6 | 13·3 |

TABLE 6(b) — COMPARATIVE EFFICACY OF INSECTICIDES AGAINST *Tachardiaephagus tachardiae tachardiae*

| Treatment | Concentration | Percentage mortality at different intervals (in hours) | | | |
|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 |
| BHC | 0·00625 | 10·0 | 18·3 | 66·6 | 78·3 |
| | 0·0125 | 15·0 | 33·3 | 75·0 | 90·0 |
| | 0·025 | 20·0 | 45·0 | 88·3 | 98·3 |
| | 0·05 | 43·3 | 48·3 | 95·0 | 100·0 |
| | 0·1 | 48·3 | 58·3 | 100·0 | 100·0 |
| Sevin | 0·00625 | 13·3 | 20·0 | 54·3 | 63·3 |
| | 0·0125 | 13·3 | 23·3 | 68·3 | 78·3 |
| | 0·025 | 18·3 | 40·0 | 72·3 | 80·0 |
| | 0·05 | 40·0 | 43·3 | 82·3 | 95·0 |
| | 0·1 | 46·6 | 50·0 | 98·3 | 100·0 |
| Thiodan | 0·00625 | 10·0 | 13·3 | 46·6 | 48·3 |
| | 0·0125 | 13·3 | 15·0 | 63·3 | 68·3 |
| | 0·025 | 15·0 | 38·3 | 68·3 | 72·3 |
| | 0·05 | 36·6 | 41·3 | 75·0 | 80·0 |
| | 0·1 | 43·3 | 45·0 | 80·0 | 96·3 |
| Lindane | 0·00625 | 66·6 | 10·0 | 40·0 | 43·3 |
| | 0·0125 | 10·0 | 16·3 | 53·3 | 66·6 |
| | 0·025 | 13·3 | 33·3 | 65·0 | 68·3 |
| | 0·05 | 26·6 | 40·0 | 72·3 | 78·3 |
| | 0·1 | 36·6 | 41·3 | 75·0 | 90·0 |
| Control | — | — | — | 6·6 | 10·0 |

TABLE 6(c)— COMPARATIVE EFFICACY OF INSECTICIDES AGAINST *Coccophagus tschirchii*

| Treatment | Concentration | Percentage mortality at different intervals (in hours) | | | |
|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 |
| BHC | 0·00625 | 10·0 | 26·6 | 60·0 | 73·3 |
| | 0·0125 | 10·0 | 33·3 | 66·6 | 78·3 |
| | 0·025 | 26·6 | 73·3 | 86·6 | 100·0 |
| | 0·05 | 46·6 | 86·6 | 96·6 | 100·0 |
| | 0·1 | 48·3 | 93·3 | 100·0 | 100·0 |
| Thiodan | 0·00625 | 6·6 | 21·6 | 46·6 | 73·3 |
| | 0·0125 | 10·0 | 26·6 | 50·0 | 78·3 |
| | 0·025 | 26·6 | 46·6 | 73·3 | 95·0 |
| | 0·05 | 33·3 | 60·0 | 73·3 | 95·0 |
| | 0·1 | 46·6 | 60·0 | 86·6 | 100·0 |
| Chlordane | 0·00625 | 6·6 | 36·6 | 50·0 | 66·6 |
| | 0·0125 | 6·6 | 40·0 | 60·0 | 73·3 |
| | 0·025 | 21·6 | 40·0 | 66·6 | 93·3 |
| | 0·05 | 25·0 | 45·0 | 75·0 | 95·0 |
| | 0·1 | 40·0 | 63·3 | 78·3 | 100·0 |
| Control | — | — | — | 5·0 | 11·6 |

### 1.4.3.5 Effect of the recommended control schedule on the associated fauna of lac insect under field conditions

*Aghani* 1981 and *katki* 1982 crops were raised with and without the recommended control schedule against the lac predators using 3 *bhalia* bushes for each treatment with 12 replications, in a randomized block design.

In the former crop, the recommended control schedule involved a spray of, Thiodan® (0·05 per cent) 4 weeks after inoculation followed by a combination spray of 0·05 per cent of Thiodan® and Thuricid® (1:1) about 4 weeks after the first spray. The latter crop was, however, sprayed only once with a combination spray as above 5 weeks after inoculation.

A sample of ten cm. long lac bearing twig was collected from each bush at the time of crop maturity in the former crop and at 3 intervals, namely, 3, 8, 12 weeks after spraying in the latter. The samples collected from each treatment were caged separately for recording the emergence of insects therefrom. The results revealed

TABLE 7 — EFFECT OF THE RECOMMENDED CONTROL SCHEDULE ON THE EMERGENCE OF INSECTS ASSOCIATED WITH LAC INSECTS UNDER FIELD CONDITIONS

(Sample: 200 cm lac stick, Crop: *Katki* 1982; Host: *Bhalia*)

| | First sampling (2 September 1982) | | Second sampling (8 October 1982) | | Third sampling (12 November 1982) | |
|---|---|---|---|---|---|---|
| | Treated | Control | Treated | Control | Treated | Control |
| Inimical parasites | | | | | | |
| *T. purpureus* | 6 | 9 | 10 | 28 | 8 | 13 |
| *Eupelmus tachardiae* | 8 | 9 | 11 | 27 | 11 | 9 |
| *Tachardiaephagus tachardiae tachardiae* | 9 | 17 | 8 | 30 | 18 | 20 |
| *Coccophagus tschirchii* | 14 | 36 | 25 | 75 | 27 | 32 |
| *Tachardiaephagus tachardiae somervilli* | 12 | 20 | 24 | 23 | 6 | Nil |
| *Marietta javensis* | - | - | - | — | — | 12 |
| Total | 49 | 91 | 78 | 183 | 70 | 86 |
| Beneficial parasites | | | | | | |
| *Elasmus claripennis* | 13 | 10 | 11 | 37 | 9 | 7 |
| *Eurytoma palidiscapus* | 14 | 13 | 18 | 32 | 5 | 1 |
| *Bracon greeni* | — | 5 | 16 | 32 | 10 | 18 |
| *Apanteles fakhrulhajiae* | 2 | 1 | 1 | 8 | — | 4 |
| *Apanteles tachardiae* | 7 | 6 | 7 | 17 | 5 | 5 |
| *Pristomerus sulci* | — | — | — | 7 | 4 | 4 |
| Total | 36 | 35 | 53 | 133 | 33 | 39 |
| Predators | | | | | | |
| *Eublemma amabilis* | 4 | 27 | 27 | 131 | 46 | 46 |
| *Holcocera pulverea* | 2 | 25 | 10 | 70 | 31 | 39 |
| Other insects | | | | | | |
| *Tineidae* (Yellow) | 36 | 83 | — | 52 | — | — |
| Total | 6 | 52 | 37 | 201 | 77 | 85 |

that from the former crop, the number of the predators, harmful and beneficial parasites respectively in the treated/control lots were 1·08/31·0, 84·0/54·0 and 78·4/62·7 showing a very high degree of control of the predators.

In the *katki* crop, however, the results of the first sampling showed a marked reduction in the number of the predators and the harmful parasites but not of the beneficial ones. The results of the second samples showed reduction in numbers of the predators and harmful and beneficial parasites. The third sampling, however, showed no appreciable difference in the number of these insects in the treated and control (Table 7).

(B. N. Sah and C. P. Malhotra)

**1.4.3.6 Hormoligotory effects on the lac insect with insecticide**

For this study, Thiodan® in concentrations of 0·003125, 0·00625, 0·0125 and 0·025 per cent along with a control were sprayed on 21-day old lac nymphs of *katki* 1981 crop on potted plants of *bhalia* with three replications. The insects treated with lowest concentration showed comparatively better growth, in respect of the size of both males and females.

(A. K. Sen and C. P. Malhotra)

**1.4.4 Laboratory evaluation of the efficacy of microbial agents for the control of lepidopterous predators**

The larvae of the major lac predators, *Eublemma amabilis* and *Holcocera pulverea* collected from different places at different times were sorted out for the diseased ones on the basis of symptomatic diagnosis but no external symptoms for the presence of diseases were observed. This was further confirmed by testing for pathogenosity through contamination and pure inoculum techniques. Thus, it was found that causative micro-organism were not prevalent during the period under report.

(S. G. Choudhary and A. H. Naqvi)

**1.4.10 Chemical control of *Chrysopa* species**

The study was undertaken to screen the insecticides for the control of *Chrysopa* spp.

*Expt. — Laboratory evaluation of the insecticides against the Chrysopa spp.*

The insecticides namely, BHC, Sevin, Chlordane, Thiodan®, Lindane, Dimecron, cryolite, Ekalux and DDT were tried each at five concentrations ranging from 0·00625 to 0·1 per cent against the larvae of *Chrysopa lacciperda* and *C. medestes* with five replications and taken ten larvae under each treatment. The insecticides in the order of their decreasing efficacy were BHC, Ekalux, Sevin, Thiodan®, Chlordane, Lindane, Dimecron, cryolite and DDT against *C. medestes* and Ekalux, BHC, Chlordane, Sevin, Lindane, Thiodan®, Dimecron, DDT and Cryolite against *C. lacciperda* (Table 8).

*Expt. — Field trials of effective insecticides against the Chrysopa spp. vis-a-vis lac yield*

The studies made under experiment 1 have shown that BHC, Chlordane and Ekalux are highly effective against the *Chrysopa* spp. A field experiment was therefore, laid out to ascertain the relative efficacy of these insecticides, each tried at three concentrations i.e. 0·025, 0·05 and 0·1 per cent in the *aghani* 1980-81 crop

TABLE 8 — COMPARATIVE EFFICACY OF INSECTICIDES AGAINST *Chrysopa* SPECIES

| Treatment | Concentration | Percentage mortality | | Remarks |
|---|---|---|---|---|
| | | *Chrysopa medestes* | *Chrysopa lacciperda* | |
| BHC | 0·00625 | 40 | 35 | There was 10% mortality in the control |
| | 0·0125 | 45 | 45 | |
| | 0·025 | 70 | 60 | |
| | 0·05 | 80 | 65 | |
| | 0·1 | 85 | 75 | |
| Ekalux | 0·00625 | 45 | 45 | |
| | 0·0125 | 45 | 45 | |
| | 0·025 | 65 | 65 | |
| | 0·05 | 70 | 75 | |
| | 0·1 | 80 | 80 | |
| Sevin | 0·00625 | 40 | 30 | |
| | 0·0125 | 40 | 30 | |
| | 0·025 | 60 | 45 | |
| | 0·05 | 65 | 55 | |
| | 0·1 | 70 | 65 | |
| Chlordane | 0·00625 | 35 | 35 | |
| | 0·0125 | 40 | 35 | |
| | 0·025 | 50 | 55 | |
| | 0·05 | 60 | 60 | |
| | 0·1 | 60 | 70 | |
| Thiodan® | 0·00625 | 40 | 25 | |
| | 0·0125 | 40 | 30 | |
| | 0·025 | 55 | 35 | |
| | 0·05 | 60 | 45 | |
| | 0·1 | 60 | 55 | |
| Lindane | 0·00625 | 30 | 30 | |
| | 0·0125 | 30 | 30 | |
| | 0·025 | 40 | 40 | |
| | 0·05 | 45 | 50 | |
| | 0·1 | 55 | 60 | |
| Dimecron | 0·00625 | 30 | 25 | |
| | 0·0125 | 35 | 25 | |
| | 0·025 | 40 | 35 | |
| | 0·05 | 45 | 45 | |
| | 0·1 | 50 | 50 | |
| Cryolite | 0·00625 | 25 | 20 | |
| | 0·0125 | 25 | 25 | |
| | 0·025 | 30 | 25 | |
| | 0·05 | 35 | 35 | |
| | 0·1 | 40 | 45 | |
| DDT | 0·00625 | 20 | 20 | |
| | 0·0125 | 25 | 20 | |
| | 0·025 | 25 | 30 | |
| | 0·05 | 35 | 35 | |
| | 0·1 | — | — | |

with 5 *bhalia* bushes under each treatment and 4 replications. The incidence of the *Chrysopa* spp. was determined before and after each spray. The results are presented in Table 9 which does not include those for Ekalux since it proved highly toxic to lac insects. It will be seen from this table that BHC was more effective than Chlordane for the suppression of *Chrysopa* spp. and thereby improving the lac yield.

(S. G. Choudhary)

**1.4.12 Studies on the biological control of the lac predators namely, *Eublemma amabilis* and *Holcocera pulverea* with beneficial parasites**

Laboratory cultures of *Apanteles tachardiae* and *Bracon greeni* were raised on an alternative host *Corcyra cephalonica*. About 1800 parasites of the former were reared from July to September. Average parasitisation was 70 per cent and of the parasites reared 60 per cent were females. *Bracon greeni* could not be reared on this host. Special magasleeves of synthetic netting were improvised for covering potted plants of *bhalia* provided with windows of plastic/celluloid material for observations and tied to the inoculated shoots of *bhalia* bushes under microplot field trials. For rearing the predators *E. amabilis*, the adult as well as their eggs got laid on the paper strips in the laboratory were introduced into these cages. However, this did not meet with much success. Rearing of the lac predators *E. amabilis* was also tried on an artificial diet of a mixture of honey, lac dye, lac wax and yeast against without much success. The final instar larvae could be fed on this diet for about a week and a few pupated.

(C. P. Malhotra, D. C. Srivastava, A. Bhattacharya and P. Sen)

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

This investigation was taken up in 1981 to determine the economic threshold level of infestation of the major lac predators, namely, *E. amabilis* and *H. pulverea*. For this study, the lac crops were raised under the cover of synthetic netting (60 mesh) sleeve cages throughout and the crop was manually infested by predator larvae in varying densities at three stages namely, 1-30 day-old, 31-60-day-old and 61-day old to the time of sexual maturity. The effect of these infestations was determined by comparing the lac yield. The results shown in Table 10 indicated that the densities of *E. amabilis* below four larvae per thirty cm lac encrustation do not appear to cause any economic injury.

(S. G. Choudhary)

**Ad-hoc Studies**

*Effect of dipping the broodlac in insecticidal emulsions on the lac insect and its associated fauna*

To see the feasibility of the study, as a first step work was taken up with the selective insecticide, namely, Thiodan® (already proven safe to the lac insect, but highly toxic to the lac predators). Broodlac of the *baisakhi* 1981-82 crop from *palas* was dipped in concentrations ranging from 0·1 to 0·4 per cent for periods ranging from 1 to 2 min, dried and inoculated on to the potted plants of *bhalia*, along with the ones dipped in distilled water for the same period which

TABLE 9 — EFFECT OF INSECTICIDAL SPRAYS ON THE *Chrysopa* spp. AND YIELD OF THE LAC CROP (*Aghani* 1980-81)

| Treatment | Concentration | Number of larvae per bush before treatment | Number of larvae/bush after | | | Percentage reduction of *Chrysopa* spp. after | | | Lac used/bush | | Lac obtained/bush | | | | | | Percentage increase in yield of lac crop over control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | First spray | Second spray | Third spray | First spray | Second spray | Third spray | Brood lac | Scraped lac | Lac stick | | | Sticklac | | | |
| | | | | | | | | | | | Brood | Rejected | Total | Brood | Rejected | Total | |
| BHC | 0·025 | 7·65 | 3·9 | 2·4 | 2·05 | 49·01 | 68·6 | 73·2 | 100 | 35·4 | 126·10 | 76·1 | 202·2 | 34 | 12·5 | 46·5 | 31·3 |
| | 0·05 | 5·95 | 2·5 | 1·3 | 1 | 57·9 | 78·1 | 83·1 | 100 | 33·8 | 146·10 | 73·1 | 219·2 | 39·19 | 11·20 | 50·39 | 42·3 |
| | 0·1 | 6·55 | 2·65 | 1·55 | 1·05 | 60·1 | 76·6 | 83·9 | 100 | 33·3 | 137·5 | 102 | 239·5 | 31·2 | 20·4 | 51·6 | 45·7 |
| Chlordane | 0·025 | 7·1 | 4·2 | 3·05 | 2·6 | 40·8 | 57·04 | 63·3 | 100 | 34·5 | 109·2 | 51·8 | 161·0 | 25·1 | 19·5 | 44·6 | 25·9 |
| | 0·05 | 7·55 | 4·15 | 2·65 | 2·4 | 45·03 | 64·9 | 68·2 | 100 | 32·3 | 112·0 | 44·9 | 156·9 | 84·8 | 12·6 | 47·4 | 33·8 |
| | 0·1 | 6·35 | 3·55 | 2·2 | 1·95 | 44·09 | 65·3 | 69·2 | 100 | 32·1 | 113·6 | 63·1 | 176·7 | 28·9 | 17·5 | 46·4 | 31·07 |
| Control | — | 6·95 | 6·65 | 6·45 | 6·35 | 4·3 | 7·1 | 8·6 | 100 | 33·6 | 95·5 | 60·5 | 146·0 | 21·5 | 13·9 | 35·4 | — |

TABLE 10 — PER CENT REDUCTION IN LAC YIELD AT VARYING LEVELS OF LARVAL DENSITIES OF *E. amabilis* DURING *Katki* 1982 CROP

| Treatment | No. of *E. amabilis* larvae/30 cm | Wt of lac stick (g) | Wt of sticklac (g) | Percentage reduction in yield of sticklac |
|---|---|---|---|---|
| A | 3 | 21·4 | 3·6 | 7·6 |
| B | 4 | 20·3 | 3·4 | 12·8 |
| C | 5 | 19·7 | 3·2 | 17·9 |
| D | 6 | 18·5 | 2·7 | 30·7 |
| E | 8 | 15·4 | 2·2 | 43·5 |
| F | 10 | 10·6 | 1·4 | 64·1 |
| G | 15 | 8·3 | 0·7 | 82·05 |
| H (Control) | Nil | 22·7 | 3·9 | — |

served as controls. The results reveal that there has been no adverse effect of the treatment on the emergence of the crawlers but there has been some mortality after settlement. The experiment, therefore, needs repeatation by shortening the dipping time.

*Hormonal control of the lac predators*

One-month-old lac nymphs of the *jethwi* 1982 and *baisakhi* 1982-83 crops raised on potted plants of *M. macrophylla* were sprayed with suspensions of the chitin inhibitor, namely, Dimilin (diflubenzuron) in concentrations ranging from 0·01 to 0·04 per cent for the former crop and 0·05-0·2 per cent in the latter crop along with the water sprayed control ones. Observations taken after a fortnight and a month revealed that there has been no adverse effect on the lac nymphs (Table 11).

(C. P. Malhotra and A. Bhattacharya)

## 1.5 Genetics and Breeding of Lac Insects

### 1.5.7 Protein polymorphism and genetic heterozygosity in lac insect population

Due to frequent load shedding, work could not be done in 1981 and the Project has, therefore, been kept in abeyance.

TABLE 11 — EFFECT OF DIMILIN ON ABOUT ONE MONTH OLD LAC NYMPHS

| Crop | Concentration | Initial settlement under observation | Per cent mortality | Corrected per cent mortality |
|---|---|---|---|---|
| *Jethwi* 1982 | 0·01 | 236 | 19·91 | 2·77 |
| | 0·02 | 234 | 23·07 | 6·61 |
| | 0·04 | 295 | 18·31 | 0·83 |
| | Control | 261 | 17·62 | — |
| *Baisakhi* 1982-83 | 0·05 | 398 | 10·55 | Nil |
| | 0·1 | 364 | 15·11 | 0·53 |
| | 0·2 | 362 | 11·33 | Nil |
| | Control | 348 | 14·66 | — |

### 1.5.8 Collection, maintenance and evaluation of genetic stocks of lac insects

The following stocks of lac insects were maintained:

| *Rangeeni* | *Kusmi* |
|---|---|
| Assam | Dharamjaigarh (New) |
| Meghalaya | Dharamjaigarh (Old) |
| Local yellow | Namkum plantation |
| Kundri | Orissa |
| Delhi | Madurai |
| Ludhiana | |
| Umaria | |

The Madurai stock was however lost during 1982.

(P. Sen and S. K. Jaipuriar)

### 1.5.10 Studies on sex determination in lac insects

Sex ratio was further studied in a *rangeeni* stock of lac insect originating from hot region, Palamau (Bihar) as per the programme followed earlier (AR.: 1979 and 1980). Fifty progenies were reared during the rainy season, forty of which could be maintained till the time of sexual maturity. The results are set out in Tables 12(a) 12(b) and 12(c). It will be seen from Table 12(a) that the progeny size and sex ratio varied widely. Table 12(b) shows that, although the sex ratio varied within wide limits in each size group, the average proportion of males was lowest in the small progenies and highest in the large. The results confirm those reported earlier (A.R.: 1979 and 1980).

Table 12(c) shows that, of the forty progeneies which could be maintained up to the time of sexual maturity as many as eleven included only the male insects and these occurred in progenies of all the size groups. The all male progenies were thus recorded in a fairly high frequency in this particular stock during a season which is otherwise known to show a higher proportion of females.

TABLE 12(a)— PROGENY SIZE AND SEX RATIO IN A *rangeeni* STOCK OF *K. lacca* ORIGINATING FROM A HOT REGION PALAMAU, BIHAR DURING RAINY SEASON

| | |
|---|---|
| No. of progenies | 40 |
| *No. of insects/progeny* | |
| (i) Range | 2-250 |
| (ii) Mean | 78·5 |
| *Sex ratio (% male)* | |
| (i) Range | 9·1-100·0 |
| (ii) Mean | 43·0 |

TABLE 12(b)— SEX RATIO IN RELATION TO PROGENY SIZE

| Progeny size | No. of progenies | *No. of insects/progeny* | | *Sex ratio (% male)* | |
|---|---|---|---|---|---|
| | | Range | Mean | Range | Mean |
| Small | 16 | 2-50 | 28·2 | 9·1-100·0 | 37·2 |
| Medium | 20 | 52-145 | 95·8 | 50·1-100·0 | 50·1 |
| Large | 4 | 160-250 | 193·5 | 47·0-100·0 | 75·8 |

TABLE 12(c)— DISTRIBUTION OF BISEXUAL AND UNISEXUAL PROGENIES

| Progeny size | No. of progenies | | | |
|---|---|---|---|---|
| | Bisexual | All-male | All-female | Total |
| Small | 13 (6-30) | 3 (2-46) | 0 | 16 (2-50) |
| Medium | 14 (52-145) | 6 (66-125) | 0 | 20 (52-145) |
| Large | 2 (164-200) | 2 (160-250) | 0 | 4 (160-250) |

Figures in parentheses show the range of no. of insects/progeny

In another experiment, 10 progenies were randomly drawn from a *rangeeni* stock and the insects in each were bred through full-sib mating. Ten females were taken at random from each progeny and their progenies reared separately for the sex ratio count. It was found that members of five progenies all produced a bisexual progeny, four included some which produced a bisexual progency and others which produced only the male insects. The results were most remarkable with the members of the last progeny, which all produced only the male insects. The parent culture of the last was examined which included thousands of insects,

all of which were male. These preliminary inbreeding results suggest that major gene differences are possibly involved for the occurrence of an all-male progeny.

The *rangeeni* stock of lac insect studied above is being inbred by full-sib mating to study sex ratio in relation to inbreeding.

(N. S. Chauhan)

**1.5.11 Cytotaxonomy of lac insects**

This investigation was taken up in 1981. Cytological studies on lac insects originating from Assam showed that the resting nucleus of the male lac insects contains darkly stained heteropycnotic body.

(S. K. Jaipuriar)

## (c) RESEARCHES CONTEMPLATED — Nil

## (d) OPERATIONAL RESEARCH PROJECT

Programmewise progress made in the project area comprising of four backward tribal villages namely, Hardag, Bargutto, Saheda and Koenjari of Namkum Development Block in Ranchi District is given below.

### A. INSECT CULTURE PROGRAMME

### (a) LAC CULTURE

Trials and demonstrations of improved methods of lac cultivation on *palas* and *ber* trees of the farmers of the operational area were continued on regular basis. Necessary inputs like broodlac, insecticides, etc. were supplied as subsidy wherever required. Improved instruments were also loaned to the beneficiaries for their use. Technical guidance was rendered and operational data were collected and maintained.

A few trials on *kusum* trees were also conducted.

*Rangeeni sticklac coupe*

The *baisakhi* 1980-81 *ari* (immature) crop was harvested from 160 *ber* tress of 35 cultivators. These trees were inoculated during October-November 1980 with an average brood rate of 3·03 kg per tree. The average yield of sticklac per tree was 10·22 kg as against 5·11 kg under the traditional method showing an increase of 100 per cent. The *baisakhi* 1981-82 crop was harvested from 168 *ber* trees of 30 cultivators. These trees were inoculated during October-November 1981 with an average brood rate of 2·69 kg per tree. The average yield of sticklac per tree was 4·94 kg as against 0·85 kg under the traditional method recording thereby 474·4 per cent increase.

*Rangeeni broodlac coupe*

The *baisakhi* 1980-81-*cum-katki* 1981 crop was harvested during October November 1981 from 160 *palas* trees of 35 cultivators. These trees were pruned during April-May 1980 and inoculated during November 1980 with an average rate of 0·50 kg broodlac per tree. The average broodlac yield per tree was 1·95 kg with

the use of synthetic netting broodlac containers against 0·56 kg under the traditional method, recording an increase of 248·29 per cent.

The *baisakhi* 1981-82-*cum-katki* 1982 crop was harvested during October-November 1982 from 90 *palas* trees of 35 cultivators. These trees were pruned during April-May 1981 and inoculated during October 1981 with an average rate of broodlac 0·475 kg per tree. The average broodlac yield was 1·15 kg as against 0·29 kg under the traditional method recording an increase of 300 per cent.

*Kusmi crop*

The *jethwi-cum-aghani* 1981-82 crop was harvested during February 1982 from 50 *kusum* trees of 5 cultivators. These unpruned trees were inoculated with an average rate of 13·61 kg broodlac per tree during January 1981 using synthetic netting broodlac containers. The average yield of broodlac and sticklac were 17·40 and 10·18 kg per tree respectively.

### (b) APICULTURE

Scientific bee keeping was encouraged by arranging supply of hives, honey extracting machines catchnets, etc. and providing technical guidance through guest lectures, demonstrations and regular contact. The disposal of honey was also organized by introducing appropriate packing procedures and fair price was ensured. Bee forage was also augmented by encouraging growing of bee pollinated crops and tree species such as Eucalyptus, mustard etc.

During 1981, total 58 bee-colonies were maintained, out of which 48 colonies were recorded to produce 200 kg honey at an average rate of 4·2 kg honey per colony generating an annual income of Rs 146.08 per family.

During 1981 also, total 79 colonies were maintained, out of which 47 colonies were recorded to produce 245 kg honey at an average rate of 5·2 kg honey per colony generating an annual income of Rs 288.41 per family.

### (c) SERICULTURE

The mulberry cuttings (175 nos.) procured from State Industries Deptt. and seedlings of *ber* (1251 nos), and *arjun* (90 nos.) from Forest Department were distributed free to the farmers for augmenting lac and sericulture in the area. By the end of 1982 many mulberry bushes attained suitable size but could not be utilised due to non-availability of mulberry egg layings.

Preliminary trials for rearing *philosamia ricini* on mature leaves of *Jatropha* spp., a recorded host available in sufficient number in the area, were not encouraging.

## B. CROP PRODUCTION PROGRAMME

### (a) AGRICULTURAL CROPS

During 1981, large scale introduction of high yielding varieties of maize, pigeonpea, green gram, soyabean, paddy, ragi, wheat, mustard, lentil, fodder crops and vegetables in the form of demonstrations, minikits and community nursuries were arranged with the cooperation of the state Agriculture Department. Demonstrations of seed treatment with fungicide and *Rhizobium* cultures, soil treat-

ment and fertilizer use were also conducted. Mussurie phos (39 tonne) was distributed free for improving soil reaction and fertility. These demonstrations (100) covered an area of 22 ha.

The availability of various agricultural inputs was facilitated by arranging mobile shops in co-operation with a local firm where farmers purchased small quantities of inputs at Ranchi rates.

During 1982, fifty-nine demonstrations of soyabean covering 9·47 ha and 32 demonstrations of paddy, ground nut and mustard covering an area of 2·25 ha were conducted.

### (b) HORTICULTURAL CROPS AND AGRO-FORESTRY

Total 6922 seedlings and 245 cuttings of the host plants of lac (1005), tasar (265), bee forage (1508), fuel (280), fodder (160), fruit (1713) and miscellaneous (915) species were procured from the Forest and other Department and distributed free of cost for planting in the area.

One crop loan and purchase of 6 irrigation pumps through Bank loan and Govt. subsidy was arranged in order to facilitate double cropping in the area.

## C. ANIMAL HUSBANDRY PROGRAMME

Animal health care and relevant lectures were arranged in co-operation with the State Animal Husbandry Department.

### (a) POULTRY KEEPING

It was observed that the farmers of the area are unable to manage big units under deep litter system.

Three units of 20 white leghorn pullets were, therefore, established in order to study the feasibility of smaller units. In these units the egg production continued till the end of the period under report.

For ensuring timely stock replacement, hatching of 85 fertile eggs of white leghorn and Red cornish breeds were tried.

Thirteen farmers were trained in poultry keeping with the co-operation of Animal Husbandry Department.

### (b) SWINE HUSBANDRY

One more pig breeding unit consisting of 2 females (sows) and one male (boar) of Yorkshire breed was added to the already existing 13 units in the area. In spite of heavy mortality amongst the parent stock, 44 pure and 16 hybrid piglets were born during 1981. By the end of 1982, three pure and 7 hybrid animals were left in stock after accounting for the mortalities, slaughter and disposals. A field day was organized with the co-operation of Govt. Bacon Factory, Ranchi in order to ensure marketing facilities. It was found that the intermediate sized and comparatively hardy hybrid (Yorkshire X local) animals were acceptable to the farmers in preference to the large sized animals.

### (c) MILCH CATTLE

Five farmers were trained in improved cattle management at Hotwar Dairy. Guest lectures and group discussions were also arranged for dissemination of information in respect of artificial insemination.

Six farmers were assisted in purchasing one cow each through Bank loan and Govt. subsidy under MESO Scheme during April 1981.

### (d) DRAUGHT ANIMALS

The purchase of 16 bullocks through Govt. subsidy and Bank loan was arranged in order to meet the urgent need of the farmers.

### (e) GOAT KEEPING

The purchase of 48 Black-Bengal goats through Govt. subsidy and Bank loan was arranged for the farmers of the area. These animals however, suffered large scale mortality due to mange disease.

Three bucks of Blac Bengal breed were supplied for stock improvement during July 1982 out of which only one survived till December 1982.

## D. FISHERIES

Fourteen farmers were trained in improved fish culture through the Fisheries Department. Three tanks were each stocked with 1000 mirror carp fry each during April 1982. The fishes attained an average size of 750 gms by the end of period under report.

A project for enlargement and improvement of two tanks in the area was submitted with the Fisheries Department for execution.

## E. EXTENSION EDUCATION PROGRAMMES

Monthly meetings of the Farmers Forum were conducted in all the four villages and discussions on the new technologies, local problems, etc. were held.

A 10-day study tour to C. S Azad University of Agriculture and Technology, Kanpur, U.P. and Indian Agriculture Research Institute, New Delhi was organized for 45 farmers of the area.

