

THE  
**TEA RESEARCH INSTITUTE**  
OF  
**CEYLON**

**Annual Report for the Year**  
**1965**  
**Part II**

*Edited by*

**E. M. CHENERY, BSc, PhD (Lond), ARCS, DIC**  
Director, Tea Research Institute of Ceylon

*and*

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Research Officer (Plant Pathology)  
Tea Research Institute of Ceylon



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**ST COOMBS, TALAWAKELE, CEYLON**

1966

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# The Tea Research Institute of Ceylon

Board of Control as at the 31st December 1965

**Chairman**

Mr F. Amarasuriya

**Ex-Officio Members**

*The Director of Agriculture :*

Mr. D. C. L. Amerasinghe, CAS

*The Honourable the Minister of Finance :*

represented by Mr G. D. Loos, CAS

*The Chairman, Planters' Association of Ceylon :*

Mr W. J. Childerstone

*The Chairman, Agency Section, Planters' Association of Ceylon :*

Mr J. L. Capper

*The Chairman, Low-Country Products Association of Ceylon :*

Mr D. B. Ellepolla, CBE

*The Tea Controller :*

Mr C. P. Chanmugam, CAS

*The Director, Tea Research Institute of Ceylon :*

Dr E. M. Chenery

**Nominated Members**

*Appointed by the Planters' Association of Ceylon :*

Mr S. P. Vytilingam

Mr G. B. Middleton

Mr A. P. Fincher

*Appointed by the Agency Section, Planters' Association of Ceylon :*

Mr H. A. Whittall

Mr D. A. Neale

Mr P. J. C. Durrant

*Appointed by the Low-Country Products Association :*

Mr F. Amarasuriya

Mr S. Pathmanathan

Mr J. L. D. Pieris

*Representing the Small Holders :*

Mr D. E. Hettiarachchi, JP, UM

Mr M. Rajendram, MBE, JP

*Representing the House of Representatives :*

Mr D. J. Ranaweera, MP

**Secretary**

Mr A. C. Perera

# The Tea Research Institute of Ceylon

Staff as at 31st December 1965

|                           |   |
|---------------------------|---|
| Director ... ..           | E. M. Chenery, BSc, PhD (Lond), ARCS, DIC |
| Deputy Director ... ..    | J. A. H. Tolhurst, BSc (Reading)          |
| Assistant Director ... .. | L. H. Fernando, BSc, PhD (Lond)           |

## Agricultural Chemistry

|                             |   |
|-----------------------------|---|
| Agricultural Chemist ... .. | J. A. H. Tolhurst, BSc (Reading)  |
| Research Assistants ... ..  | *W. M. W. B. Manipura, BSc (Cey)<br>S. Sivasubramaniam, BSc (Cey)<br>S. Sandanam, BSc (Cey)   |
| Technical Assistants ... .. | V. Mendis<br>T. C. Z. Jayman<br>(Mrs) B. I. de Silva, BSc (Cey)<br>S. Sundaralingam, BSc (Poona)<br>M. Sikurajapathy, BSc (Cey)<br>T. Kularatna, BSc (Cey)<br>K. Sivalingam, BSc (Cey)<br>A. Somaratne, BSc (Cey) |

## Plant Propagation

|                          |  |
|--------------------------|--|
| Adviser ... ..           | A. V. Richards, BSc (Lond), MSc (Calif), Dip<br>Agric (Cantab), AICTA (Trinidad) |
| Research Assistants      |  |
| Plant Propagation ... .. | *V. S. Kulasegaram, BSc (Cey)  |
| Plant Breeding ... ..    | *A. R. Sebastianpillai, BSc (Cey)  |
| Technical Assistants     |  |
| St Coombs ... ..         | H. R. Solomon<br>*D. Janakiram, BSc (Madras)<br>A. S. B. Gomez, BSc (Cey)        |
| St Joachim ... ..        | D. D. Kroon  |
| Hantane ... ..           | H. B. Ratnayake  |
| Passara ... ..           | A. M. Abeysinghe   |
| Kottawa ... ..           | K. H. G. Gunapala  |

## Low-Country Service

|                                  |   |
|----------------------------------|---|
| Assistant Director ... ..        | L. H. Fernando, BSc, PhD (Lond)   |
| District Advisory Officer ... .. | J. V. Sabanayagam, BSA (Toronto)  |
| Technical Assistants             |   |
| St Joachim ... ..                | J. I. H. Bandaranayake<br>H. D. Jayasinghe<br>H. H. Samarakoon<br>N. Yogaratnam, BSc (Alahabad)<br>U. P. de S. Waidyanatha, BSc (Cey)<br>D. D. Kroon<br>N. S. Rajendram, BSc (Madras) |
| Kottawa ... ..                   | K. H. G. Gunapala   |
| Chief Clerk ... ..               | R. I. Pereira   |
| Stenographer ... ..              | S. K. P. Tambimuttu   |
| Clerk ... ..                     | K. P. Gunawardena   |
| Electrician ... ..               | B. T. Ranasinghe  |

## Plant Physiology

|                            |  |
|----------------------------|--|
| Plant Physiologist ... ..  | U. Pethiyagoda, BSc (Cey), PhD (Lond), DIC                           |
| Research Assistants ... .. | S. Kandiah, BSc (Cey)<br>S. Nagarajah, BSc (Cey), MS (Calif)         |
| Technical Assistants       |  |
| St Coombs ... ..           | M. Piyasena<br>G. M. H. B. Wijethunga<br>S. Krishnapillai, BSc (Cey) |
| St Joachim ... ..          | N. S. Rajendram, BSc (Madras)  |

## Nematology

|                             |  |
|-----------------------------|--|
| Adviser ... ..              | A. Kerr, BSc (Edin), PhD (Adel)  |
| Actg Nematologist ... ..    | N. Shanmuganathan, BSc (Cey), PhD (Lond)   |
| Research Officer ... ..     | P. Sivapalan, BSc (Cey), PhD (Rutgers)   |
| Technical Assistants ... .. | M. K. Vythilingam<br>P. A. John<br>S. Samarajeewa<br>A. R. M. Hassim<br>T. Manivasagar |

\* Working overseas

**STAFF—Contd.**

Plant Pathology

|                      |     |     |  |
|----------------------|-----|-----|--|
| Adviser              | ... | ... | A. Kerr, BSc (Edin), PhD (Adel)  |
| Plant Pathologist    | ... | ... | N. Shanmuganathan, BSc (Cey), PhD (Lond)   |
| Research Officer     | ... | ... | R. L. de Silva, BSc (Cey), PhD (Lond), DIC   |
| Technical Assistants | ... | ... | W. W. Redlich, BSc (Cey)<br>P. V. Arulpragasam, BSc (Madras)<br>S. Murugiah<br>W. R. F. Rodrigo, BSc (Cey)<br>S. R. A. Fernando, BSc (Cey) |

Entomology

|                      |     |     |   |
|----------------------|-----|-----|---|
| Entomologist         | ... | ... | J. E. Cranham, BA (Cantab), DIC   |
| Research Officers    |     |     |   |
| Hantane              | ... | ... | D. Calnaido, BSc (Cey), PhD (Lond)  |
| St Coombs            | ... | ... | W. Danthanarayana, BSc (Cey), PhD (Lond), DIC   |
| Research Assistant   | ... | ... | D. J. W. Ranaweera  |
| Technical Assistants |     |     |   |
| St Coombs            | ... | ... | E. F. W. Fernando, BSc (Cey)<br>C. Shanmugam<br>A. Kathiravetpillai, BSc (Cey)<br>K. Thirugnanasuntharan, BSc (Cey) |
| Hantane              | ... | ... |   |

Biochemistry

|                                |     |     |   |
|--------------------------------|-----|-----|---|
| Biochemist                     | ... | ... | G. W. Sanderson, BSc (Calif), PhD (Nott)  |
| Biochemist (Manufacture)       | ... | ... | R. L. Wickremasinghe, BSc (Cey), BSc (Lond),<br>PhD (Sheff), FRIC   |
| Research Officer (Manufacture) | ... | ... | A. S. L. Tirimanna, BSc, PhD (Lond)   |
| Research Assistants            | ... | ... | *R. R. Selvandran, BSc (Cey)<br>G. R. Roberts, BSc (Cey), ARIC  |
| Technical Assistants           | ... | ... | B. P. M. Perera<br>K. Sivapalan, BSc (Cey)<br>V. Fernando<br>K. P. W. C. Perera, BSc (Cey)<br>V. H. Perera, BSc (Cey) |

Technology

|                      |     |     |  |
|----------------------|-----|-----|--|
| Technologist         | ... | ... | D. Kirtisinghe, BSc (Cey), PhD (Lond), DIC   |
| Tea Taster           | ... | ... | C. H. Wickremesinghe   |
| Research Assistant   | ... | ... | *W. Joseph, BSc (Cey)  |
| Technical Assistants |     |     |  |
| St Coombs            | ... | ... | W. C. A. de Silva, BSc (Cey)<br>C. Kandappah, BSc (Cey)<br>S. Samarasingham<br>M. T. Subramaniam, BSc (Cey)<br>T. A. Munasinghe<br>T. F. Saldin, BSc (Cey) |
| St Joachim           | ... | ... |  |

Statistics

|                     |     |     |                                     |
|---------------------|-----|-----|-------------------------------------|
| Statistician        | ... | ... | P. Kanapathipillai, BSc (Lond), FSS |
| Technical Assistant | ... | ... | K. Seevaratnam                      |

Advisory Service

|                            |     |     |   |
|----------------------------|-----|-----|---|
| Chief Advisory Officer     | ... | ... | C. B. Foster Barham, MA (Cantab)                              |
| Research Assistants        | ... | ... | *D. T. Wettasinghe, BSc (Cey)<br>R. K. Nathaniel, BSc (Poona) |
| District Advisory Officers |     |     |   |
| Uva                        | ... | ... | L. M. de W. Tillekeratne, BSc (Cey), MEd (Calif)              |
| Low Country                | ... | ... | J. V. Sabanayagam, BSA (Toronto)                              |
| Technical Assistant (Uva)  | ... | ... | D. N. R. Wijewardena  |
| Photographer               | ... | ... | D. J. M. Hettiarachchi  |
| Filing Clerk               | ... | ... | K. L. de Alwis  |

St Coombs Estate

|                      |     |     |                                 |
|----------------------|-----|-----|---------------------------------|
| Agriculturist        | ... | ... | L. A. Seevaratnam, BSc (Dunelm) |
| Office Staff         |     |     |                                 |
| Head Clerk           | ... | ... | P. E. de Silva                  |
| Senior Assistant     | ... | ... | H. C. Wickremasinghe            |
| Junior Assistant     | ... | ... | M. R. K. Gabriel                |
| Head Factory Officer | ... | ... | V. A. Fernandez                 |
| Apothecary           | ... | ... | S. P. de Silva                  |

St Joachim Estate

|                      |     |     |                      |
|----------------------|-----|-----|----------------------|
| Superintendent       | ... | ... | G. S. Muttettuwagama |
| Office Staff         |     |     |                      |
| Head Clerk           | ... | ... | G. L. A. Thomas      |
| Senior Assistant     | ... | ... | A. G. Rabot          |
| Junior Assistant     | ... | ... | A. Pathirage         |
| Head Factory Officer | ... | ... | M. S. W. Wijeratne   |

\* Working overseas

**STAFF—Contd.**Engineering

|                    |     |     |     |                   |
|--------------------|-----|-----|-----|-------------------|
| Factor             | ... | ... | ... | O. J. Fernando    |
| Electrical Foreman | ... | ... | ... | W. R. Solomon     |
| Works Clerk        | ... | ... | ... | R. A. Daniel      |
| Storekeeper        | ... | ... | ... | I. P. Dissanayake |
| Mechanics          | ... | ... | ... | D. A. S. Opatha   |
|                    |     |     |     | K. S. Vadivelu    |
| Electrician        | ... | ... | ... | W. A. C. de Silva |

Administration

|                                   |     |     |     |                                 |
|-----------------------------------|-----|-----|-----|---------------------------------|
| Actg Chief Administrative Officer | ... | ... | ... | A. C. Perera                    |
| Assistant Administrative Officer  | ... | ... | ... | S. Thiagarajah                  |
| Actg Secretary to the Director    | ... | ... | ... | G. A. S. Gunasinghe             |
| Accounting Assistant              | ... | ... | ... | A. H. B. Dias                   |
| Assistant Secretary               | ... | ... | ... | C. Kirthiratne, FCCS            |
| Stenographers                     | ... | ... | ... | F. G. de Selve                  |
|                                   |     |     |     | P. W. Uduwawala                 |
|                                   |     |     |     | S. A. L. H. Fernando            |
|                                   |     |     |     | S. D. J. J. Vitharnepathirana   |
| Accounts Clerks                   | ... | ... | ... | W. J. Samuel                    |
|                                   |     |     |     | M. B. Palies                    |
|                                   |     |     |     | T. R. B. Sally                  |
|                                   |     |     |     | K. D. B. H. Abeygunawardena     |
|                                   |     |     |     | G. A. K. P. de Silva            |
|                                   |     |     |     | S. Kulasabanathan               |
|                                   |     |     |     | H. Attanayake                   |
|                                   |     |     |     | N. Sachithanathan               |
|                                   |     |     |     | N. M. Jayatilake                |
| Clerk Typists                     | ... | ... | ... | V. Kodagoda                     |
|                                   |     |     |     | J. N. Apasinha                  |
|                                   |     |     |     | D. W. Bartholomeusz             |
|                                   |     |     |     | S. B. Wettewe                   |
| Librarian                         | ... | ... | ... | D. J. S. de Silva, BSc (Punjab) |
| Translator/Instructor             | ... | ... | ... | C. M. Fernando, BA (Cey)        |

Visiting Agents

|            |     |     |     |                 |
|------------|-----|-----|-----|-----------------|
| St Coombs  | ... | ... | ... | P. R. U. Eastal |
| St Joachim | ... | ... | ... | J. W. Craig     |

# REPORT OF THE DIRECTOR

E. M. Chenery, BSc, PhD, ARCS, DIC

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## General

Ever since the break-up of the team of research workers headed by Dr R. V. Norris considerable difficulties have been encountered in recruiting senior staff and continuity of research effort suffered accordingly. One of the consequences of this was that the same subject or aspects of it was often handled by two or more divisions and disharmony was inevitable. By merging the Division of Agronomy with that of Agricultural Chemistry it has been possible to co-ordinate research work, particularly on fertilizers, into smooth-running channels.

The Board's policy of sending Ceylonese staff abroad for advanced study is now paying handsome dividends and for the last year or two the Institute has been functioning with a full compliment of Senior Staff working on a huge experimental programme. However, the prospect of continuity is not entirely rosy because losses in Intermediate and Junior Staff still continue and replacements are not always of the same calibre. Considerable difficulty is experienced in attracting both pure scientists and engineers with the highest qualifications. This is particularly the case for engineering graduates and as a result the Technologist's programme is in jeopardy. In anticipation of the day when this situation improves, laboratory, workshop and factory accommodation is being provided at St Coombs and St Joachim for long-overdue research into modernizing factory processes. The demand for information on this subject is ever increasing as more and more factories try to keep in step with increased crops. How formidable this problem is, will be realized when hitherto unheard-of yields of 6000 to 8000 lb per acre of made tea are the rule. That they are feasible has already been proved on at least three low-country estates during 1965.

A policy regarding the future of the Institute's Sub-stations crystalized during the year. Modest expansion is to take place in all of them ; Hantane is to be rounded off to a compact unit of 54 acres ; Passara is to be augmented by an acquisition of 122 acres of tea land and 116 acres of non-tea land from Ury Group, and Kottawa is to be enlarged by about 50 acres. All three Sub-stations have now been provided with miniature factories and equipment is ready for installation.

A major policy decision was made by the Board with regard to the estates of St Coombs and St Joachim and the Institute. Formerly these estates tended to be regarded as separate entities, in future they are to be regarded as integral parts of the Institute. In this way, the essential objective of the Institute as a research organization for the Tea Industry will be perpetuated and the profit motive will be subordinated for ever to that of acquisition of new knowledge.

A new feature has been introduced in this Annual Report which will help readers more easily to follow an experiment from year to year. All field and factory experiments are given letters and numbers ; the letters refer to the divisions concerned and the centre from which the experiments are supervised, if this is not St Coombs (see p 121). The numbers usually start from the oldest experiment or trial extant of the respective divisions and run serially from one onwards. When an experiment is completed the number is suppressed and will not be used again. Labels with the letters and numbers will be displayed prominently on all TRI experiments and these will tally

with a list of experiments which is given in the index (p 121). Following the experiment number is its title, then its statistical design and finally the year in which it was commenced. Whenever an estate is not mentioned by name, the experiment is located at St Coombs or St Joachim. The context will reveal which of these Stations is concerned.

Yet another new feature is the insertion of names of officers largely connected with an experiment following its report by the divisional head, who is, of course, connected with all the experiments in his Division and unless the work reported is on his own personal researches his name will not be inserted within the text of his report.

### Staff

The Senior Staff position at the end of the year was very satisfactory, the year having ended with a full establishment.

Dr A. W. R. Joachim relinquished his duties as Director on 1st January, when I took over from him. Dr Joachim was first appointed as Low-Country Adviser in 1956 and was largely responsible for the establishment of the Low-country Station near Ratnapura. He also officiated as Director from March 1958 to October 1959, pending the appointment of a permanent Director. Dr Joachim retired from active service soon after handing over the directorship to me.

Dr L. H. Fernando was appointed Assistant Director but is still in charge of the Low-country Station. Dr H. N. Hasselo, Chief Agronomist left the Institute in order to work in Holland. The post of Chief Agronomist has now been suppressed and the work of this division has been divided among the other divisions. Mr G. M. Sparkes, Chief Administrative Officer, left the Institute to join the Ceylon Tea Propaganda Board in Australia and his place was taken by Mr A. C. Perera. Mr J. G. G. Tennekoon, Superintendent, St Coombs, also left to take up an appointment on an estate in an Agency House. The designation of the post of Superintendent was changed to that of Agriculturist and Mr L. A. Seevaratnam was appointed to this post. Mr P. Pathmanathan, Assistant Administrative Officer, who resigned in June was replaced by Mr S. Thiagarajah. There was one new appointment on the senior staff, *viz* Mr C. H. Wickremasinghe, Tea Taster.

The following appointments were made to the Intermediate grade: Dr A. S. L. Tirimanna (Research Officer, Biochemistry Division), Mr W. Joseph (Research Assistant, Technology Division), Mr S. Nagarajah (Research Assistant, Plant Physiology Division) and Mr K. G. A. Dharmawardena (Research Assistant, Technology Division). Messrs W. Joseph (Technology) and Mr A. R. Sebastiampillai (Plant Breeding) proceeded on overseas training in the UK, while Dr W. Danthanarayana (Entomology) and Dr P. Sivapalan (Nematology) returned from overseas training.

Dr S. C. Wanigaratne (Low-country Station), Mr W. M. Bandaranaike (Agricultural Chemistry) and Mr K. G. A. Dharmawardena (Technology) resigned their appointments.

The list of staff changes during the year is attached.

## RESEARCH

### Agricultural Chemistry

Dr Eden's classical experiment in No 3 Field, St Coombs is still in extremely good heart after its rejuvenation prune four years ago. Although the mean yield for this 84-year-old low jat tea is only 720 lb per acre per

annum for the cycle, for 1965 the mean yield was 900 lb and the best plots 1200-1300 lb per acre. It is interesting to note that significant differences in yield were obtained between 60 and 90 lb  $K_2O$  but with phosphate no advantage was obtained from increasing the rate from 30 to 60 lb  $P_2O_5$ . With 32-year-old, high-jat tea the response to zinc sulphate was significant over the totals for the first two years and in the third year a beneficial trend was maintained but it was not significant; responses to nitrogen were still linear at 300 lb N per acre as sulphate of ammonia. Zinc oxide proved slightly superior to zinc sulphate over an eight-month plucking period on high-jat tea—more than three years from pruning.