The farmers were taken to Kissan Melas organized by Ranchi Agricultural, College, Kanke and were encouraged to participate in fruit and vegetable shows.

One co-operative society (*Gramodaya Sahkari Samiti*) was organized in the village Saheda with a view to start a lac processing unit.

**(R. C. Misra and Jawahir Lal)**

## B. AGRONOMY AND PLANT GENETICS DIVISION

### (a) RESEARCHES COMPLETED

**2.2.1 The possibility of interspecific crossing in *Moghania* species**

*Sub-project — Synchronization of flowering period in Moghania* sp.

*Moghania macrophylla* flowers between August/September to October/November while *M. chappar in* October/November to February/March. With a view to coincide their flowering period for hybridization to combine their desirable qualities from lac cultivation stand point, the experiments were carried out with plant growth regulators namely, NAA, TIBA and MH for delaying the flowering time in *Moghania macrophylla* and Cycocel, IAA and NAA for hastening the flowering time in *M. chappar*. No significant effect was noticed (A.R.: 1972 and 1974-76).

The effect of photoperiod was studied on *M. chappar* for hastening its flowering time by exposing them to varying periods of sun light. Again, no effect was observed (A.R.: 1974-76).

Experiments were then carried out to study the effect of varying time of seed sowing with and without the use of growth regulators namely TIBA, MH and Cycocel for delaying the flowering time of *M. macrophylla*. No significant results were, however, obtained in respect of flowering time as compared to control (April sowing).

Lastly, the effect of topping and pinching with and without the use of NAA and Cycocel was studied on *M. macrophylla*.

The following treatments were tried:

$T_1$ = topping once at bud initiation stage
$T_2$ = topping twice at $T_1$ and at anthesis stage
$T_3$ = topping thrice at $T_1$, $T_2$ and post flowering stage
$T_4$ = topping four times at $T_1$, $T_2$, $T_3$ and one month after $T_3$ stage
$P_1$ = pinching once at $T_1$ stage
$P_2$ = pinching twice at $T_2$ stage
$P_3$ = pinching thrice at $T_3$ stage
$P_4$ = pinching four times at $T_4$ stage
C = Control

These treatments were also tried with the use of NAA (250 and 500 p.p.m.) and Cycocel (30 and 60 p.p.m.). As observed earlier also, the use of growth regulators was found to have no effect on the flowering time. The results of pinching and topping are shown in Fig. 2.

It will be seen from the Fig. 2 that both pinching and topping were effective in delaying the flowering time in *M. macrophylla* and were found more or less equally effective for this purpose. The flowering period of *M. macrophylla* could be coincided with that of *M. chappar* with 3 or 4 time pinching or topping.

(S. C. Srivastava, M. Ram, P. Kumar and S. Lal)

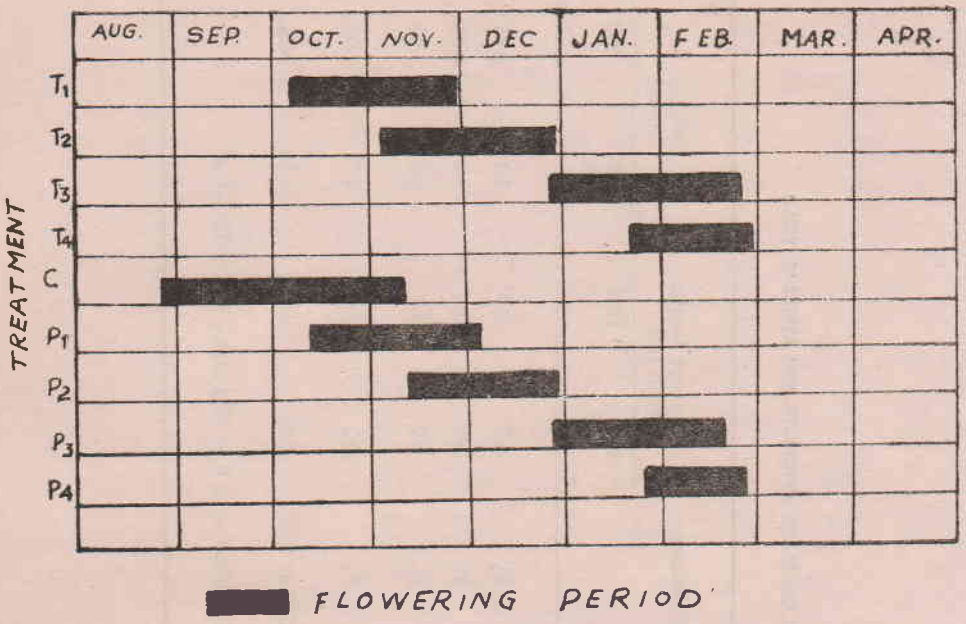


Fig. 2 — Flowering period

## (b) RESEARCHES ON HAND

### 2.1 Propagation and Management of Lac Host Plants

#### 2.1.2 Management of *bhalia* for lac cultivation

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

The study was continued as per technical programme reported earlier (A.R.: 1978). *Aghani* 1980-81 lac crop was harvested towards the end of January 1981. The observations recorded on total shoot length prior to lac inoculation and sticklac yields have been presented in Table 13. The systems of planting had no significant effect on total shoot length per plant whereas double hedge system accommodating largest number of plants has given the highest sticklac yield (5·4 q/ha). The fertilizer treatments ($F_3$ and $F_4$) had however, significant effect on both the total shoot lengths and sticklac yields.

To raise *aghani* 1981-82 crop *bhalia* bushes were inoculated in July 1981 and the plant attributes recorded at the time of lac inoculation. Similar trend of results (A.R.: 1979 and 1980) with regard to plant attributes and lac yields were observed.

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

TABLE 13 — EFFECT OF PLANTING SYSTEMS AND FERTILIZERS ON PLANT ATTRIBUTE AND STICKLAC YIELD

| System of planting | Plant population/ ha | Total shoot length/ bush (m) | | Sticklac yield (q/ha) | | Fertilizers | Total shoot length/ bush (m) | | Sticklac (q/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1981 | 1982 | 1981 | 1982 | | 1981 | 1982 | 1981 | 1982 |
| Square | 6,944 | 6·0 | 4·2 | 2·7 | 0·85 | $F_1$ | 4·3 | 3·7 | 3·2 | 0·83 |
| Quincunx | 10,850 | 5·8 | 4·5 | 2·8 | 0·72 | $F_2$ | 5·0 | 3·8 | 3·4 | 0·87 |
| Single hedge | 13,020 | 5·2 | 4·4 | 4·0 | 1·11 | $F_3$ | 6·7 | 4·7 | 4·6 | 1·03 |
| Double hedge | 17,361 | 5·3 | 4·2 | 5·4 | 1·45 | $F_4$ | 6·2 | 5·0 | 4·7 | 1·03 |
| CD at 5% | — | N.S. | N.S. | 2·37 | 0·38 | CD at 5% | 1·36 | 1·29 | 1·10 | N.S. |

*Note*: $F_1$= 20 g urea/plant; $F_2$= 40 g S.S.P./plant; $F_3$= 20 g urea+40 g S.S.P./plant; and $F_4$= 40 g urea+80 g S.S.P./plant

### 2.1.3 Integration of lac cultivation with general agriculture under dry farming condition

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

The experiment is continuing since 1978 in randomized block design. *Bhalia* and *galwang* bushes browsed by goats were replaced by fresh set of seedlings during July-August 1981. Out of the four fodder grasses grown as intercrops, Dinanath an annual fodder grass gave the highest forage yield/ha as reported earlier also. *Bhalia* plants coppiced in February 1982 did not show satisfactory growth whereas *galwang* bushes coppiced in April-May 1982 showed good response till the period under report.

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

The experiment is being continued as per the layout reported earlier (A.R.: 1978).

Observation recorded on plant height, no. of shoots and total shoot length per plant for both the lac hosts with and without the intercrops are shown in Table 14 and the economics of lac cultivation on these hosts with and without the intercrops have been shown in Tables 14 and 15.

It will be seen from these tables that the plant attributes and lac yield of these hosts have shown marked improvements by growing the intercrops and the results have been best with sweet potato+ginger for growing lac during both 1981 and 1982. The gross income per hectare from lac and ginger+sweet potato as intercrops was Rs 6022.80 as against Rs 2961.00 from growing lac only during 1981.

*Expt.* 3 — *Lac cultivation on palas under mixed cropping condition with tuber crops, rhizomes and grasses*

The experiment was laid out afresh during 1981 with some modifications. *Dinanath* as a fodder grass, tapioca and sweet potato as tuber crops and turmeric as rhizome crops were included in this study. These intercrops were raised alone and also in combination with turmeric. The experiment was conducted in R.B.D. with 7 treatments (including control i.e. without intercrops) replicated 3 times.

Dinanath grass+turmeric gave the highest gross income of Rs 2446.00/ha, (Table 16) during 1981.

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

### 2.1.4 Role of plant growth regulators on the growth of lac host plants

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

The study was continued with the layout as reported earlier (A.R.: 1978). *Baisakhi* (ari) 1980-81 lac crop was harvested in May 1981. The total shoot length and maximum sticklac yield (861·0 cm and 55·83 g respectively) per plant were recorded from the treatment of GA (160 ppm) against the lowest yield of 18·0 g per plant in case of control (Table 17). The plants were again inoculated in October 1981 to raise *baisakhi* 1981-82 (ari) crop which was harvested in May

TABLE 14 — EFFECT OF INTERCROP ON THE GROWTH ATTRIBUTES OF *bhalia* AND *galwang* DURING 1981 AND 1982

| Treatments | *Bhalia* | | | | | | *Galwang* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | | Shoots/bush (No.) | | Total shoot length/plant (cm) | | Plant height (cm) | | Shoots/bush (No.) | | Total shoot length (cm) | |
| | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 |
| $T_0$ | 144·3 | 118·2 | 7·8 | 6·7 | 776·0 | 766·5 | 126·3 | 125·2 | 4·0 | 3·6 | 470·0 | 482·0 |
| $T_1$ | 142·8 | 137·5 | 10·1 | 9·8 | 1053·0 | 983·0 | 164·7 | 185·7 | 4·9 | 4·2 | 657·0 | 692·0 |
| $T_2$ | 143·8 | 140·8 | 10·0 | 9·6 | 1150·3 | 998·6 | 137·3 | 140·2 | 4·0 | 5·1 | 531·7 | 601·5 |
| $T_3$ | 131·0 | 131·6 | 8·8 | 8·5 | 1195·3 | 1025·5 | 178·0 | 173·0 | 5·9 | 6·2 | 682·0 | 735·0 |
| $T_4$ | 140·6 | 142·5 | 8·3 | 7·0 | 1346·7 | 1100·0 | 122·3 | 125·5 | 4·4 | 4·8 | 585·3 | 632·3 |
| $T_5$ | 139·8 | 131·8 | 9·8 | 8·5 | 1292·0 | 1186·0 | 150·3 | 151·4 | 5·9 | 5·3 | 624·3 | 675·5 |
| $T_6$ | 148·4 | 145·6 | 10·6 | 9·8 | 1533·0 | 1415·5 | 179·3 | 168·5 | 5·2 | 5·5 | 693·0 | 781·0 |
| $T_7$ | 155·0 | 158·0 | 10·9 | 10·3 | 1734·3 | 1584·2 | 166·0 | 176·0 | 6·5 | 6·2 | 950·6 | 998·6 |
| $T_8$ | 160·6 | 163·6 | 12·6 | 11·4 | 1703·0 | 1605·0 | 166·0 | 178·5 | 4·8 | 6·5 | 946·0 | 1015·0 |
| $T_9$ | 160·1 | 160·0 | 10·0 | 8·8 | 1557·6 | 1487·6 | 136·7 | 140·5 | 5·1 | 4·8 | 572·7 | 665·7 |

TABLE 15 — YIELD AND ECONOMICS OF INTERCROPPING WITH LAC-HOSTS *bhalia* AND *galwang* DURING 1981 AND 1982

| Treatment | Yield of intercrops (kg) | | | | | | | | Yield of lac (Q/ha) | | Return from inter-crops Rs/ha | | Return from lac Rs/ha | | Total gross (Rs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tapioca | | Sweet potato | | Ginger | | Turmeric | | | | | | | | |
| | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 |
| $T_1$ (Tapioca) | * | 430·0 | — | — | — | — | — | — | 4·74 | 1·40 | — | 258·00 | 3318·00 | 1680·00 | 3318·00 |
| $T_2$ (Sweet potato) | — | — | 140·40 | 760·0 | — | — | — | — | 6·76 | 1·70 | 84·00 | 456·00 | 4732·00 | 1920·00 | 4816·00 |
| $T_3$ (Ginger) | — | — | — | — | 37·80 | 11·0 | — | — | 5·21 | 1·40 | 47·20 | 27·50 | 3647·00 | 1680·00 | 3694·20 |
| $T_4$ (Turmeric) | — | — | — | — | — | — | 488·40 | 82·0 | 4·70 | 1·40 | 976·00 | 82·00 | 3290·00 | 1680·00 | 4266·00 |
| $T_5$ (Tapioca+ Ginger) | — | 146·0 | — | — | 32·40 | 55·0 | — | — | 4·94 | 1·90 | 40·50 | 225·10 | 3458.00 | 2280·00 | 3598·50 |
| $T_6$ (Tapioca+ turmeric) | — | 200·0 | — | — | — | — | 361·80 | 49·0 | 4·38 | 2·00 | 723·60 | 169·00 | 3066·00 | 2400·00 | 3789·60 |
| $T_7$ (Sweet potato +Ginger) | — | — | 189·00 | 160·0 | 43·20 | 41·0 | — | — | 8·08 | 2·5 | 167·40 | 198·50 | 5656·00 | 3000·00 | 5823·40 |
| $T_8$ (Sweet potato +Turmeric) | — | — | 108·00 | 460·0 | — | — | 235·00 | 71·0 | 7·84 | 2·0 | 534·80 | 347·00 | 5488·00 | 2400·00 | 6022·80 |
| $T_9$ (Sweet potato +Ginger+ Turmeric) | — | — | 108·00 | 150·0 | 64·80 | 8·0 | 259·20 | 62·0 | 4·92 | 0·09 | 664·20 | 172·00 | 3444·00 | 1152·00 | 4108·20 |
| $T_0$ Control | — | — | — | — | — | — | — | | 4·23 | — | — | — | 29610·0 | — | 2961·00 |

*Note* —*Tapioca crop was badly affected due to the attack of rats and white grubs and hence recorded no yield. Market rate of different crop and lac per quintals are given below:
Rate per quintal: Tapioca Rs 60.00, Sweet potato Rs 60.00, Turmeric Rs 200.00, Ginger Rs 125.00 and Lac Rs 700.00.

TABLE 16 — YIELD OF GROSS INCOME PER HECTARE FROM INTERCROPS GROWN WITHIN *palas* BUSHES DURING 1981

| Treatment | Dinanath grass | | Tapioca | | Sweet potato | | Turmeric | | Total Gross income (Rs) |
|---|---|---|---|---|---|---|---|---|---|
| | Yield (Q/ha) | Gross income (Rs) | Yield (Q/ha) | Gross income (Rs) | Yield (Q/ha) | Gross income (Rs) | Yield (Q/ha) | Gross income (Rs) | |
| $T_1$ (Dinanath grass) | 112·9 | 1693·00 | — | — | — | — | — | — | 1693.00 |
| $T_2$ (Tapioca) | — | — | 13·25 | 795·00 | — | — | — | — | 795.00 |
| $T_3$ (Sweet potato) | — | — | — | — | 12·5 | 750·00 | — | — | 750.00 |
| $T_4$ (Dinanath grass +Turmeric) | 117·6 | 1764·00 | + | — | — | — | 3·41 | 682·00 | 2446.00 |
| $T_5$ (Tapioca +Turmeric) | — | — | 9·66 | 579·60 | — | — | 2·5 | 500·00 | 1079.60 |
| $T_6$ (Sweet potato +Turmeric) | — | — | — | — | 9·66 | 579·60 | 2·73 | 546·00 | 1125.60 |
| $T_0$ | — | — | — | — | — | — | — | — | — |

*Note*: Selling rate of different crops:
(i) Dinanath grass: Rs 15/Q
(ii) Tapioca: Rs 60/Q
(iii) Turmeric: Rs 200/Q
(iv) Sweet potato: Rs 60/Q

1982. On the contrary, it was observed that the total shoot length and stick lac yield were found best with the treatment of NAA (320 ppm) in place of GA (160 ppm) as reported in 1980-81 crop (Table 17).

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

| Treatment growth regulators in ppm | 1980-81 | | 1981-82 | | End of October 1982 |
|---|---|---|---|---|---|
| | Total shoot length/plant (cm) | Sticklac yield/plant (g) | Total shoot length/plant (cm) | Sticklac yield/plant (g) | Total shoot length/plant (cm) |
| NAA 40 | 292·46 | 24·66 | 346·49 | 29·33 | 348·46 |
| NAA 80 | 381·38 | 28·66 | 532·70 | 35·90 | 525·80 |
| NAA 160 | 425·35 | 34·63 | 799·20 | 45·00 | 812·33 |
| NAA 320 | 731·68 | 55·00 | 985·92 | 86·66 | 967·66 |
| $GA_3$ 20 | 226·68 | 18·66 | 324·81 | 26·00 | 341·84 |
| $GA_3$ 40 | 474·00 | 21·18 | 399·91 | 25·33 | 446·66 |
| $GA_3$ 80 | 830·00 | 40·16 | 487·75 | 39·00 | 578·66 |
| $GA_3$ 160 | 861·02 | 55·83 | 570·13 | 63·33 | 870·00 |
| Control | 175·32 | 18·00 | 300·60 | 24·33 | 314·33 |

*Expt. 4 — Effect of $GA_3$ and urea on kusum*

The experiment was repeated during 1981 and 1982 with the same schedule of treatments and technical programme as reported earlier (A.R.: 1978). Observations on shoot measurement recorded prior to lac inoculation in July showed that the average length per shoot and basal diameter were maximum with the treatments of $GA_3$ (80 p.p.m.+1% urea). The results presented in Table 18 are in con-

TABLE 18 — EFFECT OF GA AND UREA ON SHOOT LENGTH OF *kusum* AT THE TIME OF *aghani* LAC CROP INOCULATION

| Treatment | Average shoot length (cm) | | Basal diameter of shoot (cm) | |
|---|---|---|---|---|
| | 1981 | 1982 | 1981 | 1982 |
| $GA_3$ 20 ppm | 33·44 | 69·33 | 1·66 | 1·60 |
| $GA_3$ 40 ppm | 56·33 | 75·66 | 1·72 | 1·69 |
| $GA_3$ 80 ppm | 70·30 | 86·40 | 1·92 | 1·81 |
| Urea 0·5% | 34·44 | 74·15 | 1·06 | 1·05 |
| Urea 1·0% | 45·22 | 79·33 | 1·51 | 1·55 |
| $GA_3$ 20 ppm +Urea 0·5% | 40·77 | 82·22 | 1·17 | 1·18 |
| $GA_3$ 20 ppm +Urea 1·0% | 43·55 | 85·33 | 0·97 | 1·19 |
| $GA_3$ 40 ppm +Urea 0·5% | 54·50 | 86·66 | 1·40 | 1·24 |
| $GA_3$ 40 ppm +Urea 1·0% | 67·44 | 91·33 | 1·03 | 1·33 |
| $GA_3$ 80 ppm +Urea 0·5% | 87·00 | 112·66 | 1·83 | 1·85 |
| $GA_3$ 80 ppm +Urea 1·0% | 108·00 | 120·00 | 1·94 | 1·99 |
| Control | 31·00 | 60·00 | 0·65 | 0·69 |

formity with the previous year findings. *Aghani* 1981-82 lac crop was damaged by predators and parasites while the subsequent *aghani* crop in 1982-83 could not be raised due to non-availability of brood lac.

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

### 2.1.6 Agricultural utilization of lac mud

Lac mud, a bye-product of lac industry having no economic value, may be utilised as organic manure due to its rich manurial value as compared to F.Y.M. Acid precipitated lac mud has also got similar properties like other nitrogen carriers. With these objects in view, the present study was initiated in 1981.

*Expt.* 1 — *The effect of various level of lac mud on growth and yield of wheat and their residual effect on paddy*

Two sets of experiment were laid out in R.B.D. with 3 replications during 1981. The treatments were as follows:

$L_0$ = Control
$L_1$ = 2·5 ton lac mud/ha
$L_2$ = 5·0 ton lac mud/ha
$L_3$ = 10·0 ton lac mud/ha
$L_4$ = 20·0 ton lac mud/ha
$L_5$ = 40·0 ton lac mud/ha

In the first set, wheat var. (Sonalika) was sown during November 1981 and harvested in April 1982. After harvesting of wheat, paddy (IR-30) was transplanted in the same plot on the onset of monsoon. In the second set, paddy was transplanted during July 1982 after the application of lac mud as per the treatment. Paddy was harvested in November 1982 and wheat was sown thereafter. The data for first set (Paddy and wheat) and for second set (paddy only) are given in Table 19. It will be seen from the table that the lac mud has high manurial value and the yield of both wheat and paddy increased significantly with the increase in the dose of lac mud.

TABLE 19 — EFFECT OF VARIOUS LEVELS OF LAC MUD ON YIELD OF WHEAT AS MAIN CROP AND PADDY AS RESIDUAL CROP

| Treatments | Set 1 | | Set 2 |
|---|---|---|---|
| | Wheat grain yield (q/ha) | Paddy grain yield (q/ha) as residual | Paddy grain yield (q/ha) |
| $L_0$ (Control, no lac mud) | 3·4 | 5·3 | 16·1 |
| $L_1$ | 5·3 | 6·8 | 18·2 |
| $L_2$ | 6·2 | 6·7 | 19·7 |
| $L_3$ | 9·2 | 7·4 | 21·0 |
| $L_4$ | 14·3 | 8·7 | 22·0 |
| $L_5$ | 23·1 | 9·7 | 25·2 |
| CD at 5% | 6·64 | 2·12 | 2·45 |

*Expt. 2 — To study the effect of lac mud, farm yard manure over NPK manuring on the yield of wheat and their residual effect on paddy and vice versa*

In this study also, two sets of experiment were laid out during 1981 in R.B.D. with 3 replications. The treatments were as follows:

$T_1$ = Control
$T_2$ = 10 ton lac mud/ha
$T_3$ = 20 ton lac mud/ha
$T_4$ = 10 ton F.Y.M/ha
$T_5$ = 20 ton F.Y.M./ha
$T_6$ = N 100 kg, P 50 kg, K 30 kg/ha
$T_7$ = 10 ton lac mud+N 50 kg, P 25 kg, 15 kg/ha
$T_8$ = 20 ton lac mud+N 50 kg, P 25 kg, K 15 kg/ha
$T_9$ = 10 ton F.Y.M.+N 50 kg, P 25 kg, K 15 kg/ha
$T_{10}$ = 20 ton F.Y.M.+N 50 kg, P 25 kg, K 15 kg/ha

In the first set, wheat (var. Sonalika) was sown during Nov. 1981 after giving the above treatments before sowing and the crop was harvested in April 1982. Thereafter paddy (var. IR-30) was transplanted in the same plots without applying any fertilizers and manures. In the second set, paddy (var. IR-30) was transplanted in July-August 1982 after giving the above treatments and its residual effect will be observed on wheat sown during 1982. The grain yield obtained during 1982 have been shown in Table 20. The grain yield was markedly higher with the use of lac mud and F.Y.M individually and in combination with commercial fertilizers.

TABLE 20 — EFFECT OF LAC MUD, FYM, OVER NPK MANURING ON GRAIN YIELD OF WHEAT AND PADDY AS MAIN CROPS AND PADDY AS RESIDUAL CROP

| Treatment | Set 1 | | Set 2 |
|---|---|---|---|
| | Wheat grain yield (q/ha) | Paddy grain yield as residual crop (q/ha) | Paddy grain yield (q/ha) |
| $T_1$ (Control) | 4·7 | 5·4 | 10·0 |
| $T_2$ | 8·7 | 6·5 | 13·5 |
| $T_3$ | 14·6 | 7·7 | 16·3 |
| $T_4$ | 11·0 | 6·1 | 11·9 |
| $T_5$ | 10·0 | 7·3 | 12·5 |
| $T_6$ | 17·0 | 5·3 | 15·2 |
| $T_7$ | 17·2 | 5·9 | 21·5 |
| $T_8$ | 24·9 | 6·8 | 17·2 |
| $T_9$ | 22·1 | 5·8 | 12·7 |
| $T_{10}$ | 23·6 | 7·8 | 18·0 |
| CD at 5% | 0·61 | N.S. | 5·73 |

(B. P. Singh, B. K. Purkayastha and K. P. Singh Co-operator)

### 2.1.7 Management of *Putri* (*Croton oblongifolius*) for lac cultivation

Since *kusmi* lac cultivation trials on *putri* have shown promise, a systematic study was taken up to work out suitable management practices for intensive lac cultivation on this host species.

*Expt.* 1 — *The effect of spacing and height of coppicing on plant growth and lac yield*

The experiment was laid out in 1981 on a split plot design with 24 treatments replicated 3 times. The treatments were as follows:

(i) Main plot treatments (spacing)
$S_1 = 1 \times 1$ m, $S_2 = 1 \times 1{\cdot}5$ m, $S_3 = 1{\cdot}5 \times 1{\cdot}0$ m and $S_4 = 1{\cdot}5 \times 2{\cdot}0$ m.

(ii) Sub plot treatments (Height of coppicing)

$L_0$ = Coppicing from ground level
$L_1$ = Coppicing from 15 cm above ground level
$L_2$ = Coppicing from 30 cm above ground level
$L_3$ = Coppicing from 45 cm above ground level
$L_4$ = Coppicing from 60 cm above ground level
$L_5$ = Coppicing from 75 cm above ground level

Suckers of monoecious var. of *putri* were planted in the field in July 1981 as per lay out. About 50 per cent of these plants dried up during summer months and gaps filled up in July-August 1982 with the new suckers.

(B. P. Singh, M. Ram and P. Sen)

### 2.1.8 Utilization of *ber* for lac, tasar and fruit

*Ber* (*Ziziphus mauritiana*) is valued for its fruit in Chotanagpur and certain other region. It, is also used for lac cultivation and tasar rearing. Since under the present socio-economic conditions, the monoculture on *ber* has not proved very remunerative to the tribal farming community, a study was taken up to develop a suitable technology for utilising the *ber* plants for lac, tasar and fruits.

The experiment was laid out in R.B.D. with 7 treatments and 3 replications. The treatments were as follows:

$T_1$ = Lac culture (L) (*Baisakhi-ari* lac)
$T_2$ = Tasar culture (T)
$T_3$ = Fruit culture (F)
$T_4$ = Lac+Tasar (L+T)
$T_5$ = Lac+Fruit (L+F)
$T_6$ = Tasar+Fruit (T+F)
$T_7$ = Lac+Fruit+Tasar (L+F+T)

Local var. of *ber* planted earlier were pruned during May 1981. Ten laying of *Ampatia* tasar were reared during October-November 1981 and 1982. Observations recorded on plant attributes are given in Table 21. It was noted that the plant growth was not affected due to tasar rearing. Physical properties of the tasar cocoons were studied. The effective rate of rearing (E.R.R.) was found to be 30

TABLE 21 — DATA ON PLANT GROWTH ATTRIBUTES OF *ber* BUSHES AND STICKLAC YIELDS UNDER DIFFERENT TREATMENTS

| Treatments | | Plant height (cm) | | Diameter of stem (cm) | | Diameter of shoot (cm) | | Branches/bush (No.) | | Plant spread (Directions) | | | | Sticklac yield/bush (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | N-S (m) | | E-W (m) | | |
| | | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981 | 1982 | 1981-82 |
| $T_1$ | M | 212·50 | 215·60 | 4·65 | 4·67 | 2·77 | 2·80 | 3·50 | 3·55 | 1·89 | 1·82 | 1·84 | 1·88 | 415·60 |
| | A | 277·00 | 230·00 | 6·03 | 6·33 | 3·10 | 3·15 | 3·66 | 5·60 | 1·93 | 1·96 | 1·92 | 2·12 | |
| $T_2$ | M | 260·00 | 268·33 | 4·55 | 4·50 | 3·32 | 3·36 | 4·50 | 4·33 | 2·24 | 2·42 | 2·01 | 2·21 | — |
| | A | 309·33 | 312·50 | 7·46 | 7·64 | 3·50 | 3·85 | 5·33 | 5·50 | 2·48 | 2·83 | 2·15 | 2·64 | |
| $T_3$ | M | 271·75 | 275·58 | 4·20 | 4·35 | 3·82 | 3·28 | 6·50 | 5·60 | 2·43 | 2·44 | 2·32 | 2·23 | — |
| | A | 378·66 | 386·66 | 8·70 | 8·60 | 4·70 | 4·07 | 8·66 | 8·77 | 2·61 | 2·75 | 2·37 | 2·84 | |
| $T_4$ | M | 188·25 | 199·33 | 3·82 | 3·29 | 1·80 | 2·11 | 4·00 | 4·12 | 1·42 | 1·23 | 1·44 | 1·45 | 250·00 |
| | A | 243·33 | 258·00 | 5·60 | 6·50 | 2·50 | 2·75 | 4·33 | 5·36 | 1·61 | 1·70 | 1·76 | 1·93 | |
| $T_5$ | M | 217·25 | 220·00 | 4·47 | 4·57 | 2·57 | 2·50 | 7·25 | 7·39 | 1·82 | 1·90 | 1·98 | 1·98 | 355·60 |
| | A | 208·33 | 283·33 | 8·06 | 1·18 | 3·00 | 3·33 | 8·50 | 8·55 | 2·01 | 2·88 | 2·25 | 2·16 | |
| $T_6$ | M | 268·25 | 273·33 | 5·35 | 5·50 | 3·47 | 3·74 | 7·75 | 7·57 | 2·70 | 2·50 | 2·18 | 2·08 | — |
| | A | 380·00 | 386·66 | 7·90 | 8·12 | 3·86 | 3·97 | 8·66 | 8·09 | 2·72 | 2·79 | 2·51 | 2·46 | |
| $T_7$ | M | 231·50 | 239·11 | 4·02 | 4·22 | 2·60 | 2·68 | 4·66 | 4·76 | 1·90 | 1·98 | 1·93 | 1·90 | 275·00 |
| | A | 298·33 | 298·66 | 7·43 | 7·35 | 3·40 | 3·56 | 5·25 | 5·52 | 2·02 | 2·78 | 2·28 | 2·36 | |

*Note*: M = Plant attributes at the time of tasar worm mounting
A = Plant attributes at the time of harvesting of tasar cocoons

coccon per laying and the average number of coccon per plant was found as 15. *Ber* bushes were inoculated with *palas* broodlac in November 1981 for raising *baisakhi* 1981-82 (*ari*) crop which was harvested in May 1982 and data are shown in Table 21. The maximum yield of lac was 415 g per plant where only lac was grown as against the lowest 250 g per plant where both lac and tasar were grown. The experiment was repeated by inoculating *ber* bushes in November 1982 with *Porho* broodlac. The insects were developing satisfactorily till the year under report.

(M. Ram, B. K. Purkayastha, T.P.S. Teotia, N. Prasad and P. Kumar).