Several valuable pieces of information emerged from the young tea (*XT* series) experiments. At St Coombs, phosphate gave no benefit but sulphate of ammonia was extremely beneficial up to  $3\frac{1}{2}$  oz per plant dibbled in over 7 months in  $\frac{1}{2}$  oz doses. Dolomite proved deleterious when mixed with the soil at the bottom of the hole. At St Joachim in very gravelly soil both sulphate of ammonia and CAN caused many deaths when mixed with the soil surrounding the plants *ex* sleeves. Planting young tea near to rotting stools of Guatemala grass makes no difference to subsequent growth.

A start was made in a new programme of extension experiments and by the end of the year seven had been laid out and pre-treatment recordings of plucked leaf were begun.

### Plant Propagation

The clonal experiments laid down in 1961 confirmed previous findings that the TRI 2020 series were the highest yielders and that shade depressed crop. On the gravelly soil plots at the Passara Sub-station heavy casualties occurred in the shaded plots. Testing experiments laid down in subsequent years are beginning to yield results but they have not yet been fully analysed. In one experiment on the rooting of cuttings it was found that jungle soil was by far the best and that Guatemala grass soil was about the same as sub-soil. The study of clonal seedlings, both open pollinated and hand pollinated was continued; a very promising cross was TRI 777  $\times$  TRI 2024.

### Low-Country Station

The pattern of results from fertilizer experiments which has emerged over the last few years was repeated in 1965. The ten-year-old experiment at Endane showed no response to P and K and only a 7% increase in yield from 80 lb N but blocks treated with dieldrin gave 14% more crop than those which were untreated. Zinc sulphate spraying produced no benefit. In the Palmgarden experiment, responses to nitrogen and its frequency of application were significant, the most spectacular result being a 20% increase from 225 lb N in the last six months of the cycle. Responses in the last six months of the cycle to both nitrogen and zinc were not maintained in the St Joachim experiment on old seedling tea. Over the two-year cycle the only significant benefits were those from 200 lb N and 10 lb zinc sulphate per annum. Similar results were obtained with zinc sulphate on Mahawela Estate. Rehabilitation, clonal testing, shade, bringing-into-bearing, pruning and spacing experiments were laid out at St. Joachim during the year. Herbicide experiments continued to show that pre-emergence weed killers applied to a light, gravelly soil, subjected to very high rainfall were washed into the root-zone of the tea bushes and produced toxicity symptoms with rates as low as 2 lb per acre. The most promising results were obtained from mixtures of Gramoxone and one pound of Simazine or Karmex per acre. Twenty one extension experiments were demarcated and pre-treatment yields obtained during the second half of the year.

### Plant Physiology

An important step forward was made in the study of growth and dormancy in the tea bush by the finding of growth inhibitors in buds and young leaves. In a reconditioning experiment no significant difference was found between Guatamala and Mana grasses. The types of pruning experiment demonstrated that very drastic defoliation had negligible effect on crop. Another interesting finding was that total available carbohydrate content of roots at the time of pruning had no connexion with the capacity of a bush to recover from pruning. Several extension experiments were laid out on estates to investigate the problems of die-back in relation to time of pruning and time of fertilizing, also four large shade-fertilizer experiments.

### Nematology

The most notable finding of this division was that meadow eelworm counts made in Colombo were erroneous because the high temperature obtaining there killed off the eelworm. Arrangements are being made for all future counting to be done at St Coombs. Work on resistant clones is progressing. Preliminary experiments were begun in controlling meadow eelworm with methyl bromide and it would appear that 2 lb per 100 sq ft are necessary. An interesting point was made in the rehabilitation experiment on the 'half-life' of an eelworm population—it was found that during the period of rehabilitation the numbers of eelworms were halved every 1.6 months. Marigolds were found to be of limited use in controlling nematodes in mature tea.

### Plant Pathology

An outstanding discovery was made during the year in the control of *Poria* by soil fumigation with methyl bromide which proved far superior to DD in effectiveness, besides being considerably cheaper. Good progress was made in the study of sporulation in Blister blight and several new field-scale trials were laid out to test standard copper formulations against nickel chloride. An intensive study was begun on collar and branch canker and stem canker both in the field and the laboratory. Studies of root disease following the cutting out of shade trees were continued.

### Entomology

Nine trials on Shot-hole Borer control confirmed that dieldrin was still the best treatment when safety in application was taken into consideration. Mid-cycle sprays of aldrin offer a practicable alternative to dieldrin where cover of tea is not too thick. Aldrin is less liable than dieldrin to induce severe Tortrix outbreaks and has already proved very useful in the mid-country. Five trials were laid out in low-country tea to compare dieldrin with aldrin. Experiments with other insecticides were carried out in several places but none were as effective as dieldrin. Tortrix outbreaks were less severe in 1964-65 than in 1963-64. In a chemical control experiment on Waltrim Estate, DDT and Perthane gave a good initial kill but heavy rain-fall prevented firm conclusions being obtained. Side effects of dieldrin spraying showed up in several places with spectacular outbreaks of Geometrid Caterpillar. Both twig and looper caterpillars gave cause for serious concern; DDT provided good control of the former species but with the latter it was effective only on young larvae. Further evidence was obtained that nickel fungicide spraying for Blister blight control was followed by fewer mites than occurred with copper fungicides. A mixture of DDT and Kelthane or Tedion showed promise in the simultaneous control of mites and Tortrix.

Ecological studies undertaken at the Hantane Sub-station were continued throughout the year and much interesting information was obtained.

## Biochemistry

Fundamental studies of the biochemical constituents of the tea bush were continued especially on carbohydrates, photo-synthetic assimilation of carbon dioxide, biosynthesis of flavanols, and nitrogen metabolism. From this work the following facts have emerged :

- 1—Carbon assimilated by the flush remains in the flush ; that assimilated by leaves near developing shoots moves into these shoots ; that assimilated by leaves 3 nodes below the flush moves downward to the roots and never into mature leaves.
- 2—A factor influencing the production of flavanols was found to be a shikimate enzyme in immature leaves.
- 3—Further work on catechol oxidase revealed that fleshy roots contained very high levels of activity of this enzyme.
- 4—Free amino acids increase in amount during withering and then decrease during fermentation and firing. Free amino acid content of flush decreases with the quality classification of the clone from which it is obtained. Caffeine is synthesized from amino acids during withering.

## Biochemistry (Tea Manufacture)

A considerable amount of quantitative work was done on the constituents of tea manufactured by different methods. Drastic maceration as is applied in CTC and Legge Cut processes tends to produce teas containing high concentrations of unchanged polyphenols and chlorophylls—the latter compounds being responsible for the brown appearance of these teas. Ceylon teas with a brown appearance are not readily acceptable to the trade and attempts were made to obviate this by treatment with hydrogen peroxide. Addition of this harmless chemical prior to rolling considerably increased the blackness of the dry tea and reduced the content of unchanged chlorophylls. The practical implications of the finding are that it might be possible eventually to manufacture a high priced CTC tea of black appearance from low-country leaf. Six new polyphenols have been found in tea extracts, of which three have been identified as true tannins. Seasonal variations of the chemical constituents of teas made from individual clones and from plots of seedling tea under various fertilizer treatments were followed by systematic analyses throughout the year. Detailed studies have been made of the qualitative and quantitative changes that take place during manufacture, particularly of the carotenoids, keto-compounds and chlorophylls. Clones susceptible to mite attack were found to contain a high concentration of rhodoxanthin. Other compounds of black tea that have been isolated were certain sterols, terpenoids and Vitamin E. Finally, the problem of flavour in tea was vigorously tackled during the year and it was proved unexpectedly that flavoury teas contained fewer steam distillable compounds than plain teas. Evidence was obtained that the amino acid leucine could act as a precursor of some of the substances concerned with flavour and that carbon dioxide was necessary for its production.

## Technology

The services of the new TRI Tea Taster were utilized to the full since his appointment. He reported on 934 samples which enabled reliable quality assessment to be made on new clones. Only one of these—TC 9 from Tillicoultry Estate was placed in the A1 group but 6 attained A2 rank. Manufacturing tests on leaf sprayed with copper or nickel, revealed that the

copper sprayed teas could have duller infusions. Tat and trough systems of withering were compared and no significant differences in valuations of teas were found—but the cost of operating the troughs fuel-wise was only half that of the tats. In an experiment on rotorvaning low-jat leaf, no improvement in liquor or valuation was obtained in comparison with orthodox tea. Considerable latitude in fermentation times was found permissible over the 'off-season' at St Coombs. Valuations were unaffected with fermentation periods varying from 2½ to 5 hours. A study of the effect of kind of surface on which fermentation is carried out showed no differences in valuations. Local timbers were tested for suitability as chest battens, only 4 species out of 15 were entirely taint-free. Hardboard made from rubber trees was found to be quite suitable for chests provided they were lined with aluminium foil.

### Statistics

This Division provided a continuous service for other Divisions in helping to design and analyse the numerous types of experiments being conducted by them. Statistical methods proved invaluable in such diverse subjects as insect population studies to trials of factory machinery.

### Advisory Work

All aspects of the work of this Division were increased during the year. This was probably because of the narrowing of profit margins in tea growing and the consequent desire to maintain and if possible increase profits per acre by getting the utmost out of fertilizers and plant protection measures. The increased tempo of replanting also brought in many additional enquiries concerning clones, their propagation and rearing. The Advisory Officers at St Coombs, St Joachim and Passara had a large share in the work of this Division and made valuable contributions to the new programme of agronomic extension experiments.

### St Coombs and St Joachim estates

Record crops were obtained on both estates—1510 lb per acre on St Coombs and 1191 lb per acre on St Joachim. Shade was cut out entirely at St Coombs in all except three fields and two fields were dressed with CAN for six months. The factory at St Joachim became fully operational early in January but as yet has not produced teas equal to the best in the low-country. Quality at St Coombs was satisfactory but it was not a vintage year.

### Library and Publications

Twelve additional periodicals were subscribed to during the year bringing the total number of publications to 231. A total of 133 books were also added to the library.

Dr R. L. de Silva took over the duties of Joint Editor of TRI publications from Mr J. A. H. Tolhurst on 1st May. The following publications were issued during the year

- Index to *The Tea Quarterly* Volume 34 (1963)
- Index to *The Tea Quarterly* Volume 35 (1964)
- The Tea Quarterly* Volume 36, Parts 1, 2, 3 & 4
- TRI Annual Report (1963) Part 1
- TRI Annual Report (1964) Part 2
- KEEGEL, E. L. (1958). 'Tea Manufacture in Ceylon'. TRI Monograph No. 4 (179 pp). *Reprinted.*

96 names were added on the free distribution list bringing the total to 2,766.

The annual subscription to the Institute's publications is now increased to Rs. 24/- for local subscribers and to £2-5-0d to overseas subscribers. These rates will be effective from 1966. Advertisement charges were also increased by 50%.

### Buildings

The following buildings were completed during the year :

- 1—Scientific Stores
- 2—Chromatography Room
- 3—Three Minor Staff Quarters
- 4—Minor Staff Hostel
- 5—Miniature Factory Unit at Kottawa Sub-station

The following works are still under construction :

- 1—Four Junior Staff Quarters
- 2—Two-storeyed building for the Engineering Division
- 3—Extension to the District Advisory Officer's bungalow at the Passara Sub-station
- 4—Manufacturing units for the Hantane and Passara Sub-stations
- 5—Community centre for Minor Staff
- 6—Conversion of trough house to a Technology Laboratory.

### Visitors

There were many visits by planters and members of the Ceylon tea industry, government officials, scientists from Ceylon and overseas and other distinguished persons. Among the visitors to the Institute were the following : Sir John Arbuthnot, Chairman, Estate Agency Co Ltd, London ; Mr R. K. Porter, Chairman, Tea Council, Canada ; Mr S. W. Miller, Managing Director, CCC, London ; Mr M. Calligert of the US Embassy, Colombo ; FAO delegates who visited Ceylon for the *ad hoc* Committee on Tea ; Dr A. Viton, FAO, Rome, Mr Napier Ford of George, White, Sanderson & Co, UK ; Mr V. C. Ballard, Australian High Commissioner in Ceylon ; Mr F. W. Harper, Director, Harrison & Crosfield, UK ; Mr W. S. S. Mackay of James Finlay Ltd, Glasgow ; Mr D. M. Forrest of The Ceylon Tea Centre, UK ; Dr F. Sanger of Cambridge, British Association Delegate to the 21st annual sessions of the Ceylon Association for the Advancement of Science ; Mr E. C. Brooks of the International Tea Committee, London ; Mr G. Baldit of Plant Protection Ltd ; Mr G. A. Zentemeyer, President-elect, American Phytopathological Society ; Mr K. F. Kavanagh of Fisons Overseas Ltd ; Mr A. M. Hodge of Edinburgh, Scotland ; Dr. B. K. Davison, International Nickel Ltd UK ; Mr P. N. Gandhi of International Nickel Ltd, Bombay ; Mr C. A. Jackson of UK ; Mr L. Mullins, National Rubber Research Association ; Mr J. M. O. Lang of James Finlay Ltd, Munnar, South India ; Dr A. Riggenbach, Agro-Chemical Research Plant, Sandoz, Switzerland ; Mr. H. Mayer of Sandoz, Switzerland ; Mr L. W. E. Starbuck, Eastern Produce, London ; Mr P. F. Thomas, Welsh Plant Breeding Station, Aberystwyth ; Mr J. M. E. Roas, Greenways Fleet, UK ; Mr E. Seltzer and Dr R. Morse of Thomas J. Lipton Inc, USA ; Mr Shen Tung of Peking University.

### Acknowledgements

Grateful thanks of the Institute are due to the Planters' Association, Agency Houses and Superintendents of Estates for their unstinting co-operation in the conduct of our experimental programme.

**STAFF CHANGES 1965.****APPOINTMENTS****Senior Staff**

Dr E. M. Chenery, Director from 31st December 1964  
 Mr C. H. Wickremasinghe, Tea Taster from 1st June 1965  
 Mr A. C. Perera, Acting Chief Administrative Officer from 1st October  
 Dr. L. H. Fernando, Assistant Director from 1st June

**Intermediate Staff**

Mr W. Joseph, Research Assistant in Mechanical Engineering from 1st January  
 Dr A. S. L. Tirimanna, Research Officer (Biochemistry Division) from 15th January  
 Mr L. A. Seevaratnam, Agriculturist from 5th May  
 Mr S. Nagarajah, Research Assistant (Plant Physiology Division) from 1st June  
 Mr K. D. H. Dharmawardena, Research Assistant (Technology Division) from 1st July  
 Mr S. Thiagarajah, Assistant Administrative Officer from 31st August

**Junior Staff**

Mr W. A. C. de Silva, Electrician from 1st February  
 Mr B. T. Ranasinghe, Electrician (Low-Country Station) from 1st February  
 Mr N. M. Jayatilleke, Accounts Clerk from 1st February  
 Mr T. F. Saldin, Technical Assistant (Technology Division) from 15th March  
 Mr K. Sivalingam, Technical Assistant (Agricultural Chemistry Division) from 8th March  
 Mr A. Somaratne, Technical Assistant (Agricultural Chemistry Division) from 1st April  
 Mr V. H. Perera, Technical Assistant (Biochemistry Division) from 1st April  
 Mr D. Janakiram, Technical Assistant (Plant Propagation Division) from 1st April  
 Mr A. S. B. Gomez, Technical Assistant (Plant Propagation Division) from 1st October  
 Mr S. R. A. Fernando, Technical Assistant (Plant Pathology Division) from 1st October  
 Mr T. A. Munasinghe, Technical Assistant (Technology Division) from 1st November  
 Mr T. Manivasagar, Technical Assistant (Nematology Division) from 1st December

**Overseas Training**

Dr W. Danthanarayana returned from his post-graduate training from the UK on 23rd September  
 Dr P. Sivapalan returned after his post-graduate training from the USA on 19th November  
 Mr W. Joseph, Research Assistant in Mechanical Engineering (Technology Division) left for the UK on a Federation of British Industries Scholarship for his post-graduate training on 23rd April  
 Mr A. R. Sebastiampillai, Research Assistant (Plant Propagation Division) left for the UK on a Colombo Plan Scholarship for his post-graduate training on 6th August

### Leave

- Dr G. W. Sanderson, Biochemist was on overseas leave from 17th December 1964 to 8th March 1965  
Mr J. A. H. Tolhurst, Agricultural Chemist was on overseas leave from 1st June to 29th September 1965  
Dr A. Kerr, Adviser in Plant Pathology was on overseas leave from 13th June to 12th September  
Mr J. E. Cranham, Entomologist was on overseas leave from 23rd June to 23rd September  
Mr C. B. Foster-Barham, Chief Advisory Officer was on overseas leave from 1st July to 4th October

### Overseas Visits

- Mr S. P. Vytilingam, Member, TRI Board of Control and Dr R. L. de Silva, Research Officer, Plant Pathology Division, attended the 12th Annual Scientific Conference of the United Planters' Association of South India on 6th September 1965.

### Resignations

- Mr W. M. Bandaranaike, Research Assistant (Agricultural Chemistry Division) from 20th January  
Mr A. L. J. de Croos, Technical Assistant (Plant Propagation Division) from 19th January  
Mr S. K. Govindasamy, Technical Assistant (Agricultural Chemistry Division) from 25th January  
Mr L. S. Weragoda, Technical Assistant (Technology Division) from 31st January  
Mr E. O. Stuart, Technical Assistant (Agricultural Chemistry Division) from 28th February  
Mr S. M. Kandasamy, Technical Assistant (Agronomy Division) from 31st March  
Mr M. H. W. Ariyaratne, Establishment Clerk from 15th April  
Mr J. G. G. Tennekoon, Superintendent, St Coombs, from 30th April  
Dr S. C. Wanigaratne, Research Officer, Low-Country Station from 1st May  
Mr D. S. Jayasekera, Library Assistant, from 31st May  
Dr H. N. Hasselo, Chief Agronomist from 1st July  
Mr P. Pathmanathan, Assistant Administrative Officer, from 13th July  
Mr N. Peries, Stenographer/Typist from 14th July  
Mr J. P. E. Navaratne, Record Clerk, from 31st August  
Mr K. G. A. Dharmawardena, Research Assistant (Technology Division) from 1st October  
Mr G. M. Sparkes, Chief Administrative Officer, from 12th October.

# REPORT OF THE AGRICULTURAL CHEMISTRY DIVISION

*Agricultural Chemist* - J. A. H. TOLHURST, BSc

## General

The Head of the Division was on overseas furlough for four months, during which period Mr. S. Sivasubramaniam acted on his behalf. Late in the year the former Agronomy Division was merged with this Division, and the reorganization included the start of extension experiments on estates. Messrs S. Sandanam and M. Sikurajapathy were transferred from Agronomy, and Messrs A. Somaratne and S. Sivalingam were appointed to bring the field recorders staff up to strength. Mr. W. Manipura remains overseas and is due to return in 1966.

## Field Experiments and Trials

1965 was favourable climatically, with an unusually warm South-West monsoon. Details of the established experiments will be found in earlier Annual Reports. Unless otherwise stated, yields are expressed as converted to pounds dry weight per acre and fertilizer doses as pounds of the nutrient denoted by conventional symbols.

### A1—NPK—2 replicates of 3<sup>3</sup>—(1931)

With the completion of 45 months of the 11th cycle a detailed statistical analysis was made, by the Statistics Division, of the yield totals for the period. In Table 1 it will be seen that, for the first time in the 34 years of this experiment, there is a significant difference in yield between the two higher levels of potash: now 60 and 90 lb K<sub>2</sub>O.

TABLE 1—Response, 11th cycle, to N, P and K—45 months total yield at No 3 Field

|           |        |           |        |           |        |
|-----------|--------|-----------|--------|-----------|--------|
| N 1 (120) | 2300.5 | N 2 (150) | 2565.0 | N 3 (180) | 2952.5 |
| P 1 (0)   | 2268.8 | P 2 (30)  | 2832.0 | P 3 (60)  | 2717.0 |
| K 1 (0)   | 1572.5 | K 2 (60)  | 3012.0 | K 3 (90)  | 3233.6 |

LSD at P = 0.05 - 201.6  
P = 0.01 - 272.0  
P = 0.001 - 360.8

The highly significant depression resulting from the zero potash and phosphate treatments is as expected, but of greater interest is the fact that the response to N is still linear with every indication of appreciable response above the level of 180 lb N. Frames have developed strongly following the rejuvenation prunings and it appears that this low-jat tea has even greater potential than was anticipated.

Interactions between N and K, and between P and K over the same period also showed highly significant ( $P < 0.001$ ) trends. Summaries are as shown in Tables 2 and 3. The poor response to N in the absence of fertilizer potash (K 1) is especially noticeable.

TABLE 2—Interaction between N and K—I<sup>1</sup>th cycle, 45 months total yield

|     | N 1  | N 2  | N 3  |
|-----|------|------|------|
| K 1 | 1584 | 1404 | 1728 |
| K 2 | 2576 | 3062 | 3400 |
| K 3 | 2742 | 3228 | 3732 |

TABLE 3—Interaction between P and K—I<sup>1</sup>th cycle, 45 months total yield

|     | P 1  | P 2  | P 3  |
|-----|------|------|------|
| K 1 | 1562 | 1604 | 1552 |
| K 2 | 2590 | 3382 | 3064 |
| K 3 | 2654 | 3510 | 3536 |

The benefit gained by increasing N and K together in these plots is clearly shown, and also the persistence of the depressive effect of the highest level of phosphate, 60 lb P<sub>2</sub>O<sub>5</sub>, except at the highest potash level. Interactions between N and P did not reach significance. A full report will be made at the end of the present cycle.

**A2—N P Zn at No 9 Field—2 replicates of 3<sup>3</sup> with Mg split on plots—(1962)**

At the completion of three years in November, of the first cycle, yield trends were examined in some detail. Over the first period, of two years, when no phosphate had been applied to any plot, a significant effect was shown by the foliar spray of zinc sulphate at 20 lb per acre per annum and a very highly significant effect by the nitrogen (soil) applications. Table 4 illustrates the trends of the two year total yields.

TABLE 4—Yield response to N and Zn

|          |           |           |
|----------|-----------|-----------|
| N 1 (75) | N 2 (150) | N 3 (225) |
| 2175     | 2609      | 3038      |
| Zn 1 (0) | Zn 1 (10) | Zn 2 (20) |
| 2521     | 2614      | 2708      |

LSD at P = 0.05 - 171  
 P = 0.01 - 231  
 P = 0.001 - 308

Over the third year of the cycle, when N treatments were altered to 100, 200 and 300 lb N, the only significant effect was shown by response to N. This was still linear, and very highly significant.

|      |      |      |
|------|------|------|
| N 1  | N 2  | N 3  |
| 1270 | 1403 | 2083 |

LSD at P=0.001—219

Epsom salts spraying had no effect on yield, very few magnesium deficiency symptoms being shown on untreated plots. It is planned to substitute a liming treatment for the split-plot magnesium treatment once the second cycle begins, early in 1966. Nitrogen levels would be increased in order to define the response curve, and sulphate of ammonia would continue to be the nitrogenous fertilizer used. Soil pH values being uniformly low, approximately 4.1, this experiment should be well suited to investigate relations between soil acidity and yield response to nitrogen.

Analytical investigations are in hand, to determine the critical values of phosphate in both soil and leaf when the effect of withholding all phosphate fertilizer first becomes marked. This information will contribute to our

ability to advise estates on the phosphate status of their tea. No definite conclusions can yet be drawn regarding a relation between phosphatic fertilizer and zinc deficiency.

**A3—Type of Zn at No 12 Field—Randomized blocks—(1964)**

This foliar spraying experiment was concluded in May, and the results assessed on yields obtained over 8 months plucking from October 1964. With yields approximated to lb dry weight per month, the following treatments attained significance ( $P < 0.05$ ):

|               |                    |
|---------------|--------------------|
| Control plots | Zinc-treated plots |
| 157           | 185                |

There was a small but significant increase in yield in those plots which had the repeat spray treatment in October 1964, *ie* doubling the original doses equivalent to 5 and 10 lb of zinc sulphate per acre given the previous May, and in this part of the experiment the superiority of zinc oxide was appreciable.

|            |               |
|------------|---------------|
| Zinc oxide | Zinc sulphate |
| 192        | 184           |

Over the whole year under treatment it could be said that zinc oxide, at zinc rates equal to those applied in the zinc sulphate treatments, had proved to be slightly superior to the sulphate in correcting zinc deficiency; that mixing either compound with 'Perenox' at the time of spraying had no effect on this efficiency; that residual effects were such that a repeat application after 5 months had been beneficial; that no appreciable yield difference resulted from the use of compounds equivalent to 5 or 10 lb zinc sulphate at each application. It may be noted that this tea was 3 years from pruning when treatments started.

With promising results obtained from 'Perezin' in the control of Blister blight, it would appear that this mixture may be looked upon as a practicable means of correcting zinc deficiency in those areas where sufficient fungicide is applied. Zinc sulphate, as individual sprays, may still be relied upon for supplementing the zinc oxide programme; for a rapid control of severe zinc deficiency; for treatment of tea which would not receive fungicide.

**A4—Type of Nitrogen at No 9 Field—3 × 2 factorial in randomized blocks—(1961)**

Calcium ammonium nitrate was recently substituted for the compound granular fertilizer and the basal mixture of other nutrients adjusted accordingly for all plots. To-date, no differences in yield have resulted from the use of different types of N, after 25 months of the 2nd cycle; 20 months of plucking. In the second year the full doses of 150 and 300 lb N were applied, with the following trends over the cycle; dry weight per 25 months:

|                     |      |      |
|---------------------|------|------|
|                     | N 1  | N 2  |
| Collar-pruned plots | 1890 | 2100 |
| Light-pruned plots  | 3100 | 3900 |

Plucking records suggest that the light-pruned plots may have reached their peak, while the collar-pruned plots may still be increasing their yield.

**A5—Frequency of Nitrogen at No 13 Field— $3 \times 2$  factorial in randomized blocks—(1963)**

As expected, following the poor recovery from pruning, yields in the second year of the cycle, ending August 1965, were disappointing. Response to the higher level (240 lb N) was not shown until late in the year and at this stage the first suggestion of a response to frequency of application was noted.

Table 5 shows the yield trends for the full second year and for the first quarter of the third year, converted to dry weight per acre for the respective periods.

TABLE 5—Yield trends in relation to frequency of application of N

|                          | N 1 (120) |      |      | N 2 (240) |      |      |
|--------------------------|-----------|------|------|-----------|------|------|
|                          | F 2       | F 3  | F 4  | F 2       | F 3  | F 4  |
| Second year              | 1470      | 1560 | 1550 | 1760      | 1700 | 1620 |
| First Quarter third year | 525       | 554  | 552  | 470       | 650  | 660  |

(The number of applications is denoted by the figure following F)

Results from such an experiment cannot be assessed over a short period. Where the crop is capable of responding to N, the first result will always tend to show a benefit from the lowest frequency ; *ie* the highest initial dose of nutrient. This is often overlooked and may lead to false interpretation of results from apparently simple experiments. The above data suggest that these plots are just beginning to offer useful information.

**A6—N timing at No 13 Field—2 replicates of 2 mulches split on 2 levels—(1963)**

These plots, reported fully in the 1964 Annual Report, were allowed to run until November 1965 with no fertilizer. Residual effects of fertilizer treatments before and after pruning in 1964 were very small indeed.

In November, a new set of treatments was superimposed to try to assess the effect of the leaf litter on the efficiency of broadcasting sulphate of ammonia at two levels. At this stage, the quantity and quality of the mulch was very different from that which was present after pruning. Treatments involved were broadcasting on top of the mulch ; moving the mulch and applying fertilizer to the exposed soil ; as previous, but replacing the mulch on top of the fertilizer. Heavy rain followed soon after the treatments and destroyed the chance of appreciable fertilizer absorption by the mulch. To-date, a response in yield has been noted to the higher of two levels of N, with no effect of mulch treatments. The poor residual effect of pre-pruning N treatments is the most interesting result so far obtained from these plots.

**A7—N distribution at No 13 Field— $2 \times 2$  factorial, placement split on plots—(1964)**

Over the first year of its first cycle this experiment has shown a small response to N levels, 120 compared with 240, but no difference in yield has resulted from the use of either mixture, T 700 or T 750, or from distribution in alternate versus double rows. Application will continue to be made three times a year in order to provide a high concentration of fertilizer in certain plots.

**A8—NPK on Clone TRI 2024 at No 8 Field— $3^3 \times 2$ —(1962)**

This experiment was taken over from the former Agronomy Division late in the year. Tabulation of yields over the 15 months of plucking has shown that the experiment falls into quite distinct halves. Three of the six

blocks were sited on an area formerly devoted to a fertilizer experiment, and the remaining three were sited in areas obviously differing topographically and in cultural history. Response to fertilizer is different in these two groups. Examination of the records showed that an error in calculating fertilizer doses had led to the third year of the cycle, and the first year of plucking, receiving only two-thirds of the stated quantities. This added to the difficulty of assessing results in plots which are so young, and a full report will await the completion of the fourth year, late in 1966. It may be suggested that yield trends do not support the idea that vigorous plants of clone 2024, in fertile soil, are at all readily damaged by applications of N up to 240 lb per annum even from the time of planting. Evidence suggests that annual dressings as low as 80 lb N may retard development. No response to any level of phosphate has yet been shown, and the response to potash is only marked in the less fertile areas. In these areas response to N has been delayed, but it is not possible yet to ascertain the reason. It is probable that a fortuitous infestation of meadow nematode has been a major factor in limiting plant growth; observation suggests that at the lower levels of N, 0 and 80, in the less fertile areas bushes have been more severely damaged by pests and diseases than in more highly fertilized plots.

Chemical investigation of leaf samples has already shown interesting variations between the two groups of blocks, and together with soil analyses should provide valuable information to supplement the yield records.

**A9**—*Clonal-spacing at No 2 Field and No 7 Field*—2 replicates of 3<sup>3</sup>—(1964)

Also transferred from the Agronomy Division, these plots were about to be brought into plucking at the end of the year, at 18 months from planting. Growth in clones TRI 2024 and TRI 777 was vigorous, less so in DT 1. Vigorous bending followed by frequent cutting-across had given rise to a spread which, in plots of clone 2024 planted at 14' × 4', was so great at 18 months that fertilizer application was made difficult.

Changes were made in the treatments. Shade trees had been planted on three of the six blocks, but as these had been sited individually and deliberately in widely differing areas it was felt that it would not be possible to differentiate between effects of shade and of site. Accordingly the trees were ring-barked. The fertilizer treatment originally provided for three levels of a standard mixture, the levels themselves varying from year to year of the formative period. After 15 months this scheme was abandoned. Uniform fertilizer is now to be applied to all plots until the residual effects of past treatment appear to have ceased.

Pilot plots for both **A8** and **A9** would have added immeasurably to their value by providing material for detailed, destructive, harvesting. Assessing the growth response of young tea by means of uncorrelated measurements of stem diameter is of dubious value, and when plants are shaped by bending or cutting-across the use of such internal indices must be questioned. There is need for more detailed experiments to measure precisely the residual effect of treatments in the formative years, as opposed to their immediate effect.

**A10**—*CAN, S/A and Urea each at 3 levels and 3 levels of K, on clone E 727 at Wallaha, Tangakelle Group, Lindula*—2 replicates of 3<sup>3</sup>—(1965)

*Young Tea Experiments*

**AYT 1**—*Potassium metaphosphate at 2 levels mixed and unmixed with soil at the bottom of the planting hole*—Randomized blocks—(1964)

**AYT 2**—*Hoof and horn meal and Urea formaldehyde each at 2 levels mixed and unmixed with soil at the bottom of the planting hole—Randomized blocks—(1964)*

**AYT 3**—*Sulphate of ammonia at 4 levels on clone TRI 2023—Randomized blocks—(1964)*

**AYT 4**—*Sulphate of ammonia at 4 levels on clone TRI 2023—Randomized blocks—(1964)*

**AYT 5**—*Sulphate of ammonia and muriate of potash each at 3 levels applied in solution to the bottom of the planting hole—Randomized blocks—(1964)*

For details of Experiments **AYT 1** to **AYT 5** see previous annual reports. These experiments have been concluded.

The following series of investigations was continued, and aims only at measuring immediate effects of fertilizer on young tea. All plants continued to be grown with no bending or stopping, apart from that done in the nursery.

Detailed records were kept of height and girth of the stems of the St Coombs experiments, but uprooting was again used to provide the final assessment of growth. At the time of writing only one experiment had been concluded but summaries are given below of the main trends observed to-date from the remainder.

**AYT 6**—*Three levels and methods of placement of three phosphate fertilizers : superphosphate, saphosphosphate, potassium metaphosphate—3<sup>3</sup>—(1965)*

Levels were equivalent to 0,  $\frac{1}{2}$  and 1 ounce of superphosphate per plant, in one application at or near the time of planting. None of the three clones, TRI 2142, CY 9 or DT 1, showed significant response in terms of dry weight of leaf, stem, or root. There was an indication that leaf weight was more likely to be increased by higher levels of phosphate than was root weight.

No consistent superiority could be attached to any one fertilizer, but superphosphate was significantly superior in increasing both leaf and root weight of clone DT 1.

Surface placement, with dibbling, showed no difference compared with placing at either of two depths in the bottom of the planting hole.

**AYT 7**—*Type of N—2 × 4 factorial, 2 frequencies split on plots—(1965)*

To compare sulphate of ammonia (S/A) with hoof and horn granules (HH) at four levels and two frequencies of application. Clones TRI 2142 and DT 1 harvested to-date.

No appreciable differences were recorded between the fertilizers. Splitting a given dose into half and applying every 6 weeks instead of every 3 months gave a significant benefit in clone TRI 2142, and a similar trend in DT 1.

Clone DT 1 showed significant responses in weights of leaf and root to the full range of N, *ie* from 0 to the equivalent of nearly 1 ounce of S/A every 3 months. Clone TRI 2142 showed a much weaker response to levels of N.

Fertilizer was dibbled in at 3 to 6" from the stem and the whole range of treatments repeated three times before harvesting. It is of interest to note that in spite of the fact that some plots had as much as 3 ounces of S/A per plant within 7 months, the yield trends have been consistently favourable. No indication of damage has yet been seen in any respect.

**ATT 8—Type of N at Gouravilla Estate, Upcot—2<sup>3</sup> + control in 4 replicates—(1965)**

A generous offer by Mr P. R. U. Easteal enabled us to plant two clones in an experiment to compare sulphate of ammonia with urea formaldehyde (18%N). Results were assessed on the basis of an abnormally severe cut-across 8 months after planting, during which period no additional fertilizer had been applied.

The slower-developing clone, T 7, showed little response to treatments but the more vigorous KEN 16/3 showed some significant responses.

In spite of the heavy fertilizer dressings given to the Guatemala grass and the presence of the decaying leaf litter in the plots, added N at the time of planting gave increased growth. Neither fertilizer was significantly superior to the other, and each tended to give better results from surface application (plus dibbling) compared with placement at the bottom of the hole.

**ATT 9—Alkaline fertilizer—2 replicates of 3 × 3 factorial with 3 levels of metaphosphate split on plots—(1965)**

Two clones have been harvested, and it can be seen that dolomite has had a depressive effect, even when confined to a region at the bottom of the planting hole. No further experiments will be done with dolomite used in this way, but this does not preclude the use of dolomite as a broadcast application at some stage in the rehabilitation or pre-planting operations.

The other two fertilizers used in mixtures with dolomite, all placement being at the bottom of the hole well mixed with soil, were urea-formaldehyde and potassium metaphosphate. Indications are that both have been beneficial, up to doses of 1½ and ½ ounce per plant respectively.

**ATT 10—Depth of holing—8 randomized blocks of 5 treatments—(1965)**

Measurements of height and girth on the two clones, TRI 2142 and DT 1, showed so little response to the original treatments after 6 months, that a simple comparison of S/A with urea formadehyde was superimposed.

Holing treatments comprised : disturbing the subsoil to either 12 or 16 inches depth, compared to the normal eight-inch hole : removing subsoil and replacing with surface soil to depths of either 12 or 16 inches. This type of experiment might be expected to give highly variable results if repeated in other areas, and the above conclusions must not be generalized.

**ATT 11—Guatemala Grass root stock on young tea—30 replicates of 2 treatments—(1965)**

Clones DT 1 and CY 9 were planted in a simple, highly replicated experiment to study the effect of planting tea close to the residues of the one-year-old Guatemala Grass root stocks. All the other St Coombs young-tea experiments had been planted so that tea was sited uniformly in relation to the regularly planted grass. Height and girth measurements on these clones indicated that a wide variation in distance from the root stocks had no effect on the tea in the first 6 months.

Accordingly a simple experiment was superimposed to compare muriate and sulphate of potash, as surface applications at high levels.

**AYT 12—Guatemala Grass ; NP Dolomite—3<sup>3</sup>—(1965)**

These plots, which will receive only one application of fertilizer, were established in the same area as used for the earlier *YT* experiments and will be planted in tea by mid-1964. It is hoped to assess the residual effects of the grass mulch and to superimpose other fertilizer treatments to the tea itself.

**AYT 13—Rehabilitation—(1965)**

This experiment is related to **AYT 12** and will enable a comparison to be made between soil (previously under tea) left fallow for one year, and areas under Guatemala Grass over the same period.

**LAYT 1—S/A, CAN and urea formaldehyde placed in 3 different ways—3<sup>3</sup> factorial—(1965)****LAYT 2—Three levels and methods of placement of three phosphate fertilizers : superphosphate, saphosphosphate, potassium metaphosphate placed in 3 different ways—3<sup>3</sup> factorial—(1965)**

Late in the year it was possible to plant three clones on St Joachim Estate in two experiments, each of a standard 3<sup>3</sup> design. **LAYT 1** investigates the effect of S/A, calcium ammonium nitrate and urea formaldehyde placed in three ways : dibbled in to the surface immediately after planting, mixed into the bottom of the hole, mixed with the spill and placed round the sides of the polythene sleeve plant (polythene having been removed). To-date, it can be seen that the first two fertilizers have caused several deaths when placed near the shallower roots. This effect is of considerable importance when compared with the findings in **AYT 7** on St Coombs. It is intended to follow up all investigations under conditions differing widely from St Coombs, whenever the opportunity arises.

**LAYT 2** is similar to the above, substituting the same phosphate fertilizers used in **AYT 6** on St Coombs.

S. Sivasubramaniam

*Chemical Control of Weeds*

Responsibility for this work was transferred from the Agronomy Division with one experiment.

**W 1—3 levels of Simazine + Gramoxone on clone TRI 2142—Randomized block of 3 levels of Simazine replicated twice, split on 2 levels of Gramoxone in blocks—(1965)**

The bushes have recently been brought into plucking and it is not yet possible to determine if past treatments have had appreciable effects on bush development.

Work in this field cannot at present be given high priority, but there is need to include some of the commoner available herbicides in the series of experiments already started in the *YT* series. Emphasis will be laid on the use of several clones, as with other crops it is already established that different crop clones can react in very different ways to the same herbicide. Enhancement of growth may even be expected in some cases.