**2.1.9 Standardization of agroforestry practices for raising high lac yielding *kusum* plants through air layering**

In view of the success achieved in vegetative propagation of *kusum* through *air* layering, the raising of systematic plantations of *kusum* with proven trees is found necessary for sustained *kusumi* lac production. This study was, therefore, initiated to find the optimum agroforestry practices for quick establishment of *kusum* plantations through air layers.

The experiment was laid out under field conditions during 1981 in Split Plot Design replicated 3 times. The treatments were as follows:

(i) Main plot treatment (Fertilizer application)

$M_1$ = NPK at planting of air layers
$M_2$ = NPK at two successive seasons
$M_3$ = NPK at three successive seasons

(ii) Sub plot treatments

$S_1$ = 80 ppm $GA_3$ on the new sprouts in January-February in second, third year
$S_2$ = 80 ppm $GA_3$ on the new sprouts in January-February in second, third year
$S_3$ = 80 ppm $GA_3$ in second, third and fourth year
$S_4$ = 80 ppm $GA_3$+1 percent urea in second year
$S_5$ = 80 ppm $GA_3$+1 percent urea in second and third year
$S_6$ = 80 ppm $GA_3$+1 percent urea in second, third and fourth year
$S_7$ = Control (water spray)

Air layering of *kusum* which was the first stage of this study could not be done in 1981 due to non-availability of *sphagnum* moss in time. In 1982, air layering of proven, *kusum* trees situated both at Namkum and Hesal was carried out. In all 1000 layers were prepared with the help of mixtures of IBA+IAA (100 ppm) and *sphagnum* moss, out of which only 162 air layers could produce rootage. These were planted in September 1982 in the field and showed satisfactory growth at initial stage but later on these dried up due to prolonged drought conditions.

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

**2.1.10 Study and assessment of economics of cultivation of *kusmi* lac on bushes of of *bhalia* and *galwang***

*Aghani* 1980-81 lac crop was harvested in Jan. 1981 from *bhalia* bushes which yielded 400 kg broodlac out of which 120 kg broodlac was used for inoculation of 400 *galwang* bushes and the rest 280 kg was supplied to the Divisions of Agronomy

and Plant Genetics and Entomology for experimental purpose. The yield of scraped lac was 150 kg. Lac insects inoculated on *Albizzia lucida* (*galwang*) suffered heavy mortality at the initial stage of settlement resulting in poor crop yield.

Growth of *galwang* seedlings planted in August 1981 was not up to the mark in spite of manuring and proper care measures.

In July 1981 again, 3600 *bhalia* bushes were inoculated with 400 kg of *kusmi*, broodlac for raising *aghani* 1981-82 lac crop. The lac crop was harvested in February 1982 which yielded 550 kg broodlac, out of which 150 kg of broodlac was used for inoculation of 600 *galwang* bushes for raising *Jethwi* 1982 crop and the rest 400 kg was supplied to the Divisions of Entomology and Agronomy and Plant Genetics. In addition 120 kg rejected scraped lac was also obtained.

Lac larvae settlement on *galwang* bushes was very good at the initial stage but later on it was badly affected due to severe hail storms followed by heavy rains, resulting in poor crop yield.

(B. K. Purkayastha)

## 2.2 Genetics and Breeding of Lac Host Plants

### 2.2.1 The possibility of interspecific crossing in *Moghania* sp.

*Sub-project — Crossing in Moghania sp.*

Total five hundred fifty reciprocal crosses were made between *bhalia* and *barasalpan* during 8.30 to 9.30 a.m. with and without the use of 0·01% boric acid, 20% sucrose solution and 0·02% fresh solution of Ca-complex ($Ca(NO_3)_2$, $4H_2O$; $MgSO_4$, $7H_2O$; $KNO_3$) on the stigmatic surface of emasculated floral buds. It was observed that the pollinated flowers shed off in all the cases after 8 to 10 days of pollination except with the use of 0·01% boric acid on the stigmatic surface of *barasalpan* which showed appreciable growth in ovarian region. However, these buds also shed off after 8 to 15 days of pollination.

(S. C. Srivastava and Moti Ram)

### 2.2.2 Selection for better performance of *Moghania macrophylla* as a lac host for *kusmi* strain of lac insects

*Aghani* 1980-81 lac crop was harvested during January 1981 from individual plants. On the basis of lac yield performance, 10 plants showing higher lac yield were selected and their seeds were sown during April 1981 in nursery bed and later on the seedlings were transplanted in progeny rows during July 1981.

Similarly, the seeds of *bhalia* collected from Netarhat area were also sown in nursery beds and the seedlings were transplanted in the field during July 1981. The plants raised in progeny rows as well as from Netarhat, collections were inoculated with *kusmi* broodlac during July to raise *aghani* 1982-83 crop. The larval settlement and the development of lac insects were not satisfactory. However, on the basis of lac yield performance, the plants were selected for further study.

(P. Kumar and D. C. Srivastava)

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

#### 2.2.3.1 Evaluation of *arhar* varieties/cultivars for winter lac as well as pulse production

*Katki crop*

Five early medium maturing *arhar* varieties viz. UPAS-120, T-21, TT-5, TT-6 and BR-183 were sown during April 1982 alongwith summer moong/groundnut as intercrops in a split-plot design with varieties as main-plot treatment, lac inoculation as sub plot and intercrop as sub plot treatments. Two to three irrigations were provided to summer moong (K-851) which boosted the growth of *arhar* also. Moong was harvested during June 1982. The yield was 261·2, 215·0, 183·75, 258·25 and 197·5 g per plot with UPAS-120, T-21, TT-5, TT-6 and BR-183 varieties of *arhar* respectively. Groundnut was sown during July 1982 as intercrop in plots from where moong was harvested. The groundnut yield was 292·45, 193·10, 166·25, 96·25 and 106·85 g per plot with UPAS-120, T-21, TT-5, TT-6 and BR-183 varieties of *arhar* respectively. Pods from *arhar* plants were collected in November 1982. It was observed that due to lac inculation, there was a reduction in the yield of pulse in almost all the varieties. The data collected on *arhar* plants survival and grain yield have been shown in Table 22. It will be seen from the table that varieties differed markedly for their survival and grain yield when inoculated with lac. The varieties showed reduction in grain yield except variety T-12 and TT-5. The effect of intercrop has not been significant. *Arhar* plants were inoculated during July 1982 to raise *katki* 1982 crop. The *katki* 1982 crop was a general failure and the yield was very low under this experiment also. Crop data available, however, indicated var. BR-183 as the highest yielder followed by TT-5, TT-6, T-21 and UPAS-120 varieties.

TABLE 22 — PLANT SURVIVAL AT THE TIME OF PULSE MATURITY AND GRAIN YIELD DURING *katki* 1982 ON *arhar*

| Variety | Without lac and without intercrop | | With lac and without intercrop | | Without lac and with intercrop | | With lac and with intercrop | |
|---|---|---|---|---|---|---|---|---|
| | Wt of grain per plant (g) | Plant survival (%) | Wt of grain per plant (g) | Plant survival (%) | Wt of grain per plant (g) | Plant survival (%) | Wt of grain per plant (g) | Plant survival (%) |
| $V_1$ | 34·3 | 87·5 | 17·6 | 89·5 | 21·1 | 82·0 | 18·8 | 87·5 |
| $V_2$ | 41·4 | 92·5 | 76·7 | 84·1 | 47·9 | 89·5 | 54·0 | 97·9 |
| $V_3$ | 26·8 | 87·5 | 32·2 | 93·7 | 40·1 | 82·0 | 31·2 | 82·0 |
| $V_4$ | 72·3 | 89·5 | 50·3 | 87·5 | 56·1 | 87·5 | 45·5 | 90·4 |
| $V_5$ | 56·5 | 82·0 | 43·6 | 82·0 | 47·7 | 93·7 | 42·2 | 85·4 |

*Aghani crop*

The *arhar* varieties evaluated for *katki* crop were also tried for *aghani* crop except var. TT-6 which was replaced by var. ICPL-6. The experiment was carried

out as per the lay out reported for the *katki* crop. The *moong* was harvested during June 1982 and the yield was 246·25, 208·75, 241·25, 207·5 and 126·25 g per plot with UPAS-120, T-21, TT-5, ICPL-6 and BR-183 varieties respectively. Groundnut was harvested in November and the yield was 243·1, 213·7, 246·25, 61·25 and 113·1 g per plot with the varieties UPSA-120, T-21, TT-5, ICPL-6 and BR-183 respectively. The *arhar* plants were inoculated with lac in July 1982 but the crop was badly attacked by fungii in the early stages of development and was thus a total failure.

*Sub-project 2 — Evaluation of arhar varieties/cultivars for summer lac crop*

*Baisakhi crop*

The 18 varieties/cultivars of *arhar* raised by sowing in June 1980 and inoculated in October 1980 to raise the *baisakhi* 1980-81 crop were scored for their lac and grain yields. The data set out in Table 23 show that five varieties viz. *Bahar*, 2E, ICP nos 3783, 7188 and 7197 hold promise from lac cultivation stand point. Of these *Bahar* showed the maximum lac yield (11·1 g) with highest reduction in grain yield (35%) whereas ICP no. 7197 showed the lowest lac yield (7·12g) with no reduction in grain yield. The 20 varieties/cultivars viz. K 356, ICP nos. 3783, 7197, 8501, 4704, 6986, 6344, 6443, 7188 2E Laxmi, 7336-$W_5$, 7424-$W_5$, 7424-$W_1$, ICP-1-6-$W_5W_1$ Basant, no. 3570, AS-29, *Bihar* and Assam were raised by sowing in July 1981 but could not be evaluated for their lac performance as the plants were not ready for receiving inoculation for *baisakhi* 1981-82 crop due to adverse climatic conditions.

In the following 1982-83 season, sixteen varieties viz. *Basant*, *Bahar*, *Laxmi*, K 356, ICP nos. 7188, 8501, 3783 and 7197, 2E no. 3570, BDN-3, 7-S, T-17, SA-1, S-80 and gwl-3 were raised by sowing in July 1982 and were inoculated in Novem-

TABLE 23 — PULSE AND LAC YIELD PER PLANT IN DIFFERENT VARIETIES OF *Cajanus cajan*

| Variety | Pulse yield (g) | | Lac yield (g) |
|---|---|---|---|
| | With lac crop | Without lac crop | |
| 1. Bahar | 41·3 | 63·8 | 11·1 |
| 2. Basant | 60·8 | 60·1 | 3·71 |
| 3. T 121 | 7·4 | 7·9 | 0·83 |
| 4. ICRISAT ICP No. 6443 | 45·2 | 50·0 | 3·76 |
| 5. AS-29 | 39·7 | 42·7 | 6·40 |
| 6. 7 S | 57·3 | 63·7 | 4·13 |
| 7. Laxmi | 38·3 | 50·3 | 6·86 |
| 8. 2 E | 57·2 | 67·0 | 9·42 |
| 9. K 35/6 | 60·9 | 78·1 | 3·75 |
| 10. No. 3570 | 59·3 | 63·9 | 6·00 |
| 11. ICRISAT ICP No. 3783 | 36·9 | 46·6 | 9·33 |
| 12. ICRISAT ICP No. 6986 | 30·1 | 38·5 | D.M. |
| 13. ICRISAT ICP No. 7188 | 47·5 | 54·2 | 8·48 |
| 14. ICRISAT ICP No. 7197 | 49·9 | 44·8 | 7·12 |
| 15. ICRISAT ICP No. 4704 | 51·8 | 71·8 | 3·96 |
| 16. ICRISAT ICP No. 8501 | 56·1 | 51·4 | 2·05 |
| 17. ICRISAT ICP No. 6344 | 67·3 | 89·9 | 2·08 |
| 18. Assam | 48·1 | 63·1 | 4·4 |

ber 1982 for raising the *baisakhi* 1982-83 crop. The crop developed satisfactorily till the period under report.

*Jethwi crop*

The sixteen varieties of *arhar* evaluated for *baisakhi* 1982-83 crop were also raised by sowing in July 1982 for raising the *jethwi* 1983 crop. The plants developed satisfactorily till the period of report.

(P. Kumar, B. P. Singh, D. C. Srivastava and T. P. S. Teotia)

### 2.2.4 Mutation studies on *arhar* in relation to lac and pulse production

*Baisakhi* 1980-81 lac crop was harvested as *ari* during May 1981 and the lac yield recorded plantwise and compared in terms of per unit shoot length. The data are presented in Table 24. $M_3$ generation was raised by sowing in progeny rows of 17 plants selected on the basis of lac yield and were later inoculated in November 1982 for raising *baisakhi* 1982-83 crop. These plants were, however, badly affected by sterility mosaic disease. The lac crop was developing satisfactorily till the period under report.

(P. Kumar)

TABLE 24 — FREQUENCY DATA OF THE CORRESPONDING RANGES OF DIFFERENT CHARACTERS OF PLANTS IN $M_2$ GENERATION

| Character | Range | 10 KR (No. of plants) | 20 KR (No. of plants) | 30 KR (No. of plants) | 40 KR (No. of plants) | 50 KR (No. of plants) |
|---|---|---|---|---|---|---|
| Total shoot length (cm) | 0-500 | 184 | 177 | 179 | 137 | 140 |
| | 501-1000 | 62 | 130 | 101 | 64 | 89 |
| | 1001-1500 | 29 | 100 | 56 | 36 | 67 |
| | 1501-2000 | 7 | 62 | 30 | 11 | 63 |
| | 2001-2500 | 3 | 17 | 3 | — | 11 |
| | 2501 and above | — | — | — | — | 5 |
| Pulse grain yield (g) | 0-10·0 | 78 | 55 | 87 | 54 | 48 |
| | 11·0-20·0 | 35 | 35 | 37 | 16 | 3 |
| | 21·0-30·0 | 5 | 20 | 13 | 13 | 1 |
| | 31·0-40·0 | — | 4 | 2 | 1 | — |
| | 41·0 and above | 2 | 7 | 2 | 7 | — |
| Sticklac yield (g) | 0-10·0 | 44 | 45 | 66 | 24 | 24 |
| | 11·0-20·0 | 30 | 52 | 24 | 22 | 10 |
| | 21·0-30·0 | 15 | 31 | 13 | 8 | 2 |
| | 31·0-40·0 | 6 | 8 | 9 | 3 | — |
| | 41·0 and above | 7 | 11 | 9 | 3 | — |

### 2.2.5 Induction of polyploidy in ber for improved lac productivity

With a view to induce polyploidy in *ber* for improving lac production, this study was initiated. The newly coming sprouts of pruned *ber* bushes and seedlings at two leaf stage were treated with the different concentration (0·1-2·0%) of aqueous solution of colchicine. The observations on seedlings showed that their survival percentage decreases with the increase in the concentration of colchicine solution.

(S. C. Srivastava and P. Kumar)

(c) RESEARCHES CONTEMPLATED — Nil

(d) INSTITUTE PLANTATION

During 1981 and 1982, massive programme of cleanliness was taken up for the entire plantation including *ber*, *palas*, *kusum*, *khair* plots and also the experimental area with a view to eradicate the weed flora of plantation which have hitherto posed serious problems to the undergoing research projects. In the model demonstration unit and also in the existing *kusm*, *ber*, and *palas* plots, the new seedlings were transplanted within the rows of existing lac host plants in order to develop new plants replacing old ones. Hoeing, mulching and manuring of *kusum*, *ber*, *palas* and *khair* seedlings transplanted earlier were carried out from time to time for improving the vigour of these plants. Some new seedlings of *bhalia* and *galwang* were transplanted in the new area for experimental purposes. The path along the fence line was rejuvenated to facilitate the guarding more efficiently. Niger was grown in between the rows of *kusum* plants for supressnig the weeds. Dinanath grass was also grown in between the spaces of *kusum* and *khair* trees which in turn supressed the growth of unwanted weeds and also earned revenue through the sale of these grasses.

Paddy and wheat were grown alongwith the lac hosts on bunds in low land, marshy area of the plantation. In addition, the general upkeep of the plantation including roads and paths and also proper management of lac hosts were carried out. The revenue obtained from the plantation through the sale of various produce including experimental ones were Rs 14,495.03 during 1981 and Rs 19,339.17 during 1982.

Two ponds, each in *khair* and *palas* plots in the low lying area were dug on the basis of water harvest technology for the irrigation purposes.

## C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED

### 3.1.7 Physico-chemical properties of the resin recovered from byproducts of lac

During the processing of sticklac to seedlac and seedlac to shellac, certain byproducts viz., *ghonghi*, *patti*, *molamma*, *kunhi* and *kiri* are obtained which contain 40-70 per cent lac resin along with wax and other impurities. These byproducts have limited use and market value at present in the lac industry. Work was, therefore, undertaken to study physico-chemical properties of the resin recovered from these byproducts, with a view to throw light on possible additional uses of these byproducts in different industries.

Genuine *kusmi* and *rangeeni* stick lac samples strains were procured from the Entomology Division of the institute and got processed in the Technology Division. Besides parent seed lac and shellac, samples of six byproducts namely, *ghonghi*, *patti*, *molamma* (before soda washing, BSW and after soda washing, ASW), *kunhi* and *kiri* of each type were obtained during processing of sticklac samples. Two methods for the extraction of the resin from the by products were adopted i.e. (i) with alcohol and (ii) with alkali (sodium carbonate). The resin obtained by the

second method, however, got polymerized possibly due to the presence of traces of mineral acid. Therefore, only the alcohol extraction method was adopted for the study. The optical, electrical and other properties of the resin samples were determined by the standard methods and the data are given in Table 25.

It was observed that the percentage of impurity is quite high in *ghonghi* and *patti* samples followed by *molamma* (BSW), *molamma* (ASW) *kunhi* and *kiri* repectively while seedlac, shellac have the lowest impurity. Both the electrical properties such as dissipation factor and conductivity of the resin samples (1 % w/v) were on the higher side as compared to those of parent seedlac and shellac. The dielectric strength was, however, found on lower side as compared to the parent seedlac and shellac. The varnish obtained from the resin samples of *ghonghi* and *patti* gave non-uniform films while the films obtained from other samples were smooth and uniform. The dielectric strengths of the *molamma* and *kiri* resin samples obtained from both types of stick lacs were above the minimum value (specified in IS specification, 750 V/mil) for air-drying type insulating varnish.

The chemical constants such as acid, saponification, hydroxyl, ester and carbonyl values of the resins are also low by a few number of units than those of seedlac and shellac. The data reveal that the resin samples of *kusmi* differ from *rangeeni* strain in almost all the properties studied. The drop in the values of chemical constants indicates the possibility of some reaction taking place while recovering the resin from byproducts.

The optical density and colour index of the resin samples were found to be, higher than those of parent seedlac and shellac. The absorption spectra of the alcoholic solutions of resin samples of both the strains were examined in complete UV and visible range at different concentrations ($10^{-3}$ and $10^{-4}$ gm/ml). From the comparison of the values of colour indices and optical densities (noted at 435 nm) it is inferred that the resin samples of the *rangeeni* strain contain more colouring matter than *kusmi* strain.

(S. C. Agarwal, D. N. Goswami, N. Prasad and R. K. Banerjee)

### 3.3.3 (i) Ion exchange resin from shellac

### 3.3.6 (Old)

Cation exchange resins are costly materials and widely used in water treatment and pharmaceutical industries. The cation exchange property is due to the presence of strongly acidic sulphonic and the weakly acidic carboxyl or phenolic hydroxyl groups. The presence of hydroxyl and carboxyl groups in shellac led to the idea of utilising shellac for the preparation of cation exchange resin having higher cation exchange capacity.

**Preparation of the resin**

Sulphonated lac (22 g) was dissolved in sodium hydroxide solution (4%, 100 ml) and boiled with paraformaldehyde (1·5 g) for 1 hr in the presence of ammonium chloride (0·88 g). Thereafter, resorcinol (4 g) was added and boiled for another 1 hr. The solution was cooled to 50°c and another lot of paraformaldehyde (1·5 g) was added with stirring. The mass was boiled and cooled slowly. Two more batches of paraformaldehyde (1·5 g) were added with stirring at 1 hr interval and a brown gel was formed within a few minutes. The gel was broken and

TABLE 25a — PHYSICO-CHEMICAL PROPERTIES OF THE RESIN RECOVERED FROM LAC BYPRODUCTS

| Sl No. | Sample | Acid value | | Saponification value | | Ester value | | Hydroxyl value | | Carbonyl value | | Optical density density at 435 nm | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | K | R | K | R | K | R | K | R | K | R | K | R |
| 1. | *Ghonghi* | 53·2 | 51·5 | 218·0 | 210·7 | 164·8 | 159·2 | 234·5 | 230·1 | 15·4 | 15·6 | 0·26 | 0·33 |
| 2. | *Patti* | 55·5 | 51·6 | 220·0 | 215·2 | 164·5 | 163·6 | 234·6 | 233·0 | 15·6 | 16·5 | 0·24 | 0·30 |
| 3. | *Molamma* (BSW) | 58·8 | 52·5 | 230·8 | 217·1 | 172·0 | 164·6 | 243·3 | 235·0 | 17·6 | 16·6 | 0·18 | 0·22 |
| 4. | *Molamma* (ASW) | 60·6 | 55·7 | 231·0 | 219·6 | 170·0 | 163·9 | 242·7 | 239·0 | 18·8 | 17·6 | 0·16 | 0·18 |
| 5. | *Kunhi* | 64·0 | 62·0 | 235·4 | 234·1 | 171·4 | 172·1 | 250·5 | 246·6 | 20·5 | 18·8 | 0·13 | 0·14 |
| 6. | Seedlac | 67·2 | 65·2 | 241·2 | 237·2 | 174·0 | 172·0 | 258·3 | 252·5 | 21·4 | 20·7 | 0·10 | 0·15 |
| 7. | *Kiri* | 62·0 | 61·2 | 232·6 | 228·2 | 170·6 | 167·0 | 243·2 | 239·4 | 18·1 | 16·6 | 0·09 | 0·18 |
| 8. | Shellac | 68·1 | 65·3 | 244·6 | 242·0 | 176·5 | 176·7 | 272·6 | 264·6 | 23·2 | 22·2 | 0·06 | 0·11 |

TABLE 25b — PHYSICO-CHEMICAL PROPERTIES OF THE RESIN RECOVERED FROM LAC BYPRODUCTS

| Sl No. | Sample | Colour index | | Dissipation factor (Df) 100 kHZ | | Dielectric strength kV/mil | | Conductivity mho $cm^{-1}$ | | Hot alcohol insolubles in byproducts (%) | | Lac resin content recovered including wax (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | K | R | K | R | K | R | K | R | K | R | K | R |
| 1. | *Ghonghi* | 35·8 | 45·2 | 0·27 | — | 0·42 | 0·14 | $1·88 \times 10^{-6}$ | — | 33·12 | 38·46 | 66·5 | 62·0 |
| 2. | *Patti* | 32·8 | 41·1 | 0·25 | 0·31 | 0·76 | 0·31 | $1·46 \times 10^{-6}$ | $2·54 \times 10^{-6}$ | 33·6 | 28·09 | 66·0 | 71·5 |
| 3. | *Molamma* (BSW) | 24·60 | 30·1 | 0·24 | 0·30 | 0·95 | 0·83 | $1·25 \times 10^{-6}$ | $2·41 \times 10^{-6}$ | 17·0 | 27·5 | 82·5 | 72·0 |
| 4. | *Molamma* (ASW) | 21·10 | 24·6 | 0·18 | 0·33 | 0·89 | 0·97 | $0·68 \times 10^{-6}$ | $3·1 \times 10^{-6}$ | 14·2 | 19·4 | 85·0 | 80·0 |
| 5. | *Kunhi* | 17·8 | 18·7 | 0·15 | 0·16 | 0·54 | 0·53 | $0·47 \times 10^{-6}$ | $0·632 \times 10^{-6}$ | 14·1 | 28·9 | 85·4 | 70·5 |
| 6. | Seedlac | 13·7 | 20·5 | 0·11 | 0·19 | 1·10 | 0·75 | $0·28 \times 10^{-6}$ | $0·92 \times 10^{-6}$ | 2·52 | 3·73 | 97·0 | 95·5 |
| 7. | *Kiri* | 12·30 | 24·6 | 0·12 | 0·17 | 0·87 | 0·92 | $0·29 \times 10^{-6}$ | $0·72 \times 10^{-6}$ | 20·5 | 25·2 | 79·0 | 74·0 |
| 8. | Shellac | 8·2 | 15·1 | 0·10 | 0·14 | 1·19 | 0·98 | $0·23 \times 10^{-6}$ | $0·5 \times 10^{-6}$ | Nil | Nil | 99·5 | 99·3 |

N.B. — K = *Kusmi* sticklac
R = *Rangeeni* sticklac
BSW = *Before soda washing*
ASW = *After soda washing*

hardened in an oven at 100-105° for 24 hr. The resin was first washed with water, subsequently with sodium carbonate solution (4%), equilibrated with hydrochloric acid (4%) and then washed with water and dried. The recovered resin was then refluxed with spirit in a soxhlet for 8 hr. It was finally washed with water and dried. A black, fine mesh resin of irregular shape was obtained which was leached with hydrochloric acid (0·1N) for 24 hr washed to free from acid and air dried. The H-form of the resin was got evaluated at Central Salt and Marine Chemical Research Institute, Bhavnagar. The properties reported are given in Table 26.

TABLE 26 — PROPERTIES OF ION EXCHANGE RESIN FROM SULPHONATED LAC

| | |
|---|---|
| Moisture content (%) | 9·2 |
| Salt splitting capacity (meq/g) | 0·195 |
| Total capacity (meq/g) | 4·58 |
| Wet absolute density (g/ml) | 1·1082 |
| Apparent density (g/ml) | 0·569 |
| Thermal stability | Tolerable |
| Colour throw | High, in alkaline medium |
| Void volume | 40% of bed volume |

Ninety-seven per cent of the ion exchange resin is in usable form. The results indicate that the resin has good capacity, thermal stability but requires improvement in respect of colour throw, column utilization and rate of exchange.

As the cost of production of cation exchange resin, prepared from sulphonated lac, paraformaldehyde and resorcinol, was high, cashewnut shell liquid (CNSL) was employed as a substitute of resorcinol. Sulphonated lac (1 part) was dissolved in NaoH salution (6%). The resorcinol: CNSL mixtures in the ratio of 1:0, 1:1, 1:2, 1:3 and 0:1·5 were then added to it. This was followed by addition of formaldehyde (150 ml) in lots till a gel was formed. The properties of the resin, thus, obtained are given in Table 27.

TABLE 27 — PROPERTIES OF ION EXCHANGE RESIN PREPARED FROM SULPHONATED LAC: CNSL

| Properties | Resorcinol : CNSL ratios | | | | |
|---|---|---|---|---|---|
| | 1:0 | 1:1 | 1:2 | 1:3 | 0:1·5 |
| Moisture (%) | 9·2 | 8·25 | 9·36 | 8·85 | – |
| Yield (%) | 65 | 48 | 44·3 | 41·8 | 42·0 |
| Cation exchange capacity (meq/g) | 4·58 | 3·25 | 2·82 | 2·45 | 2·23 |

It was noted that the resin showed lowering in yield and cation exchange capactity with increase proportion of CNSL.

One advantage of this approach was that the cost of the product is very low. The present study has shown that there exists a possibility for the use of shellac in the field of ion exchange resins although the resin developed requires improvement in some of its properties.

(A. Rahman, P. R. Bhattacharya and B. B. Khanna)

### 3.3.6 Modification of lac/hydrolysed lac with glycols and dicarboxylic acids

### 3.3.8 (Old)

Coatings based on polyurethanes have very good flexibility, adhesion, impact and solvent resistance. Polyurethane coatings also find a variety of outdoor and marine uses because of their good weather ability.

Shellac has got certain drawbacks for coating compositions like brittleness, low softening point, poor resistance to water and chemicals. The object of the project is to prepare shellac based polyurethane coatings by first modifying shellac with glycols and dicarboxylic acids for chain extension and then reacting the resultant polyesters with isocyanates.

(i) *Preparation of polyesters from lac*

Shellac-based polyesters were prepared by two methods. In the first (one step process) shellac, ethylene glycol/diethylene glycol and dicarboxylic acids were reacted at the same time while in the second (two step process), ethylene glycol ester of shellac was first prepared and subsequently reacted with a dicarboxylic acid.

Shellac (powdered 40 mesh, 100 g), ethylene glycol/diethylene glycol (38 gm) and dicarboxylic acid (10, 15, 20 g) were reacted together in a three necked flask at 120°C with constant stirring until all the shellac dissolved. The temperature was lowered to 80°C and *p*-toluene sulphonic acid (0·5 g) added. The temperature was again raised and the mixture heated at 175±5°C for 8 hr. Samples were drawn at regular interval to determine acid value till it was constant. The solubility of the polyesters, thus prepared was determined in different solvents and mixture of solvents with a view to find a suitable solvent medium for treating these polyesters with diisocyanates. All the polyesters were found soluble in cold methyl ethyl ketone and methyl isobutyl ketone, but none of the nonhydroxy solvents or mixture of solvents was found to completely dissolve the shellac-based diethylene glycol polyesters.

*Preparation of polyurethanes from polyesters of lac*

Modified shellac based polyurethanes were prepared by treating shellac based ethylene glycol polyesters in methyl ethyl ketone with different proportions of toluene diisocyanate. After thorough mixing and allowing to stand for 15 min, films were prepared on glass slides and tin panels. Clear, non-tacky, highly glossy, hard and smooth films were obtained. The gelation period was noted in each case. After allowing to stand at room temp. for one week, the films were tested for flexibility, resistance to water, acid and alkali at room temperature. A set of films on glass slides and tin panel was also baked at 150°C for 30 min and tested.

All the polyurethane coatings were found to have good flexibility. No cracks were observed in the films when they were subjected to double bend test on the conical mandrel (3 mm). They were also unaffected by normal organic solvents. A marked improvement in the properties of the film was noticed after baking. Taking into consideration the pot life, the optimum proportion of toluene diisocyanate for obtaining polyurethanes was 30% on the weight of the polyester. The polyurethanes obtained from shellac are much superior to plain shellac as regards film properties.

(ii) *Preparation of polyesters from hydrolysed lac*

Hydrolysed lac (100 g) was reacted with ethylene glycol (60 g) at 175±2°C in a three necked flask equipped with a reflux condenser, electrical stirrer and thermometer and it was found that the acid value became constant after 4 hr

The excess ethylene glycol was removed under vacuum and the residue was then reacted separately with adipic, maleic, phthalic and terephthalic acids in the proportions of 10 and 20 per cent on the weight of hydrolysed lac at the above temp. for 2 hr. In this way, different esters were prepared and their acid values determined.

*Preparation of polyurethanes from polyesters of hydrolysed lac*

The polyesters were dissolved in pure dry methyl ethyl ketone (25% solution) and reacted separately with toluene diisocyanates (TDI) (30 and 40% based on the weight of solid) and Desmodur N (75 and 100% on the weight of the solid) at room temp. After thorough mixing and allowing to stand for 15 min, films were prepared on glass slides and tin panels. Non-tacky, smooth, glossy and flexible films were obtained. The gelation period was noted in each case. Air dried films (dried for one week) and baked films (baked at 150°C for 30 min) were tested for water, acid and alkali resistance.

Air dried films obtained from polyesters cured with TDI or Desmodur N showed good water and acid resistance but poor alkali resistance which was, however, improved upon by baking the films at 150°C for 30 min. The compositions based on hydrolysed lac/ethylene glycol/adipic acid treated with Desmodur N (100% on the weight of polyester) gave the best results and even air dried films could resist water, acid and alkali.

(B. B. Khanna, P. M. Patil, K. Mohan and K. N. Rao)

**3.3.9 Modification of lac with unsaturated acids**

**3.3.11 (Old)**

The project was taken up with a view to esterify shellac through its hydroxyl group with unsaturated acids like maleic, acrylic and crotonic. The composition expected may have better adhesion, elasticity and solvent resistance and may find use in surface coatings and adhesives.

Preliminary experiments were carried out by direct fusion of shellac with maleic/acrylic acid at 150°C in varying proportions (by weight). It was observed that the compositions, so prepared, become partly insoluble in methylated spirit. Hence, this approach was not continued.

Next, the compositions were prepared taking shellac and different proportions of maleic, acrylic and crotonic acids in an inert solvent (tetrahydrofuran). The adhesive and surface coating properties of these compositions were studied on different surfaces but it did not show any remarkable improvement in comparison to parent shellac.

Again, the modification of shellac with different proportions of maleic, acrylic and crotonic acids was carried out in methylated spirit and the chemical constants of the resultant products determined (Table 28). A lowering in the hydroxyl value and an increase in the iodine value were noted indicating that at least one or two hydroxyl groups of lac have reacted with the unsaturated acid. The air dried films of all the compositions were smooth, glossy, non-tacky and hard having good resistance to water but no improvement in the adhesive strength on the steel surface was observed as compared to parent shellac (Table 29).

TABLE 28 — CHEMICAL CONSTANTS OF COMPOSITIONS BASED ON LAC AND MALEIC ACID (A-1 TO A-4) LAC AND ACRYLIC ACID (B-1 TO B-5) AND LAC AND CROTONIC ACID (C-1 TO C-5)

| Composition No. | Acid value | Hydroxyl value | Iodine value |
|---|---|---|---|
| A-1 | 54·5 | 170·5 | 25·3 |
| A-2 | 50·4 | 175·4 | 24·7 |
| A-3 | 48·6 | 145·7 | 24·2 |
| A-4 | 48·5 | 128·5 | 26·1 |
| B-1 | 48·0 | 136·8 | 24·9 |
| B-2 | 51·1 | 140·0 | 23·8 |
| B-3 | 51·0 | 142·5 | 25·4 |
| B-4 | 54·5 | 168·5 | 24·8 |
| B-5 | 54·3 | 158·0 | 25·3 |
| C-1 | 51·6 | 162·0 | 26·2 |
| C-2 | 50·7 | 161·7 | 24·7 |
| C-3 | 52·3 | 159·3 | 25·0 |
| C-4 | 53·8 | 160·5 | 25·2 |
| C-5 | 55·0 | 159·7 | 24·2 |
| Control | 74·7 | 239·0 | 16·4 |

TABLE 29 — FILM PROPERTIES OF COMPOSITIONS BASED ON LAC AND MALEIC, ACRYLIC AND CROTONIC ACIDS (WITHOUT INITIATOR)

| Comp. No. | Composition | Film appearance (air dried) | Water resistance (air-dried) | | Scratch hardness (g) | Conical mandrel Bend test |
|---|---|---|---|---|---|---|
| | | | Glass panel Time of blush (hr) | Wooden panel Time of blush (hr) | | |
| A-1 | Lac + Maleic acid (2%) | Smooth, glossy and non tacky | 3 | 4 | 1000 | Passes |
| A-2 | do (4%) | do | 2·5 | 3 | 1000 | do |
| A-3 | do (5%) | do | 2·5 | 3 | 1000 | do |
| A-4 | do (6%) | do | 2·5 | 3 | 1000 | do |
| B-1 | Lac + Acrylic acid (2%) | do | 3 | 4 | 900 | do |
| B-2 | do (4%) | do | 3 | 4 | 1000 | do |
| B-3 | do (5%) | do | 2·5 | 4 | 1000 | do |
| B-4 | do (6%) | do | 3·5 | 3 | 1000 | do |
| B-5 | do (8%) | do | 3 | 4 | 1000 | do |
| C-1 | Lac + Crotonic acid (2%) | do | 2·5 | 3 | 900 | do |
| C-2 | do (4%) | do | 3 | 4 | 1000 | do |
| C-3 | do (5%) | do | 2 | 3 | 1000 | do |
| C-4 | do (6%) | do | 3 | 3 | 1000 | do |
| C-5 | do (8%) | do | 3 | 3 | 900 | do |
| Control | | do | 1 | 2 | 700 | do |

In order to bring about further improvement, modifications of these compositions was carried out. Two best proportions each from maleic, acrylic and, crotonic acids were chosen from the respective set according to their performances in surface coating and adhesive properties. The compositions were prepared by carrying out the reaction in presence of benzoyl peroxide (Table 30).

The adhesive strength of these compositions (Table 31) were determined on iron surface and a maximum bond strength of 0·35, 0·28 and 0·23 ton/sq. inch was observed in case of maleic, crotonic and acrylic acids respectively. The film properties of these compositions (Table 32) were studied on glass, wood and tin panels. Some improvement in the properties like water and acid resistance and scratch hardness was observed but resistance towards acid, alkali and solvent remained unchanged.

TABLE 30 — ADHESION STRENGTH OF THE COMPOSITIONS BASED ON LAC AND MALEIC, CROTONIC AND ACRYLIC ACIDS ON STEEL SURFACE (WITH INITIATOR)

| Sl No. | Composition | Bond strength (ton/sq. inch) |
|---|---|---|
| A | Lac+Maleic acid (4% on wt. of lac+Benzoyl peroxide (1%) | 0·35 |
| B | Lac+Maleic acid (5%)+Benzoyl peroxide (1%) | 0·29 |
| C | Lac+Crotonic acid (2%)+Benzoyl peroxide (1%) | 0·24 |
| D | Lac+Crotonic acid (5%)+Benzoyl peroxide (1%) | 0·28 |
| E | Lac+Acrylic acid (5%)+Benzoyl peroxide (1%) | 0·23 |
| F | Lac+Acrylic acid (6%)+Benzoyl peroxide (1%) | 0·21 |
| G | Control | 0·13 |

TABLE 31 — ADHESION STRENGTH OF COMPOSITIONS BASED ON LAC AND MALEIC, ACRYLIC AND CROTONIC ACIDS (WITHOUT INITIATOR)

| Sl No. | Composition No. | Bond strength (ton/sq. inch) |
|---|---|---|
| 1 | A-1 | 0·15 |
| 2 | A-2 | 0·14 |
| 3 | A-3 | 0·12 |
| 4 | A-4 | 0·11 |
| 5 | B-1 | 0·09 |
| 6 | B-2 | 0·08 |
| 7 | B-3 | 0·14 |
| 8 | B-4 | 0·11 |
| 9 | B-5 | 0·10 |
| 10 | C-1 | 0·12 |
| 11 | C-2 | 0·11 |
| 12 | C-3 | 0·12 |
| 13 | C-4 | 0·10 |
| 14 | C-5 | 0·10 |
| 15 | Control | 0·13 |

TABLE 32 — FILM PROPERTIES OF COMPOSITIONS BASED ON LAC AND MALEIC, CROTONIC AND ACRYLIC ACID (WITH INITIATOR)

| Sl No. | Composition | Film appearance (AD) | Water resistance 48 hr | | Acid resistance 24 hr | | Scratch hardness (gm) | | Flexibility | | Impact resistance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A.D. | Bak. | A.D. | Bak. | A.D. | Bak. | A.D. | Bak. | A.D. | Bak. |
| A | Lac+maleic acid (4% on weight of lac)+benzoyl peroxide (1%) | Smooth, glossy and nontacky | B | NB | B | NB | 800 | 900 | P | P | P | P |
| B | Lac+maleic acid (5%)+ benzoyl peroxide (1%) | do | B | NB | B | NB | 900 | 900 | P | P | P | P |
| C | Lac+crotonic acid (2%) +benzoyl peroxide (1%) | do | B | NB | B | NB | 1000 | 1000 | P | P | P | P |
| D | Lac+crotonic acid (5%) +benzoyl peroxide (1%) | do | B | NB | B | NB | 1000 | 1000 | P | P | P | P |
| E | Lac+acrylic acid (5%)+ benzoyl peroxide (1%) | do | B | NB | B | NB | 900 | 900 | P | P | P | P |
| F | Lac+acrylic acid (6%)+ benzoyl peroxide (1%) | do | B | NB | B | NB | 900 | 1000 | P | P | P | P |
| G | Control | do | B | B | B | B | 600 | 700 | P | P | P | P |

B = Blush; N3 = No blush; AD = Air dried; Bak. = baked at 150° for 1 hr; P = Passed

Infrared spectra of the above compositions and shellac were compared which showed the presence of unsaturation at 1640 and 760 $cm^{-1}$ confirming that the desired reaction takes place.

(N. Prasad, S. C. Agarwal, P. C. Gupta and A. K. Dasgupta)

**3.4.1 Studies on lac-oil combinations and their utilization**

**3.4.3 (Old)**

Lac-oil varnishes were prepared earlier but their drying characteristics were poor. The film obtained by these varnishes remained tacky for long and showed poor resistance to water. The present study was, therefore, undertaken with a view to develop suitable compositions of lac-oil varnishes and paints which may be thinned with cheaper aromatic hydrocarbon solvents and produce films of improved hardness, gloss and water resistance.

In the beginning, the process for the preparation of lac-oil varnishes was studied in detail. A series of experiments were carried out to prepare lac-linseed oil varnishes under different conditions of time and temperature and also in the presence of different catalysts. The best performance was obtained when lac (60 g) was reacted with linseed oil (100 g) at 290°C for 20 min in the presence of litharge (3%) as a catalyst.

The effect of using different varieties of lac and linseed oil in the above formulation was also studied and it was found that when dewaxed lac and double-boiled linseed oil were used in the above formula further improvement in the film performance was obtained. The lac-oil varnishes thus obtained were clear, transparent and pale yellow in colour. The varnishes showed good drying characteristics and produced films which were hard, smooth, glossy and flexible. These film did not show any persistent tackiness. Further, the air dried films of these varnishes showed better hardness to scratch and improved resistance to water and solvents.

*Modification of lac-oil varnish with melamine resin*

With a view to further improve upon the film performance, lac-double-boiled linseed oil varnish was modified with different proportions of melamine resin. Clear and homogeneous solutions were obtained which produced hard, smooth and glossy films. Performance of both air dried as well as baked films of these varnishes was studied and it was observed that air dried films of these compositions did not show any appreciable improvement but the baked films containing 20% melamine resin gave much better performance in respect of scratch hardness and resistance to water, dilute acids and hydrocarbon solvents.

*Baking type insulating varnish*

In view of good drying characteristics and improved film performance of lac-double-boiled linseed oil varnish, its suitability as baking type insulating varnish was studied.

For this purpose fresh samples of lac-double-boiled linseed oil varnish were prepared and tested as per IS: 350/1968. The varnish was found to possess the desired solid content and thermosetting properties and it could be thinned with white spirit without developing turbidity. Baked films of the varnish possessed a high break down strength of the order of 2·1 kV/mil and passed the tests for resistance to water, mineral oil and transformer oil. These films showed good resistance to

heat up to 120°C and also to ageing. The varnish satisfied the requirement of IS: 350/1968 for baking type insulating varnish.

*Lac-oil paints*

Suitability of lac-double-boiled linseed oil varnish as vehicle for enamel paints was also studied. For this purpose lac-double-boiled linseed oil varnish was pigmented with hiding and coloured pigments. Invariably, uniform paint compositions were obtained which when applied by brush, produced hard, smooth, flexible and glossy films on various substrates. The films showed good resistance to water, dilute acids, and hydrocarbon solvents. Air dried films did not show any blushing in water up to 24 hr and gave a scratch hardness of 1000 g.

The result obtained, thus clearly show that lac-double boiled linseed oil varnish can be used as a vehicle for enamel paints and also as baking type insulating varnish for coating coils of electric motor etc.

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

### 3.5.1 Encapsulation of pesticides with lac

Encapsulation, a rapidly expanding technology, has opened a new field of pesticide formulations which makes pest control easier, safer and economical. It extends the activity period of pesticides, creates the specificity in their mode of action, shields users from toxic hazards and minimises the dose of application.

Shellac is an excellent film former and, therefore, its suitability as a coating/ wall material in this field was tried.

Commerically available pesticide formulations namely, carbofuran, Dimethoate, phorate, Warfarin, DDT, BTB etc. were encapsulated with lac and its hydrosol by different techniques and it was found that shellac as such and in the form of hydrosol can successfully be used as a wall material for encapsulation of granular and powdered pesticide formulations. Suitable physical processes of encapsulation for solid pesticides based on *p*H-coacervation and phase-separation techniques using shellac in hydrosol form as a wall material have been developed. A coating composition for granular pesticide formulation based on pan method has also been developed using shellac in the form of dry powder. Details of these processes have been worked out.

Encapsulated pesticides obtained by both macro-and microencapsulation processes have been found to be free flowing, having uniform wall and practically no odour of core pesticides and showed satisfactory wettability. Microencapsulation with lac does not adversely affect the spores viability of microbial insecticides. The palatability trials conducted on rodents have shown that dialysed shellac is acceptable to rodents, indicating its suitability as a wall material for encapsulating rodenticide formulations.

Evaluation studies on granular systemic pesticides namely, carbofuran, phorate and Dimethoate were undertaken at Kerala Agricultural University. For this purpose, the pesticides were encapsulated with lac and sent to the above University for field trials. The results obtained indicate that lac-encapsulated carbofuran granules give better performance as compared to non-encapsulated ones in regard to their efficacy in controlling aphids on cow-pea crop.

Comparative study on the bio-efficacy of lac encapsulated, non-encapsulated and commercially available encapsulated carbofuran and phorate granules under-

taken at this Institute on aphids on *chrysantheneum* plants showed that the performance of lac-encapsulated Furadon was at par with other insecticides indicating that lac-encapsulation does not adversely affect the bio-efficacy of carbofuran but on the other hand masks its odour and makes it safer for handling thereby fullfilling one of the major objectives of encapsulation.

Experiments were also carried out to see the relative effect of different levels of wall material over granular pesticides. For this purpose, carbofuran granules were encapsulated at three levels (11, 14 and 17% on the weight of pesticide formulation of wall material by adopting the pan-method of encapsulation. These formulations along with non-encapsulated and commercially available carbofuran granules have been sent to two centres of Kerala Agricultural University and also to the collaborating Entomologists of this Institute for evaluation of their bio-efficacy.

Evaluation, studies on lac-encapsulated systemic granular pesticides have been carried out at Kerala Agricultural University and at this Institute. The performance of lac-encapsulated carbofuran has been found better at Kerala Agricultural University while at this Institute it has been found at par with non-encapsulated and commercially available encapsulated carbofuran granules. It is thus indicated that lac encapsulation does not adversely affect bio-efficacy but improves the handling property thereby minimizes the use of protective clothing.

This study has, thus, established the potentiality of lac in the field of encapsulation.

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

**3.6.2 Curing behaviour of shellac-synthetic resin composites by dielectric measurements**

**3.6.3 (Old)**

The study was undertaken with a view to develop a convenient and quicker method based on measurement of electrical parameters for the determination of cure-time of shellac-synthetic resin compositions and also to develop a varnish having electrical properties superior to shellac.

The work was initiated with the studies on the curing between shellac and melamine resin which was then extended to epoxy and phenolic resins.

*Curing of shellac and melamine resin (in the cold)*

Studies were made on the curing behaviour of different compositions of shellac and butylated melamine resin (Biomine 1651, obtained from M/s Hard Castle, Waud & Co., Bombay) at 20°C in the solvent medium. Solution of dewaxed-shellac (25%) and melamine resin (25%) were prepared separately in the mixed solvent (1:1) of butyl alcohol and commercial denatured alcohol (freshly distilled). Different compositions e.g. SMF 82 (80% shellac and 20% melamine resin by wt) and likewise SMF 64 and SMF 46 were prepared. The capacitance and dissipation factor (tau) of the varnishes were measured at 100 kHz for few days by a General Radio (USA) capacitance bridge. The values of the dielectric constant and dielectric loss were then determined from the observed capacitance values.

A marked decrease in the values of dissipation factor, dielectric constant and dielectric loss of the blends was noted up to first 3 days after blending and thereafter no appreciable change was noticed up to 13 days. The decrease in the dissi-

pation factor suggests a reduction in the number of hydroxyl groups available for relaxation in the system. This might have arisen due to the interaction between the methylol group of the melamine resin and the carboxyl group of the shellac. The curing was found to be complete within 24 hr at a little higher temperature (~40°C) as revealed from the variation of dissipation factor with time.

*Curing of shellac and epoxy resin (in the cold)*

The study was then extended to epoxy resin (mol. wt 1000 and 500). Separate solutions of both the resins (25% w/w) were prepared in a mixture (2:1) of methyl ethyl ketone and denatured alcohol (commercial, freshly distilled). Different blends were prepared by mixing 80, 70, 60 and 50 parts of shellac solution with 20, 30, 40 and 50 parts of expoxy resin. The dissipation factor of the blends, thus prepared, were then measured (as described before) at 30°C after one hr of blending and this was continued for few days. An increase in the value of dissipation factor for 70:30, 60:40 and 50:50 shellac-epoxy compositions was observed up to sixth day after blending and thereafter no appreciable change was noticed (Fig. 3). The initial increase in the values of dissipation factor indicated an increase in the number of hydroxyl groups available for relaxation in the system. This increase in hydroxyl group might have arisen due to the interaction between the carboxyl group of shellac and the epoxy group of the resin. However, no appreciable change in the dissipation factor was noticed for the 80:20 shellac-epoxy composition.

The curing behaviour of 70:30 and 50:50 shellac-epoxy compositions was then investigated by the measurements of conductivity, specific viscosity and dielectric strength with time. The dielectric strength measurements were made on the films prepared from the above blends at regular interval of time. Conductivity measurements were made in the solvent medium at 100 kHz. For both the compositions, an initial increase in the conductivity was observed up to sixth day. The conductivity v/s time plot (Fig. 4) showed two slopes with an inflection around sixth day.

An initial rise in the values of specific viscosities of the blends was also observed up to sixth day after blending. These were almost constant for next few days and therafter, showed an increase again with time (Fig. 5). The increase in specific viscosity suggests an increase in the molecular size of shellac possibly due to the reaction, stated above.

An increase in the dielectric strength was observed from a value of 1·0 kV/mil (for shellac) to about 1·5 and 1·6 kV/mil for the 70:30 and 50:50 compositions respectively as a result of curing up to sixth day and thereafter no appreciable change in the value was noticed (Fig. 6). The results thus obtained from the studies on dielectric strength, conductivity and specific viscosity are in agreement with that obtained from the variation of dissipation factor with time.

Similar behaviour for epoxy resin of molecular weight 500 was observed as reported for molecular weight 1000. For the 70:30 and 50:50, shellac-epoxy resin compositions, the maximum values of dielectric strengths were about 1·7 and 1·8 kV/mil respectively after six days of curing in the cold.

*Curing by fusion*

Studies were made to observe the changes in the values of dielectric strength of the varnishes prepared from the compositions obtained by fusing together different proportions of DL shellac and epoxy resin at 150°C for 15 min. These studies were also made with *bhatta* shellac and seedlac. The fused products were soluble in a mixture of 2:1 of methyl ethyl ketone and denatured spirit (freshly distilled). The films obtained were smooth and uniform (drying time 30-40 min).

The values of dielectric strength of the varnishes prepared from the 70:30 and 50:50 DL shellac epoxy combination were about 1·1 kV/mil, for *bhatta* shellac-epoxy resin combination 1·4 kV/mil and for the seedlac-epoxy resin compositions was 1·2 kV/mil in both the proportions. The varnishes prepared from 70:30, DL shellac-epoxy resin and 50:50 *bhatta* shellac-epoxy resin compositions passed the test for resistance to transformer oil.

The thermal resistance of the air-dried films obtained from the cured products of shellac and epoxy resin was investigated. No appreciable improvement was noticed over plain shellac. However, when the films were baked at 170°C for 15 min, appreciable improvement in thermal resistance was noticed.

*Studies with phenolic resin*

Studies on the curing between shellac and phenolic resin in the cold by the measurement of dissipation factor could not be made because the capacitance bridge could not be balanced. Studies were, therefore, made on the curing bet-

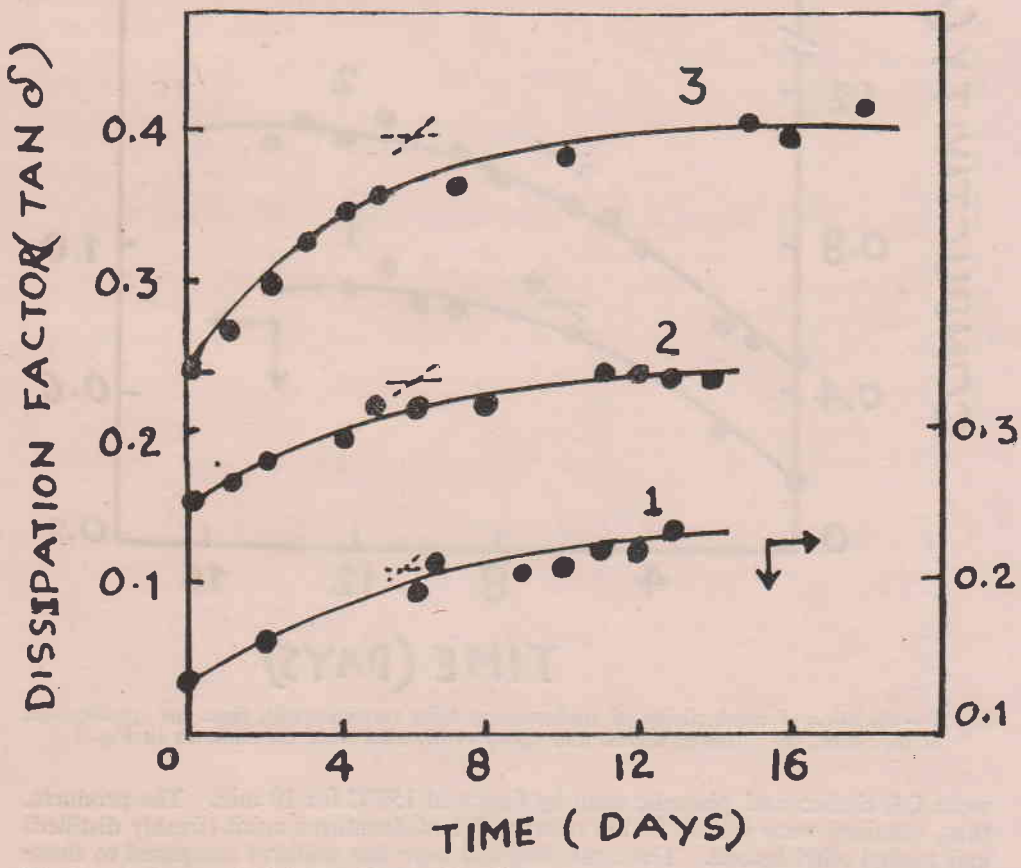


Fig. 3 — Variation of dissipator factor of shellac-epoxy resin varnishes with time [Ratio of shellac and epoxy resin: (1) 60:40 (mol. wt of epoxy resin 500); (2) 70:30 (mol. wt of epoxy resin 1000, CIBA-GEIGY); (3) 50:50 (mol. wt of epoxy resin 1000, Shalimar Paints Ltd.); DL-shellac was used in the first two compositions whereas dewaxed orange in the third composition]

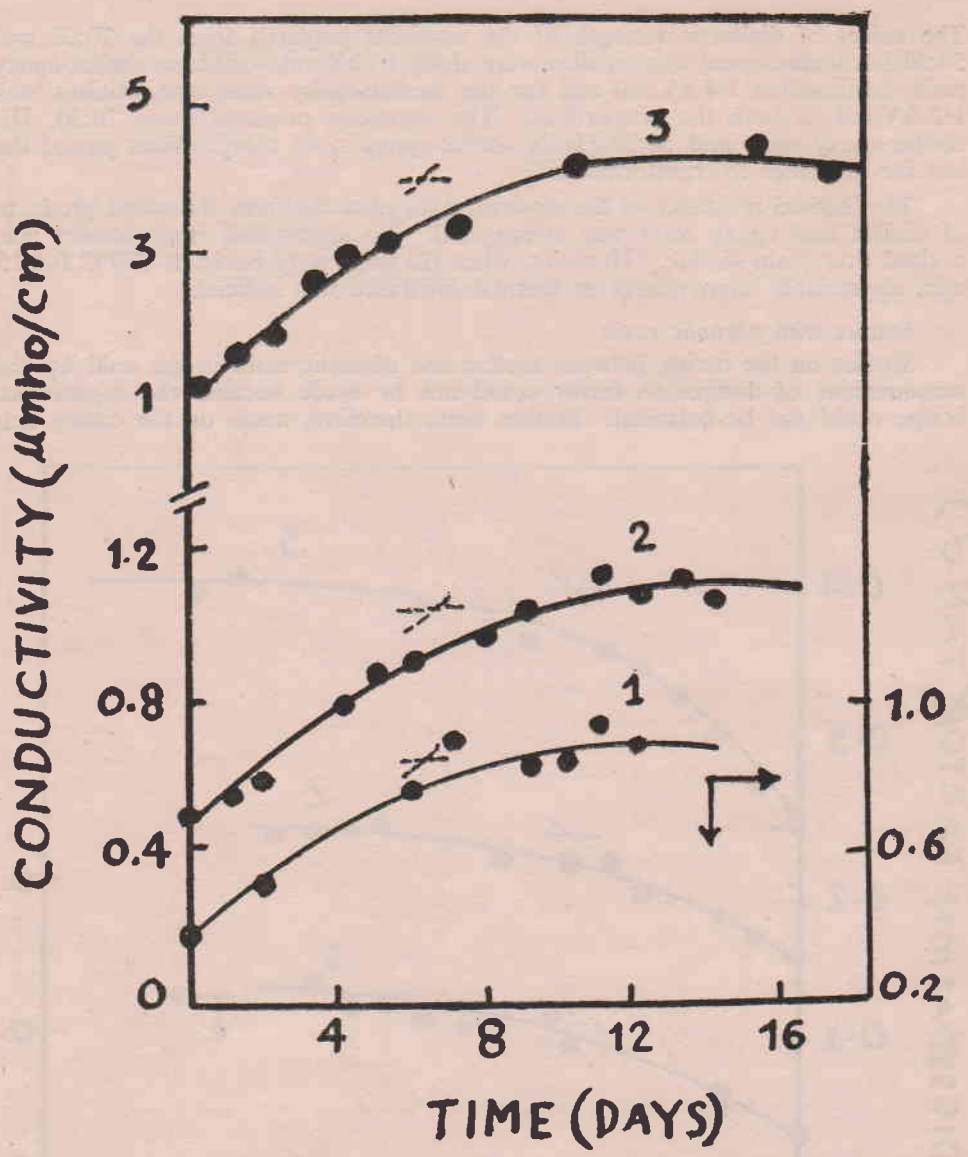


Fig. 4 — Variation of conductivity of shellac-epoxy resin varnishes with time: the specifications of the resins, the ratios of shellac and epoxy resins used were the same as in Fig. 1

ween DL shellac and phenolic resin by fusion at 150°C for 10 min. The products, thus, obtained were soluble in the mixture 2:1 of denatured spirit (freshly distilled) and methyl ethyl ketone. The films obtained were less uniform compared to those obtained from shellac-epoxy resin combination. The dielectric strengths of most of the compositions studied were low as compared to that of DL shellac. However, for 50:50 shellac phenolic resin composition, the dielectric strength was found to be 1·2 kV/mil and this only passed the test for resistance to transformer oil.