Pre-emergence herbicides, such as Simazine and diuron (Karmex), and the contact herbicides paraquat and diquat will form the basis of these experiments. The need to control weeds between the time of cutting-out Guatemala Grass and of planting the tea is the focal point of three experiments, just started in a very weedy area of Guatemala Grass on St Coombs.

Exploratory spraying with paraquat suggested the value of more detailed work with this chemical to control moss and fern after pruning. Flood jets may be used, enabling a more powerful penetration of the spray into the frames and possibly offering a practicable means of spraying into lung-pruned frames without damaging the lungs themselves.

Diquat has been brought into the picture recently as it was found that paraquat was not effective at low dosage against some of the commonest and most troublesome *Compositae*; especially *Gynura crepidioides*. Young-tea areas have been used for this investigation and again flood-jets, used to give a horizontal fan of spray, appear to offer a means of reducing damage to low-lying tea branches.

S. Sandanam & A. Somaratne

### Extension Experiments

After many years of discussion, the policy was adopted of inviting the co-operation of estates in running long-term field experiments. The Agricultural Chemistry Division has been assigned responsibility for the overall design of all fertilizer experiments and for the conduct of those experiments outside the low-country and Uva. To-date the small staff yet available have assisted the Plant Physiology Division in marking out shade experiments, and have started six new fertilizer experiments. One of these (A11) through a generous offer by Mr G. B. Middleton of Tangakelle Estate, will be recorded in detail by our staff. The remainder will be of very simple design and plucking records will be kept by the estates themselves. Levels of nitrogen in conjunction with three types of nitrogenous fertilizer are the treatments calling for immediate investigation.

**XA1**—CAN, S/A and urea each at 3 levels with shade on seedling tea at Tangakelle Group, Lindula—2 replicates of  $3^2$ —(1965)

**XA2**—CAN, S/A and urea each at 3 levels with shade on seedling tea at Mayfield Estate, Kotagala—2 replicates of  $3^2$ —(1965)

**XA3**—CAN, S/A and urea each at 3 levels with shade on seedling tea at Hauteville Estate, Agrapatana—2 replicates of  $3^2$ —(1965)

**XA4**—CAN, S/A and urea each at 3 levels without shade on seedling tea at Diyagama East Estate, Agrapatana—2 replicates of  $3^2$ —(1965)

**XA5**—CAN, S/A and urea each at 3 levels without shade on clone TRI 2023 at Ederapolla Group, Bulathkohupitiya—2 replicates of  $3^2$ —(1965)

As the staff is enlarged it should be possible to see an increase in momentum in 1966. Results from established, more comprehensive experiments on St Coombs and in the low-country already show the urgent necessity to obtain supplementary information from simple experiments done under a wide range of conditions of management and of ecology.

### Publications

TOLHURST, J. A. H. & RICHARDS, A. V. (1965). A revised fertilizer mixture for nurseries—T 55. *Tea Quart.* **36**: 43-45.

TOLHURST, J. A. H. (1965). Economizing on phosphate and potash for mature tea. *Tea Quart.* **36**: 45-47.

# REPORT OF THE PLANT PROPAGATION DIVISION

*Adviser* - A. V. Richards, MSc, Dip Agric, AICTA

## General

Mr A. L. J. de Croos, Technical Assistant, resigned in February to take up a planting appointment. Messrs D. Janakiram and A. S. B. Gomez assumed duties as Technical Assistants from 1st April and 1st October, respectively. Mr A. R. Sebastiampillai, Research Assistant in Plant Breeding was awarded a Colombo Plan Fellowship and left for the UK in August for post-graduate studies. Mr D. D. Kroon, Technical Assistant, was transferred to the Low-Country Station in June. Mr D. Janakiram left in August on a Commonwealth Scholarship for post-graduate studies at New Delhi. Mr V. S. Kulasegeram, Research Assistant, continued his post-graduate studies at the College of Agriculture, Wye.

The nursery on St Coombs Estate was supervised by this Division from 1st October. A food production garden was started in September.

## Field Experiments and Trials

**VP1—Clonal testing—Split-plot—2 replicates of 32 clones split on shade—(1961)**

The clones tested were TRI 777, TRI 2024, TRI 2025, TRI 2023, TRI 2026, TRI 2027, TRI 2151, CR 4, CV 4 B1, CV 5 B1, CY 9, DG 39, DT 1, EN 31, GMT 9, K 136, K 150, KEN 15/7, KEN 16/3, MT 18, MT/BG N, NL 3/1, NL 4/2, PA 22, PO 26, QT 1/5, Seed, T 5/3, T 5/35, TK 48, UH 9/3.

Two years of weekly plucking were completed in August 1965. The highest yielders continued to be the TRI Clones 2025, 2023, 2026 and 2024, with CV 4 B1, CR 4, QT 1/5, EN 31 as the lowest. The calculated mean yields in lb/acre/annum of made tea for two years of each of the 31 clones and the seedling selection are given in Table 1. Yields from both unshaded and shaded plots have been combined.

TABLE 1—Mean yield of clones at St Coombs

|          |        |          |        |
|----------|--------|----------|--------|
| TRI 2025 | — 2817 | K 150    | — 1861 |
| TRI 2023 | — 2699 | T 5/3    | — 1783 |
| TRI 2026 | — 2583 | PA 22    | — 1780 |
| TRI 2024 | — 2521 | MT 18    | — 1764 |
| GMT 9    | — 2501 | DG 39    | — 1696 |
| TRI 2027 | — 2475 | K 136    | — 1662 |
| TK 48    | — 2424 | NL 3/1   | — 1638 |
| TRI 2151 | — 2411 | T 5/35   | — 1584 |
| KEN 16/3 | — 2379 | TRI 777  | — 1479 |
| N        | — 2367 | KEN 15/7 | — 1444 |
| DT 1     | — 2357 | PO 26    | — 1297 |
| CY 9     | — 2324 | NL 4/2   | — 1289 |
| MT/BG    | — 2273 | EN 31    | — 1116 |
| CV 5 B1  | — 2161 | QT 1/5   | — 1097 |
| UH 9/3   | — 1917 | CR 4     | — 1020 |
| Seed     | — 1875 | CV 4 B1  | — 1006 |

LSD at P=0.05—337

The difference in yield under shade and no shade treatments is also statistically significant (Table 2).

TABLE 2—Mean yield of all clones with and without shade

| Mean yield<br>(lb made tea/acre) | Shade | No Shade |
|----------------------------------|-------|----------|
|                                  | 1849  | 2000     |

LSD at P=0.05 — 85

**VP2—Clonal testing—Split-plot—2 replicates of 16 clones split on shade—(1962)**

The clones tested were TRI 2016, TRI 2043, TRI 2024, TRI 2022, TRI 2039, TRI 2020, CH 13, D, H6 A1, H 13/4, KP 204, MG, MG 3 B1, MPA 1, N3, NK 4 B29.

One year's weekly plucking was completed in December. The results have yet to be analysed. The highest yields were obtained from clones TRI 2022 and N3.

H. R. Solomon

**VP3—Clonal testing—Split-plot—2 replicates of 12 clones split on shade—(1963)**

The clones tested were TRI 2021, TRI 2046, TRI 2024, B 275, DG 3, DG 7, DG, E 7/27, ML 7, TGK 2, W 3, W/2 145.

The plants were brought into plucking.

H. R. Solomon

**VP4—Clonal testing—Split, split-plot—2 replicates of 14 clones and 2 seedling progenies split on shade—2 levels of N further split on the sub-blocks—(1964)**

The clones tested were TRI 1530, TRI 1526, TRI 1114, TRI 2024, TRI 2142, CAR 7/10, DW 12, MO 114, MO 116, MO 146, MO 208, MO 241, PLLG 2, QT 4/4, Seed (Bi-clonal Lansdowne C), Seed (Illuketenne).

The N treatments will be introduced in 1966. The shade vs none treatments are in 4 blocks. Each plot contains 36 bushes.

H. R. Solomon

**VP5—Clonal testing—Split plot—4 replicates of 2 bringing-into-bearing treatments split on 10 clones—(1965)**

The clones tested were TRI 2024, TRI 2045, DA 1408, DK 1, DK 8, DK 17, DT 95, K 145, QT 3/3, TC 9.

None of the plots have shade. The two bringing-into-bearing treatments are bending, and cutting across.

H. R. Solomon

**VP6—Nursery testing of clones—(1965)**

Over 14 clones from estates in the Nuwara Eliya District were tested for rooting ability in the nursery. Of these Park 1, Park 2, Park 4, Pedro MG 3B & Concordia 34 which gave over 80% strike were selected for inclusion in the 1966 clonal proving trials subject to showing promise in other characteristics such as leaf quality and yield potential. Four other promising quality clones *viz* Powysland 1, Yuillefield 6/1, Goatfell SM 404 and GF 5/10 have also been included.

H. R. Solomon

**VP7—Suitability of different rooting media—Split-plot—4 replicates of 3 clones split on 5 rooting media—(1964)**

The final assessment which was completed in 1964 included dry weights of roots. These results were analysed and the significant difference between soils and between clones were calculated. The results are given in Table 3.

TABLE 3—Mean dry weight on roots  
(Date of planting cuttings—30th May 1964)

| Soils                              | Subsoil & tea fluff  | Tea soil | Subsoil | Guatemala Grass soil | Jungle soil |
|------------------------------------|----------------------|----------|---------|----------------------|-------------|
| Corrected mean dry weight of roots | 1.423                | 1.621    | 1.953   | 2.117                | 2.565       |
|                                    | LSD at P=0.05 —0.373 |          |         |                      |             |
|                                    | P=0.01 —0.498        |          |         |                      |             |
|                                    | P=0.001—0.654        |          |         |                      |             |
| Clones                             | TRI 25               |          | S 106   |                      | TRI 2024    |
| Corrected mean dry weight of roots | 1.258                |          | 1.746   |                      | 2.802       |
|                                    | LSD at P=0.05 —0.290 |          |         |                      |             |
|                                    | P=0.01 —0.387        |          |         |                      |             |
|                                    | P=0.001—0.508        |          |         |                      |             |

H. R. Solomon &amp; A. L. J. de Croos

**VP8—Phosphates on rooting of cuttings—4 replicates of 80 treatment combinations—(1965)**

A nursery experiment using two phosphatic fertilizers, superphosphate and saphosphosphate each at 4 levels. Five types of soil were used as rooting media. The clones tested were TRI 2025 (good rooter) and TRI 25 (poor rooter). The different levels of phosphate given in oz/cu yard of soil are as follows :

|                 |   |             |
|-----------------|---|-------------|
| Superphosphate  | — | 0, 3, 9, 15 |
| Saphosphosphate | — | 0, 2, 6, 10 |

The five types of soil used for testing were Guatemala soil, Gum soil, yellow subsoil, red (deep) subsoil and tea soil.

The 1st assessment was done in November and the results are being analysed. The final assessment will be completed in February 1966.

H. R. Solomon &amp; A. S. B. Gomez

**VP9**—*Rooting potential of cuttings taken from mother bushes pruned every month in the year—4 replicates of 12 treatment combinations—(1964)*

Three mother bushes of each of the TRI clones 2024, 1114, 777 and 23 were pruned every month starting from 1st October 1964 in order to provide three types of cuttings (a) those with dormant buds (b) those with active buds and (c) those with axillary shoots.

The 1st batch of cuttings became available for planting on 1st April 1965 *ie* six months after pruning. Because of high incidence of Blister Blight in May/June, suitable cuttings were not available from clones TRI 1114 and TRI 777 for planting in subsequent months. The trial is, however, being continued with the remaining TRI clones 2024 and 25.

H. R. Solomon

**LVP1**—*Clonal testing at the Kottawa Sub-station—Split-plot—2 replicates of 32 clones split on shade—(1961)*

(See **VP1** for list of clones)

Two years weekly plucking was completed during the year. The 1st two highest yielders are TRI 2023 and TRI 2026, the most popular clones in the low-country, while the two lowest yielders are N and TRI 777.

K. H. G. Gunapala

**LVP2**—*Clonal testing at the Kottawa Sub-station—Split-plot—2 replicates of 16 clones split on shade—(1962)*

(See **VP2** for list of clones)

One year's weekly plucking was completed and the results are being analysed.

K. H. G. Gunapala

**LVP3**—*Clonal testing at the Kottawa Sub-station—Split-plot—2 replicates of 12 clones split on shade—(1963)*

(See **VP3** for list of clones)

The plants were brought into plucking.

K. H. G. Gunapala

**LVP4** *Clonal testing at the Kottawa Sub-station—Split-plot—2 replicates of 14 clones and 2 seedling progenies split on shade—2 levels of N further split on the sub-blocks—(1964)*

(See **VP4** for list of clones)

The N treatments will be introduced in 1966. The shade *vs* none treatments are in 4 blocks. Each plot contains 36 bushes.

H. R. Solomon

**LVP5**—*Clonal testing at the Kottawa Sub-station Split-plot—4 replicates of 2 bringing-into-bearing treatments split on 10 clones—(1965)*

The clones tested were TRI 2024, TRI 2045, C 34, DA 1408, DK 8, DK 17, DT 95, K 145, LD 999, PK 4, QT 3/3, TC 9. None of the plots have shade. The two bringing-into-bearing treatments are bending, and cutting across.

K. H. G. Gunapala

**UVP1**—*Clonal testing at the Passara Sub-station*—Split-plot—2 replicates of 32 clones split on shade—(1961)

(See **VP1** for list of clones)

One year's weekly plucking was completed in April. The highest yielders were TRI 2026, T 5/3, TRI 2027, KEN 16/3, and NL 4/2, while the lowest were KEN 15/7, NL 3/1, K 136, CR 4 and the seedlings. The plants were severely affected by drought in July/August. It was of interest to observe that all the clones in a block on a wind-swept hill without shade but with slightly better soil were fresh and green compared to the clones in a similar block under shade but with comparatively poor gravelly soil which were badly scorched by drought. Evidently, clones on poor gravelly soil with low moisture retaining capacity are unable to compete successfully for moisture with shade. Both N and CY 9 showed appreciable resistance to drought although their yields were low compared to some of the TRI clones.

A. M. Abeysinghe

**UVP2**—*Clonal testing at the Passara Sub-station*—Split-plot—2 replicates of 16 clones split on shade—(1962)

(See **VP2** for list of clones)

A. M. Abeysinghe

**UVP3**—*Clonal testing at the Passara Sub-station*—Split-plot—2 replicates of 12 clones split on shade—(1963)

(See **VP3** for list of clones)

The plants will be brought into plucking in 1966.

A. M. Abeysinghe

**MVP1**—*Clonal testing at the Hantane Sub-station*—Split-plot—2 replicates of 32 clones split on shade—(1961)

(See **VP1** for list of clones)

Table 4 gives the calculated yields of one year's weekly plucking which was completed during the year.

TABLE 4—*Mean yield of clones (lb made tea/acre/year)*

|          |   |      |          |   |      |
|----------|---|------|----------|---|------|
| TRI 2026 | — | 2064 | KEN 15/7 | — | 1119 |
| DG 39    | — | 2053 | N        | — | 1106 |
| TRI 2023 | — | 1967 | PO 26    | — | 1083 |
| TRI 2025 | — | 1866 | PA 22    | — | 1049 |
| TRI 2151 | — | 1742 | T 5/3    | — | 1037 |
| KEN 16/3 | — | 1654 | UH 9/3   | — | 942  |
| TRI 2027 | — | 1651 | CR 4     | — | 936  |
| NL 3/1   | — | 1649 | Seed     | — | 914  |
| BG 18    | — | 1518 | TK 48    | — | 906  |
| MT/BG    | — | 1498 | QT 1/5   | — | 905  |
| T 5/35   | — | 1428 | CV 5 B1  | — | 834  |
| TRI 2024 | — | 1360 | K 150    | — | 809  |
| K 136    | — | 1236 | NL 4/2   | — | 780  |
| GMT 9    | — | 1234 | CY 9     | — | 739  |
| DT 1     | — | 1189 | TRI 777  | — | 512  |
| EN 31    | — | 1171 | CV 4 B1  | — | 446  |

Again the differences in yield under shade and no shade treatments is statistically significant (Table 5).

TABLE 5—Mean yield of all clones with shade and without shade

| Mean yield<br>(lb made tea/acre) | Shade<br>1094 | No shade<br>1368 |
|----------------------------------|---------------|------------------|
|----------------------------------|---------------|------------------|

LSD at  $P=0.05$  — 136

H. B. Ratnayake

**MVP2**—Clonal testing at the Hantane Sub-station—Split-plot—2 replicates of 16 clones split on shade—(1962)

(See **VP2** for list of clones)

H. B. Ratnayake

**MVP3**—Clonal testing at the Hantane Sub-station—Split-plot—2 replicates of 12 clones split on shade—(1963)

(See **VP3** for list of clones)

The plants will be brought into plucking in 1966.

H. B. Ratnayake

**MVP4**—Clonal testing at the Hantane Sub-station—Split-plot—2 replicates of 14 clones and 2 seedling progenies split on shade—2 levels of N further split on the sub-blocks—(1964)

(See **VP4** for list of clones)

The details are the same as for **VP4**.

H. B. Ratnayake

**MVP5**—Clonal testing at the Hantane Sub-station—Split-plot—4 replicates of 2 bringing-into-bearing treatments split on 10 clones—(1965)

The clones tested were TRI 2024, TRI 2025, DA 1408, DK 1, DK 8, DK 17, DT 95, K 145, QT 3/3, TC 9.

None of the plots have shade. The two bringing-into-bearing treatments are bending and cutting across.

H. B. Ratnayake

### Plant Breeding

**VP10**—Selection from open-pollinated clonal seedlings—(1962)

Open pollinated seedling of clone TRI 2078, ASS 4/10, TRI 2075, TRI 2024, TRI 2023, TRI 2025, TRI 2079, TRI 3011, TRI 777, E 7/27, KEN 16/3, TK 48, KEN 15/12 were planted in rows. Initial selections of seedlings from clones TRI 2025 and TRI 2024 appear to be vigorous growers. Twenty five of the most promising bushes were propagated by cuttings and all the bushes were brought into plucking.

A. R. Sebastampillai

**VP11—Selections from hand pollinated seedlings—(1963)**

A field trial consisting of seedlings obtained by controlled hand pollination involving clones TRI 2024, TRI 777, TRI 1114, ASS 4/10, DT 1, and DT 95 planted in rows. The hybrids show marked variability especially where DT 1 is a parent. The progeny of TRI 1114 × TRI 2024 continue to show vigorous growth and are large leaved. About 40 of the bushes planted in 1963 were propagated by cuttings. Cuttings obtained from the progeny of TRI 777 × TRI 2024 exhibited better vigour and uniformity than those of the other crosses. Twenty two of the bushes planted in 1964 were also propagated.

A. R. Sebastiampillai

**VP12—Selections from biclonal progeny—5 replicates of 7 treatments—(1964)**

The biclonal seedlings TRI 2023 × 2026 obtained from Lansdowne and Rambukkande are being compared with open-pollinated TRI 2024 seed and the respective clones. Yield records of these blocks will be maintained from early 1966.

A. R. Sebastiampillai

**VP13—Seedling progeny obtained from 8 commercial seed gardens—7 replicates of 10 treatments in randomized blocks—(1965)**

In each block 10 seedlings from seed gardens were planted in a row. The treatments also included open-pollinated seedlings of TRI clones 2024, 2025 and 2026. The estates from which seeds were obtained are Pettiagalala, Moolgama, Illuktenne, Glenanore, Kirimetiya, Tembiligala, Killarney and Chapelton.