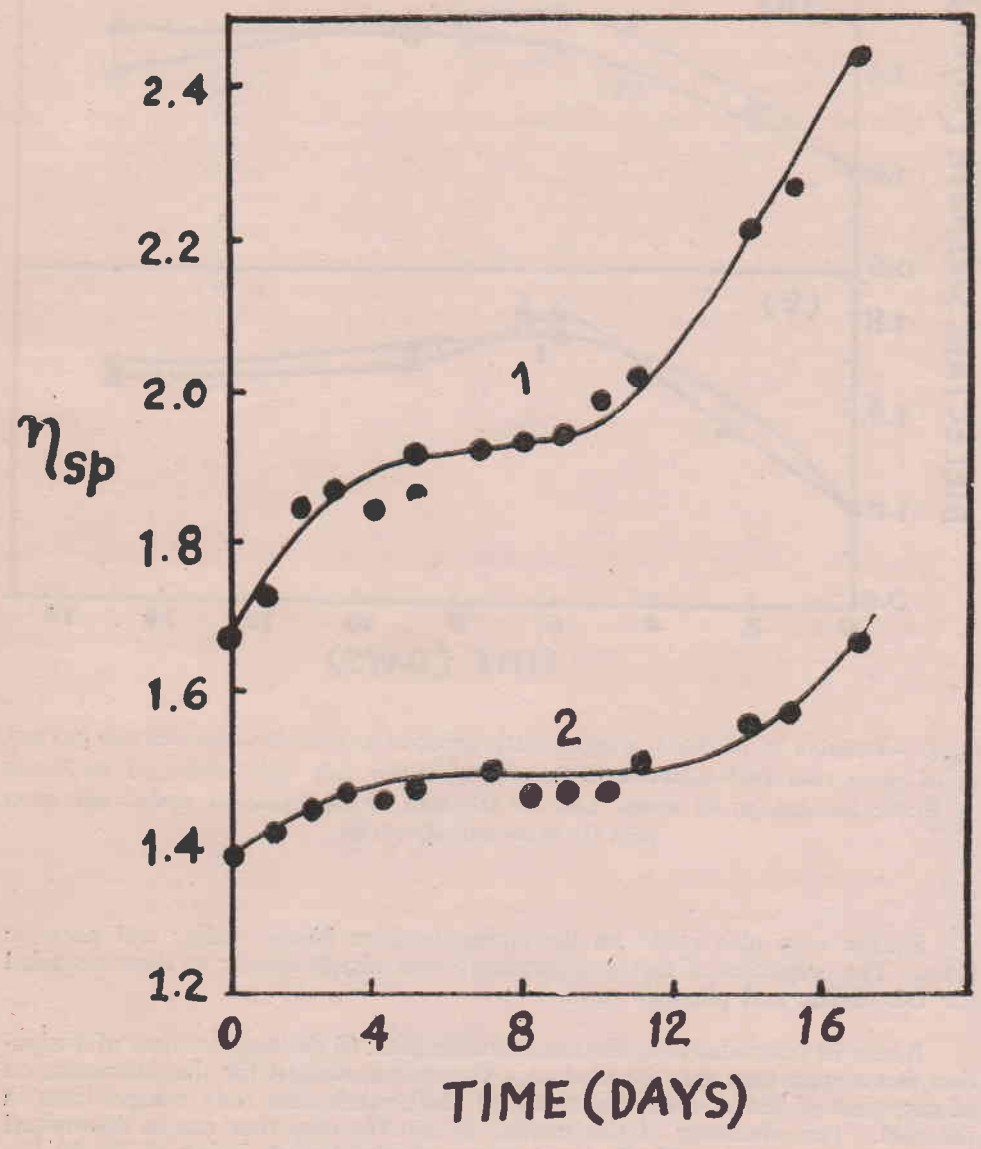


Fig. 5 — Variation of specific viscosity of DL-shellac-epoxy resin [mol. wt 1000, CIBA-GEIGY) varnishes; ratio of shellac and epoxy resin: (1) 70:30 and (2) 50:50]

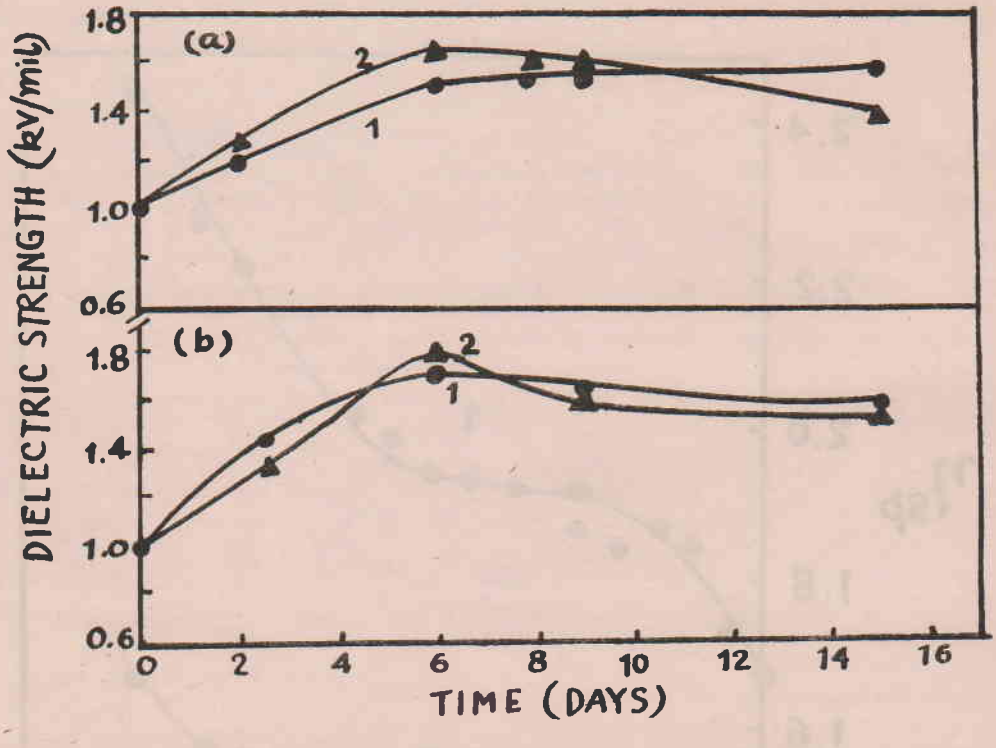


Fig. 6 — Variation of dielectric strength of DL-shellac-epoxy resin varnishes with time [(a) mol. wt of epoxy resin 1000 (CIBA-GEIGY); ratio of shellac and epoxy resin: (1) 70:30 and (2) 50:50; (b) mol. wt of epoxy resin 500 (Dr Beck & Co.); ratio of shellac and epoxy resin (1) 70:30 and (2) 50:50]

Studies were also made on the curing between *bhatta* shellac and phenolic resin. The properties of the fused products were almost similar to those obtained for DL shellac and phenolic resin.

It may be concluded from the above studies that: (i) the measurement of dissipation factor with time may be used as a convenient method for the determination of cure-time of shellac-epoxy resin and of shellac-melamine resin compositions in the cold. The advantage of this method is that the cure time can be determined in the solution stage itself; (ii) the products obtained after curing of 70: 30 DL shellac and epoxy resin and 50: 50 *bhatta* shellac and epoxy resin when dissolved in appropriate solvent may be used as general purpose air-drying insulating varnishes.

(D. N. Goswami and S. Kumar)

## (b) RESEARCHES ON HAND

### 3.1 Chemistry of Lac/Constituents

#### 3.1.1 Separation and study of components of lac wax

#### 3.1.2 (Old)

(i) The fractionation of lac wax into three fractions namely, A, B and C by alcohol, refractionation of the fraction B into two fractions B-1 and B-2 by ether as solubles and insolubles respectively was reported earlier. An ester (10%, m.p. 94-95°C) obtained from fraction A hydrolysed to corresponding alcohol and acid and examined by Mass and NMR spectra at Regional Research Laboratory, Hyderabad, was found to consist of a straight chain $C_{38}$ acid and a straight chain $C_{36}$ alcohol.

The fraction B-2 when examined by T.L.C. was found to be a mixture of two components (Rf values 0·15 and 0·75). The IR spectra of fraction B-2 indicated that one of the components may be alcohol. The fraction B-2 was acetylated by refluxing with acetic anhydride-pyridine for 6 hr. The product, so obtained, was again fractionated with ether into ether-soluble, fraction B-2-1 (acetylated alcohol, m.p. 63-64°C, Rf 0·08) and ether insoluble B-2-2 (unchanged, m.p. 79-80°C, Rf = 0·85). The fraction B-2-1 was hydrolysed to the corresponding alcohol which was identified as $C_{32}$ straight chain alcohol (m.p. 81-82°C). The unacetylated fraction B-2-2 was identified as $C_{27}$ hydrocarbon on the basis of IR and Mass spectra. For further confirmation, the sample of hydrocarbon has been sent to Central Drug Research Laboratory for PMR analysis.

The fraction C was treated with sodium-bicarbonate solution and the free acid components were separated. The neutral components were fractionated with chloroform into soluble and insoluble fractions. The chloroform insoluble fraction was found to be a hydrocarbon by IR and T.L.C. examination.

(ii) Studies were also made to characterize samples of lac wax obtained from sticklacs of various lac host plants such as *arhar*, *moghania*, *kusum*, *ber* and *palas*. A few characteristics such as wax content, free acid content, melting point, acid, iodine and saponification values of these samples were determined and the same are given in Table 33.

TABLE 33 — CHARACTERISTICS OF LAC WAX OBTAINED FROM STICKLAC FROM DIFFERENT HOSTS

| Hosts | Wax content (%) | Free acid content (%) | Melting point (°C) | Acid value | Iodine value | Saponification value |
|---|---|---|---|---|---|---|
| *Palas* | 6·3 | 10·2 | 74-78·5 | 4·5 | 4·7 | 66·2 |
| *Ber* | 7·0 | 12·5 | 76-82 | 7·0 | 8·4 | 94·0 |
| *Kusum* | 6·0 | 9·0 | 75-82 | 3·1 | 4·0 | 68·5 |
| *Arhar* | 3·0 | 5·0 | 74-79 | 2·5 | 3·2 | 65·1 |
| *Moghania* | 4·5 | 9·8 | 75-79 | 4·3 | 6·5 | 43·1 |

(K. M. Prasad, S. C. Agarwal, J. N. Chatterjea and S. N. Mukherjee)

### 3.1.3. Correlation of the properties of seedlac and shellac with age

Fresh sample of *kusum* sticklac (*aghani* 1981) from Balrampur was procured and processed into seedlac and shellac during the period under report.

The samples of seed lac and shellac, so obtained, as well as those from previous years were being stored in gunny bags under room conditions and analysed periodically for their physico-chemical properties.

A gradual lowering in life under heat, flow, rate of filtration, dielectric strength, dissipation factor, conductivity and an increase in cold and hot alcohol insolubles and intrinsic viscocity were noticed while colour and TLC behaviour remained mostly unaffected.

From the data collected, it appears flow is the most sensitive property which is affected on storage. If a *rangeeni* seed lac has less than 40 mm flow, it is more than one year and 30 mm, more than 2 yr old. In case of *kusmi* seedlac, corresponding figures are 55 mm and 45 respectively.

(B. B. Khanna, S. K. Saha, A. K. Ghosh, D. N. Goswami, N. Prasad and P. M. Patil)

### 3.1.5 Improvement in the method of isolating aleuritic acid from lac for maximizing its recovery

### 3.1.7 (Old)

A consistent yield of *threo*-aleuritic acid to the tune of 25 per cent was obtained from wax-free seedlac solution by adopting the modified method of alkaline hydrolysis reported earlier. No improvement in the yield of aleuritic acid was possible by increasing the alkali concentration from 20 to 30 per cent. The time of hydrolysis, however, could be reduced from 15 days to 7 days by heating the aqueous alkaline solution (20%) of seedlac, obtained after removal of wax, on water bath for 3-4 hr. The addition of sodium sulphite during hydrolysis resulted in an improvement in the recovery of aleuritic acid by 4-5 per cent. The wax, which retards the rate of filtration of sodium aleuritate, was removed by the addition of a small amount of alkali at the initial stage and allowing the solution to stand overnight.

With a view to increase the rate of filtration of sodium aleuritate, the effect of different filtering aids namely, kiselguhr, bentonite, fullers earth, paper pulp and asbestos wool using drill cloth as the filtering medium, was studied. When nylon cloth was used in place of drill cloth, a little improvement in the rate of filtration was noticed. The use of nylon cloth was also found to be economical because of its longer life and resistance to alkali.

In order to maximize the recovery of aleuritic acid further studies were made. The mother liquor (obtained after separation of sodium aleuritate) was divided into two parts: A and B. Attempt was made to revover aleuritic acid from the barium salt of part A but was unsuccessful. However, butolic acid (6-hydroxy myristic acid, m.p. 56°C) could be isolated from this part.

The aliphatic acid portion, separated from Part B, was treated either with hydrobromic acid-acetic acid (HBr-AcOH) at room temperature for 24 hr or with conc. HCL at 100°C for 8-12 hr. The bromo/chloro derivatives so obtained, were then hydrolysed with alkali (10%) at 100°C for 30-36 hr. The compound recovered by this method was found to be *erythro*-aleuritic acid (m.p. 125-126°C).

The total recovery of aleuritic acid was approximately 30-35 per cent including 7-10% *erythro*-derivative).

Seedlac generally contains some amount of water-soluble dye which causes difficulty in the removal of colour of aleuritic acid. In order to isolate pure colour free aleuritic acid, attempts were made to remove this colour during the process of hydrolysis. Accordingly, *rangeeni* seedlac (1 kg) was treated with washing soda solution (10% w/w, 5 lit.) during the course of 1 hr by stirring. The solution was then allowed to settle and the water-soluble colouring material was decanted off. The seedlac was repeatedly washed with water till the wash-water was found to be colourless. The modified method of alkaline hydrolysis was then adopted in the usual way. The sodium aleuritate, so obtained, was dissolved in boiling water, treated with charcoal (10%, w/w) and filtered hot under vacuum. After cooling, the colour-free sodium-aleuritate solution was neutralised with sulphuric acid (10%, w/w) to obtain aleuritic acid. Further purification, if necessary, may be carried out by dissolving the aleuritic acid in (hot) methyl acetate and decolourising with charcoal (5% w/w) to yield pure crystals of aleuritic acid. The solubility of aleuritic acid at 30°C in water and ethyl acetate was 0·9 and 20 g/100 ml respectively.

The cost of preparing aleuritic acid on laboratory scale is being determined and work on the use of gummy mass left after separation of aleuritic acid is in progress.

(S. C. Agarwal, B. C. Srivastava and R. N. Majee)

### 3.1.6 Spectrophotometric studies on lac

### 3.1.8 (Old)

The results of the studies on the absorption spectra of DL shellac, hard and soft fractions of lac and of their different physical mixtures were reported earlier. During the period under report, the absorption spectra of six more natural resins viz., benzoin, pontianac, rosin, kauri, dragon and gamboge were investigated at different concentrations in ethyl alcohol in the complete U.V. and visible range. No absorption peak was noticed in the visible range for these resins except for gamboge and dragon in which case absorption maxima were obtained at 485 and 475 nm respectively. All these natural resins, however, exhibited distinct absorption maxima in the U.V. range. The positions of the absorption maxima and shoulder obtained for different natural resins including shellac in ethyl alcohol have been shown in Table 34.

TABLE 34 — POSITIONS OF ABSORPTION MAXIMA AND SHOULDER OF DIFFERENT NATURAL RESINS IN ETHYL ALCOHOL

| Natural resin | Positions of absorption maxima (nm) | Position of shoulder (nm) |
|---|---|---|
| Shellac (DL) | 225, 290, 425 | 350 |
| Kauri | 230, 265, 275 | — |
| Pontianac | 240, 280 | 310 |
| Benzoin | 232·5, 280 | — |
| Rosin | 225, 245 | 300 |
| Gamboge | 220, 240, 285 | 290 |
| Dragon | 235, 285, 475 | 350 |

The absorption spectra of DL shellac, *bhatta* shellac, ammoniated shellac, autoclave shellac (ASK-grade), bleached lac and soft fraction of lac at different concentrations in freshly distilled denatured spirit were also studied in the complete U.V. and visible range and the positions of the absorption maxima and shoulder obtained have been shown in Table 35. It may be seen from the table that for all shellacs absorption peaks were obtained at 277 and in most cases at 425 nm and a shoulder was noticed at 350 nm. For autoclave shellac, the absorption maxima were obtained at 277 in addition to at 440 nm and the shoulder was noticed at 360 nm. For bleached lac, only one absorption maximum was obtained at 277 nm. It was concluded from the study that: (i) the peak due to the aldehydic group of shellac which was obtained at 225 nm in ethyl alcohol shifts towards higher wavelength by about 52 nm in denatured spirit and (ii) denatured spirit (distilled) can also be used as an alternative solvent for the determination of colour index of shellac by spectrophotometric method.

The absorption spectra of DL shellac were then investigated in two other solvents viz. methyl and isopropyl alcohols. In methanol, absorption maxima were obtained at 230, around 290 and at 425 nm and a shoulder was noticed at 350 nm. In isopropyl alcohol, absorption maxima were obtained at 230 and 425 nm and the shoulder at 250 nm. The absorption spectra of sodium salt of lac were then studied in ethyl alcohol. In the U.V. range, a few more absorption maxima at 252·5, 258 and 265 nm were observed in addition to that at 225 nm obtained previously for DL shellac. The peak due to erythrolaccin was observed around 430 nm and the same was absent in bleached lac.

TABLE 35 — POSITIONS OF ABSORPTION MAXIMA AND SHOULDER OF DIFFERENT SHELLACS IN DISTILLED DENATURED ALCOHOL

| Type of shellac | Position of absorption maxima (nm) | Position of shoulder (nm) |
|---|---|---|
| DL | 277, 425 | 350 |
| *Bhatta* | 277, 430 | 340 |
| Ammoniated | 277, 425 | — |
| Autoclave (ASK-grade) | 277, 440 | 360 |
| Bleached | 277 | — |
| Soft fraction of lac | 280, 435 | 350 |

The absorption spectra of different mixtures of DL shellac and a few other natural resins were also investigated in ethyl, methyl and isopropyl alcohols. For all the above solvents, it was observed that the characteristic absorption peak at 425 nm of shellac was obtained only when the concentration of shellac was ten times greater than that of other resin in the mixture. It is concluded that identification of shellac in presence of other natural resins is not possible by absorption spectra study.

(D. N. Goswami and N. Prasad)

### 3.1.8 Biophysical studies on the interaction between laccaic acid and DNA

The study was initiated with an objective to establish the nature and mode of interaction of laccaic acid with DNA. During the period under report, studies were made on the changes in the absorption spectra (visible range) of lac-dye

(laccaic acid) due to the progressive addition of DNA. Both the dye and DNA solution were prepared separately in sodium chloride solution (0·01M). The *p*H of the solutions were found to be 6·8-6·9. The abosrption spectra of dye-DNA systems were studied in sodium chloride solution (0·01 and 0·001M) at different DNA phosphate to dye ratios. For both the molarities, a red shift in the spectra of lac-dye was observed with the progressive addition of DNA.

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

### 3.2 Fine Chemicals from Lac

#### 3.2.2 Synthesis of exaltone, isoambrettolide and prostanoid synthon

#### 3.2.1 (Old)

*Trans*-isoambrettolide (prepared from *threo*-aleuritic acid) was reduced to cyclic ether (having musk-like odour) with sodium borohydride-boron trifluoride in tetrahydrofuran. It gave the picrate, m.p. 159°-60°C. The same cyclic ether was also prepared from *threo*-aleuritic acid, by reducing 16-hydroxy-$\Delta^9$-hexadecenoic acid with lithium aluminium hydride in tetra hydrofuran and cyclizing the resultant diol with para-toluene sulphonic acid (PTS) in benzene. It also gave the picrate of same melting point.

*Trans*-ismoabrettolide was prepared in improved yield from *threo*-aleuritic acid adopting a modified procedure. *Threo*-aleuritic acid was heated with ethyl-orthoformate/benzoic acid at 170°C for 4 hr, hydrolysed with alkali (alcoholic) for 5 hr and acidified to yield 16-hydroxy-$\Delta^9$-hexadecenoic acid m.p. 68-70°C yield$\sim$ 90 per cent. The foregoing unsaturated acid was then refluxed with catalytic amount of PTS in toluene for 8 hr with azeotropic removal of water. The polyester, so obtained, was depolymerized with magnesium chloride to yield *trans*-isoambrettolide as a thick liquid. It was then distilled and the distillate was taken up in ether, washed with sodium carbonate solution followed by water. Ether extract was then dried over anhydrous sodium sulphate. Removal of ether afforded pure product, yield 70 per cent.

Dehydroexaltone, *trans*-isoambrettolide and prostanoid synthon were purified by the column chromatography. The T.L.C. examination (solvent system ethyl-acetate: acetic acid 100:1, v/v) revealed them to be pure, having Rf values 0·67, 0·76 and 0·75 respectively.

(R. N. Majee, S. C. Agarwal, J. N. Chatterjea, S. C. Sengupta and S. N. Mukherjee)

#### 3.2.8 Synthesis of civetone and cyclic ureides from aleuritic acid

#### 3.2.2 (Old)

Cyclic ureide was prepared from-$\Delta^9$-hexadecene-1,16 dioic acid as follows: *Threo*-9,10-dihydroxy-hexadecane-1,16-dioic acid (prepared from *threo*-aleuritic acid) was treated with phosphonium iodide-acetic acid and hydrolysed to yield$\Delta^9$-hexadecene-1,16-dioic acid. It was then converted to the corresponding acid chloride by thionyl chloride. The crude product was then refluxed with urea in dry benzene for 3·5 hr when a solid product was obtained, which crystallized from ethanol (m.p. 185°C). The product is being identified. Following the same procedure, cyclic ureide was also prepared from$\Delta^9$-heptadecane-1,17-dioic acid and pimelic acid (m.p. 102-104°C, obtained from aleuritic acid).

The $C_{17}$ cyclic ketone (Dehydrocivetone) having musk like odour was synthesized from aleuritic acid. Aleuritic acid was converted into 16-hydroxy-$\Delta^9$-hexadecenoic acid with phosphonium iodide followed by alkaline hydrolysis which

was treated with Jones reagent for 10 min to yield the corresponding unsatuarated aldehydic acid, m.p. 78-80°C. This aldehydic acid was treated with malonic acid in pyridine for 4 hr on a water bath. The resultant unsaturated diacid was converted to acid chloride (liquid). The crude product was then cyclized by the high dilution principle to give hydrocivetone which was distilled at 220-225°C, 5 mm. Its 2,4-DNP derivative melted at 178-80°C. The purity of the compound was tested by T.L.C. in solvent system, ethylacetate: acetic acid, 100:1, v/v, (Rf 0·76). For improving the yield of 16-hydroxy-$\Delta^9$-hexadecenoic acid, an intermediate in the synthesis of dehydrocivetone, *threo*-aleuritic was heated with ethyl orthoformate/benzoic acid at 170°C for 4 hr, followed by hydrolysis with alkali (alcoholic). The resultant product *i.e.*, 16-hydroxy-$\Delta^9$-hexadecenoic acid was obtained in 90 per cent yield.

(R. N. Majee, S. C. Agarwal, J. N. Chatterjea and S. N. Mukherjee)

### 3.2.10 Synthesis of Queen-bee pheromone and juvenile hormone analogues from aleuritic acid

(i) Queen-bee pheromone (9-oxo-$\Delta^9$-decenoic acid) was synthesized from aleuritic acid adopting simple reaction sequence.

One of the periodate oxidation products of aleuritic acid, 7-hydroxy heptanal was treated with malonic acid in the presence of pyridine on steam bath for 4 hr to yield unsaturated hydroxy acid. The foregoing acid was then treated with pyridinium chlorochromate in methylene chloride to yield the corresponding unsaturated aldehydic acid (thick liquid). This compound on condensation with methyl magnesium iodide yielded 9-hydroxy-$\Delta^2$-decenoic acid which on oxidation by aluminium tert. butoxide resulted in 9-oxo-$\Delta^2$-decenoic acid, m.p. 53-55°. The compound was established by NMR, MS and IR data.

(ii) A juvenile hormone (JH) analogue, 1,4,12-trimethoxy dodecane was synthesized from aleuritic acid.

Azelaic semialdehyde, one of the periodate oxidation products of aleuritic acid, was converted to its methyl ester with diazomethane which was then condensede with dimethyl succinate-sodium methoxide in methanol to yield half ester (thick liquid). The foregoing ester, on treatment with HBr-AcOH-$H_2O$ (3:2:1, v/v) for 13 hr, resulted in lactone ester (thick liquid) which was reduced to 1,4,12-trihydroxy dodecane with lithium aluminium hydride:

IR: presence of $-OH$ group at 3250 $cm^{-1}$

Its treatment with diazomethane/borontrifluoride yielded 1,4,12-trimethoxy dodecane. The liquid product was purified by column chromatography. Preliminary testing of 1,4,12-trihydroxy dodecane on one day-old pupae of *Coreyra cephalonica* did not yield any juvenile mimetic activity.

(iii) Methyl 9-oxo decanoate. an intermediate for the synthesis of JH was also synthesised from azelaic acid aldehyde by adopting the standard precedure.

(R. N. Majee and R. Ramani)

### 3.3 Modification of Lac/Constituents

### 3.3.3 Ion exchange resin from shellac

### 3.3.6 (Old)

(ii) *Cation exchange resin from styrenated lac*

The preparation of a cation exchange resin from shellac has already been reported. The resin had certain shortcomings in respect of colour, throw,

column utilization and rate of exchange which require improvement. It was thought styrenation of lac would bring improvemnt in the properties and therefore, the present study was undertaken. Bleached lac was styrenated (20 and 50%, w/w) in ammonical solution in the presence of potassium permanganate (initiator) in nitrogen atmosphere. The composition containing styrene (20%) was soluble in spirit-toluene mixture (1:1) whereas the composition containing styrene (50%) was insoluble. Hence, the sulphonation of the former composition was carried out in solution stage whereas of the latter. in dry stage at 140-145°C. Thereafter, the cation exchange resin was prepared by fusing the resultant product with paraformaldehyde and resorcinol. The properties of the resins, thus obtained, are given in Table 36.

As no improvement over cation exchange resin prepared earlier was observed, a possible reason could be that sufficient sulphonation had not taken place.

TABLE 36 — PROPERTIES OF THE STYRENATED CATION EXCHANGE RESIN

| | Composition 1 | Composition 2 |
|---|---|---|
| Styrene content | 20% | 50% |
| Moisture % | 8·98 | 8·26 |
| Yield of cation exchange resin (%) | 62 | 65 |
| Cation exchange capacity (meq/g) | 1·92 | 0·93 |

(A. Rahman, P. C. Gupta and B. B. Khanna)

### 3.3.10 Addition polymerization of shellac

### 3.3.12 (Old)

Experiments were carried out earlier to bring about addition polymerization of shellac in the presence of potassium persulphate as an initiator. During the period under report, the intrinsic viscocity and mol. wt of the reaction product were determined and found to be 0·04 and 482 respectively. The mol. wt was determined by the vapour phase osmometer. As the mol. wt of the reaction product was very low, effect of other polymerization initiators such as benzoyl peroxide, azodi-iso-butyro nitrile (ADIBN) and boron trifluoride etherate was examined. The products were separated by the aid of the aqueous sodium chloride solution (1%) except in the case of ADIBN wherein the evoporation of the solvent was necessitated to separate out the polymer. The products obtained in three cases were solid and different in colour and texture than shellac.

The physical and chemical properties of the reaction products so obtained were studied. The iodine and acid values were found to be higher while the dielectric constant and tan $\delta$ values were much higher than those of shellac. The results indicate that some structural changes had occurred during addition polymerization reaction.

The U.V. absorption spectra of the reaction product and of shellac were studied to get an idea about the chemical changes taking place during the reaction but no conclusion could be drawn.

The bond strength of the reaction product was 0·14 as against 0·09 ton/sq. inch for shellac. Hence the reaction product may be used in adhesives by incorporating certain addititives.

The film properties namely, scratch hardness, gloss and resistance to water of the reaction product were not good and the product is not suitable for use in surface coatings.

(A. Kumar)

### 3.4 Use of Shellac and Modified Shellac in Surface Coatings

#### 3.4.3 Shellac paints for wood patterns

#### 3.4.7 (Old)

It was reported earlier that shellac paints based on lac-melamine resin varnish as vehicle did not show any deterioration in the film properties when tested after storage for one year.

Further experiments were, therefore, carried out to prepare bigger lots of shellac paints of different shades by using lac melamine resin varnish as vehicle. In all cases, uniform paints were obtained which on application by brush, produced hard, smooth, glossy and adherent films on wooden surface. These films showed good resistance to water and to wet abrasion. Two paint samples which were found to be the best were supplied to National Institute of Foundry and Forge Technology, Dhurwa for evaluation in the shop. The evaluation report indicated that shellac paints possess most of the desirable properties of synthetic resin based pattern enamels excepting the desired film hardness, and viscosity.

Two compositions of pattern paints were also prepared by using ordinary shellac and a commercial solvent IPA-CBM (manufactured by NOCIL), but these paint compositions did not produce films of the desired gloss, hardness and water resistance; drying characteristics of these paints were also inferior, compared to paint compositions prepared from spirit as the main solvent.

A few samples of pattern paints based on ordinary shellac and spirit as main solvent were also prepared. The pattern paints so prepared were sufficiently viscous and uniform. On application by brush, they produced hard, smooth but moderately glossy films on wooden surface. The air dried films showed slightly inferior resistance to water as compared to the films obtained from pattern paints based on dewaxed lac.

(S. Kumar and A. K. Dasgupta)

#### 3.4.4 Studies on shellac esters and their utilization

#### 3.4.8 (Old)

It was reported last year that esterification of aleuritic acid with methanol in the presence of concentrated sulphuric acid is completed within 2 hr.

During the period under report, the reaction of aleuritic acid with glycerol, was carried out under different conditions of time, temperature an also in the presence of different catalysts. When the reaction of aleuritic acid with glycerol was carried out at 150-160°C for 30 min in the molar ratio of 3:1 in the presence of boron trifluoride, a waxy product was obtained which consisted of a mixture of mono-, di- and triglycerides of aleuritic acid. From this mixture,

triglyceride of aleuritic acid was separated by preparative T.L.C. and identified by comparing with triacetin. Separation of mono- and diglycerides of aleuritic acid from the said mixture was also tried by adopting similar procedure but was not successful. Attempts were then made to prepare mono-, di- and triglycerides of aleuritic acid separatley.

In one experiment, it was observed that triglyceride of aleuritic acid could be formed up to 85-90 per cent by reacting methyl aleuritate with glycerol in the molar ratio of 1:1.5 at 180-200°C for 2 hr.

Next, 16-hydroxy-$\Delta^9$-hexadecenoic and $\Delta^9$-hexadecene 1:16-dioic acids were prepared from aleuritic acid and converted to their corresponding acid chlorides according to the method reported in the literature. These were reacted separately with glycerol, iso-propylidene and derivative of glycerol and ethylene glycol respectively in different molar ratios under different conditions of time and temperature and also in the presence of different catalysts such as zinc dust and boron trifluoride. The reaction products, so obtained, were examined by TLC but satisfactory results could not be obtained.

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

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

The study has been taken up with a view to develop suitable compositions of shellac based anticorrosive primers and paints which may be used for painting railway coaches, wagons, bridges etc. The research programme has been drawn in consultation with the Scientists and Technologists of the Research Design Standards Organization, Lucknow.

A few samples of oil based vehicle (based on dewaxed lac and double boiled linseed oil) were prepared but due to non-availability of dewaxed lac, sufficient quantity of the vehicle could not be obtained. These small samples of vehicle were pigmented in a small ball mill with red oxide of iron, zinc chromate and other minor ingredients to prepare suitable primer compositions. The primers, so obtained, were uniform in texture and on application by brush, produced hard, smooth and characteristic egg shell films on G.I and M.S. panels. Film properties of these samples are under study.

Experiments were also carried out to prepare oil based primer compositions by using ordinary shellac in place of dewaxed lac. The primer compositions, so prepared, were also uniform and on application by brush produced hard, smooth and egg shell films but in this case, the drying chracteristics of the films were comparatively inferior. Film properties of these compositions are also under study.

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

## 3.5 Use of Lac for Encapsulation and Controlled-release

### 3.5.3 Slow-release chemically combined lac-based weedicides

Shellac was combined previously with 2,4-D through esterification in homogeneous reaction system. Further studies were carried out to develop a simpler and cheaper method of combining lac with 2,4-D using a low cost solvent.

The acid chloride of 2,4-D prepared earlier was dissolved in benzene and reacted in heterogeneous reaction system in the molar proportions of 1:1, 1:2

and 1:3 with shellac, which was kept suspended in the benzene solution in the presence of pyridine. The resultant product was filtered, washed with benzene, dried and analysed. It was found that when lac and chloride of 2,4-D were used in molar proportions of 1:1 and 1:2, ester of lac-2,4-D was formed.

In this process, the difficulties of preparing, handling and heating of viscous polymeric solutions, experienced in the earlier methods have been overcome. Further, benzene which is a comparatively cheaper solvent has been used in place of dioxane.

Different Agricultural Universities and Institutions were approached for the evaluation of lac-2,4-D ester. Samples of 2,4-D ester formulations (10 kg) were prepared by using direct combination method developed earlier and have been sent for evaluation to:

1. Indian Agriculture Research Institute, New Delhi
2. Haryana Agriculture University, Hissar
3. Central Rice Research Institute, Cuttack
4. Regional Research Laboratory, Jammu
5. Indian Grass Land and Fodder Research Institute, Jhansi
6. G.B. Pant Agriculture University, Nainital
7. Forest Research Institute, Dehradun

Another approach for combining lac with 2,4-D through amide formation was also made. The amide of 2,4-D (m.p. 150°C) was prepared using urea. The 2,4-D and urea were heated in equimolar proportions.

The resultant product was washed and dried. The acid equivalent of this amide was determined and found to be 7·11 per cent confirming the amide formation of the acid. This acid amide was combined molecularly with shellac with and without a catalyst (*p*-toluene sulphonic acid). The resultant product on examination revealed that this approach is not feasible.