A. R. Sebastiampillai &amp; A. S. B. Gomez

**VP14—Hand pollinated seedlings—(1965)**

Seedlings obtained by controlled hand-pollination of clones TRI 2024, TRI 777, ASS 4/10 and DT 95 were planted in rows. The biclonal progeny of TRI 777 × TRI 2043 is being compared with clone TRI 2043.

A. R. Sebastiampillai

**VP15—Field selections at No 11 and No 14—(1964)**

The 63 bushes selected from the 2 fields were categorized into three groups by carrying out a statistical analysis on the yield data of 32 plucks. The members of group 1 seem to be influenced by climatic changes and this group included the high-yielding ones. The yield pattern of these bushes corresponds to those of the high yielding ones over the same period.

Group 3 shows no noticeable fluctuation in yield and the yield pattern seems to correspond with that of the low-yielding clones. Group 2, however, is intermediate between groups 1 and 3.

A. R. Sebastiampillai &amp; A. S. B. Gomez

**VP16—To test the viability of seeds stored under different temperatures and for different periods of time—(1965)**

The material tested was TRI 2024 open pollinated seeds packed in sealed polythene bags and stored under temperatures of  $-15^{\circ}\text{C}$ ,  $-2^{\circ}\text{C}$ ,  $7^{\circ}\text{C}$  and  $24-28^{\circ}\text{C}$ . The trial was started on 9th July and the 1st batch of seeds

planted on 18th October in river sand beds and continued in subsequent months. Initial observations show that the seeds stored at a temperature of 7°C gave 100% germination and seeds stored at 24-28° gave 65-70% germination.

A. S. B. Gomez

### Visits, Lectures and Symposia

Mr A. V. Richards read a paper at the sessions of the Ceylon Association for the Advancement of Science on 'The Breeding, selection and propagation of tea'.

### Publications

- RICHARDS, A. V. (1965). The origin of the popular TRI clones. *Tea Quart.* **36** : 183-188.
- TOLHURST, J. A. H. & RICHARDS, A. V. (1965). A revised fertilizer mixture for nurseries—T 55. *Tea Quart.* **36** : 43-44.

A. S. B. Gomez

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# REPORT ON THE LOW-COUNTRY STATION

*Assistant Director* – L. H. Fernando, BSc, PhD

## **General**

### *The Low-country Station, St Joachim, Ratnapura*

Landscape gardening around the factory, laboratory and bungalows received attention under the direction of Mr D. M. A. Jayaweera, Superintendent of the Royal Botanic Gardens, Peradeniya, to whom we are grateful for his advice and visits to the Low-country Station. The roads around the factory, laboratory and bungalows were metalled and tarred ; and so also was the main road through St Joachim, which was done by the Public Works Department and paid for by the TRI. Mr G. S. Muttettuwegama, Superintendent, St Joachim Estate, co-operated wholeheartedly with the research staff of the Station, especially in the implementation of the experimental programme.

### *The Kottawa Sub-station, Talgampola, Galle District*

Mr K. H. G. Gunapala remained in charge of the Sub-station, and was responsible for its steady progress. The Sub-station is now 60 acres in extent, one-third of which has so far been planted in VP tea. A Tea Technology Experimental Unit was built and equipped.

## **Advisory Service**

Mr J. V. Sabanayagam continued to function as District Advisory Officer, covering the planting districts of Balangoda, Galle, Kalutara, Kegalle, Kelani Valley, Morawak Korale, Rakwana and Ratnapura. He was assisted by Mr H. H. Samarakoon. The third Wednesday of each month was reserved for visitors to St Joachim, and the Technologist, was invariably present to advise on tea manufacture. Special visits from District Planters' Associations to St Joachim were encouraged ; the Morawak Korale Planters' Association spent a full day on the Station. Mr J. V. Sabanayagam and Dr L. H. Fernando attended meetings of the District Planters' Associations.

Shot-hole Borer control was adopted on a larger extent of the low-country estates. Side effects arising from dieldrin spraying were more severe than usual this year. Tea Tortrix was reported from many estates ; Faggot Worm, Cut Worm, Red Slug and Nettle Grub were less widespread. Three estates reported the Looper and Twig Caterpillar in large numbers ; chemical control measures were adopted ; in addition, hand-picking of the caterpillars and moths was done on some estates.

Consequent on the new fertilizer recommendations of the TRI, several estates sought advice on fertilizer economy and use ; generally nitrogen was increased and phosphorus and potassium reduced in fertilizer mixtures.

Rim-lung pruning was recommended where cut-across pruning was previously done, particularly where Shot-hole Borer occurred, and cleaning out of the dead wood was necessary.

Estates were advised to extend their cycles from 18 to 24 months ; some estates changed from 2 to 3 year cycles. One low-country estate adopting a four year cycle with VP tea obtained unprecedentedly high yields.

Wind damage is a serious problem in the Balangoda, Deniyaya and Rakwana Districts. Advice was given on the establishment of effective shelter belts of *Hakea saligna* and *Fagraea fragrans*.

Zinc deficiency was wide-spread on seedling tea in the low-country particularly on low-yielding estates. Zinc sulphate at 10 to 20 lb per acre per year was recommended.

Boron deficiency occurred on one estate in the Balangoda District. An initial application of 8 to 12 lb of fertilizer borate per acre per year, followed thereafter by applications of four pounds per acre per year was recommended for incorporation in the fertilizer mixture.

### Field Experiments and Trials

#### Fertilizer Experiments\*

**LA 1—NPKMg on seedling tea at Endane Estate, Kahawatte—3<sup>4</sup> factorial in 2 replicates—(1955)**

The sixth experimental cycle of 18 months was completed in April 1965. The response to nitrogen was significant in the last six months of the cycle—80 lb/N/acre/year increased the yield by 7% over no nitrogen. There was no significant increase in yield with applications of phosphorus, potassium and magnesium. Blocks treated with dieldrin yielded 14% more than those without dieldrin. Blocks treated with zinc sulphate gave no increase in yield, possibly because no dieldrin was applied.

J. I. H. Bandaranayake

**LA2—NKMg on VP tea at Karapincha, Palmgarden Group, Ratnapura—3<sup>4</sup> factorial (1961)**

The second experimental cycle of two years was completed in May 1965. The responses to nitrogen and its frequency of application were significant, and are given in Table 1.

TABLE 1—Yields in lb/acre over successive six-months periods

| Lb N/acre/year | 1st six months |     | 2nd six months |     | 3rd six months |     | 4th six months |     | Total yield of the 2-year cycle |     |
|----------------|----------------|-----|----------------|-----|----------------|-----|----------------|-----|---------------------------------|-----|
|                | yield          | %   | yield          | %   | yield          | %   | yield          | %   | yield                           | %   |
| 75             | 618            | 100 | 1968           | 100 | 2161           | 100 | 1598           | 100 | 6445                            | 100 |
| 150            | 619            | 100 | 2174           | 110 | 2319           | 107 | 1741           | 109 | 6753                            | 105 |
| 225            | 610            | 98  | 2094           | 106 | 2431           | 112 | 1913           | 120 | 7048                            | 109 |
| LSD (P=0.05)   | 29             | 5   | 119            | 6   | 151            | 7   | 49             | 3   | 246                             | 4   |

The response to nitrogen increased with time over the cycle. An average yield of 3222 lb/acre/year was obtained with only 75 lb N/acre/year. The highest yield, 3652 lb/acre/year was obtained with the highest level of nitrogen and the highest frequency of application *ie* 450 lb/N/acre/cycle in 11 applications. The decline in yield in the last six months of the cycle was a result of adverse weather.

N. Yogaratham

\* In collaboration with Mr. J. A. H. Tolhurst, Agricultural Chemist

**LA 3—NPKMg shade on seedling tea at St Joachim—3<sup>4</sup> factorial (1964)**

Over the first year shade was uniform over all plots. Thereafter, three shade treatments, *viz* no shade, *Gliricidia* at 14' x 14' and 7' x 7' were imposed on the 9 blocks. No significant differences in yield have so far resulted from any of the treatments.

U. P. de S. Waidyanatha

**LA 4—NPKMg on VP tea at Kottawa, Galle—3<sup>5</sup> factorial (1963)**

The tea was brought into plucking in December 1965. In addition to the three levels of N, P, K and Mg, an unfertilized plot was included in each block. Deficiency or insufficiency of the nutrient elements tested were evident, and affected the growth of the young tea. Three forms of nitrogen *viz* sulphate of ammonia, hoof and horn, and urea formaldehyde were also compared. The plots had no shade and were unsheltered; wind damage affected the plants adversely in the early stages.

K. H. G. Gunapala

**LA 5—Zn N frequency of application on seedling tea at St Joachim—Unreplicated—3<sup>3</sup> factorial—(1963)**

The response to Zn and to N recorded in the first 18 months of the cycle was not maintained in the last six months of the two year cycle ending April 1965; this may be a result of the adverse weather prevailing during a part of this period. The mean yields over the entire cycle are presented in Table 2.

TABLE 2—Mean yields over the cycle ending April 1965

| Treatments                            |     | Yields<br>lb/acre/cycle | %   |
|---------------------------------------|-----|-------------------------|-----|
| N (lb/acre/cycle)                     | 100 | 2785                    | 100 |
|                                       | 250 | 2948                    | 106 |
|                                       | 400 | 3042                    | 109 |
| ZnSO <sub>4</sub> (lb/acre/cycle)     | 0   | 2784                    | 100 |
|                                       | 20  | 3034                    | 109 |
|                                       | 40  | 2957                    | 106 |
| Frequency of application<br>per cycle | 7   | 2860                    | 100 |
|                                       | 9   | 2889                    | 101 |
|                                       | 11  | 3026                    | 106 |
| LSD (P=0.05)                          |     | 263                     | 9   |

The experiment is being continued; similar responses to nitrogen and zinc have been recorded over the first six months (June to December 1965) of the second experimental cycle.

J. I. H. Bandaranayake

**LA 6—Zn on seedling tea at Mahawela Estate, Ratnapura—8 randomized blocks (1963)**

The effects of zinc sulphate at 0, 10 and 20 lb/acre were compared. Yields over a two year cycle ending in October 1965 were increased 5 and 9% respectively by 10 and 20 lb zinc sulphate per acre, and the effect was

more pronounced in the latter part of the cycle. The yield without zinc was 979 lb/acre/year. The management of the experiment and the recording of yields was done by the Superintendent and staff of Mahawela Estate.

J. I. H. Bandaranayake

*Rehabilitation Experiments\**

**LA 7—Rehabilitation : species and fertilizer—Randomized blocks—(1963)**

Guatemala grass and *Pueraria phaseoloides* were grown separately and together. Guatemala grass surpassed *P. phaseoloides* in growth, and the two did not grow too well in association. The main plots were sub-divided to compare 2 and 4 cwt of sulphate of ammonia and 1 and 2 cwt of saphosphosphate, per acre per year. There were no great differences in growth between the two levels of fertilizer. In July 1965 clone TRI 2023 was planted in all the plots. Differences between plots in respect of the growth of tea will now be observed.

N. Yogaratnam

**LA 8—Rehabilitation with legumes—Randomized blocks—(1963)**

- The species are—
- 1 *Pueraria javanica*
  - 2 *Pueraria triloba*
  - 3 *Pueraria thunbergiana* (Kudzu)
  - 4 *Pueraria phaseoloides*
  - 5 *Crotalaria anagyroides*
  - 6 *Crotalaria brownei*
  - 7 *Flemingia congesta*
  - 8 *Tephrosia candida*
  - 9 *Centrosema pubescens*
  - 10 *Calapogonium mucunoides*
  - 11 *Alysicarpus vaginalis*
  - 12 *Dolichos lab-lab*
  - 13 *Indigofera steymanii*
  - 14 *Stylosanthes gracilis*
  - 15 *Desmodium ovalifolium*

The legumes were uprooted and clone TRI 2023 was planted in October 1965.

N. Yogaratnam

**LA 9—Rehabilitation : species, fertilizer and duration—3<sup>5</sup> factorial—(1965)**

Eighty-one plots were demarcated. The plots will be uprooted of tea in 1965, 1966 and 1967 and tea will be replanted in all plots in 1967, thus providing 2, 1 and 0 years of rehabilitation respectively. The rehabilitation species are Guatemala with *Pueraria phaseoloides*, Guatemala with *Calapogonium mucunoides*, and *Crotalaria anagyroides* with *P. phaseoloides*. Three levels of nitrogen will also be compared during the rehabilitation period.

N. Yogaratnam

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\* In collaboration with Mr J. A. H. Tolhurst, Agricultural Chemist

*Cultural Experiments*

**LA 10**—6 promising clones at 3 levels of N and 3 levels of shade at St Joachim—Fertilizer  $\times$  shade in 9 main plots, clones in 6 sub-plots, 2 replicates—(1965)

Clones : TRI 2023, TRI 2026, TRI 2043, MT 18, KEN 16/3 and N 3  
 Nitrogen : 40, 80 and 120 lb/acre/year  
 Shade : *Gliricidia* at 7'  $\times$  7', 14'  $\times$  14' and no shade  
 The experiment was planted in June.

H. D. Jayasinghe

**LA 11**—Bringing into bearing, plucking, pruning, and duration of cycle at St Joachim—3<sup>5</sup> factorial—(1964)

Clone TRI 2023 is being used for this experiment. A comparison is being made between bending once, bending twice and centering. Levels of N, intensity of plucking, methods of pruning and duration of cycle will be introduced later. For the present all plots have been fertilized uniformly with T200. Plucking will commence in June 1966.

H. D. Jayasinghe

**LA 12**—3 clones, 3 spacings and 3 levels of N at the Kottawa Sub-station—3<sup>3</sup> unreplicated—(1961)

Clones TRI 2024, TRI 2016 and QT 4/4 were planted at Kottawa in July 1961 at spacings of 4'  $\times$  1½', 4'  $\times$  2' and 4'  $\times$  2½'. All plots were initially fertilized uniformly ; later 100, 200 and 300 lb N per acre per year were applied. The results obtained have not yet been statistically analysed. Clone TRI 2024 at the spacing of 4'  $\times$  2' gave the highest yield so far.

K. H. G. Gunapala

**LA 13**—3 clones, 3 spacings and 3 levels of N at the Kottawa Sub-station—3<sup>3</sup> unreplicated (1962)

Clones TRI 2023, TRI 2026 and 18B were planted at Kottawa in October 1962 at a spacing of 4' between rows and 14", 28" and 42" in the row. All plots were initially fertilized uniformly and later differentially with 100, 200 and 300 lb N per acre per year. The results have not yet been analysed. Clone TRI 2023 at 4'  $\times$  28" has so far given the highest yield.

K. H. G. Gunapala

**LA 14**—Spacing and fertilizer on VP tea at St Joachim—3<sup>5</sup>—(1965)

Clone 2023 was planted in August 1965 at spacings of 3½', 4' and 4½' between rows, and 1½', 2' and 2½' in the row. Nitrogen is being compared at 50, 100 and 150 lb per acre per year. Other cultural factors may be introduced later.

H. D. Jayasinghe

**LA 15**—Pruning of VP tea at St Joachim—4 randomized blocks—(1964)

Rim lung, centre lung and cut across pruning were compared, with and without a preceding rest period of two months, during which no plucking was done. The results obtained indicated that rim-lung pruning gave the highest yield and that no rest was better than rest. With time these differences decreased and were not significant at the end of 18 months.

J. I. H. Bandaranayake

**LA 16—NPK on VP tea at Hunuwella Group, Opanaike—3<sup>5</sup> factorial—(1965)**

Ninety plots were demarcated and pre-treatment yields recorded.

**LA 17—Types and levels of N, levels of dolomite on seedling tea—3<sup>3</sup> factorial—(1965)**

27 plots were demarcated and pre-treatment yields recorded.

**Testing of Clones\*****LVP 1-5—Evaluation of clones at the Kottawa Sub-station—Randomized blocks, 2 with shade and 2 without shade**

Clones planted in experimental plots every year from 1961 to 1965 are listed below :

| 1961     | 1962     | 1963     | 1964              | 1965     |
|----------|----------|----------|-------------------|----------|
| TRI 777  | TRI 2016 | TRI 2021 | TRI 1114          | TRI 2024 |
| TRI 2023 | TRI 2020 | TRI 2024 | TRI 1526          | TRI 2045 |
| TRI 2024 | TRI 2022 | TRI 2045 | TRI 1530          | C 34     |
| TRI 2025 | TRI 2024 | TRI 2046 | TRI 2024          | DA 1408  |
| TRI 2026 | TRI 2039 | B 275    | CAR 7/10          | DK 8     |
| TRI 2027 | TRI 2043 | DG       | CW 21             | DK 17    |
| TRI 2151 | CH 13    | DG 3     | DW 12             | DT 95    |
| CR 4     | D        | DT 7     | H 1/58            | K 145    |
| CV 4 B1  | H 6 A1   | DT 43    | MO 114            | LD 999   |
| CV 5 B1  | H 13/4   | E 7/27   | MO 116            | PK 4     |
| CY 9     | KP 204   | ML 7     | MO 146            | QT 3/3   |
| DG 39    | MG       | TK 2     | MO 208            | TC 9     |
| DT 1     | MG 3 B1  | W/2 145  | PLIG 2            |          |
| DT 18    | MPA 1    | W 3      | QT 4/4            |          |
| EN 31    | N 3      |          | Seed (Illuktenne) |          |
| K 136    | NK 4B 29 |          | Seed (Bi-clonal   |          |
| K 150    |          |          | Landsdowne C)     |          |
| KEN 15/7 |          |          |                   |          |
| KEN 16/3 |          |          |                   |          |
| MT/BG    |          |          |                   |          |
| N        |          |          |                   |          |
| NL 3/1   |          |          |                   |          |
| NL 4/2   |          |          |                   |          |
| PAS 22   |          |          |                   |          |
| PO 26    |          |          |                   |          |
| QT 1/5   |          |          |                   |          |
| T 5/3    |          |          |                   |          |
| T 5/35   |          |          |                   |          |
| TK 48    |          |          |                   |          |
| UH 9/3   |          |          |                   |          |
| Seed     |          |          |                   |          |

In the 1961 experiment, TRI 2023 and TRI 2026 yielded highest, giving 3982 and 3831 lb/acre in the fourth year from planting. Other clones which yielded between 2500 and 3000 lb/acre were TRI 2024, MT/BG, MT 18, DG 39, T 5/35, UG 9/3, PO 26 and PA 22. In the 1962 experiment TRI 2043, yielded highest, giving 1871 lb/acre in the third year from planting.

K. H. G. Gunapala

\* In collaboration with Mr A. V. Richards, Adviser in Pant Propagation

**LVP 6—Clonal testing at St Joachim—observation plots unreplicated—(1964)**

Seventy-eight VP clones along with seedlings of TRI 2023, TRI 2026 and TRI 2023 × TRI 2026 were planted at St Joachim in June 1964 :

|                         |  |
|-------------------------|--|
| Tea Research Institute  | — 331, 452, 777, 1114, 1526, 1530, 2016, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2039, 2043, 2045, 2046, 2142, 2151. |
| Balangoda               | — DG 39, MT/BG, MT 18, DG 7  |
| Canavarella             | — MG 3/B 1, NK 4/B29, CV 4/B1, CV 5/B1   |
| Carolina                | — CAR 7/10   |
| Coombewood              | — CW 21  |
| Court Lodge             | — CL 26  |
| Craig                   | — CR 4   |
| Craighead               | — CH 13  |
| Diyagama West           | — N, DG, D   |
| Diyaniakelle            | — DK 8, DK 1   |
| Downside                | — DW 12, DW 29   |
| Drayton                 | — DT 1   |
| Endane                  | — EN 31  |
| Gonamotawa              | — GMT 9  |
| Hellbodde               | — H 13/4   |
| Hulanduwa               | — H 1/58   |
| Karapincha (Palmgarden) | — KP 204, K 2039   |
| Kenilworth              | — KEN 15/7, KEN 16/3   |
| Kirkoswald              | — K 136, K 150   |
| Landsdowne Seed         | — 2023, 2026, BI-CLONAL (2023 × 2026)  |
| Mooloya                 | — M 209, M 21, M 20, M 241, M 208, M 116   |
| Moraya                  | — MG   |
| Nayabedde               | — Nay 3  |
| Neluwa                  | — NL 4/2, NL 3/1   |
| Passara                 | — PA 22, MPA 1   |
| Poonagala               | — PUH 5, PCG 2   |
| Poronuwa                | — PO 26  |
| Queenstown              | — QT 4/4, QT 1/5   |
| Rambukkande Seed        | — BI-CLONAL (2023 × 2026)  |
| Somerset                | — E 7/27   |
| Talankande              | — TK 48  |
| Tangakelle              | — CY 9, WY   |
| Thotulagalle            | — T 5/35, T 5/3  |
| Tillicoultry            | — TC 9   |
| Uva Highlands           | — UH 9/3   |
| Wooton                  | — W 3  |

The plots will be brought into plucking in June 1966.

D. D. Kroon

**LVP 7—Clonal selection—(1965)**

In four fields of St Joachim, 1000 bushes were selected initially; 500 of these were eventually propagated in the nursery for further tests. 4000 seedlings, raised from open pollinated seed from Endane, were planted closely (6" × 6") in nursery beds. Any outstanding plants will be selected for further tests. One thousand biclonal seedlings of TRI 2023 × TRI 2026 have also been planted at 6" × 6", and 12" × 12" for selection.

D. D. Kroon

*Herbicide Experiments***LW 1—Efficacy of herbicides on weeds in seedling tea—3 randomized blocks—(1964)**

The herbicides tested are given below :

| <i>Herbicide</i> | <i>Rate per acre</i> |
|------------------|----------------------|
| 1 Gramoxone      | — 1 & 2 pints        |
| 2 Diuron         | — 2 & 4 lb           |
| 3 Simazine       | — 2 & 4 lb           |
| 4 Aminotriazole  | — 2 & 4 lb           |
| 5 Dowpon         | — 2 & 4 lb           |
| 6 2.4 D          | — 1 & 2 lb           |
| 7 MCPA           | — 1 & 3 pints        |
| 8 2.4.5. T       | — 1 & 2 pints        |
| 9 Shell DH 34    | — 2 & 6 pints        |

Weeded and unweeded plots, 2 of each, were included in each block. Of the several herbicides tested, Gramoxone, Diuron and Simazine were the most effective. Gramoxone at 1 and 2 pints per acre controlled weeds effectively for a period of 2 to 3 months. Gramoxone caused scorching of the tea leaves on contact, but had no residual effects. Simazine and Diuron at 2 and 4 lb per acre were also effective, but toxic symptoms were observed in the tea particularly at the higher level, and persisted because of the residual effects of these herbicides. Diuron caused chlorosis of the leaves of tea on contact, and also through root absorption, while Simazine acted only through the roots. Diuron was effective for a longer period than Gramoxone and Simazine. None of the herbicides tested were without phytotoxic effects on tea, but in this respect Gramoxone was the best. There were no differences in yield between the herbicide-treated plots, the hand-weeded plots and the un-weeded plots over a period of six months.

U. P. de S. Waidyanatha

**LW 2—Some Triazines on weeds in seedling tea—2 randomized blocks—(1965)**

Simazine, Atrazine, Prometone, Semeron (Desmetryne), Propazine, Atratone and Prometryne at 2 and 4 lb per acre were compared. Weeded and unweeded plots, 2 of each were included in each block. Simazine was the least phytotoxic on tea. Atrazine, Atratone and Semeron (Desmetryne) were more effective but more toxic on tea. It was observed that the Triazines tested were not sufficiently effective on *Cyperus tenuiculmis* which is the predominant cyperaceous weed at St Joachim.

U. P. de S. Waidyanatha

**LW 3—Efficacy of Gramoxone, Diuron and Simazine, separately and in combination—4 randomized blocks—(1965)**

As Simazine and Diuron are pre-emergent herbicides and Gramoxone a contact herbicide, an attempt is being made to combine these to achieve better control of weeds. Gramoxone ( $\frac{1}{2}$  pint per acre) in combination with Simazine or Diuron (1 lb per acre) was more effective than each of these herbicides applied separately.

U. P. de S. Waidyanatha

**LW 4**—*Levels of Gramoxone on weed populations of various densities—3 randomized blocks—(1965)*

1,  $\frac{1}{2}$ ,  $\frac{1}{4}$  and  $\frac{1}{8}$  pint of Gramoxone are being compared on plots which were unweeded for 2, 3 and 4 months.

U. P. de S. Waidyanatha

**LW 5**—*Weed effects on crop growth and yield—5 randomized blocks—(1965)*

Yields of plots hand-weeded once in 2, 4 and 6 months will be compared against the yield of a Gramoxone treated plot, at 100 and 200 lb N per acre per year.

U. P. de S. Waidyanatha

### Extension Experiments

In all 18 Extension Experiments were set down in 1965. **XLA 1** to **XLA 10** were carried out in collaboration with the Division of Agricultural Chemistry, **XLPH 1** in collaboration with the Division of Plant Physiology and **XLE 1** to **XLE 7** in collaboration with the Division of Entomology.

**XLA 1**—*Types of N (Urea, CAN, S/A) on VP tea at Hunuwella Group, Opanake*

**XLA 2**—*3 levels of N  $\times$  3 frequencies of application on VP tea at Hunuwella Group, Opanake*

**XLA 3**—*Levels of Dolomite on VP tea at Hunuwella Group, Opanake*

**XLA 4**—*4 levels of N  $\times$  2 levels of shade on VP tea at Hunuwella Group, Opanake*

**XLA 5**—*4 levels of N  $\times$  2 levels of shade on seedling tea at Hunuwella Group, Opanake*

**XLA 6**—*4 levels of N  $\times$  2 levels of shade on VP tea at Endane Estate, Kahawatta*

**XLA 7**—*4 levels of N  $\times$  2 levels of shade on seedling tea at Endane Estate, Kahawatta*

**XLA 8**—*4 levels of N  $\times$  4 levels of shade on seedling tea at Rayigam Estate, Ingiriya*

**XLA 9**—*4 levels of N  $\times$  2 levels of shade on seedling tea at Hatherleigh Estate, Rakwana*

**XLA 10**—*4 levels of N  $\times$  2 levels of shade on VP tea at Millakande Estate, Bulathsinhala*

**XLPH 1**—*Shade and no shade on seedling tea at St Joachim, Ratnapura*

**XLE 1**—*Diieldrin, aldrin and control on seedling tea at Hapugastenne Group, Ratnapura*

**XLE 2**—*Diieldrin, aldrin and control on seedling tea at Alupolla Group, Ratnapura*

**XLE 3**—*Diieldrin, aldrin and control on seedling tea at Hatherleigh Estate, Rakwana*

**XLE 4**—*Diieldrin, aldrin and control on seedling tea at Madampé Group, Rakwana*

**XLE 5**—*Methods of diieldrin spraying on seedling tea at Hapugastenne Group, Ratnapura*

**XLE 6**—*Mid cycle application of aldrin on seedling tea at Hapugastenne Group, Ratnapura*

**XLE 7**—*Mid cycle application of aldrin on seedling tea at Alupolla Group, Ratnapura.*

# REPORT OF THE PLANT PHYSIOLOGY DIVISION

*Plant Physiologist* – U. Pethiyagoda, BSc, PhD, DIC

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## General

Mr S. Nagarajah was promoted to the post of Research Assistant from 1st June. Mr N. S. Rajendram was transferred to the Low-Country Station on 1st November on medical advice. With his immediate presence, it is hoped to expand the activities of the Division in the low-country.

## Laboratory Investigations

### The determination of leaf areas

A 'grid' for the direct assessment of the areas of tea leaves was designed, and an article has already been published. The device has proved to be very convenient and accurate, and now provides a rapid and non-destructive means for the measurement of this important factor.

N. S. Rajendram

### Growth inhibitory substances in tea

Arising from observations in field experiments (Nagarajah and Pethiyagoda 1965) attempts have been made to investigate further the apparent growth inhibitory influence in different organs of the tea bush. Ethanol extracts fed from chlorophyll are fractionated by paper chromatography and the successive segments of the chromatogram are eluted and bio-assayed using very young seedlings of lettuce. Strong inhibition of extension of lettuce hypocotyls is consistently associated with certain regions of the chromatogram. Although the identities of the inhibitors remain to be established the possibility of their being polyphenols or related substances is under investigation. They are present in relatively large amounts in unopened buds and young leaves, somewhat less in the older leaves and in small amounts in stem and root.

S. Nagarajah

## Field Experiments and Trials

**PH 1—Artificial shade**—Split-plot with shade on the main blocks, 4 fertilizer combinations split on shade—(1961)

The shade screens were removed at the end of June and plucking records continue to be maintained. Fertilizer applications continued at the previous rates. The yields recorded since the inception of this experiment are summarized in Table 1, being separated into the yields recorded while the shade screens were present (Periods 1 & 2) and those after their removal (Period 3).

TABLE 1—Summary of yields of crop for the duration of the experiment (May 1961-December 1965)—Each figure for yield represents the mean fresh weight in pounds per plot—Period 1, part of first cycle—Period 2, second cycle until shade removal—Period 3, second cycle after shade removal

(a) *Shade effects*

| Light Intensity<br>as % sunlight | Period and number of plucks |        |          |       |
|----------------------------------|-----------------------------|--------|----------|-------|
|                                  | 1(69)                       | 2(117) | 1+2(186) | 3(24) |
| 40                               | 36.08                       | 52.99  | 89.07    | 11.98 |
| 60                               | 40.24                       | 58.41  | 98.65    | 12.18 |
| 100                              | 37.98                       | 51.06  | 89.04    | 10.46 |
| LSD at P=0.05                    | NS                          | 5.16   | NS       | NS    |

(b) *Nitrogen effects*

| Nitrogen as lb<br>per acre annum | Period and number of plucks |        |          |       |
|----------------------------------|-----------------------------|--------|----------|-------|
|                                  | 1(69)                       | 2(117) | 1+2(186) | 3(24) |
| 100                              | 35.55                       | 50.16  | 85.71    | 10.22 |
| 200                              | 40.65                       | 58.15  | 98.80    | 12.87 |
| LSD at P=0.001                   | 3.48                        | 4.13   | 6.04     | 1.37  |

(c) *Shade × nitrogen interaction* (186 plucks, May 1961-June 1965)

| Nitrogen                       | Light intensity as % sunlight |        |       |       |
|--------------------------------|-------------------------------|--------|-------|-------|
|                                | 40                            | 60     | 100   | Mean  |
| N <sub>1</sub> (100 lb)        | 86.19                         | 91.61  | 79.30 | 85.70 |
| N <sub>2</sub> (200 lb)        | 91.94                         | 105.69 | 98.77 | 98.80 |
| Mean                           | 89.07                         | 98.65  | 89.04 | 92.25 |
| N <sub>2</sub> —N <sub>1</sub> | 5.75                          | 14.08  | 19.47 | —     |

LSD for difference P=0.05–5.82 ; P=0.01–7.86 ; P=0.001–10.46

It will be noted that light intensity by itself has not brought about significant differences in yield while the higher nitrogen level was consistently superior to the lower level. Levels of potash were without significant effect throughout the experiment. The interaction table illustrates the progressively superior response to increased nitrogen as the level of illumination increases.

Just prior to the removal of the shade screens, wind intensity recordings were made at one foot above the level of the plucking table in the centre of each shade block. The results indicated that under similar shade and fertilizer treatments, the more sheltered blocks tended to give higher yields. Examined in conjunction with the pre-treatment yield records, there is a strong suggestion that the plots which secured the greater shelter from the erection of the screens bettered their performance in comparison to those which remained more exposed to wind.

**PH2**—*Mana and Guatemala as reconditioning grasses*—2 plots of each grass, replicated at 4 locations—(1962)

Plants of clone TRI 2026 were planted on the plots at a spacing of 2 ft × 2 ft after normal preparation of the land. The plants have been allowed free growth, being fertilized with T200 at  $\frac{1}{2}$  oz every two months. Sample

subplots consisting of 12 plants were assessed periodically from all of the plots. Fresh and dry weight determinations of leaf, stem and root were made. There were no significant differences in the growth of tea on the plots reconditioned with the two grasses, at any of the four locations.

**PH 3—Growth analysis**—split-plot design ; 5 replicates of 5 cultural treatments split on 2 clones—(1963)

Fresh and dry weight assessments of all the main plant components as well as leaf areas have been measured at each sampling occasion for the calculation of conventional 'growth analysis' terms. No significant differences have yet emerged. It is too early to comment further on the results.

**PH 4—Types of pruning**—5 replicates of 6 treatments—(1963)

With the exception of the clean pruned treatment and the pruned portions of the 'half-pruned' bushes, the experimental area was pruned in July. The yields during the period before pruning (82 plucks) are summarized in the first column of Table 2.

TABLE 2—*Effects of pruning treatments on yield of crop and on subsequent pruning weights—Yields are in pounds fresh weight of flush per plot of 25 bushes—Pruning weights represent the combined fresh weight of wood and leaf and are the means of two sample plots for each treatment*

| Pruning treatment           | (1)              |                         | (2)                        |
|-----------------------------|------------------|-------------------------|----------------------------|
|                             | Yield<br>(in lb) | Yield<br>(as % control) | Pruning weights<br>(in lb) |
| (a) Clean prune             | 101.38           | 71.2                    | —                          |
| (b) Peripheral half prune   | 116.26           | 81.7                    | 189.55                     |
| (c) Longitudinal half prune | 120.74           | 84.8                    | 258.38                     |
| (d) Cut across              | 130.70           | 91.8                    | 399.70                     |
| (e) Lower leaves stripped   | 133.22           | 93.6                    | 377.02                     |
| (f) Control                 | 142.38           | 100.0                   | 417.00                     |
| LSD at P=0.05               | 11.04            |                         | 54.91                      |
| P=0.01                      | 14.96            |                         | 75.65                      |
| P=0.001                     | 20.04            |                         | 103.99                     |

The very drastic defoliation which constituted treatment (e) above has resulted in a negligible effect on crop. Removal of half of a bush in the half-prune treatments has apparently stimulated the yield of the remainder. Likewise the presence of the unpruned halves in the two half-prune treatments has evidently retarded the growth of the pruned halves. The mean weights of prunings recorded from two sample plots of each treatment are presented in the right hand column (2) of Table 2.

Recovery from pruning was very good in all treatments and yield records are being maintained in the new cycle. Once again, crop from the earlier and later pruned halves of treatments (b) and (c) are being recorded separately.

**PH 5—Mulching**—Split plot—3 replicates of 3 fertilizer levels as main treatment with 5 mulch treatments split on fertilizer levels—(1965)

The five mulching treatments are *Grevillea*, Dadap, Tea, Mana and un-mulched control. The levels of N are 45, 135 and 225 lb/acre/annum (as T700 mixture). The mulch in the form of green leaf is to be spread every month at a rate designed to provide 6.2 tons of fresh matter/acre/annum. The fertilizer will be applied in three equal doses at approximately four-month intervals. The mulching and fertilizing will be so arranged that

shortly after every fourth mulching, the fertilizer will be uniformly spread over the undecayed litter. In the unmulched controls, any natural tea leaf droppings will be swept away every two months.

Pre-treatment yields have been recorded and the first spreading of mulch carried out. It is hoped that the yields recorded will indicate whether any benefits or deleterious effects result from mulching; whether the different types of leaf used as mulch differ in their effects and whether there is any interaction between the levels of nitrogen (or potash or phosphate) and the mulch treatments as reflected in yield responses to nitrogen levels.

**PH 6—Hard pruning and methods of bringing into plucking—paired plots—(1964)**

This is a simple observation trial in an area where 'hard clean' and collar pruning were carried out by St Coombs Estate.

Each block was further split into three treatments viz 'plucked in' in June 1965, 'early tipping' in June 1965 and 'late tipping' in September 1965.

Yield records for each of the 36 plots will be maintained by the Estate. The frame development during the cycle will be assessed at the next prune.

**PH 7—Growth in the nursery—5 replicates of 5 treatments completely randomized—(1965)**

This experiment, using cuttings of TRI 2025 was laid down with the two-fold objective of obtaining growth analysis data for the early stages of growth to supplement PH3 and to study the effect of removal of the mother leaf at different intervals from planting, on the pattern of growth of the young plants.

The first three assessments have been carried out and full results will be available in about 9 months time.

S. Kandiah

**PH 8—The effect of varying duration of lung retention on recovery from pruning—5 replicates of 5 treatments in randomized blocks—(1965)**

Arising from the observation that unduly long retention of lungs could adversely affect recovery from pruning, an experiment has been commenced to assess the effect of 4, 8, 12 and 16 weeks of lung retention against a control that was clean pruned at the same time (*ie* 0 weeks).

The assessment falls due early in 1966.

N. S. Rajendram & S. Kandiah

**PH 9—Plucking rounds cum plucked unit—6 replicated blocks comprising 9 combinations (3 × 3) of treatments—(1965)**

Plucking rounds of 7, 10 and 14 days are combined with three types of plucked unit—bud plus one leaf, bud plus two leaves and bud plus three leaves.

After an appropriate period of 'normal' pre-treatment plucking (bud plus two leaves, on seven dry rounds), the treatments have commenced. It is yet too early to comment on the yield recorded.

**PH 10**—*Timing of fertilizer applications and recovery from pruning*—4 replicates of 6 treatments in randomized blocks—(1965)

This experiment was laid down in view of circumstantial evidence that certain cases of die-back from pruning may result from too close proximity to the pruning operation of the immediate pre-pruning and post-pruning applications of fertilizer. Fertilizer applications, each amounting to 60 lb N as T700 mixture are applied at the following intervals from pruning.

| Pre-pruning application  |         | Post-pruning application |
|--|---------|--------------------------|
| At 4 months before   | Pruning | At 2 months after        |
| At 3 months before   | Pruning | At 3 months after        |
| At 2 months before   | Pruning | At 4 months after        |
| At 1 month before  | Pruning | At 5 months after        |
| At 2 months before   | Pruning | At 2 months after        |
| No fertilizer applications between August 1965 and August 1966 |         |                          |

In order to create the best conditions for damage, pruning has intentionally been timed for mid-January 1966 in anticipation of prolonged dry weather following pruning.

N. S. Rajendram & S. Kandiah

**PH 11**—*Growth substances and recovery from pruning*—Unreplicated Latin square design with 14 treatments—(1965)

Fourteen compounds with known or presumed effects on bud initiation and growth were sprayed on to pruned frames of bushes of clone TRI 2025 at a concentration of 50 ppm. Drenchings were done immediately after pruning and again two weeks later, before bud growth had commenced. The numbers of sprouted buds on each bush were counted at eight weeks after pruning. There were no significant effects of the treatments. The same chemicals were sprayed on observation rows of five bushes each in the same area. In this trial, the first spray was at six weeks—after the commencement of bud break and again two weeks later. Three weeks after the second spray, all buds were stripped off the experimental bushes and assessed. Treatment effects on the numbers of shoots were significant ( $P < 0.01$ ) while total fresh weights, fresh weight of stems, fresh weight per shoot and fresh weight per stem were all significant ( $P < 0.001$ ). Adopting an arbitrary scoring system, it would appear that the compounds tested ranked themselves in the following order of decreasing benefit :

Indole-acetic acid (best), naphthoxyacetic acid, sucrose, potassium dihydrogen phosphate, untreated control, adenine, naphthaleneacetic acid, coumarin, gibberellic acid, urea, indolebutyric acid, fructose 1-6 diphosphate, tryptophan and 2-4 dichlorophenoxyacetic acid (worst).