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

### 3.5.4 Studies on the use of lac as adjuvant in pesticide formulations

Studies were started to adjudge the suitability of hydrolysed lac obtained under different conditions of hydrolysis as sticker in pesticide formulations. Ten sets of experiments were conducted using shellac in aqueous and alcoholic medium (Table 37). Keeping in view the energy consumptions and the degree of hydrolysis affected and required, it was found that refluxing for one hr or keeping at room temperature for 6 hr appeared to be suitable for this purpose. However, the latter process was found to be less energy consuming. The above two sets of experiments were repeated thrice and yield and physico-chemical characteristics of the resultant product were determined and found to be of the same order (Table 38). The mother liquor obtained after isolation of aleuritic acid on acidification gave a gummy mass. The acid and hydroxyl values of this product were determined. The physico-chemical characteristics of the above set of products showed that they may be used for lac-based sticker formulations.

The solid content of the procured commercial BASF (West Germany) namely, acronal 4D, acronal 7D, and lutanol 65D stickers (water based) was determined and found to be 49·9, 50·2 and 55·4 per cent respectively. Sticker formulation, based on water, triethanolamine and liquor ammonia as solubilizing agent were

TABLE 37 — HYDROLYSIS OF SHELLAC UNDER DIFFERENT CONDITIONS

| Sl No. | Method | Condition | Duration (hr) | Operations during preparation | Acid value |
|---|---|---|---|---|---|
| 1 | Aqueous | Reflux | 6 | Left overnight, diluted, filtered, neutralized and washed | 185·5 |
| 2 | Alcoholic | Reflux | | (Published method—by Banerjee and Sengupta) | 124·7 (Low) |
| 3 | Aqueous | Reflux | 1 | Immediately cooled in ice, left overnight, diluted, filtered, neutralized and washed | 178·6 |
| 4 | Aqueous | Reflux | 2 | Immediately cooled in ice, left overnight, diluted, filtered, neutralized and washed | 177·1 |
| 5 | Aqueous | Reflux | 3 | Immediately cooled in ice, left overnight, diluted, filtered, neutralized and washed | 176·7 |
| 6 | Aqueous | Reflux | 4 | Immediately cooled in ice, left overnight, diluted, filtered, neutralized and washed | 175·4 |
| 7 | Aqueous | Room temp. | 24 | Diluted, filtered, neutralized and washed | 173·8 |
| 8 | Aqueous | Room temp. | 6 | Diluted, filtered, neutralized and washed | 165·3 |
| 9 | Aqueous | Reflux | 1 | Immediately cooled in ice, diluted, filtered, neutralized and washed | 155·1 |
| 10 | Aqueous | Reflux | 6 | Immediately cooled in ice, diluted, filtered, neutralized and washed | 175·5 |

TABLE 38 — CHARACTERISTICS OF PARTIALLY HYDROLYSED LAC

| Sample No. | Acid value | Hydroxyl value | Yield (%w/w) |
|---|---|---|---|
| 8 | 165·3 | 315·1 | 60 |
| 9 | 173·8 | 321 | 66 |
| Mother liquor (obtained after removal of aleuritic acid) | 171·0 | 295 | 58 |

prepared by using the above three samples of partially hydrolysed lac. The solid content of these formulations was kept at 50 per cent (w/w). It appeared that the sticking characterstics of the lac-based sticker formulations and commercial BASF stickers were more or less similar type indicating that lac may find use in this field.

(B. C. Srivastava and T. P. S. Teotia)

### 3.7 Standardization of Lac/Constituents

#### 3.7.1 To prepare a standard for lac dye for use as a food colour

The preparation of lac dye and some of its characteristics such as melting point, volatile matter, water and alcohol solubility were reported last year. During the period under report, it was observed that when the lac dye solution was concentrated at reduced pressure at 50°C and allowed to crystallize for ten days, the solubility of the product in the hot water increased from 94 to 99 per cent. The lac dye, obtained from two sticklacs *palas and kusum* was found to have a linear relationship between concentration and absorbance measured in a Photo-Electric Colorimeter (Green filter). The acid value of the dye was determined by adopting the following methods and the data are given below:

| *Method* | *Acid value* |
|---|---|
| Titration using thymol blue as indicator | 238-245 |
| Photo-electric colorimeter | 240-255 |
| *p*H-meter | 234-238 |

As the lac dye possesses low solubility in cold water, its sodium salt was prepared by treating the calcium salt of the dye with the calculated amount of sodium carbonate solution. The solution, so obtained, was filtered and evaporated to dryness. The dried sodium salt, thus obtained, was found to be highly soluble in water but insoluble in alcohol.

UV absorption (visible) studies of lac dye in different solvents i.e. water, ethyl alcohol, methyl alcohol and acetone indicated four absorption mixima at 530, 500, 292 and 230 nm in methyl and ethyl alcohols, at 490 and 292 nm in water and at 500 nm only in acetone. In case of sodium salt of lac dye solution in water, only one peak was observed at 530 nm. Studies in other solvent media could not be done due to insolubility of the sodium salt of dye.

(B. B. Khanna, A. K. Ghosh, K. M. Prasad and N. Prasad)

#### 3.7.2 To prepare a standard for different grades of lac wax

Some characteristics of three lac wax samples, procured from M/s Waxpol Industries, Tatisilwai, were reported vide A.R.: 1979-80.

During the period under report, three more samples of lac wax were procured from (i) the Technology Division of the Institute, (ii) M/s Angelo Bros., Calcutta, and (iii) BISCOLAMF, Ranchi.

Some of the physico-chemical constants of the wax samples procured were determined and are given in Table 39.

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

## (c) RESEARCHES CONTEMPLATED

(1) Degradation studies on lac
(2) Isolation of jalaric acid from lac on technical scale
(3) Adsorption studies on lac

TABLE 39 — PHYSICO-CHEMICAL CHARACTERISTICS OF LAC WAX SAMPLES OBTAINED FROM DIFFERENT SOURCES

| Sl No. | Type of lac wax | M.P. (°C) | Acid value | Sap. value | Iodine value | Pene-tration value | Volatile matter (%) | Resin content (%) | Solvent retention | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | After (96 hr) | After (120 hr) | After (148 hr) |
| 1. | Acid treated lac mud (BISCOLAMF) | 65-72 | 35·0 | 106·0 | 15·0 | 5·0 | — | 6·5 | 27·5 | 22·0 | 20·8 |
| 2. | Lac-mud without acid treatment (BISCOLAMF) | 64-70 | 14·3 | 85·1 | 11·5 | 7·0 | — | 4·4 | 75·0 | 72·7 | 64·0 |
| 3. | Lac wax (Angelo Bros) | 70-82 | 20·7 | 94·6 | 5·3 | 2·0 | 0·6 | 0·9 | 19·0 | 16·0 | 11·0 |
| 4. | Wax from alkaline solution of lac (Technology Division) | 70-80 | 6·3 | 45·0 | 3·0 | 3·0 | — | 0·8 | 63·7 | 59·0 | 49·5 |
| 5. | Wax from lac dust | | 8·0 | 89·0 | 8·0 | 12·0 | 0·88 | 2·3 | 15·0 | 14·0 | 12·0 |
| 6. | Wax from lac mud | | 47·0 | 114·0 | 11·4 | 27·0 | 0·94 | 11·0 | 64·8 | 57·8 | 53·5 |
| 7. | Refined wax from lac | | 48·0 | 125·0 | 15·4 | 25·0 | 1·15 | 10·0 | — | — | — |

(4) Thermal polymerisation of lac-studies on the molecular weight, size and shape
(5) Modification of lac/hydrolysed lac with polyisocyanates
(6) Modification of lac with ethyl cellulose

## D. TECHNOLOGY DIVISION

### (a) RESEARCHES COMPLETED

**4.1.6(i) Improvement in dewaxing technique in aqueous medium**

Dewaxing of lac in aqueous medium is a very lengthy process and takes 48 hr. The process involves two steps: (i) cooling the extract at room temperature and removing the scum of lac wax and (ii) filtration of the solution to separate the remaining wax. It was, therefore, desired to shorten the process by combining the two steps into one:

To achieve the above objective, a series of experiments were carried out. The dewaxing was done at different temperatures and by using different filtering aids such as fullers earth, paper pulp, hyflosupercel and cellulose powder. It was found that cooling of the hot extract at 15-16°C and using cellulose powder as filtering aid gave the best results. The details of the process developed are as follows:

Seedlac (1 kg, 10 mesh) was dissolved in water (3:l) containing sodium carbonate (80 g) and sodium sulphite (30 g) at 80-85°C for 45 min, and filtered through muslin cloth to remove the insolubles. The residue was washed with water (0·5:l).

For immediate cooling of the extract, ice was added to bring down the temperature to 15-16°C. To the cooled solution, cellulose powder (70 g) was added, mixed thoroughly and filtered through a gavardin cloth under gravity. Sodium hydrosulphite (20 g, on the weight of seedlac) was then added to the filtrate to get normal colour of shellac. The filtrate was diluted to 5 per cent lac content with cold water, precipitated with sulphuric acid (5%) and washed as usual to remove the excess acid. The precipitated lac was boiled in fresh water and converted into sheets. The whole process of dewaxing takes about 20-24 hr as against 48 hr in the previous technique. The cellulose powder and the residue obtained from the seedlac solution after filtration were hot extracted with *n*-hexane to recover the wax. A light yellow coloured wax was obtained. The cellulose powder, so recovered can be reused for dewaxing by mixing with equal part of fresh cellulose powder. The dewaxed product, obtained by this technique, contains wax (0·12-0·16%) on an average.

Several charges on semi-pilot scale by taking 10 kg seedlac per charge have been carried out and the results were found reproducible.

(A. K. Ghosh)

**4.3.2 Heat and water proof laminates**

The object of this project was to develop shellac/modified shellac based heat and water proof decorative laminates which may be used as table tops and for other decorative purposes.

In order to prepare above laminate, shellac synthetic resin combinations viz. shellac melamine resin and shellac urea resin were tried. The details are given below:

The tissue paper and designed papers were coated with shellac melamine solution (20%) in the ratio of 60:40 for top layers and for the bottom layers kraft papers were coated with same composition (10%). These coated papers were cut in the size of 15×15 cm and pressed at 140-150°C employing pressure 8000-10,000 lbs per inch$^2$ in a hydraulic press for 30 min. In this process, sticking of the board with plate was observed. Hence a curing agent (*p*-toluene sulphonic acid PTS) was used in the varnish in different proportions and boards were made. It was observed that PTS (1%) on the weight of total resin was optimum to prevent the board from sticking to the plates as well as to avoid the baking of the papers in the oven. The boards, thus prepared were quite glossy and smooth and were resistant to water, heat, cooking oil containing turmeric powder but did not resist caustic soda, iodine, silver nitrate etc. as per IS: 2046-69.

With a view to improve surface resistance of the board, the top layers were coated with pure melamine resin which passed all the tests except those of iodine and silver nitrate.

The boards were also made by coating the top layers with alcoholic urea-formaldehyde resin soln. (20%) in presence and absence of PTS. The boards came out with good gloss and flexibility and passed the test for dry heat, caustic soda, iodine, cooking oil containing turmeric powder, tea, coffee etc. except of silver nitrate.

For bottom layers, another composition, viz., alcoholic shellac solution (10%), urea (3%) and hydrolysed lac (5%) on the weight of shellac was found equally good in performance as compared to shellac-melamine compositions.

The best compositions for the preparation of laminated boards have been found to be (i) urea-formaldehyde resin solution (20%) containing PTS (1%) for top layers and (ii) shellac-urea hydrolysed lac solution (10%) w/w) for bottom layers. Using these compositions, bigger boards 30×30 cm were prepared adopting the above technique when similar results were obtained.

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

### 4.3.3 Lac as an adhesive for utilization of waste mica

Quite a good amount of undersize scrap mica flakes and mica dust is obtained as a waste during mining and processing of mica products. The object of this investigation was to find utility of these waste mica flakes and dust for the preparation of insulating boards/sheets to use them in the electrical industry.

Two types of waste mica *viz.* (i) waste mica powder (20 to 300 mesh) and (2) waste mica scrapes were received from a mica factory, Koderma (Hazaribagh) for the said purpose.

1. *Waste mica powder*

Waste mica powder (20 to 300 mesh) was hot rolled at 100°C with shellac and (15%) hydrolysed lac (5%) on the weight of powder. Insulating boards could be prepared from these hot rolled products by powdering them (40 mesh) and finally hot pressing in a hydraulic press. The boards thus prepared, were found to withstand drilling, punching and sawing operations.

2. *Waste mica scrap*

The waste scrap mica was first heated at a high temperature (800°-900°C) for 3 hr to convert into calcined mica which was easily powdered and made into paste by grinding in water. The fine calcined mica was prepared by drying the paste. This fine powder was mixed with shellac based compositions as given below for making flexible insulating sheets using tissue paper as a base:

Composition (1) Shellac: 100 parts
Spirit: 400 parts
Urea: 10 parts

Composition (2) Shellac: 100 parts
Butylated —
Melamine —
Resin (60%): 66 parts
Spirit: 500 parts

Composition (3) Hydrolysed lac: 100 parts
Spirit: 400 parts

For making insulating sheets (15×15 cm), 15 ml of either (1)/(2) together with 15 ml of (3) were mixed with calcined mica powder (10 g) and made into a paste which could be diluted with spirit to the desired consistency. The tissue papers of the said size (4 sheets) were coated by brushing, air dried, baked at 110°C for 30 min. and finally pressed in a hydraulic press (having cooking arrangement) at 130°C, 2000 lbs pressure for 10 min. Similarly, insulating sheets (30×30 cm), were also prepared using four times materials as mentioned above.

These flexible sheets were water resistant up to 24 hr and had an average break down strength (BDS) of 17·0-23·0 kV/mm when tested according to B.S. 626: 1946. These data are comparable with those of standard micafolium (BDS 15-20 kV/mm) which are prepared from standard mica flakes and are used in electrical industry. The bond content has been found in good agreement to IS:2464-1963.

(P. C. Gupta and R. Singh)

## (b) RESEARCHES ON HAND

### 4.1 Improvements in the Processing Techniques

#### 4.1.5 Washing of sticklac with synthetic detergents

Bigger lots of *rangeeni* sticklac (10 kg) were washed separately with detergents namely Biz$^R$, Det$^R$, Gnat$^R$, Key$^R$, Surf$^R$ and Genteel$^R$ on semi-pilot scale and the yield, colour and bleach indices of the seedlacs obtained were compared with the one washed conventionally by washing soda.

In general, increase in yield was found to be 3-8 per cent, bleach index reduced by 2-10 units and colour by 1-2 units (Table 40).

As yield of seedlac was maximum when Genteel$^R$ was used, 10 kg lots of *kusmi* sticklac were washed with Genteel$^R$ (0·1, 0·2, 0·3, 0·4 and 0·5%) to find the optimum amount of Genteel$^R$ which was found to be 0·1 per cent (Table 41). The yield, colour and bleach index were found to improve by 6 per cent, 1 unit and

TABLE 40 — EFFECT OF SYNTHETIC DETERGENTS AS WASHING AID FOR *rangeeni* STICKLAC

| Sl No. | Synthetic detergent (0·1% on the weight of sticklac) | Properties of seedlac | | |
|---|---|---|---|---|
| | | Yield (%) | Colour index | Bleach index |
| 1 | Biz | 64·0 | 14·0 | 96·0 |
| 2 | Det | 65·0 | 14·0 | 96·0 |
| 3 | Gnat | 65·5 | 13·0 | 95·0 |
| 4 | Key | 65·0 | 14·0 | 96·0 |
| 5 | Genteel | 67·0 | 14·0 | 95·0 |
| 6 | Surf | 62·0 | 13·0 | 88·0 |
| 7 | Control (Washing soda) | 59·0 | 15·0 | 98·0 |

TABLE 41 — PROPERTIES OF SEEDLACS OBTAINED BY WASHING *kusmi* STICKLAC (10 kg LOTS) WITH DIFFERENT PERCENTAGE OF GENTEEL

| Sl No. | Properties | Washing soda (0·1%) (Control) | Genteel (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 0·1 | 0·2 | 0·3 | 0·4 | 0·5 |
| 1 | Yield (%) | 64·5 | 70·5 | 69·6 | 69·5 | 68·6 | 68·5 |
| 2 | Colour index | 11·0 | 10·0 | 10·0 | 10·0 | 9·5 | 9·0 |
| 3 | Bleach index | 84·0 | 78·0 | 78·0 | 78·0 | 77·0 | 74·0 |

6 units respectively. Also no appreciable change in other properties such as life, flow and hot alcohol insolubles was observed.

*Rangeeni* sticklac was also washed with different concentrations of Ritha and Teepol[R] and the properties (yield, colour and bleach indices) of the seedlacs obtained were compared with the one obtained by washing conventionally with washing soda (Table 42). In both the cases, the yield of seedlac was found to

TABLE 42 — PROPERTIES OF SEEDLACS OBTAINED BY WASHING *rangeeni* SEEDLAC WITH RITHA AND TEEPOL

| Properties of seedlac | *Rangeeni* sticklac washed with | | | | | | |
|---|---|---|---|---|---|---|---|
| | Washing soda 0·1% (Control) | Ritha (1%) | | | Teepol (1%) | | |
| | | 0·1 | 0·2 | 0·3 | 0·1 | 0·2 | 0·3 |
| Yield (%) | 60·2 | 62·2 | 63·3 | 63·0 | 66·2 | 62·5 | 63·1 |
| Colour index | 18·0 | 18·5 | 18·5 | 18·0 | 18·0 | 18·5 | 18·0 |
| Bleach index | 95·0 | 96·0 | 95·0 | 96·0 | 95·0 | 95·0 | 95·0 |

increase by 2-6 per cent, but there was no improvement in other properties. When washed with Ritha, the seedlacs obtained were blackish in appearance.

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

### 4.1.6 (ii) Improvements in dewaxing and decolourizing techniques in solvent medium

Experiments were continued to find the optimum time and temperature for decolourization of dewaxed lac solution. The solution of *kusmi* seedlac (25%, colour index 10·8) in denatured spirit was dewaxed vide (A.R.: 1979-80), filtered, treated with activated carbon (E. Merck, 20% on the weight of lac) and the resulting solution was divided into a number of parts to study the effect of temperatures and duration of treatment at 30°, 40°, 50°, 60° and 78°C for 1, 2 and 3 hr. The colour indices of the shellacs, thus obtained, were compared with the one decolourized at room temperature (25°C). It was found that one hr heating was sufficient for decolourization. Shellacs obtained by decolourizing at higher temperatures (*i.e.*, 50°, 60° and 78°C) were of blackish tinge, possibly due to the presence of alcohol soluble impurities of the activated carbon. The problem was solved by removing the impurities from the activated charcoal by refluxing it for about 1 hr and washing with alcohol. The best result was obtained when lac was decolourised at 78°C for 1 hr (Table 43).

TABLE 43 — DECOLOURIZATION OF SEEDLAC (COLOUR INDEX 10·8) AT DIFFERENT TEMPERATURES

| Property of shellac | Control room temp. (25°C) | Temperature in (°C) | | | | |
|---|---|---|---|---|---|---|
| | | 30 | 40 | 50 | 60 | 78 |
| Colour index | 3·9 | 3·6 | 1·9 | 1·6 | 1·3 | 1·2 |

(R. K. Banerjee)

### 4.1.7 Making of shellac from *kiri* without use of alcohol

*Kiri* is a byproduct of lac industry and contains 50-65 per cent of lac. The lac is normally recovered by extraction with alcohol. Since the process is costly and lengthy, an alternate method was proposed to be worked out.

Two samples of *kiri* (machine made) were obtained from commercial firms. Lac was extracted from them by alcohol and also by different aqueous alkalies.. For extraction with alcohol, the powdered *kiri* was boiled with 10 times of alcohol and filtered through drill cloth. Fifty per cent of the solvent was recovered and the rest was poured into common salt solution (1%) to get the lac precipitated which was boiled with water, dried and powdered.

For extraction with different alkalies, the *kiri* was powdered and boiled for an hour with 4 times of water containing requisite amount of alkali (Table 44) and filtered. The filtrate was diluted, precipitated and washed in the usual manner.

During the preparation of lac as mentioned at Sl. 6, the *kiri* was first dissolved in sodium carbonate and sodium sulphite and filtered. The filtrate was first reacted with sodium hydroxide (2%) for 10 hr and then sodium bisulphite (2%) was added and finally preciptated.

TABLE 44 — PROPERTIES OF LAC RECOVERED FROM *kiri*

| Sl No. | Solvent/alkali used (percent on the weight of lac) | Yield (%) | Life (min) | Flow (mm) | Colour index | Solubility in alcohol |
|---|---|---|---|---|---|---|
| 1. | Alcohol Sample 1 | 40·0 | 28 | 27 | Very dark not comparable | Yes |
| | Sample 2 | 42·0 | 30 | 28 | do | Yes |
| 2. | Sodium carbonate (10%) Sample 1 | 35·0 | Nil | Nil | Very dark not comparable | Yes |
| | Sample 2 | 36·5 | Nil | Nil | do | Yes |
| 3. | Sodium carbonate (7%) +sod. sulphite (3%)+ bisulphite (2%) Sample 1 | 35·5 | 18 | 12 | 32 | Yes |
| | Sample 2 | 36·0 | 20 | 14 | 30 | Yes |
| 4. | Ammonia (10%) Sample 1 | 22·0 | Nil | Nil | Very dark not comparable | No |
| | Sample 2 | 23·0 | Nil | Nil | do | No |
| 5. | Sodium hydroxide (10%) Sample 1 | 36·0 | 16 | Nil | Very dark not comparable | Yes |
| | Sample 2 | 38·0 | 16 | Nil | do | Yes |
| 6. | Sodium carbonate (7%) +sodium sulphite (3%) + sodium bisulphite (2%) + sodium hydroxide (2%) Sample 1 | 35·0 | 18 | 17 | 28 | Yes |
| | Sample 2 | 36·5 | 20 | 17 | 28 | Yes |

The sample at Sl nos. 1, 2 and 3 were tested for their life, flow and solubility in alcohol, after keeping for six months. None of them was found to possess any life and flow but were soluble in alcohol excepting Sl No. 2.

(A. K. Ghosh)

## 4.2 Rubber-Shellac Combinations

### 4.2.1 Incorporation of modified lacs into rubber

The work on the effect of incorporation of shellac and its zinc-salt into a blend of natural and styrene-butadiene rubbers (SBR) was continued. The mechanical properties such as mooney plasticity and scorch time in presence of shellac and its zinc-salt (gum stock) have been studied. In both the cases, mooney number was found to decrease while scorch time to increase (Table 45).

Further, the effect of the incorporation of zinc-salt of lac into a blend of NR and SBR in presence of China clay as a filler was studied. It was found that mooney number and scorch time of vulcanised stock increased. Resilience and flexing property of vulcanised samples were found constant up to 5 parts of Zn-salt of lac, but, thereafter, flexing property was found to decrease with the increased concentration of zinc salt (Table 46).

TABLE 45 — EFFECT OF INCORPORATION OF SHELLAC AND ITS Zn-SALT INTO A BLEND OF NR AND SBR IN GUM STOCK

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

| Shellac added per 100 parts of the blend | Mooney number (ML 1+4 at 120°C) | Scorch time (min-sec) |
|---|---|---|
| 0 | 26·5 | 20-00 |
| 5 | 24·0 | 39-19 |
| 10 | 23·0 | 39-20 |
| 20 | 22·0 | 43-13 |
| Zinc-salt added per 100 parts of the blend | | |
| 0 | 26·5 | 20-00 |
| 5 | 24·0 | 32-12 |
| 10 | 24·0 | 28-15 |

TABLE 46 — EFFECT OF INCORPORATION OF Zn-SALT OF LAC INTO A BLEND OF NR AND SBR USING CHINA CLAY AS A FILLER

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

| Zn-salt added per 100 parts of the blend | Mooney number (ML 1+4 at 120°C) | Scorch time (min-sec) | Resilience (%) | Flexing property (cracking started after thousand revolution) |
|---|---|---|---|---|
| 0 | 38·0 | 25-03 | 60·05 | 70 |
| 5 | 44·0 | 38-07 | 60·05 | 70 |
| 10 | 41·0 | 37-49 | — | 40 |
| 20 | 40·0 | 52-30 | — | 40 |

TABLE 47 — EFFECT OF INCORPORATION OF Mg-SALT OF LAC INTO A BLEND OF NR AND SBR

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

| Mg-salt of lac added per 100 parts of the blend | Optimum times of cure at 140°C (min) | Mooney No. (ML1+4 at 120°C) | Scorch time (min-sec.) | Modulus at elongation 200% (kg/cm²) | Ultimate elongation % | Tensile strength (kg/cm²) | Tear Resistance (kg/cm) | Impact resilience (%) | Hardness (shore A Durometre) |
|---|---|---|---|---|---|---|---|---|---|
| ACCELERATOR MBT, 1 PART PER HUNDRED PARTS OF THE BLEND | | | | | | | | | |
| 0 | 30 | 28·5 | 17-41 | 10·4 | 650 | 39·0 | 16·1 | 67·0 | 40 |
| 5 | 20 | 28·0 | 16-37 | 11·7 | 760 | 49·0 | 16·5 | 62·4 | 42 |
| 10 | 20 | 27·0 | 10-40 | 13·2 | 750 | 58·8 | 19·9 | 53·5 | 44 |
| 15 | 20 | 29·5 | 11-41 | 11·6 | 650 | 39·7 | 12·4 | 56·7 | 42 |
| 20 | 30 | 30·5 | 19-06 | 19·6 | 990 | 78·7 | 20·5 | 60·5 | 44 |
| ACCELERATOR CBS, 1 PART PER HUNDRED PART OF THE BLEND | | | | | | | | | |
| 0 | 20 | 40 | 27-24 | 7·7 | 470 | 16·2 | 15·7 | 79·9 | 44 |
| 5 | 20 | 21 | 38-45 | — | — | — | — | — | — |
| 10 | 20 | 33·0 | 30-08 | 12·3 | 560 | 30·0 | 19·2 | 70·5 | 45 |
| 15 | 30 | 25·0 | 28-27 | 12·4 | 600 | 37·8 | 18·8 | 68·8 | 46 |
| 20 | 30 | 29·0 | 39-26 | 11·3 | 780 | 51·1 | 21·4 | 62·0 | 46 |

Further, the effect of incorporation of Mg-salt of lac into a blend of NR and SBR using MBT and CBS as accelerators was studied. From the data (Table 47), it can be seen that by using MBT as the accelerator, optimum time of cure decreased when 5 to 15 parts of Mg-salt of lac were added, but with 20 parts, it was the same. In case of CBS (accelerator), it remained constant up to 10 parts of Mg-salt of lac, but at higher concentration it increased.

In the case of MBT, Mooney number and scorch time decreased up to 10 parts of magnesium salt of lac but thereafter, it increased. However, with CBS no definite trend was noticed.

Modulus increased with both the accelerators. Ultimate elongation, tear resistance and tensile strength increased with the Mg-salt of lac. The increase was maximum with 20 parts of magnesium salt of lac per hundred parts of the blend. Impact resilience decreased while the hardness increased.

(R. Singh and B. B. Khanna)

### 4.3 Use of Lac in Adhesives

#### 4.3.1 (ii) Modified lacs (with synthetic monomers) as adhesives

Two adhesive compositions based on bleached lac-hydrolysed lac-methylacrylate and bleached lac-hydrolysed lac-ethyl acrylate were developed last year for fixing sunmica to wooden surfaces. During the period under report, these compositions were prepared in larger quantities in the laboratory. The compositions were used for fixing sunmica on wooden surface (2′×2′ and 3′×1′) to know the effect of weather (rainy season) and impact etc. It was observed that up to ten months, both the surfaces remained intact and there was no adverse effect such as swelling and delamination.

Further, chemical combination of bleached lac with ethylacrylate was studied. For this purpose, bleached lac (10 g) and bleached hydrolysed lac (1 g) were dissolved in triethanolamine solution having *p*H 8·3 to 8·5 and to this, ethyl acrylate (11 g) was added and reaction was allowed to proceed in presence of potassium permanganate for 3·5 hr in inert atmosphere at room temperature. The whole mass was, thereafter, precipitated with dilute sulphuric acid, dried and weighed. The percentage conversion of the monomer was estimated to be 35·5 per cent. The product was soluble in hot alcohol or toluene and its mixture but was insoluble in cold toluene.

The above monomers are costlier as compared to vinyl acetate which is used in huge quantity for various surfaces. Therefore, attempts were made to co-polymerise bleached lac with vinyl acetate in different alkaline/acidic media such as ammonia, triethanolamine, sodium carbonate, borax and sodium bisulphite. But copolymerisation could not be affected presumably due to hydrolysis of the monomer. Subsequently, bleached lac was modified with methylmethacrylate and several compositions were prepared. The bond strength of the products was determined and found inferior compared to methyl and ethyl acrylate compositions. The adhesion between sunmica to wood and storage stability of the products were also very poor.

Another attempt to co-polymerise bleached lac with styrene was made but the bond strength was not satisfactory. Therefore, a mixture of styrene and ethyl acrylated was reacted with bleached lac and several compostions were prepared adopting the previous technique. The optimum proportion of styrene and ethylacrylate was found to be 1:3 in the above composition which had a bond strength of 0·25 ton/inch$^2$ over wood to wood surfaces and could be used for fixing sunmica to wood.

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

**4.3.4 Modified hydrolysed lac (with epoxy resin and isocyanates) as adhesives**

Work carried out last year had resulted in the introduction of one epoxy-group in total hydrolysed lac.

Further attempts were made to introduce more epoxy groups in total hydrolysed lac by refluxing its solution (20%) in dioxane with different molar ratios of sodium metal 1:1, 1:2, 1:3 and 1:4 respectively. The reaction products, thus obtained, were further refluxed in epichlorohydrin (1:4 w/w) for 16 hr.

The end products, thus obtained, were soft and sticky and none of them could be air dried as such. In order to cure them at low temperature, these were further treated with different amines and their mixtures. Of the amines tried, triethanolamine, triethanol tetraamine, hexa methylene tetra amine showed some encouraging results.

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

**4.4 Pilot Plant Studies on Lac-based Products and Processes**

**4.4.2 Standardization and pilot plant studies on shellac based water thinnable red oxide primers**

The process for the preparation of lac-linseed oil fatty acid glycerine based red oxide primer was scaled up 10 times (10 l.) and no difficulty was experienced during the preparation of the vehicle and the final primer composition.

(P. C. Gupta)

**Ad-hoc research**

*Shellac modified with toluene di-isocyanate as an adhesive*

Dewaxed lemon shellac was modified with different proportions of toluene diisocyanate (TDI 20 to 60% w/w) in dioxane at room temperature and bond strength of the order of 0·22 and 0·27 ton/sq inch was obtained on wood to wood and wood to mild steel surfaces respectively. The optimum amounts of TDI in case of wood to wood and wood to mild steel surfaces were 40 and 60 per cent respectively.