It is intended to test the more interesting compounds further.

N. S. Rajendram

**PH 12**—*Hakea saligna as a 'shelter belt' plant*—(1965)

In trials in East Africa, *Hakea saligna* has proved to be very satisfactory as a 'shelter belt' tree for tea. An observation trial to assess its value under local conditions has been laid down.

Seedlings of *H. saligna* were spaced four ft apart to enclose three rectangular areas of tea of approximately 60 ft × 75 ft in a locality exposed to wind. In comparison, tea plants are being allowed to grow freely as borders to enclose three similar-sized areas.

Estimations of wind reduction will be carried out after the hedges are established and observations will also be made on any competitive effects of the hedges on the tea plants in their vicinity.

**PH 13—Rested tea bushes as shelterbelts—(1965)**

Selected rows of tea in a field which was recently pruned are being allowed to run up without being tipped or plucked, to produce windbreaks. Two different spacings between rested rows have been provided (50 and 35 rows apart).

It is intended to record crop yields from each of the sheltered areas and also to measure the reduction of wind resulting from the provision of the shelterbelts.

**PH 14—Total available carbohydrate (TAC) levels and recovery from pruning**

A trial in which an attempt was made to relate TAC percentages in the roots of sixty individual seedling bushes to their recovery from pruning was described in the Annual Report for 1964.

As reported, there was no significant correlation between TAC at pruning time and the weights of buds stripped off the recovering frames. It was further found that a similar situation existed in respect of the percentages of TAC apparently mobilized during recovery. However, the same bushes when stripped a second time showed a strong positive correlation between the bud weights at the two strippings of each individual bush. It is of interest to record that in spite of the second stripping of buds which must have reduced already low TAC levels even further, there followed fair recovery of nearly all the experimental bushes—although admittedly at a slower rate.

**TABLE 3—Partial correlation co-efficients to illustrate the relationship between TAC percentages and recovery of bushes from pruning—Recovery was assessed by weighing of stripped buds, the stripping being carried out twice successively.**

|                            | Bud numbers | Weights at first stripping | Weights at second stripping |
|----------------------------|-------------|----------------------------|-----------------------------|
| TAC initially present      | +0.058 NS   | +0.188 NS                  | —                           |
| TAC mobilized              | -0.036 NS   | +0.160 NS                  | —                           |
| Weights at first stripping | +0.554***   | —                          | +0.551***                   |

A similar trial at Passara also confirmed the absence of a significant correlation between TAC at pruning time and weight of stripped buds. ( $r = +0.172$ ). Similarly, there was no significant correlation between weight of prunings and TAC ( $r = +0.108$ ). However, the correlation between pruning weights and weights of stripped buds is significant ( $r = +0.296$ ).

The results suggest that bushes that have grown well during a pruning cycle (high pruning weights) tend to recover better (weights of stripped buds). This capacity of a bush to recover is retained at least through one total stripping of buds off the recovering frames. The absence of a significant correlation between either TAC at pruning time or TAC mobilized and the criteria of recovery here employed, points to some factor other than TAC as primarily determining the inherent capacity of a bush to recover from pruning. This is, however, not to suggest that carbohydrate resources are totally unimportant in regulating recovery of pruned tea.

**PH 15**—Quantities of TAC and recovery from pruning—5 clones at three locations—(1965)

Using nursery plants, an attempt is being made to relate the amount of new growth taking place after pruning to the patterns of change of the total quantity of TAC contained in the roots. Hitherto, only percentages of TAC in root samples have been considered. By the use of small plants with quantitatively recoverable root systems, absolute quantities of TAC will be estimated, together with growth assessments.

The experiment has commenced at Kottawa, St Coombs and St Joachim with five clones at each location. Batches of 150 plants of each clone were collected at the time of pruning. Similar batches were collected after a suitable period for recovery and the roots await analysis for TAC.

S. Nagarajah

**PH 16**—Time of pruning at Moolgama Estate, Panwilatenne—(1965)

The experiment was designed to determine the relative merits of pruning in different months of the year. Visual observations, coupled with records of tipping weight and intervals to bud-break and tipping are being made. The main observation will be the percentages of bushes showing differing degrees of recovery.

**PH 17**—Die-back after pruning at New Peacock Group, Pussellawa—2 pruning times  $\times$  2 boron levels  $\times$  2 NPK levels—(1965)

The importance of time of pruning (Feb/March and May/June), levels of fertilizer mixture (132 and 165 lb N/acre/annum as T725), and levels of boron (0 and 12 lbs fertilizer borate/acre) on the incidence of die-back from pruning are being investigated. Each plot is approximately 2 acres in extent. All the plots have recovered very well from pruning and on differential effects of the treatments can thus be observed.

**PH 18**—Die-back after pruning at Beaumont Group, Pussellawa—2 pruning times  $\times$  2 boron levels  $\times$  2 NPK levels—(1965)

Essentially similar design to that of **PH17** on 2 acre plots to be pruned in 1966.

**PH 19**—Die-back in relation to timing of fertilizer application at Beaumont Group, Pussellawa—(1965)

Similar to **PH10** but on 2 acre plots. All plots are to be pruned in June 1966 and fertilizer applications (at 43 lb N per application) will be at 2 and 6 months before pruning and 2 and 6 months after pruning, in all four combinations, and repeated twice.

### Extension Experiments

The following experiments have commenced :

**XPH 1**—Nitrogen at 4 levels with shade vs no shade as the main treatments at Liddesdale Group, Halgranoya—4 replicates of 8 treatment combinations—(1965)

**XPH 2**—Nitrogen at 4 levels with shade vs no shade as the main treatments at Rothschild Estate, Pussellawa—4 replicates of 8 treatment combinations—(1965)

**XPH 3**—Nitrogen at 4 levels with shade vs no shade as the main treatments at Mayfield Estate, Kotagala—4 replicates of 8 treatment combinations—(1965)

**XPH 4**—Nitrogen at 4 levels with shade vs no shade as the main treatments at Hau-teville Estate, Agrabatana—4 replicates of 8 treatment combinations—(1965)

An appreciation has to be recorded of the services of Mr R. K. Nathaniel (Advisory Division) and Mr M. Sikurajapathy (Agricultural Chemistry Division) who in association with the staff of the Physiology Division carried out the laying down of the above experiments.

### Acknowledgements

It is a pleasure to record my thanks to the numerous Superintendents, Assistants and others of their staff who assisted us, particularly in the laying down of trials on their Estates. I wish also to record my thanks to the Statistician and his Assistant for their help in the design of experiments and in the analysis of the data. Finally to my staff—in particular Field Assistants Messrs Piyasena and Wijethunga, who though not mentioned by name rendered most valuable assistance in the management of experiments, I wish to express my thanks.

### Publications

PETHIYAGODA, U. & RAJENDRAM, N. S. (1965). The determination of leaf areas in tea. *Tea Quart.* **36** : 48-58.

NAGARAJAH, S. & PETHIYAGODA, U. (1965). The influence of 'lungs' on carbohydrate reserves and growth of shoots. *Tea Quart.* **36** : 88-102.

# REPORT OF THE PLANT PATHOLOGY DIVISION

Adviser - A. Kerr, BSc, PhD

## General

Mr S. R. A. Fernando was appointed Technical Assistant on 1st October. In addition to his normal duties, Dr R. L. de Silva was appointed joint editor of the Institute's publications on 1st May. Dr N. Shanmuganathan functioned as Convener Secretary of the Experimental and Estates Committee during the year. Mr S. Murugiah now supervises the Blister Blight spray programme on St Coombs Estate.

## Laboratory Investigations

### Effectiveness of soil fumigants against *Poria hypolateritia*

Using three different techniques, eight soil fumigants were compared with DD. All three methods gave similar results and there was good correlation between laboratory tests and pot tests carried out in the greenhouse. Trapex, WN 12 and Vapam were more effective than DD, whereas Nemagon, Dowfume W85, Fumazone 70E, carbon disulphide and formalin were generally inferior to DD.

N. Shanmuganathan & W. W. Redlich

### Factors affecting spore production by *Exobasidium vexans*

Using a standardized technique, preliminary investigations on the factors affecting spore production by *E. vexans* have been carried out using both detached and intact shoots. Slight variations in the environment affected spore production, but this difficulty should be obviated by using a constant environment growth cabinet which has just been installed.

R. L. de Silva & P. V. Arulpragasam

### Pathogenicity of *Rhizoctonia solani*

A new isolate of *R. solani* from the low-country was used to investigate pathogenicity towards four tea clones under controlled laboratory conditions. All attempts to obtain infection of tea shoots have so far failed. New isolates will be tested because it seems that several strains of varying pathogenicity may be present.

R. L. de Silva

### Red Rust (*Cephaleuros parasiticus*)

Laboratory investigations were carried out at St Coombs to investigate spore production, infection and spore viability. Results obtained were inconclusive and the investigation will be continued at St Joachim.

R. L. de Silva

### Decay of shade tree stumps

In collaboration with the Forest Research Laboratory, 3 more wood-rotting fungi isolated from decaying *Grevillea robusta* stumps were compared with *Polystictus sanguineus* and *Lentinus giganteus* for ability to decompose *G. robusta* wood. The 3 fungi tested were much slower than either *P. sanguineus* or *L. giganteus* in decomposing *G. robusta* wood.

N. Shanmuganathan

## Field Experiments and Trials

**Red Root Disease (*Poria hypolateritia*)**

- P1**—Soil fumigation with Vapam at Kirimetiya Estate, Galaha—4 replicates of 6 treatments + control in randomized blocks—(1964-1965)
- P2**—Soil fumigation with Vapam at St John del Rey Estate, Norwood—4 replicates of 6 treatments + control in randomized blocks—(1964-1965)
- P3**—Soil fumigation with Vapam at Templestowe Estate, Rozelle—4 replicates of 6 treatments + control in randomized blocks—(1964-1965)
- P4**—Soil fumigation with Vapam at Queensberry Estate, Kotmale—4 replicates of 6 treatments + control in randomized blocks—(1964-1965)
- P5**—Soil fumigation with Vapam at Bambrakelly Estate, Lindula—4 replicates of 6 treatments + control in randomized blocks—(1964-1965)

In all these experiments, Vapam at 3 different rates (100, 150 and 200 gallons per acre) and at 2 depths of injection (6 and 12 inches) is being tested for control of *Poria*. Results will be assessed in 1966.

N. Shanmuganathan & W. W. Redlich

- P6**—Soil fumigation with methyl bromide—4 replicates of 4 treatments each—(1964)

Methyl bromide at 1, 2 and 4 lb per 100 sq feet was compared with the standard DD treatment (2000 lb per acre) for *Poria* control. Methyl bromide was applied under a polythene cover using 1 lb cans of the fumigant. Results were assessed after 3 months by determining survival of *Poria* in infected segments of tea roots buried in the plots at 3 depths (1, 2 and 3 feet). The results show that the three methyl bromide treatments were very effective and far superior to DD in controlling *Poria* (Table 1).

N. Shanmuganathan & W. W. Redlich

TABLE 1—Relative effectiveness of different rates of methyl bromide and a standard rate of DD in controlling *Poria hypolateritia*

| Treatments                       | No of root segments containing living <i>Poria</i> |      |      |       |
|----------------------------------|--|------|------|-------|
|                                  | Root depth (feet)                                  | 1    | 2    | 3     |
| Methyl bromide at 1 lb/100 sq ft |  | 0/12 | 0/12 | 0/12  |
| Methyl bromide at 2 lb/100 sq ft |  | 0/12 | 0/12 | 0/12  |
| Methyl bromide at 4 lb/100 sq ft |  | 0/12 | 0/12 | 0/12  |
| DD at 2000 lb/acre               |  | 1/12 | 9/12 | 12/12 |
| Control                          |  | 3/3  | 3/3  | 3/3   |

- P7**—Soil fumigation with methyl bromide at Mattakelle Estate, Lindula—4 replicates of 3 treatments in randomized blocks—(1965)

Methyl bromide at  $\frac{1}{2}$  and 1 lb per 100 sq feet was compared with DD at 2000 lb per acre. Results were assessed as in P6 and show (see Table 2) that  $\frac{1}{2}$  lb methyl bromide is adequate to control *Poria* in an area of 100 sq ft to a depth of 3 ft.

N. Shanmuganathan & W. W. Redlich

TABLE 2—Relative effectiveness of two rates of methyl bromide and a standard rate of DD in controlling *Poria hypolateritia*

| Treatments                                   | No of root segments containing living <i>Poria</i> |      |      |       |
|--|--|------|------|-------|
|  | Root depth (feet)                                  | 1    | 2    | 3     |
| Methyl bromide at $\frac{1}{2}$ lb/100 sq ft |  | 0/16 | 0/16 | 0/16  |
| Methyl bromide at 1 lb/100 sq ft             |  | 0/16 | 0/16 | 0/16  |
| DD at 2000 lb/acre                           |  | 2/16 | 1/16 | 13/16 |
| Control (untreated)                          |  | 4/4  | 3/4  | 4/4   |

**P8**—Soil fumigation with WN12—4 replicates of 4 treatments + control—(1965)

WN12 at 3 different rates (5, 10 and 20 ml per sq ft) was compared with DD at the standard rate (20 ml per sq ft). The fumigants were applied at 6-inch depth using an injector gun and plots were thatched immediately with Guatemala Grass loppings. Effectiveness of treatments was assessed as in the earlier experiments. WN12 appears to be more effective than DD although the difference was not significant. WN12 will be re-tested in 1966 (see Table 3).

N. Shanmuganathan & W. W. Redlich

TABLE 3—Effectiveness of 3 different rates of WN 12 and a standard rate of DD in controlling *Poria hypolateritia*

| Treatments           | Percentage of roots containing living <i>Poria</i> |
|----------------------|--|
| WN 12 at 5 ml/sq ft  | 66.7   |
| WN 12 at 10 ml/sq ft | 63.9   |
| WN 12 at 20 ml/sq ft | 33.3   |
| DD at 20 ml/sq ft    | 47.2   |
| Control              | 100.0  |

Non-significant differences bracketed ( $P < 0.05$ )

**P9**—Duration of survival of *Poria* in soil—(1962)

Potted tea plants inoculated last year with root segments retrieved after 2 years' burial in fallow soil have still not shown any signs of infection. Observations will be continued.

N. Shanmuganathan & W. W. Redlich

**P10**—Survival of *Poria* in soil at different depths—5 replicates of 4 treatments in randomized blocks—(1964)

Tea roots 4 inches long and of 4 different diameters (1, 2, 3 and 4 cm) were buried in soil at 3 depths (1, 2 and 3 ft). The segments were inoculated with *P. hypolateritia* and incubated for 4 months in the laboratory prior to burial. Sixty segments will be removed every year and examined for viability of the fungus. After one year, 57 of the 60 roots removed contained viable *P. hypolateritia* and there was no significant effect of depth or size.

N. Shanmuganathan & W. W. Redlich

**P11—Resistance of clones to Poria—(1964)**

Nineteen clones of ten plants each were potted in August 1964 and inoculated in July 1965 using artificially infected tea roots. The clones are CY 9, DT 95, DUN 7, E 7/27, KEN 16/3, KM 247, MO 116, MO 208, NL 3/1, NL 4/2, TC 9, W 3, W 14 and TRI clones 26, 425, 740, 2027, 2142 and 2151. Observations to-date indicate that clones W 3 and NL 4/2 are susceptible.

N. Shanmuganathan & W. W. Redlich

**P12—Resistance of clones to Poria—(1965)**

Twenty clones of ten plants each were potted in June and inoculated in October. The clones are CAR 710, DA 1408, DK 1, DK 8, DK 17, DK 19, DK 26, DK 48, DN, EH 8/15, F 4, GW 19, K 136, K 145, KEN 15/7, MO 21, NL 8/3, TC 15/9, TRI 1446 and TRI 2116. Clones CAR 7/10, D 18, EH 8/15, F 4 and TC 15/9 have already been found to be susceptible.

N. Shanmuganathan & W. W. Redlich

**P13—Selection of resistant bushes at Mattakelle-Estate, Lindula—(1964)**

Fifty bushes surviving in infected patches were inoculated with *P. hypolateritia*. Root examination showed that 30 were infected and these were discarded while the remaining 20 were re-inoculated in July; these bushes will be examined next year.

N. Shanmuganathan & W. W. Redlich

**Blister blight (*Exobasidium vexans*)****P14—Epidemiology—(1962)**

Two equations have been developed to estimate the sporulation of *E. vexans*. The equations are  $Y = 2.5824 - 0.6169x_1 + 0.06x_2$  for the period April to December excluding August, and  $Y = 3.1411 - 0.9867x_1$  for August; where  $Y = \log$  spores per blister,  $x_1 = \log$  blisters per 100 shoots and  $x_2 =$  mean daily sunshine. By calculating  $Y$ , converting to spores per blister and multiplying by the number of blisters per unit area of crop, the number of spores in the atmosphere can be estimated.

The relationship between spores in the atmosphere and spores deposited on susceptible tea leaves is being investigated. This data will be used, along with meteorological data to predict the incidence of Blister blight.

W. F. Rodrigo & P. V. Arulpragasam

**P15—Fungicides—4 replicates of 4 fungicides  $\times$  3 dosages + 2 controls in randomized blocks—(1965)**

The 4 fungicides were Perenox, Perezin, nickel chloride hexahydrate and a colloidal copper oxychloride. The results will be published shortly.

R. L. de Silva & S. Murugiah

**P16—Taint tests with new fungicides—(1965)**

Three new fungicides, a colloidal copper oxide, a colloidal copper oxychloride and a copper oxychloride wettable powder with a dye incorporated, were tested for producing taints in the made tea. The tests will continue in 1966.

R. L. de Silva, S. Murugiah &  
the Technology Division

**P17**—*The effect of fungicides on the colour of infusions of made tea*—12 replicates of 2 fungicides + control in randomized blocks—(1965)

A preliminary report has already been published (Kirtisinghe & de Silva 1965).

R. L. de Silva & D. Kirtisinghe

### **Collar and Branch Canker** (*Phomopsis theae*)

**UP1**—*Bringing into bearing by 'bending' and 'cutting across' at Downside Estate, Welimada*—Paired plots—(1963)

Further observations made during the year on clone TRI 2024 confirmed that the incidence of canker was greater on the bent bushes than on those not bent.

N. Shanmuganathan

**UP2**—*Bringing into bearing by 'bending' and 'cutting across' at Nayabedde Estate, Bandarawela*—Paired plots—(1963)

The incidence of canker was very low in Clone N 3 and there was no significant difference between the two treatments. In clone N 13 there was a higher incidence of canker and there were more on the cut across bushes than on the bent bushes.

N. Shanmuganathan

### *Seasonal variation in susceptibility* (UP3—UP6)

To determine which time of year is most critical for canker infection, 2 clones are being inoculated monthly and at the same time bark and soil moisture are measured. Every month 80 inoculations are made on the collar and branches of 2-year-old bushes and the resulting cankers are measured 4 months later.

Preliminary results indicate a negative correlation between rainfall during the month of inoculation and canker size. Cankers were generally larger at Nayabedde than at Demodera. At present there is no clear relationship between bark moisture at the time of inoculation and canker size.

**UP3**—*Seasonal variation in susceptibility of clone N 3 at Nayabedde Estate, Bandarawela*—(1964)

**UP4**—*Seasonal variation in susceptibility of clone TRI 2024 at Demodera Group, Demodera*—(1964)

**UP5**—*Seasonal variation in susceptibility of clone TRI 2023 at the Passara Substation*—(1965)

Clone TRI 2023 is being inoculated monthly as in the previous 2 experiments. No results are available.

**UP6**—*Seasonal variation in susceptibility of clone TRI 2024 at Aislaby Estate, Bandarawela*—(1965)

Monthly inoculations are being made. No results are available.