(P. C. Gupta)

## (c) RESEARCHES CONTEMPLATED

Nil

## E. EXTENSION DIVISION

## (a) RESEARCHES COMPLETED

### 5.2 Development of Shellac Bond Powder

The project was taken up with the object to develop the technology for the manufacture of shellac bond powder which is being imported at present for use in the manufacture of commutator segment and general purpose moulding micanite sheets. Initially, the sample of the imported bond powder supplied by M/S Bharat Heavy Electricals Ltd., Bhopal (BHEL) was tested for its various properties such as flow, heat polymerization time, hot alcohol insolubles, iodine value and particle size. Since ordinary shellac powder was found unsuitable, a modified lac obtained by precipitating an alkaline solution of seedlac with dil. Sulphuric acid was used. After several trials, a composition based on this modified lac mixed with rosin (15-25%) was found satisfactory. The process in brief is described below:

Seedlac is dissolved in aqueous alkali containing sodium carbonate, sodium sulphite and other chemical additives. The lac is then precipitated with dil. sulphuric acid. Both the dissolution and precipitation is carried out under suitable conditions to obtain the desired product. Rosin (15-25% w/w) is mixed with the product and the mixture allowed to melt at a temperature not exceeding 100°C. The molten mass is passed through rollers to obtain hard sheets which are then crushed in a disintegrator. The product is finally transferred to a Pascal type whizzer sieve and the powder with desired particle size is obtained. The final product should have a heat polymerization time within the range of 45-65 min. and particle size so as to pass almost entirely through 250 micro I.S. sieve but a minimum 80 per cent should be retained on 75 micron I.S. sieve.

The powder was subjected to laboratory evaluation and the micanite segments prepared using the powder as the bonding material were tested for heat stability and bond content at BHEL, Bhopal. It has been reported that the material passed the above tests satisfactorily.

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

## (b) RESEARCHES ON HAND

### 3.3.4.1: Studies on AC deposition of shellac based paints

It was reported earlier that the thickness of the films deposited from pigmented vehicles of lac based paints was 0·5-0·8 mil on the outer surfaces and 0·3-0·5 mil on the inner surfaces of the steel panels. During the period under report, the above coated panels were exposed to highly humid condition in the laboratory along with control (undeposited panel). It was noticed that the control panel was heavily rusted whereas no corrosion was noticed on the outer surface of the coated panel and only slight corrosion was noticed on the inner side of the panel. To increase the film thickness for better corrosion resistance, it was planned to deposit films from emulsions having different shellac/rubber ratios, by changing pigment/binder ratio, bath concentration, *p*H etc. However while preparing fresh emulsions with increasing shellac proportions, shellac proportion could not be increased beyond a ratio 5:1 (shellac: rubber) as coagulation took place during mixing of the two solutions. This observation was contradictory to the results obtained earlier and was suspected to be due to old chlorinated rubber. Deposition from unpigmented and pigmented (with titanium dioxide) vehicles having 5:1 (shellac: rubber) ratio was tried but instead of deposition, dissolution was noticed. The dissolution during the passage of the current could not be stopped even by increasing bath *p*H and decreasing bath concentration. Only with increase in current density, the deposition was noticed from unpigmented vehicle showing high delay period as well as longer deposition time. The films, so obtained, were non-uniform compared to those obtained earlier.

On receipt of fresh chlorinated rubber, preparation of emulsion was tried but the same difficulty was experienced. However, a good emulsion based on shellac/chlorinated rubber was prepared by adding small quantity of linseed oil fatty acids. The emulsion, thus prepared, did not break even on heating for short period or, diluting with water. On adding more shellac solution, no coagulation was noticed.

(A. Pandey and S. K. Saha)

### 5.3 Effect of storage on sticklac

The storage experiments were continued with the following 6 sticklac samples:

1. *Baisakhi* 1977-78 *ari* sticklac (Palamau)
2. *Baisakhi* 1977-78 *ari* sticklac (Ranchi)
3. *Baisakhi* 1978-79 *ari* sticklac (Purulia)
4. *Baisakhi* 1979-80 *ari* sticklac (Palamau)
5. *Aghani* 1979-80 sticklac (Ranchi)
6. *Baisakhi* 1980-81 *ari* sticklac (Ranchi)

Of these, the first two samples had been kept stored for a period of 4½ years, the third sample for 3½ years, the fourth and fifth samples for 2½ years and the last sample for 1½ years. The extent of deterioration in respect of flow, life, impurities (hot alcohol insolubles), colour and rate of filtration of the seedlac samples obtained from the stored sticklacs washed at intervals of 6 months was studied in all the cases. Simultaneously, the seedlac samples obtained from the first washings were also stored and tested at the same intervals.

TABLE 48 — EFFECT OF STORAGE ON STICKLAC AND SEEDLAC

| | Type of sticklac | Period of storage (yrs) | Nature of the samples stored | Impurities (%) | Life under heat (min) | Flow (mm) |
|---|---|---|---|---|---|---|
| 1. | *Baisakhi* 1977-78 (Palamau) | 4½ | Sticklac | 6·14 | 40 | 10 |
| | | | Seedlac | 3·76 | 40 | 10 |
| 2. | *Baisakhi* 1977-78 (Ranchi) | 4½ | Sticklac | 4·82 | 37 | 14 |
| | | | Seedlac | 4·41 | 38 | 12 |
| 3. | *Baisakhi* 1978-79 (Purulia) | 3½ | Sticklac | 5·09 | 40 | 24 |
| | | | Seedlac | 4·32 | 41 | 20 |
| 4. | *Baisakhi* 1979-80 (Palamau) | 2½ | Sticklac | — | 47 | 27 |
| | | | Seedlac | — | 43 | 25 |
| 5. | *Aghani* 1979-80 (Ranchi) | 2½ | Sticklac | — | 52 | 36 |
| | | | Seedlac | — | 51 | 33 |

It has been found that storage in sticklac form has a slight advantage over the storage in seedlac form. As regards changes in flow and life of different samples after a period of 2½-4½ year, the data is shown in Table 48. The increase in impurities was, however, significantly higher when stored in sticklac form.

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

### 5.4 Studies on the Problems of Handmade Shellac Manufacturing Units and Their Possible Remedial Measures — Purulia District

The study was undertaken to investigate the problems of handmade shellac manufacturing units and to examine the feasiblity of mechanization of these units as a remedial measure. During the period, extensive door to door survey of all the handmade shellac manufacturing units at Balarampur, Jhalda and Tulin in Purulia District was conducted. A preliminary analysis of the data revealed that:

(i) The handmade shellac manufacturers are facing difficulties due to unfavourable market and non-availability of finance and other credit facilities.

(ii) Most of the small scale manufacturers favour mechanization of their individual units with assistance from the Government. They are against formation of any cooperatives.

(iii) The future of handmade shellac is not as bleak as is being projected. The demand for button lac is on the increase which is an encouraging factor.

(iv) There is a general feeling among the handmade shellac manufacturers that some manufacturers-cum-exporters are adopting questionable tactics to discredit handmade shellac.

(A. Arya and S. K. Saha)

**Ad-hoc Problem**

*Standardization of method for determining the colour index of kiri*

In a recent meeting of the CDC-9 of the Indian Standards Institution, it was decided that ILRI should suggest the minimum colour values for handmade and machine made *kiri* so that the same may be included in the standard specifications for *kiri*. It was found, however, that the prescribed method for determination of colour index of seedlac and shellac is not applicable to *kiri* and the same needs modification. The work was taken up accordingly and of the several methods, tried, the following appeared to be satisfactory.

Powder the samples to pass through 425 micron I.S. sieve and prepare a 10 per cent solution (based on the resin content as determined by the method prescribed in I.S.: 6921-1973 for hot alcohol insolubles) by dissolving in calculated quantity of alcohol. Allow to stand for 16 to 24 hr and note the volume. Heat the solution slowly for one hr on a sand bath. After cooling, measure the volume again and make up the loss of solvent, if any, by adding alcohol. Filter the solution through a medium grade filter paper in an ordinary funnel, keeping it covered. Discard first 15 ml of the filtrate and then collect 5 ml of the clear for the test.

Transfer 5 ml of the filtrate to a thin walled colour tube (200×13 mm) by means of a pipette. Take 5 ml of the standard iodine solution (0·005 N) and compare the colour of the two solutions by holding the colour tubes against light with a piece of moistened filter paper. Add alcohol from a burette to the sample solution with shaking until the colour is the same as that of the standard iodine solution.

*Calculation*

The volume in ml. of alcohol added plus 5 or the total volume in ml of the sample solution after dilution is the colour index of the sample.

Following the above method, the colour indices for handmade and machine made *kiri* were found to be 22 and 28 respectively.

(L. C. Mishra and S. K. Saha)

## (c) SPONSORED RESEARCH

*Commercial feasibility studies on storage of sticklac and seedlac*

The study was taken up in March 1979 and was continued with 8 sticklac and 2 seedlac samples stored under different conditions. During the period under report, the storage studies on sticklac were concluded after carrying out the experiments for 30 months.

The storage experiments with the seedlac samples were, however, continued. The effect of storage on hot alcohol insolubles, colour, flow, heat polymerization time and rate of filtration are shown in Tables 49 and 50. It may be seen from the

TABLE 49 — EFFECT OF STORAGE ON SEEDLAC (*Baisakhi* 1979 SEEDLAC)

| Period of storage (months) | Condition of storage | Hot alcohol insol. (%) | Colour index | Flow (mm) | Life under heat (min) | Rate of filtration at 25°C (ml) |
|---|---|---|---|---|---|---|
| 0 | — | 3·12 | 12 | 48 | 49 | — |
| 6 | A.C. | 3·73 | 13 | 49 | 49 | — |
| 6 | Ordy (Ranchi) | 3·70 | 13 | 49 | 49 | — |
| 9 | A.C. | 3·91 | 13 | 45 | 53 | — |
| 9 | Ordy (Ranchi) | 3·20 | 11 | 45 | 50 | 68 |
| 12 | A.C. | 3·35 | 11 | 38 | 50 | 64 |
| 12 | Ordy (Ranchi) | 3·50 | 11 | 45 | 55 | 69 |
| 15 | A.C. | 3·56 | 11 | 47 | 52 | 59 |
| 15 | Ordy (Ranchi) | 3·85 | 10 | 42 | 50 | 70 |
| 21 | A.C. | 3·60 | 11 | 44 | 53 | 69 |
| 21 | Ordy (Ranchi) | 3·48 | 11 | 35 | 52 | 61 |
| 33 | A.C. | 3·90 | 12 | 46 | 57 | 61 |
| 30 | Ordy (Ranchi) | 4·68 | 11 | 35 | 49 | 47 |
| 42 | Ordy (Ranchi) | 4·83 | 11 | 22 | 45 | 38 |
| 45 | A.C. | 4·00 | 12 | 50 | 55 | 53 |

TABLE 50 — EFFECT OF STORAGE ON SEEDLAC (*Baisakhi* 1980 SEEDLAC)

| Period of storages (months) | Condition of storage | Hot alcohol insol. (%) | Colour | Flow (mm) | Life under heat (min) | Rate of filtration at 25°C (ml) |
|---|---|---|---|---|---|---|
| 0 | — | 3·9 | 11 | 64 | — | — |
| 9 | Ordy (Cal.) | 3·79 | 12 | 50 | 55 | 67 |
| 9 | A.C. | 3·65 | 11 | 62 | 60 | 73 |
| 10 | Ordy (Ranchi) | 3·46 | 11 | 54 | 48 | 63 |
| 13 | Ordy (Cal.) | 3·38 | 12 | 44 | 56 | 70 |
| 13 | A.C. | 3·32 | 10 | 63 | 58 | 76 |
| 12 | Ordy (Ranchi) | 3·50 | 11 | 48 | 56 | — |
| 20 | Ordy (Cal.) | 3·64 | 12 | 35 | 48 | 54 |
| 20 | A.C. | 3·64 | 12 | 58 | 58 | 64 |
| 20 | Ordy (Ranchi) | 3·83 | 13 | 30 | 47 | — |
| 32 | Ordy (Cal.) | 5·46 | 13 | 10 | 39 | 30 |
| 32 | A.C. | 3·84 | 12 | 58 | 56 | 58 |
| 32 | Ordy (Ranchi) | 3·50 | 13 | 30 | 44 | 47 |

tables that the quality deterioration (specially flow) of the seedlac samples is only marginal in case of samples stored in the air-conditioned godown but very significant in respect of samples which were stored under ordinary conditions at Calcutta and Ranchi.

(S. K. Saha)

## (d) RESEARCHES CONTEMPLATED

Nil

# 3. EXTENSION

The principal activities of the Extension Division were as follows:

(1) Large scale cultivation of lac at Kundri
(2) Technical services and development work
(3) Publicity
(4) Testing of lac and lac products
(5) Training
(6) Production and sale of special shellacs in the production unit

(1) *Large-scale cultivation of lac at Kundri*

Technical assistance was rendered as usual to the Bihar Forest Department for lac production at *Kundri* Lac Orchard having a total of about 40,000 *palas* trees. The yearwise information with regard to the number of trees utilised, amount of broodlac used, yield of sticklac and expenditure incurred is given below:

| Year | No. of trees utilized | Brood lac used (kg) | Yield (kg) | | Expenditure (Rs) |
|---|---|---|---|---|---|
| | | | Brood lac | Stick lac | |
| 1981 | 36521 | 7517 | 7930 | 3511 | 14875.60 |
| 1982 | 33354 | 5823 | 5893 | 4453 | 13663.90 |

(2) *Technical service and development work*

The important activities are reported below:

(i) Fiftythree crop samples received from various lac farms were examined either for forecasting of larval emergence or ascertaining the causes of insect mortality.

(ii) Technical enquiries regarding lac cultivation received from various States were attended.

(iii) Samples of lac insects, parasites, predators, lac/lac products were supplied to Universities and Research Institutes for their research work.

(iv) Samples of water-thinned shellac based red-oxide primer were supplied to one private entrepreneur and one leading paint manufacturer for evaluation. The reports are awaited.

(v) A leading rubber industry has been assisted in their R & D work on use of shellac in rubber industry.

(vi) A well known firm was assisted in starting the manufacture of aleuritic acid.

(vii) Samples of lac based glue were supplied to six interested entrepreneurs for their trial. The report is awaited.

(viii) Samples of empire sleevings received from Dy Manager (E.L.) Govt. of Pondichery were examined and suggestions to improve the quality were sent.

(ix) Samples of gasket-shellac compound sent by entrepreneurs were evaluated and necessary suggestions to improve the product were made.

(x) Technical notes, schemes, copies of the published papers and folders were supplied to the interested parties whenever asked for. In addition to the above, formulations for bulb capping cement, were also supplied.

(3) *Publicity*

The Division participated in the following Kisan melas/Exhibitions:

(i) Rabi and Kharif Kisan melas held at Birsa Agricultural University, Ranchi during 1981 and 1982.

(ii) National Agricultural Fair held at Calcutta in 1982.

(iii) Exhibition organised by the Directorate of Lac Development at Bhubaneswar in 1982.

(iv) Kisan mela organised on the occasion of the inauguration of Birsa Agricultural University, Ranchi in June, 1981.

(v) Kisan mela held at Divyayan Krishi Vigyan Kendra, Getalsud, Ranchi in 1981.

(vi) Annual Exhibition at Chakradharpur during October, 1981.

Exhibits, charts and photographs were also sent for display at London Trade Fair — 1982 and International Trade Fair held at Delhi during 1981 and 1982. Use of water soluble lac for coating earthenwares was demonstrated to the villagers under the Operational Research Project of the Institute.

An Industrial Liaison Committee of the Institute was constituted by the Director General, ICAR during the period under report. The first meeting was held in November, 1982 and was well attended and proved very useful.

(4) *Testing of Lac and Lac Products*

Test reports for 501 samples of seedlac, shellac and sealing wax, comprising 1600 tests were issued from the Division.

(5) *Training*

*Improved Methods of Lac Cultivation (Regular Course)*

Four regular certificate courses of six month duration were conducted during the period and in all 21 trainees completed their training successfully. Another batch of three candidates was admitted to the course beginning in October, 1982 and their training is in progress.

*Industrial Uses of Lac (Regular Course)*

Three private candidates were admitted to the regular 3-month certificate course on "Industrial Uses of Lac" commencing November, 1981 and all of them completed their training successfully.

*Short Term Courses*

A short term introductory training in Lac Cultivation Practices was arranged for a nominee of the Directorate of Lac Development, Ranchi. Besides, 3 short term courses on manufacture and testing of gasket shellac compound, processing of lac and testing of lac were arranged for 3 nominees of lac manufacturing/ consuming industries. Short course training in the manufacture of hydrolysed lac and Rebulac was also arranged for two entrepreneurs seeking establishment of lac based industry.

Demonstration of the method for the preparation of aleuritic acid was arranged for 2 candidates sponsored by the industry. Besides, the manufacture of bleached lac was also demonstrated to 4 interested entrepreneurs.

(6) *Production Unit*

The production unit of the Institute continued to function as usual. The following items were manufactured and sold to the interested purchasers/consumers. In addition, all sale enquiries were also attended by the unit.

| Sl No. | Materials | Quantity (kg) | Value (Rs) |
|---|---|---|---|
| 1. | DXO-grade water soluble lac | 144·00 | 5997.00 |
| 2. | DXG-grade water soluble lac | 103·50 | 2560.30 |
| 3. | BHL-grade hydrolysed lac | 21·00 | 661.50 |
| 4. | BOL-grade hydrolysed lacs | 20·05 | 380.95 |
| | Total | 288·55 | 9599.75 |

# 4. PAPERS PUBLISHED

## (a) 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 t982 is given bellow

| | |
|---|---|
| 1. *Bulletins* | |
| (i) Chemical | 157 |
| (ii) Entomological | 95 |
| 2. *Technical notes* | 30 |
| 3. *Research notes* | |
| (i) Chemical | 85 |
| (ii) Entomological | 52 |
| 4. *Miscellaneous technical publications* | |
| (i) Physico-chemical | 25 |
| (ii) Entomological | 48 |
| 5. *Books and Monographs* | 14 |
| 6. *Pamphlets and leaflets* | 29 |

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 years 1981 and 82**

| Sl No. | Authors | Title of paper | Name of Journal |
|---|---|---|---|
| | | **ENTOMOLOGY DIVISION** | |
| 1. | Malhotra, C. P. | Strategies of the lac insect complex and management of its pest | *Proc. Seminar on Strategies of Pest Management* (Abst.), Entomological Society of India, I.A.R.I., New Delhi, 1981 |
| 2. | Malhotra, C. P. | Control of Pest of lac insect, *K. lacca* (Kerr.) for easy adoption by cultivators | *Seminar on Production and Augmenting internal consumption of lac* held at Bhubaneswar during 1982 |
| 3. | Sah, B. N. | Bionomics of *Hyposidra* successaria Walker, a Pest of *Moghania macrophylla* (Willd.) O. Ktze | *Proc. Indian Sci. Cong.* (68th Session) 1981 |

| | | | |
|---|---|---|---|
| 4. | Sah, B. N. | Bionomics of *Spodoptera lithra* (Fabr.) (Lepidopetera, Noctuidea) under Laboratory Condition | *Proc. Indian Sci. Cong.* 68th Session) (Abst.): 69, 1981 |
| 5. | Srivastava, D. C. | *Palas tatha ber* Par Lakh Ki Sammilit Kheti Ki ek Unnat Pranali (In Hindi) | *ILRI Extension Pamphlet*, 1981 |
| 6. | Teotia, T. P. S. and Mishra, R. C. | Development of tribal economy through the introduction of Scientific Management of lac cultivation | Presented in a Seminar held at the University of Udaipur, 1981 |

## AGRONOMY AND PLANT GENETICS DIVISION

| | | | |
|---|---|---|---|
| 1. | Purkayastha, B. K. and Kumar, P. | Effect of foliage treatment of Gibberellic Aicd on lac host plants | *Agric. Sci. Digest* **1**(i): 27-28, 1981 |
| 2. | Purkayastha, B. K., Singh, B. P. and Ram, Moti | Inter-cropping of tuber and rhizome crops within mixed plantation of young lac hosts, *Albizzia lucida*, and *Moghania macrophylla* | *Ind. J. Agric. Sci.*, **57**(8): 574-6, 1981 |
| 3. | Srivastava, S. C. and Kumar, P. | Floral biology of *bhalia*, *Moghania macrophylla* (Willd.) O. Ktze | *Indian J. Forestry*, **5**(4), 265-270, 1982 |

## CHEMISTRY DIVISION

| | | | |
|---|---|---|---|
| 1. | Goswami, D. N., Prasad, N. and Das, R. N. | Spectrophotometric studies on shellac — Relation between optical density and colour index | *J. Oil. Col. Chem. Assoc.*, **64**, 20-24, 1981 |
| 2. | Mukherjee, M., Goswami, D.N. and Kumar Shravan | An improved baking type insulating shellac varnish | *Res. and Ind.*, **26**, 217-19, 1981 |
| 3. | Prasad, N. and Khanna, B. B. | Estimation of shellac | *J. Oil. Col. Chem. Assoc.*, **64**, 234-236, 1981 |
| 4. | Agarwal, S. C. and Majee R. N. | Aleuritic acid — an attractive raw material | *Indian Perfumer*, **25**(314), 20-24, 1981 |
| 5. | Banerjee, P. K., Srivastava, B.C. and Kumar, Shravan | Cohesive-energy density of shellac | *Polymer*, **23**(3), 517-21, 1982 |
| 6. | Banerjee, P. K., Srivastava, B.C. and Kumar, Shravan | Shellac-solvent interaction parameter | *Polymer*, **23**(7), 1244-45, 1982 |
| 7. | Dasgupta, A. K., Kumar, Shravan and Chatterjea, J. N. | Water-thinned shellac paints for internal decoration | *Jr. Col. Soc.*, **21**(2), 37, 1982 |
| 8. | Goswami, D. N. | The dielectric behaviour of the natural resins mestic and damur | *J. Oil. Col. Chem. Assoc.*, **65**, 178-181, 1982 |
| 9. | Goswami, D. N. | Effect of plasticizers on the breakdown strength of air drying shellac varnishes | *Res. and Ind.*, **27**, 156-157, 1982 |
| 10. | Goswami, D. N. and Prasad, N. | Spectrophotometric studies on hard and soft lac resin | *J. Oil. Col. Chem. Assoc.*, **65**, 223-26, 1982 |
| 11. | Mukherjee, M. and Kumar, Shravan | Surface coatings based on lac-linseed oil combinations | *PaintIndia*, **32**(4), 3-6, 1982 |
| 12. | Mukherjee, M. and Kumar, Shravan | Shellac emulsion paint for Interior Decoration | *Res. and Ind.*, **27**(9), 1982 |
| 13. | Prasad, N., Agarwal, S. C., Chatterjea, J. N. and Sengupta, S. C. | Free acids in lac resin | *J. Ind. Chem. Soc.*, **LIX**, 963-694, 1982 |
| 14. | Srivastava, B. C. and Kumar, P. | Medicinal potentials of some Indian lac host plants | *Eastern Pharmacist*, **25**, (297), 47-51, 1982 |

| | | | |
|---|---|---|---|
| 15. | Kumar, Shravan | Promotion of lac based industries for augmenting internal consumption of lac | *Proc. Seminar on production and augmenting internal consumption of lac*, at Bhubaneswar, 1982 |
| 16. | Kumar, Shravan | An improved baking type insulating varnish | *ILRI Extension Pamphlet*, 1981 |
| 17. | Kumar, Shravan | Melfolac — a heat and water proof shellac varnish | *ILRI Extension Pamphlet*, 1981 |
| 18. | Srivastava, B. C. | Slow release lac coated urea fertilizer | *ILRI Extension Pamphlet* 1981 |

## TECHNOLOGY DIVISION

| | | | |
|---|---|---|---|
| 1. | Prasad, R., Islam, M. and Gupta, P. C. | Lac based adhesive glue for paper | *Res. and Ind.*, **26**(12), 244-45, 1981 |
| 2. | Singh, R. and Khanna, B. B. | Shellac as a compounding ingredient for SBR, NR and blend of two rubbers | *11th Rubber Conf. IRMRA Bombay*, 287-90, 1981 |
| 3. | Banerjee, R. K. and Sengupta, S. C. | Modification of totally hydrolysed lac; uses of rebulac in water thinnable paints and primers | *Pigment and Resin Tech.*, **11**(9), 10-12, 1982 |
| 4. | Islam, M., Ghosh, P. K. and Gupta, P. C. | Effect of adhesion promotors on the adhesion property of shellac over metal to metal surfaces | *Res. and Ind.*, **27**(6), 178-180, 1982 |

## EXTENSION DIVISION

| | | | |
|---|---|---|---|
| 1. | Saha, S. K. and Teotia, T. P. S. | Research at ILRI | Indian Shellac, Special Issue, March 20-24. 1982 |

# 5. CONFERENCES AND SYMPOSIA

The Institute has been deputing scientists to attend conferences/symposia/seminars and training held at various institutions/organizations/universities in India. The details for the period under report are as follows:

## ENTOMOLOGY DIVISION

| | |
|---|---|
| 1. Dr C. P. Malhotra, S-2<br>Dec. 1981 | Seminar on "Strategies of Pest Management"; I.A.R.I., New Delhi |
| 2. Dr C. P. Malhotra, S-2<br>7-8 Dec. 1982 | Seminar on "Production and augmenting of lac", Bhubaneshwar, organized by Directorate of Lac Development, Ranchi |
| 3. Sri B. N. Sah, S-1<br>Jan. 1981 | Sixty-eighth session of Indian Science Congress, 1981 |
| 4. Sri A. Bhattacharya, S-1<br>11 May-9 June 1982 | Summer Institute on "Principles and Concepts of Integrated Pest Management", I.A.R.I., New Delhi |
| 5. Sri R. C. Mishra, S-2<br>20 May-18 June 1981 | Summer Institute on "Tribal Culture and Development", Udaipur University, organized by ICAR |
| 6. Sri R. C. Mishra<br>8-11 Feb. 1982 | "Second Work shop of All India Coordinated Project on Tribal Area Research", Saputara (Surat) |
| 7. Sri R. C. Mishra,<br>12-14 May 1982 | "National Seminar on the role of Universities and Colleges in planning, continuing education for tribals" held at Ukai, Gujarat in Collaboration with South Gujarat University, Surat |

## CHEMISTRY DIVISION

| | |
|---|---|
| 1. Dr B. B. Khanna, S-3<br>26-28 Nov. 1981 | "Eleventh Rubber Conference" Bombay, organized by Indian Rubber Manufacturers Research Association |
| 2. Dr B. B. Khanna, S-3<br>17-18 Sept. 1982 | "A Get-together" of Entrepreneurs and Scientists" Patna, organized by N.R.D.C., C.S.I.R. and Industries Dept., Bihar |

| | |
|---|---|
| 3. Dr S. C. Agarwal, S-2<br>29-31 March 1981 | " Seminar and Instrument show on modern methods of analysis ", Indian Association for Cultivation of Science, Jadavpur, organized by Perkin-Elmer U.S.A. and and M/s Blue star Ltd., Calcutta |
| 4. Sri S. Kumar, S-3<br>17-18 Sept. 1982 | " A Get-gogether " of Entrepreneurs and Scientists ", Patna, organized by N.R.D.C., C.S.I.R. and Industries Dept., Bihar |
| 5. Dr D. N. Goswami, S-1<br>17-18 Sept. 1982 | do |
| 6. Dr B. C. Srivastava, S-1<br>11 Aug.-3 Sept. 1981 | National Seminar on " Current Thrusts in Soil and Fertilizer Research in relation to Crop Production " at I.A.R.I., New Delhi |
| 7. Dr N. Prasad, S-1<br>29-31 March 1981 | Seminar and Instrument show on UV-visible and IR-spectrophotometers at Indian Association for Cultivation of Science, Jadavpur, Calcutta organized by M/s Perkin-Elmer, U.S.A. and M/s Blue Star Ltd., Calcutta |
| 8. Sri A. K. Dasgupta, S-1<br>25-27 March 1982 | Symposium on ' New Developments in Surface Coatings and Printing inks " Bombay |

## TECHNOLOGY DIVISION

| | |
|---|---|
| 1. Dr P. C. Gupta, S-2<br>17-18 Sept. 1982 | " A Get-together of Entrepreneurs and Scientists ", Patna, organized by N.R.D.C., C.S.I.R. and Industries Dept., Bihar |

# 6. SUMMARY

## A. ENTOMOLOGY DIVISION

### (a) RESEARCHES COMPLETED

**1.3.5 (a)** Two new practices for lac cultivation on *kusum* were tried which, however, did not show any improvement on the 4-*coupe* system developed earlier.

**1.5.5** Cytological studies of lac insects have confirmed a 'Lecanoid' system of chromosome behaviour in *K. lacca.*

### (b) RESEARCHES ON HAND

**1.1.8** *Rangeeni* lac cultivation trials using *khair* in alternation with *palas* showed that the crop was better on *khair* than on *palas* in the *katki* season.

**1.2.5** The lac insects reared on transplanted potted *bhalia* plants, raised with and without the application of fertilizers, suffered heavy mortality except on those raised with N, P and K.

**1.2.6** Three fractions were obtained from the lipoids extracted from *rangeeni* lac insect crawlers, the physical characteristics of which were studied.

**1.2.7** Scanning electron microscopic studies of the female lac insect have revealed interesting ultrastructural details.

**1.2.8** Studies made with the water-soluble lac dye (laccaic acid) as a biological stain have given encouraging results.

**1.3.5 (b)** A number of plant species were tried as alternative *kusmi* lac host. The results, however, were not encouraging.

**1.3.5 (d)** The crop performance of *kusmi* brood lacs originating from different states is being compared.

**1.3.8** The population trend, key mortality factors and stages were studied in *rangeeni* lac insect population. Sampling considerations showed that inter-tree differences were more important than the intra-tree differences.

**1.3.9** Studies on the pattern of lac insect larval settlement showed that this is influenced by the inclination of the shoot.

**1.3.10** The abundance of lac associated insects was studied in six locations of Chotanagpur. Preliminary results have shown interesting locational differences.

**1.4.1.2** A field experiment has been initiated for the integration of the three pest-control measures developed earlier.

**1.4.3 (i)** Ten insecticides were screened for their safety to lac insect. Some of these were found safe, but their safety differed with the lac insect age and the crop.

**1.4.3 (ii)** Experiments were continued to determine the safety levels of certain plant poisons to the lac insect.

**1.4.3 (iii)** Screening trials against three inimical parasites of lac insects have shown that of the five insecticides tried, BHC was the most effective against all of them.

**1.4.3 (iv)** The use of recommended lac pest control schdule has resulted in marked reduction of lac insect predators.

**1.4.3 (v)** Very low concentrations of Thiodan$^{R}$ were found to improve the size of both male and female lac insects.

**1.4.4** Screening of the larvae of major lac insect predators did not show the presence of any disease.

**1.4.10** Nine insecticides were screened against two species of *Chrysopa*, predatory on lac insects under laboratory conditions. BHC was the most effective against *C. medestes* and Ekalux against *C. lacciperda.*

Under field trials with BHC, Ekalux and chlordane, Ekalux was highly toxic to lac insects, of the other two, BHC was more effective than chlordane against *Chrysopa* spp.

**1.4.12** For the biological control of major lac insect predators, attempts were made to mass breed *apanteles techardiae* and *Bracon greeni* on an alternative laboratory host. Success, however, could be achieved only with the former.

**1.4.13** Manual infestation of lac insect populations with varying densities of the predatory larvae of *Eublemma amabilis* has shown that densities lower than 4 larvae per 30 cm lac encrustation do not cause any economic injury.

**1.5.8** Twelve genetic stocks of lac insect were maintained.

**1.5.10** The sex ratio was further studied in individual progenies of *rangeeni* lac insects. The results have shown that major gene effective could possibly be involved for the occurrence of the all-male progeny.

**1.5.11** Cyto-taxonomic studies on lac insect were initiated.

## B. AGRONOMY AND PLANT GENETICS DIVISION

### RESEARCHES COMPLETED

**2.2.1** Spraying of plant growth regulators on *bhalia* (*M. macrophylla*) and *M. chappar* had no effect on the time of their flowering.

*M. chappar* plant were exposed to varying photo periods which, however, did not effect the time of their flowering. Varying the time of seed, sowing with and without the use of plant growth regulators also did not effect the time of flowering in *M. macrophylla.*

Both pinching and topping (3 to 4 times) were effective in delaying the flowering time in *M. macrophylla* for coinciding it with that of *M. chappar.*

### RESEARCHES ON HAND

**2.1.2** In *M. macrophylla*, the system of planting has no significant effect on the total shoot length per plant. The double hedge system accommodating the largest number of plants gave the highest sticklac yield.

**2.1.3** Four fodder grasses were grown as intercrops in between the spaces of *bhalia* and *galwang*. Dinanath gave the highest forage yield per ha. Growing of intercrops in between the spaces of *bhalia* and *galwang* have shown marked improvement in plant attributes and lac yield. The highest gross income per ha was obtained from lac with ginger+sweet potato as intercrop. Of the four intercrops raised in between the spaces of *palas*, *dinanath+turmeric* gave the highest gross income.

**2.1.4** The effect of plant growth regulators was studied on *ber*. The results for total shoot lenght and sticklac yield differed in the two *baisakhi* seasons. The effect of plant growth regulators was also studied on *kusum*. The average shoot length and basal diametre were maximum with $GA_3$ and urea in both the years.

**2.1.6** The use of lac mud as manure for raising wheat and paddy has resulted in marked improvement of their yield. The effect of lac mud, FYM and NPK individually and in combination, was studied on the yield of wheat followed by paddy. The grain yield was the highest with lac mud in combination with NPK.

**2.1.7** A field experiment was initiated to work out suitable management practices for raising plantation of monoecious variety *putri*.

**2.1.8** It was observed that the lac yield per plant was higher when only lac crop was taken as against the minimum when lac and tasar both were taken.

**2.1.9** The air layer (1000 nos.) of proven *kusum* trees were prepared with the help of mixtures of IAA+IBA and sphagnum moss. Of these, 162 produced rootage which were later transplanted in the field.

**2.1.10** *Kusmi* lac cultivation was continued on a mix plantation of *bhalia* and *galwang* bushes during *aghani* and *jethwi* crops at Chandwa Farm.

**2.2.1** Attemps were continued to Cross *M. macrophylla* with *M. chappar*.

**2.2.2** Selection studies were continued for improving lac yield potential of *bhalia*.

**2.2.3** Screening trials were continued with *arhar* varieties/cultivars for lac and seed production.

**2.2.4** Mutation studies were continued in *arhar* for improving lac and seed production but could not be carried out due to sterility mosaic disease.

**2.2.5** Studies were undertaken to induce polyploidy in *ber* seedlings for improving lac production. It was found that survival percentage decreased with the increase in the dose of *colchicine*.

## C. CHEMISTRY DIVISION

### (a) RESEARCHES COMPLETED

**3.1.7** The study revealed that the resin samples recovered from the byproducts of *kusmi* strain obtained during refining of *kusmi* and *rangeeni* sticklacs, differ in almost all the physico-chemical properties. The conductivity, dissipation factor, optical density and colour index of all the samples were found to be on the higher side as compared to parent seedlac and shellac while dielectric strength and other chemical constants were found to be on the lower side.

**3.3.3 (i)** A cation exchange resin based on shellac was prepared. The resin had good ion exchange capacity and thermal stability but showed colour throw and low rate of exchange.

**3.3.6** Shellac/hydrolysed lac was reacted with ethylene glycol and dicarboxylic acids such as adipic, phthalic and terephthalic or maleic anhydride to give polyesters through chain extension. The polyesters were characterized by finding their acid and hydroxyl values and solubility in various solvents.

The polyesters were further reacted with toluene diisocyanate (TDI) to give polyurethanes whose film properties were studied. The performance of lac-ethylene glycoladipic acid and hydrolysed lac-ethylene glycol-terephthalic acid based polyurethanes was the best. Incorporation of 30 per cent TDI was found optimum to bring about the crosslinking. The air dried films showed good flexibility and water and acid resistance but had poor alkali resistance which however improved on baking the films.

The composition based on hydrolysed lac-ethylene glycol-adipic acid treated with Desmodur N gave best properties and even air dried films could resist the action of water, acid and alkali.

**3.3.9** The compositions, based on the modification of lac with unsaturated acids viz., maleic, acrylic and crotonic acids, were prepared by carrying out the reaction in presence of benzoyl peroxide as a catalyst. It was observed that the modification carried out in presence of catalyst improve the adhesive strength and most of the surface coating properties. The IR spectrum of the compositions further supported that the desired reaction has taken place in all modifications.

**3.4.1** An improved lac-linseed oil varnish has been prepared by reacting shellac (DL) with double boiled linseed oil (60:100) in the presence of litharge. This varnish possesses very good drying characteristics and produces hard, smooth, flexible and glossy films which are resistant to water and aromatic hydrocarbon solvents. Baked films of this varnish possess high break down strength of the order of 2·1 kV/mil and many other desirable properties of a baking type insulating varnish. This varnish in conjunction with hiding and tinting pigments produce decorative paints which can be used as general purpose paints for painting wood and metal articles.

**3.5.1** Shellac as such and in the form of hydrosol has been successfully used as a wall material for encapsulation of powdered and granular pesticides by the physical process of micro-encapsulation based on complex *p*H-coacervation and simple coacervation and mechanical process of macro-encapsulation based on pan-method.

Lac-encapsulated pesticides, so developed, have been found to be free-flowing, having uniform wall and practically no odour of the core pesticides and showed satisfactory wettability. It was observed that the micro-encapsulation process did not adversely affect the spores viability of the microbial insecticides. The palatability trials carried out on rodents have shown that shellac may be used as a wall material for the preparation of encapsulated rodenticide formulations.

**3.6.2** Studies on the curing between shellac and melamine resin and also between shellac and epoxy resin in the cold have revealed that the measurement of dissipation factor with time can be used as a convenient method for the determination of cure-time of shellac and the above mentioned synthetic resin blends.

The products obtained after curing of shellac and epoxy resin 70:30 and bhatta shellac and epoxy resin 50:50 when dissolved in appropriate solvents may be used as general purpose air-drying insulating varnish.

## (b) RESEARCHES ON HAND

**3.1.1** The ester component from Fr. A of lac wax has been found to consist of straight chain $C_{38}$ acid and $C_{36}$ alcohol. The B-2-1 Fr. has been identified as $C_{32}$ straight chain alcohol and B-2-2 Fr., a $C_{27}$ hydrocarbon.

Some physical characteristics like wax content, free acid content, melting point, acid, iodine and saponfication values and UV absorption of wax samples obtained from sticklacs of different host plants e.g. *arhar*, *moghania*, *kusum*, *ber* and *palas* have been studied.

**3.1.3** The determination of physical and chemical properties of 14 samples of seedlac and shellac on storage has indicated that flow is the most sensitive property which is affected on ageing.

**3.1.5** The optimum conditions for isolation of aleuritic acid in increased yield 30-35 per cent have been worked out.

**3.1.6** The absorption spectra of different varieties of shellac were studied in commercial (distilled) denatured alcohol. The results showed that it can be used safely as the solvent for the spectrophotometric determination of colour index of shellac at 425 nm in place of ethylalcohol. The absorption spectra of different admixtures of shellac with six other natural resins in the complete U.V. and visible range in different solvents showed that the identification of shellac in presence of other natural resins is possible only when the concentration of shellac is ten times greater than that of other resins in the mixtures.

**3.1.8** A study has been initiated to establish the nature and mode of interaction of laccaic acid with DNA.

**3.2.2** A $C_{16}$ cyclic ether, having odour has been synthesized from aleuritic acid adopting simple reaction sequences. *Trans*-isoambrettolide has been synthesized in improved yield from *threo*-aleuritic acid by adopting modified procedure.

Dehydroexaltone, *trans*-isoambrettolide and prostanoid synthon were purified by column chromatography.

**3.2.8** Cyclic ureides have been prepared from $\Delta^9$-hexadecenel, 16 and $\Delta^9$-heptadecene-1,17-dioic acids and pimelic acid.

A cyclic ketone (Dehydro civetone) having musk-like odour has also been synthesized from *threo*-aleuritic acid.

**3.2.10** The major components of the queen been pheromone viz., 9-oxo-2-decenoic acid and 9-hydroxydecenoic acid have been synthesized from *threo*-aleuritic acid. Juvenile hormone analogue (1,4,12-trimethoxy dodecane) has also been synthesized from *threo*-aleuritic acid.

**3.2.3 (ii)** Cation exchange resin was prepared from styrenated lac. As no improvement in the cation exchange capacity was observed it was inferred that sulphonation of styrenated lac was not as effective as that of lac alone.

**3.3.10** Different physico-chemical properties of the reaction product (addition polymer) obtained from shellac using potassium persulphate as initiator were investigated and it was observed that addition polymerization did not take place. Further attempts are being made with three different initiators.

**3.4.3** Bigger lots of shellac paints of different shades were prepared and sent to National Institute of Foundry and Forge Technology, Dhurwa for their evaluation in the shop. The evaluation report indicates that these paints possess most of the desirable properties of synthetic resin based pattern enamels excepting the film hardness and viscosity.

A few compositions of shellac based pattern paints were prepared by using ordinary shellac in place of dewaxed lac.

**3.4.4** The reaction of aleuritic acid with glycerol has been studied under different conditions of time, temperature and also in the presence of different catalysts. The products were found to be a mixture of mono-, di- and triglycerides of aleuritic acid. From this mixture, triglyceride of aleuritic acid was separated and identified when methylaleuritate was used in place of aleuritic acid, triglyceride (85-90%) was obtained.

**3.4.5** A few compositions of anticorrosive primers based on dewaxed lac double boiled linseed oil and ordinary shellac double boiled linseed oil vehicles were prepared. Both the compositions were found to produce hard, smooth, egg shell films on GI and MS panels. The composition prepared by using ordinary shellac, however, showed comparatively poor drying characteristics.

**3.5.3** Two alternative methods namely, acid chloride and acid amide for the preparation of lac-2,4-D weedlicide were tried. The former method was found successful.

**3.5.4** Partially and fully hydrolysed lac under various conditions were prepared and their suitability along with hydrolysed gummy lac (left after isolation of a leuritic acid) in sticker formulations were examined.

**3.7.2** The absorption studies (UV-visible) on lac dye solution indicated four absorption maxima at 530, 500, 292 and 230 nm in methyl and ethyl alcohols, at 490 and 292 nm in water and at 500 nm only in acetone whereas sodium salt of dye solution indicated only one peak at 530 nm in water.

Acid value of lac dye was determined by three different methods and was found to vary from 234 to 255.

**3.7.3** Some of the physico-chemical constants of lac-wax, procured from different sources, were determined and it has been found that the values differ depending on the source.

## D. TECHNOLOGY DIVISION

### (a) RESEARCHES COMPLETED

**4.1.6 (i)** A technique for dewaxing of seedlac in aqueous alkaline medium has been developed up to semi-pilot scale. The main advantage in this technique over the previous one is that it takes about half of the time.

**4.3.3** A process for making flexible insulating sheets/boards from waste mica using shellac/modified shellac as a bonding material has been developed. The sheets were found to possess breakdown strength of the same magnitude as that of similar standard micafolium.

## (b) RESEARCHES ON HAND

**4.1.5** Sticklacs in larger quantity (10 kg) lot were washed with different synthetic detergents. The yield, colour and bleach indices of the seedlacs thus obtained were similar to those obtained on laboratory scale washed with Ritha and Teepol[R], the yield of seedlac was increased by 2-6 per cent, but there was no improvement in colour and bleach index.

**4.1.6 (ii)** Decolourization of seedlac using activated charcoal (20%) in alcoholic medium was studied. The optimum temperature and time for decolourization of seedlac were found to be 78°C for 1 hr respectively.

**4.1.7** Shellac from *kiri* has been prepared in alcoholic and aqueous alkaline medium and their properties compared.

**4.2.1** Mooney number and scorch time in presence of shellac and its Zn-salt in a blend of NR and SBR were found to decrease and increase respectively. The properties in presence of china clay filler with Zn-salt of lac in a blend of NR and SBR were found to increase. The effect of incorporation of Mg-salt of lac into a blend of NR and SBR was also studied and improvement in mechanical properties was observed.

**4.3** The possibility of combining bleached lac with ethylacrylate was studied and it was found that 30 per cent ethylacrylate had combined. Bleached lac when modified with a mixture of styrene and ethylacrylate showed good adhesive property.

**4.3.4** The products obtained after treatment of *total* hydrolysed lac with sodium metal and epichlorohydrin possessed better drying properties. Preliminary observations have indicated that it may be cured at room temperature with amines.

**4.4.2** The water thinnable red oxide primer based on lac-linseed oil fatty acid-glycerine vehicle has been successfully prepared on semi pilot scale.

## AD-HOC RESEARCH

The compositions obtained by reacting shellac with 40 and 60% toluene di-isocyanate were found satisfactory for fixing wood to wood and wood to mild steel surfaces respectively.

# E. EXTENSION DIVISION

## RESEARCHES COMPLETED

**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. A composition based on this precipitated lac and rosin has been tested at Bharat Heavy Electricals Ltd., Bhopal and passed all the specifications laid down by them satisfactorily.

## RESEARCHES ON HAND

**3.3.4.1** The stable emulsion of shellac/chlorinated rubber could be prepared by the addition of small proportion of linseed oil fatty acids in the mixture.

**5.3** The storage experiments were continued with 6 sticklac samples. It has been found that storage in sticklac form has a slight edge over the storage in seedlac form, so far as quality deterioration in flow is concerned.

**5.4** A survey was carried out in Purulia district (W. Bengal) in order to study the problem of hand made shellac manufacturing units in the area.

## AD-HOC RESEARCH

A modified method for determining the colour index of *kiri* lac has been worked out.

## SPONSORED RESEARCH

The studies on storage of sticklac were concluded after carrying out the experiments for about 33 months. The quality deterioration of seedlac during storage have been found to be only marginal when stored in A.C. godown but very significant for those samples stored under ordinary conditions.

# 7a. METEOROLOGICAL REPORT FOR THE YEAR 1981

The meteorological data for each month were as follows:

| Month | Mean barometric pressure mm | Mean maximum temp. °C | Mean minimum temp. °C | Mean dry bulb temp. °C | Mean wet bulb temp. °C | Mean humidity % | Mean sunshine hr/day | Total rainfall mm | Highest maximum temp. °C | Lowest minimum temp. °C |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 709·60 | 22·6 | 9·1 | 14·1 | 12·1 | 77·0 | Paper not available | 41·9 | 28·0 | 5·0 |
| February | 708·13 | 27·0 | 11·6 | 18·0 | 14·3 | 65·0 | do | 56·1 | 33·5 | 8·3 |
| March | 706·77 | 30·3 | 15·0 | 20·0 | 16·5 | 70·0 | do | 9·1 | 33·5 | 10·5 |
| April | 703·38 | 35·1 | 19·0 | 25·4 | 20·0 | 60·0 | do | 18·0 | 38·0 | 16·6 |
| May | 701·53 | 35·1 | 22·0 | 27·9 | 23·2 | 67·0 | do | 137·5 | 41·5 | 18·8 |
| June | 697·95 | 35·5 | 22·8 | 27·3 | 22·8 | 78·43 | do | 126·3 | 39·0 | 20·0 |
| July | 697·88 | 29·9 | 20·7 | 25·0 | 22·2 | 90·19 | do | 448·5 | 32·5 | 21·1 |
| August | 698·00 | 29·9 | 22·2 | 25·5 | 24·1 | 89·51 | do | 187·0 | 35·0 | 21·6 |
| September | 702·65 | 30·0 | 26·9 | 25·6 | 23·9 | 87·6 | do | 195·0 | 33·5 | 26·1 |
| October | 705·90 | 31·2 | 18·8 | 24·4 | 19·5 | 67·35 | do | Nil | 32·5 | 14·4 |
| November | 706·96 | 28·6 | 12·2 | 21·9 | 16·7 | 57·8 | do | 1·0 | 33·5 | 8·8 |
| December | 707·19 | 24·4 | 9·0 | 17·98 | 13·69 | 63·0 | do | 14·0 | 26·5 | 5·0 |

The highest maximum temperature recorded was 41·5°C on 18th May and lowest minimum 5·0°C on 10th January and 25th, 26th December. The total rainfall during the year amounted to 1234·4 mm of which the monsoon (June to Sept.) rainfall was 956·8 mm. The rainfall during the year was 310·98 mm lower than that of 1980 (1545·38 mm). There was no hail storm.

## 7b. METEOROLOGICAL REPORT FOR THE YEAR 1982

The meteorological data for each month were as follows:

| Month | Mean barometric pressure mm | Mean maximum temp. °C | Mean minimum temp. °C | Mean dry bulb temp. °C | Mean wet bulb temp. °C | Mean humidity % | Mean sunshine hr/day | Total rainfall mm | Highest maximum temp. °C | Lowest minimum temp. °C |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 709·6 | 26·6 | 11·1 | 16·56 | 13·9 | 73·9 | Paper not available | 2·5 | 28·5 | 6·6 |
| February | 707·86 | 26·35 | 11·9 | 17·35 | 14·19 | 71·0 | do | 53·7 | 30·0 | 7·2 |
| March | 706·5 | 29·79 | 14·2 | 19·95 | 16·6 | 71·3 | do | 83·0 | 36·0 | 11·1 |
| April | 703·30 | 35·9 | 19·45 | 27·78 | 21·3 | 55·86 | do | 32·6 | 39·5 | 15·5 |
| May | 702·48 | 38·4 | 23·24 | 31·7 | 23·8 | 51·0 | do | 19·1 | 41·0 | 19·4 |
| June | 697·77 | 34·15 | 23·6 | 27·98 | 25·26 | 80·43 | do | 237·3 | 41·5 | 20·0 |
| July | 698·06 | 32·96 | 23·75 | 27·54 | 25·08 | 72·58 | do | 264·9 | 38·0 | 22·2 |
| August | 697·61 | 29·12 | 22·8 | 24·87 | 24·14 | 94·19 | do | 551·8 | 33·0 | 21·0 |
| September | 702·42 | 31·63 | 21·75 | 26·2 | 23·8 | 81·9 | do | 173·4 | 34·5 | 17·7 |
| October | 707·19 | 30·93 | 17·92 | 24·62 | 21·19 | 73·1 | do | 45·2 | 33·0 | 15·0 |
| November | 708·41 | 27·3 | 13·79 | 20·53 | 17·35 | 72·6 | do | 2·6 | 31·0 | 8·3 |
| December | 709·8 | 25·5 | 9·6 | 16·5 | 13·5 | 70·3 | do | Nil | 28·5 | 6·6 |

The highest maximum temperature recorded was 41·5°C on 1st June and lowest minimum 6·6°C on 1st, 3rd and 19th January, and 26th, 27th, 28th and 31st December. The total rainfall during the year amounted to 1466·1 mm of which the monsoon (June to Sept.) rainfall was 1227·4 mm. The rainfall during the year was 231·7 mm higher than that of 1981 (1234·3 mm). There was a hail storm on 10th October.

# 8. PERSONNEL

| Sl No. | Name of the Post | Staff position as on 31-12-1982 |
|---|---|---|
| 1. | Director | Dr T. P. S. Teotia |
| | **Entomology Division** | |
| 1a. | Head, Division of Entomology | Sri N. S. Chauhan w.e.f. 8-2-80 |
| 2. | Scientist S-2 (Agricultural Entomology) | (1) Dr C. P. Malhotra<br>(2) Sri A. H. Naqvi<br>(3) Sri R. C. Mishra<br>(4) Dr D. C. Srivastava w.e.f. 1-7-82 |
| 3. | Scientist S-1 (Agricultural Entomology) | (1) Sri S. G. Choudhary<br>(2) Dr A. K. Sen<br>(3) Sri B. N. Sah<br>(4) Dr D. C. Srivastava up to 30-6-82<br>(5) Sri S. K. Jaipuriar<br>(6) Sri A. Bhattacharya<br>(7) Sri R. Ramani<br>(8) Sri Y. D. Mishra |
| 5. | Scientist S (Agricultural Entomology) | (1) Sri M. L. Bhagat<br>(2) Sri Jawahir Lal |
| 6. | Senior Technical Assistant (T-4) | (1) Sri J. M. Dasgupta<br>(2) Sri M. K. Chowdhary |
| 7. | Technical Assistant (T-II-3) | (1) Sri A. K. Sahay<br>(2) Sri K. U. S. Sinha<br>(3) Sri R. N. Vaidya<br>(4) Sri H. Bhengra<br>(5) Sri L. C. Nath Sahadeo<br>(6) Sri R. S. Maliya |
| 8. | Senior Artist (T-4) | Sri R. L. Singh |
| 9. | Junior Artist-cum-Photographer (T-1) | Sri R. P. Srivastava |
| 10. | Laboratory Technician (T-2) | (1) Sri B. B. Chakravorty<br>(2) Sri G. M. Borkar<br>(3) Sri Ajmer Hussain<br>(4) Sri S. K. Chatterjee<br>(5) Smt Santoshi Minz<br>(6) Sri Bhola Ram<br>(7) Sri Ghan Shyam Das |
| 11. | Field Technician (T-2) | (1) Sri H. R. Munda<br>(2) Sri K. C. Jain<br>(3) Sri S. S. Prasad<br>(4) Sri R. D. Pathak<br>(5) Sri H. N. Shukla<br>(6) Sri Jiwan Lal<br>(7) Sri K. P. Gupta w.e.f. 6-10-80 |
| 12. | Insect Collection Tender (T-2) | Sri Ram Lochan Ram |
| 13. | Lab. Technician (T-1) | Sri R. K. Swansi |
| 14. | Field Farm Technician (T-1) | (1) Sri A. K. Sinha w.e.f. 25-11-81<br>(2) Sri Dilip Kumar Singh w.e.f. 30-11-81 |
| 15. | Field Plantation and Store Assistant (T-1) | Sri Munna Lal Ravidas |
| 16. | Junior Stenographer | Sri Sant Kumar |

### Agronomy and Plant Genetics Division

| | | |
|---|---|---|
| 1. | Scientist S-2 (Plant Genetics) | Dr P. Kumar |
| 2. | Scientist S-1 (Plant Breeding) | Sri S. C. Srivastava |
| 3. | Scientist S-1 (Horticulture) | Dr Moti Ram (on deputation to Birsa Agriculture University, Ranchi) |
| 4. | Scientist S-1 (Agronomy) | Sri B. P. Singh (on study leave) |
| 5. | Laboratory Technician (T-1-III) | (1) Sri D. D. Prasad |
| | (T-1) | (2) Sri Mohan Singh w.e.f. 23-11-81 |
| 6. | Field Technician(T-1) | (1) Sri Jagarnath Oraon |
| | | (2) Sri K. A. Naguruar w.e.f. 24-11-81 |

### Chemistry Division

| | | |
|---|---|---|
| 1. | Head, Division of Chemistry | (1) Sri Shravan Kumar up to 10-4-82 |
| | | (2) Dr B. B. Khanna w.e.f. 11-4-82 |
| 2. | Scientist S-3 (Organic Chemistry) | (1) Dr B. B. Khanna |
| | | (2) Sri S. Kumar |
| 3. | Scientist S-2 (Organic Chemistry) | (1) Dr S. C. Agarwal |
| | (Physical Chemistry) | (2) Dr A. Kumar |
| | (Physics) | (3) Dr D. N. Goswami w.e.f. 1-7-82 |
| 4. | Scientist S-1 (Organic Chemistry) | (1) Sri A. K. Dasgupta |
| | (Physics) | (2) Dr D. N. Goswami up to 30-6-82 |
| | (Organic Chemistry) | (3) Dr B. C. Srivastava |
| | (do) | (4) Dr N. Prasad |
| | (do) | (5) Dr R. N. Majee |
| | (do) | (6) Dr K. Mohan |
| | (do) | (7) Sri K. M. Prasad |
| 5. | Scientist-S (do) | (1) Sri M. Mukherjee |
| | (do) | (2) Sri P. M. Patil |
| 6. | Senior Technical Assistant (T-4) | Sri A. Rahman |
| 7. | Technical Assistant (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 |
| | | (6) Sri S. N. Sharma |
| | | (7) Miss P. R. Chatterjee |
| 8. | Laboratory Technician (T-2) | (1) Sri U. Sahay |
| | | (2) Sri B. P. Keshri |
| | | (3) Sri P. B. Sen |
| 9. | Laboratory Technician (T-1) | (1) Sri G. Mishra |
| | | (2) Smt Prabha Devi |
| 10. | Glass Blower | Sri B. S. Chowdhary |
| 11. | Junior Stenographer | Sri B. K. Rajak |

### Technology Division

| | | |
|---|---|---|
| 1. | Scientist (S-2) (Organic Chemistry) | Dr P. C. Gupta |
| 2. | Jr. Technologist (Processing) | Sri A. K. Ghosh |
| 3. | Scientist S-1 (Organic Chemistry) | (1) Sri R. K. Banerjee |
| | (Physical Chemistry) | (2) Sri Radha Singh |
| 4. | Senior Mechanic (T-II-3) | Sri S. K. Bhaduri |
| 5. | Senior Technical Assistant (T-4) | (1) Sri M. Islam |
| | | (2) Sri B. P. Banerjee |
| | | (3) Sri R. Prasad |
| 6. | Technical Assistant (T-II-3) | Sri K. K. Prasad |
| 7. | Laboratory Technician (T-2) | (1) Sri N. Minz |
| | | (2) Sri M. K. Singh |
| | | (3) Sri Tulsi Ram |

**Extension Division**

| | | |
|---|---|---|
| 1. | Scientist S-3 (Physical Chemistry) | Dr S. K. Saha |
| 2. | Scientist S-1 (Organic Chemistry) | Dr A. Arya up to 20-1-82 |
| 3. | Scientist S-1 (Agricultural Entomology) | Sri R. S. Gokulpure up to 13-4-82 |
| 4. | Scientist S-1 (Physical Chemistry) | Dr A. Pandey |
| 5. | Senior Analyst (T-5) | Sri L. C. Mishra |
| 6. | Senior Technical Assistant (T-5) | (1) Sri R. C. Maurya |
| 7. | do (T-4) | (2) Sri Dipak Ghosh |
| 8. | Technical Assistant (T-II-3) | (1) Sri K. M. Sinha |
| | | (2) Sri Jagdish Singh |
| 9. | Commercial Artist (T-II-3) | (1) Sri Pyare Das |
| 10. | Laboratory Technician (T-I-3) | (1) Sri D. Runda |
| 11. | Lab Technician (T-2) | (1) Sri B. P. Ghosh |
| 12. | Junior Stenographer | Sri A. K. Sinha |

**Administrative, Audit and Accounts Section**

| | | |
|---|---|---|
| 1. | Administrative Officer | Sri S. Ramanujam |
| 2. | Assistant Administrative Officer | Sri S. N. Sharma |
| 3. | Assistant Accounts Officer | Sri G. C. Chakravorty w.e.f. 8-1-82 |
| 4. | Superintendent | (1) Sri S. N. Prasad |
| | | (2) Sri R. K. Singh |
| 5. | Assistants | (1) Sri P. K. Chowdhary |
| | | (2) Sri D. P. Sengupta |
| | | (3) Sri H. S. Munda |
| | | (4) Sri R. P. Singh |
| | | (5) Sri Musafir Singh |
| | | (6) Sri Enamul Haque |
| | | (7) Md Shamiullah |
| | | (8) Sri A. K. Lal |
| 6. | Senior Stenographer | Sri R. Rabidas |
| 7. | Senior Clerk | (1) Sri N. Mahato |
| | | (2) Sri A. K. Chowdhury |
| | | (3) Sri Elias Tirkey |
| | | (4) Sri S. K. P. Keshri |
| | | (5) Sri A. Haque |
| | | (6) Sri R. B. Singh |
| | | (7) Smt Sati Guha |
| | | (8) Sri K. N. Sinha |
| | | (9) Sri K. D. Pandey |
| | | (10) Sri S. Ram |
| | | (11) Sri D. Ram |
| 8. | Senior Clerk (Estate) | Sri D. N. Mahto |
| 9. | Junior Stenographer | Smt Sushanti Minz |
| 10. | Junior Clerk | (1) Sri K. L. Choudhury |
| | | (2) Sri R. K. Upadhaya |
| | | (3) Sri Budhan Ram |
| | | (4) Md Mubarak |
| | | (5) Sri N. Topno |
| | | (6) Sri V. Ram |
| | | (7) Sri E. Gari |
| | | (8) Sri J. P. Srivastava |
| | | (9) Sri Lakshmi Kant up to 27-11-81 |
| | | (10) Sri N. Gope 27-11-81 |
| | | (11) Sri Thibu Minz |
| | | (12) Sri B. N. Gope |
| | | (13) Sri Ravi Shankar |
| | | (14) Sri Shambhu Chanda |
| | | (15) Sri Anant Pandey |
| 11. | Stockman-cum-Compounder (T-1-3) | Sri Chandreswar Pandey |
| 12. | Hindi Translator (T-II-3) | Sri Lakshmi Kant w.e.f. 28-11-81 |

### Project File and Technical Cell

| | | |
|---|---|---|
| 1. | Junior Technical Officer (T-6) | Sri S. K. M. Tripathi |
| 2. | Senior Technical Assistant (T-4) | Sri P. Sen |

### Library

| | | |
|---|---|---|
| 1. | Senior Library Assistant (T-4) | Sri R. P. Tiwari |
| 2. | Library Assistant (T-II-3) | Sri V. K. Singh (1980) |

### Maintenance and Workshop Unit

| | | |
|---|---|---|
| 1. | Chief Mechanic (T-II-3) | Sri S. K. Srivastava |
| 2. | Assistant Mechanic | Vacant |
| 3. | Instrument Maker | Sri Baiju Mishtri |
| 4. | Turner (T-2) | Sri A. S. Manoranjan |
| 5. | Driver for vehicle | (1) Sri J. Ram |
| | | (2) Sri Bandhan Runda |
| | | (3) Sri M. Khalko |
| | | (4) Sri Bimal Ram |

### Institute Plantation

| | | |
|---|---|---|
| 1. | Farm Superintendent (T-6) | Sri B. K. Purkayastha |
| 2. | Field Farm Technician (T-2) (T-1-III) | (1) Sri G. Lakra |
| | | (2) Md Ali Ansari |
| 3. | Tractor Driver (T-2) | Sri Markus Surin |

### Mixed Plantation Scheme at Chandwa

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

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