N. Shanmuganathan & W. F. Rodrigo

**P18—Clonal resistance, pathogenicity of fungal isolates and effect of age of bush on disease development—(1964)**

In May 1965, twenty clones of 50 plants each were inoculated in the field with 5 isolates of *P. theae* and the resulting cankers measured in August. The clones varied markedly in susceptibility but none were immune. Isolates LT 3 and LT 10 were more virulent than isolates LT 1, LT 2 and LT 5. Inoculations will be repeated yearly during the next 3 years using different isolates.

N. Shanmuganathan

**UP7—Resistance of clones to *P. theae* at Nayabedde Estate, Bandarawela—(1964)**

Twenty clones of 50 plants each have been planted in rows on a site that previously had a high incidence of canker. Each clone has on either side a row of clone TRI 2024 which acts as a buffer. The resistance of these clones will be assessed on field performance. The following clones are being tested: DK 1, DT 1, GMT 9, K 145, MT/BG, N 3, N 13, N 27, N 25/5, NL 3/1, UH 9/3 and TRI clones 25, 777, 2016, 2022, 2025, 2027, 2039, 2046 and 2151. Results of the 1965 observations have not yet been evaluated.

N. Shanmuganathan

**UP8—Resistance of clones to *P. theae* at Glen Devon Estate, Halgranoya—(1965)**

The following 20 clones are being tested in this trial which is similar in lay-out to **UP7**: DK 1, DT 1, DT 95, GD 3/113, GD 5/110, K 145, KEN 16/3 and TRI clones 740, 777, 1526, 2016, 2021, 2022, 2023, 2025, 2026, 2039, 2046, 2142 and 2151. The clones were planted in December and the first observations will be made in June 1966.

N. Shanmuganathan

**Root diseases and shade trees****P19—Killing *Grevillea robusta* trees with arboricides—10 treatments × 10 replicates completely randomized—(1965)**

The object of the experiment is to find out if *G. robusta* trees are killed quicker by arboricides than by ring-barking and also to study the susceptibility of the treated trees to root diseases. The treatments are 2 chemicals, Phortox (2-4-5-T) and Fernoxone (2-4-D), at 2 concentrations *viz* 5 and 10%, in 2 solvents, heavy dieseline and auto-diesel, making 8 treatments, ring-barking and untreated trees as controls.

The mean circumference of the trees is 37 inches and the treatments were applied in March at the rate of approximately 120 ml of chemical per tree. Visual observations on the health of the trees were first made once in 2 months and are now being continued monthly. The most effective treatment appears to be Phortox at both 5 and 10%. Most of the trees receiving these treatments have completely defoliated and are dying. Phortox in heavy dieseline seems to be slightly better than Phortox in auto-diesel. The Fernoxone-treated trees showed slight defoliation after 4 months but recovered later and a second application in July had no obvious effect. Ring-barked trees are still not dead. During the course of the experiment, five estimations of the amount of carbohydrate reserves in the roots were made. So far the only reduction in root reserves is in the Phortox-treated trees where the starch content is approximately half that of the control trees. Further estimations will be made next year.

Some of the Phortox-treated trees have been inoculated with *Ustulina deusta* to assess their susceptibility to this fungus.

N. Shanmuganathan & W. W. Redlich

**P20** *Incidence of root diseases in tea following removal of shade trees by various methods—(1965)*

*Grevillea robusta* and *Erythrina lithosperma* trees have been removed with and without ring-barking. Records of the incidence of root diseases are being maintained.

R. L. de Silva & L. A. Seevaratnam

**Oilspot Disease**

**P21**—*To investigate the rate of spread of the disease at Pedro Estate, Nuwara Eliya—(1964)*

An area containing 1000 bushes has been mapped out and half-yearly observations on the rate of spread of the disease are being made.

R. L. de Silva & P. V. Arulpragasam

**P22**—*Control of the disease by pruning at Pedro Estate, Nuwara Eliya—(1964)*

Diseased bushes have been pruned in different ways to determine if the disease can be eliminated from the stems by removing the infected wood. No results are yet available.

R. L. de Silva & P. V. Arulpragasam

**Phloem Necrosis Virus Disease**

**P23**—*Search for indicator clones at Eskdale Estate, Kandapola—(1960)*

Ten low jat clones are planted in an area that is heavily infected with phloem necrosis virus disease to determine if they might serve as suitable indicator clones for experiments.

R. L. de Silva

**P24**—*Seed Transmission—(1958)*

Seedlings from diseased bushes have been planted in observation plots to investigate whether the virus is transmitted by seed.

R. L. de Silva

**Maintenance leaf-fall in the low-country**

**LP1**—*The effect of various sanitary treatments at the Low-country Station—5 replicates of 5 treatments in randomized blocks—(1964)*

The tea was pruned in April 1964 and pre-treatment records were maintained for one year. Treatments were applied in April 1965 and records of the amount of leaf fall are being maintained until the end of the pruning cycle in April 1966.

R. L. de Silva & U. P. de S. Waidyanatha

**LP2** *The effect of shade on maintenance leaf fall at the Low-country station—Randomized blocks (1964)*

Results will be presented at the conclusion of the experiment.

R. L. de Silva & U. P. de S. Waidyanatha

**Stem cankers in low-grown clonal tea****LP3—Rate of spread at Millakande Estate, Bulathsinhala—(1964)**

Five hundred bushes have been mapped and periodic observations are being made to investigate the rate of spread of the cankers.

R. L. de Silva

**LP4—Inoculation experiments with the fungus *Botryodiplodia theobromae* at Millakande Estate, Bulathsinhala—(1964)**

*B. theobromae* is consistently isolated from cankers but results of inoculation experiments indicate that it is not the primary cause of the disease. A detailed report will be published shortly.

R. L. de Silva

**LP5—Fertilizer contact with tea stems at Millakande Estate, Bulathsinhala—(1964)**

Results indicate that fertilizers coming in contact with green tea stems could be an important contributory factor in the formation of cankers. A report on these experiments will be published shortly.

R. L. de Silva

**LP6—Pruning experiments for the removal of cankers at Millakande Estate, Bulathsinhala—(1964)**

R. L. de Silva

**Extension Experiments**

**XP1—Efficacy of  $\frac{1}{2}$  lb methyl bromide per 100 sq feet in controlling *Poria* at Bogahawatte Estate, Dimbula—Paired plots—(1965)**

**XP2—Efficacy of  $\frac{1}{2}$  lb methyl bromide per 100 sq feet in controlling *Poria* at Dunsinane Estate, Pundaluoya—Paired plots—(1965)**

**XP3—Efficacy of  $\frac{1}{2}$  lb methyl bromide per 100 sq feet in controlling *Poria* at Kelaneiya Estate, Maskeliya—Paired plots—(1965)**

**XP4—Efficacy of  $\frac{1}{2}$  lb methyl bromide per 100 sq feet in controlling *Poria* at Kirkoswald Group, Bogawantalawa—Paired plots—(1965)**

**XP5—Efficacy of  $\frac{1}{2}$  lb methyl bromide per 100 sq feet in controlling *Poria* at Rahanawatte Estate, Lindula—(1965)**

Plots were 200 sq feet in area and assessments were carried out as before. The results (Table 4) confirmed the earlier finding that good control of *Poria* can be obtained by treating infested land with methyl bromide at the rate of  $\frac{1}{2}$  lb per 100 sq feet.

TABLE 4—Effectiveness of methyl bromide at  $\frac{1}{2}$  lb/100 sq ft in controlling *Poria* in five estates

| Estate                    |         | No of root segments out of 3 showing viable <i>Poria</i> |      |      |      |
|---------------------------|---------|--|------|------|------|
|                           |         | Depth  | 1 ft | 2 ft | 3 ft |
| Rahanwatte<br>(Dimbula)   | Treated |  | 0    | 0    | 0    |
|                           | Control |  | 3    | 3    | 3    |
| Kirkoswald<br>(Dickoya)   | Treated |  | 0    | 0    | 0    |
|                           | Control |  | 3    | 3    | 3    |
| Dunsinane<br>(Pundaluoya) | Treated |  | 0    | 0    | 0    |
|                           | Control |  | 3    | 3    | 3    |
| Kelanciya<br>(Maskeliya)  | Treated |  | 0    | 0    | 0    |
|                           | Control |  | 3    | 3    | 3    |
| Bogahawatte<br>(Dimbula)  | Treated |  | 0    | 0    | 1    |
|                           | Control |  | 3    | 3    | 3    |

**XP6—Fungicide trial—Lindoola Estate—Paired fields trial—(1965 May-Dec.)**

Perezin was compared with Perenox for the control of Blister blight. Results are not yet available.

R. L. de Silva

**XP7—Fungicide trial at St Coombs Estate—Paired fields—(1965)**

Perezin and Perenox each at the rate of 4 oz in  $2\frac{1}{2}$  gallons of water per acre were compared for their efficacy in controlling Blister Blight. Mistblowers were used for the spraying. The results will be published shortly.

R. L. de Silva &amp; L. A. Seevaratnam

**XUP1—Fungicide trial at Hopton Group, Lunugala—Paired fields—(1965 October-December)**

Nickel chloride hexahydrate is being compared with Perenox and a colloidal copper oxychloride. Alternate rounds of Perenox and nickel chloride are being used in one treatment. Results are not yet available.

R. L. de Silva

**XUP2—Fungicide trial at Dammeria Group, Passara—Paired fields—(1965 October-December)**

The experiment is being carried out in an isolated tea field to determine whether the eradicator effect of nickel chloride on *E. vexans* brings about any appreciable reduction in the amount of infection in a tea field. The results have yet to be analysed.

R. L. de Silva, L. M. de W. Tillekeratne &  
D. N. R. Wijewardene

### Visits, Lectures and Symposia

Dr R. L. de Silva represented the Tea Research Institute at the 72nd Annual Conference of the United Planters' Association of Southern India held at Coonor in September. He also visited several tea estates and factories in various districts of Southern India to study cultural practices there. A report of his visit has been published.

Two papers were read at the 21st Annual Sessions of the Ceylon Association for the Advancement of Science; one by Dr N. Shanmuganathan and Mr W. W. Redlich on 'Experiments with soil fumigants to control *Poria hypolateritia*' and the other by Dr R. L. de Silva on 'Stem cankers in high-yielding low-grown clonal tea'.

Dr A. Kerr and Dr N. Shanmuganathan addressed a meeting of the Dimbula Planters Association at Talawakelle and Dr N. Shanmuganathan and Dr R. L. de Silva participated in a symposium of the Morawak Korale Planters' at the Low-Country Station, Ratnapura.

Several demonstrations of the method of soil fumigation with methyl bromide against *P. hypolateritia* by Dr Shanmuganathan and Mr Redlich were held at St Coombs, St Joachim and other estates in the Dickoya, Dimbula, Maskeliya and Pundaluoya districts.

### Publications

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- DE SILVA, R. L. (1965). The use of nickel chloride and Perezin for the control of blister blight (*Exobasidium vexans* Masee) on tea. *Tea Quart.* **36** : 191.
- DE SILVA, R. L. & VYTINGAM, S. P. (1966). Some aspects of tea culture in Southern India. *Tea Quart.* **37** : 3-10.
- KERR, A. & SHANMUGANATHAN, N. (1966). Epidemiology of tea blister blight (*Exobasidium vexans* Masee) : I. Sporulation. *Trans. Brit. mycol. Soc.* **49** : 139-145.
- KIRTISINGHE, D. & DE SILVA, R. L. (1965). Investigations on the effect of some foliar fungicidal sprays on certain properties of made tea. *Tea Quart.* **36** : 112-114.
- SHANMUGANATHAN, N. (1965). Collar and branch canker in young tea caused by *Phomopsis theae*. *Tea Quart.* **36** : 14-21.
- SHANMUGANATHAN, N. & ARULPRAGASAM, P. V. (1966). Epidemiology of tea blister blight (*Exobasidium vexans* Masee) : II The Diurnal and seasonal periodicity of spores in the air over a tea estate. *Trans. Brit. mycol. Soc.* **49** : (In the press).
- SHANMUGANATHAN, N. & REDLICH, W. W. (1965). Control of *Poria* root disease with methyl bromide. *Tea Quart.* **36** : 144-150.

# REPORT OF THE NEMATOLOGY DIVISION

Adviser — A. Kerr, BSc, PhD

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## General

Dr P. Sivapalan returned to the Institute in November after successfully completing three years post-graduate work at Rutgers University, USA. Mr T. Manivasager was appointed as Technical Assistant to process routine soil samples from tea estates. All experiments reported below were designed by Dr A. Kerr, organized by Mr M. K. Vythilingam and carried out by all members of the staff of the Division.

## Laboratory Investigations

### The influence of temperature on extraction of nematodes from soil

Until 1960, soil samples from tea estates were processed at the TRI, St Coombs to determine the number of plant parasitic nematodes present. In this year, however, the number of samples received was so high, that the processing of them seriously interfered with the research programme of the Nematology Division, and arrangements were made to have all routine soil samples processed in Colombo by three mercantile establishments.

In 1965, at the instigation of Mr W. T. Williams, detailed comparisons were made between nematode counts obtained in Colombo and St Coombs. Duplicate soil samples were processed concurrently in Colombo and at St Coombs. At St Coombs counts of *Pratylenchus loosi* were approximately seven times higher than those obtained at the Colombo Commercial laboratory in Colombo. Experimental results showed that this difference was due to the temperature difference between the two locations. The number of *P. loosi* and other nematodes extracted from soil is markedly reduced by temperatures of 27-35°C (80.6-95.0°F) during the extraction process. As Colombo temperatures are frequently higher than 27°C, only a small proportion of the nematodes present will be extracted. In future, counting nematodes in routine soil samples from tea estates will be carried out at the TRI at St Coombs.

## Field Trials and Experiments

**N1**—Resistance and tolerance of clones to *P. loosi*—4 replicates of 18 clones completely randomized in compact blocks at 4 locations—(1962)

Sixteen test clones and 2 standard clones, DT 95 and TRI 2024 were included in this experiment which was started in May 1964 and the results assessed 12 months later (see Table 1). The clones were grown in both infested and fumigated soil. As in previous experiments, DT 95 was the most resistant clone. DUN 7, DT 1 and KEN 16/3 were the best of the test clones. All clones except NL 4/2, TRI 425 and NL 3/1 were significantly more resistant than TRI 2024. Clone TRI 2142 did not perform as well as it did in a previous experiment (Hutchinson 1963).

The comparison of growth in infested and fumigated soil (percentage growth) gave virtually no additional information and this also applied to the results of the 1962 and 1963 experiments; because of this, fumigated soil was not used in the 1965 experiment which was started in July and 32 test clones were planted in infested soil. Results are not yet available.

TABLE 1—Third test of clones for resistance and tolerance, using beds of infested and fumigated soil

|   | DT*<br>95 | DUN<br>7 | DT<br>1 | KEN<br>16/3 | KM<br>247 | E<br>7/27 | TRI<br>2025 | TC<br>9 | TRI<br>2142 | MO<br>20 | TRI<br>2024 | NL<br>3/1 | TRI<br>425 | NL<br>4/2 | LSD (P) |       |       |
|---|-----------|----------|---------|-------------|-----------|-----------|-------------|---------|-------------|----------|-------------|-----------|------------|-----------|---------|-------|-------|
|   |           |          |         |             |           |           |             |         |             |          |             |           |            |           | 0.05    | 0.01  | 0.001 |
| Shoot and root growth (g)<br>(infested soil) ...              | 344.7     | 276.7    | 258.2   | 221.0       | 188.6     | 181.2     | 180.7       | 179.7   | 177.9       | 177.8    | 122.1       | 111.3     | 63.7       | 52.4      | 22.3    | 29.4  | 37.5  |
| <i>P. loosi</i> per g root<br>(infested soil) ...             | 83.3      | 173.7    | 221.4   | 253.2       | 365.2     | 404.3     | 271.4       | 454.9   | 173.8       | 158.7    | 672.3       | 440.6     | 508.4      | 317.1     | 158.5   | 208.3 | 266.1 |
| Percentage growth<br>(cf infested and<br>fumigated soils) ... | 112.8     | 61.1     | 64.3    | 43.0        | 48.8      | 33.0      | 26.5        | 37.4    | 50.6        | 47.4     | 25.6        | 24.3      | 15.8       | 17.3      | 17.0    | 22.7  | 29.8  |

\* Four clones did not grow satisfactorily in either fumigated or infested soil and were discarded.

**N2—Resistance and tolerance of seedlings to *P. loosi*—(September 1964)**

Four hundred and fifty seedlings of clone TRI 2024 were planted in soil heavily infested with *P. loosi* and then each plant was inoculated with a heavy suspension of *P. loosi*. After 15 months most of the seedlings are dead or dying, but a few are growing well. Cuttings will be taken from these plants in 1966 and tested for resistance to *P. loosi* using adequate replication.

**N3—Field performance of clones resistant to *P. loosi*—4 replicates of 6 clones completely randomized in compact blocks at 4 different estates—(1964)**

Clones DT 1, MO 116, MO 208, MO 241, TRI 2025 and TRI 2142 are being tested in Chapelton, Derryclare, Mooloya and St Coombs estates. Plants are growing well on all estates and plucking has started on St Coombs. There has been no measurable increase in the population of *P. loosi* since planting. Yield data are not yet available.

**N4—Level of infestation of *P. loosi* in estate nurseries—Random selection of estates and of nursery plants—(1965)**

A list was prepared of all estates above 3000 feet from which *P. loosi* has been recorded, and 55 estates selected at random ensuring adequate representation of the different planting districts. Sampling has been completed on 11 estates in the North-East monsoon area. No *P. loosi* was detected on 4 estates, 4 had very light infestation and 3 had moderate infestation. The survey will be completed in 1966.

**N5—DD and methyl bromide as soil fumigants for *P. loosi*—4 randomized blocks of 3 treatments each—(1965)**

Preliminary trials indicated that 2 lb methyl bromide per 100 sq ft was necessary to eradicate *P. loosi* from soil. In experiment N5 the 3 treatments were standard DD fumigation; separate fumigation of bag soil and bed soil with methyl bromide at 2 lb per 100 sq ft; and, soil bagged and placed on nursery beds and then fumigated with methyl bromide at 2 lb per 100 sq ft. Results are not yet available.

**N6—Nursery infestation by *P. loosi* carried in water—2 blocks of 2 treatments each—Each block had 360 cuttings sampled 3 times—(1965)**

Water directly from an infested field is being used to water one block of cuttings, while for the other, the same water stands in sedimentation tanks for 24 hours before being used. After 6 months, no *P. loosi* was detected in either block. Further samples will be taken after 12 and 18 months.

**N7—Number of *P. loosi* in infested soil during the rehabilitation period and after re-planting—4 replicates of 2 treatments randomized in a compact block—(1964)**

This experiment was designed originally to determine the effect of growing potatoes during the rehabilitation period, on the number of *P. loosi* in the soil. The 2 treatments were (a) the normal rehabilitation crop, Guatemala grass and (b) 1 crop of potatoes followed by Guatemala grass. As there was no significant difference between treatments, data from all 8 plots were combined to measure the decrease in numbers of *P. loosi* during the rehabilitation period.

Sixteen months after uprooting only one *P. loosi* was recorded in 32 soil samples, each of 100 g. Numbers fall logarithmically with time according to the equation  $\log \frac{I}{I_0} = -0.188t$  where  $I_0$  = infestation immediately

after uprooting and  $I =$  infestation after  $t$  months. The 'half-life' of *P. loosi* can be calculated to be 1.6 months. In other words, during the rehabilitation period, numbers are reduced by half every 1.6 months. The eight plots will be replanted with tea in 1966 and the increase in numbers of *P. loosi* measured.

**N8**—*The effect of 2 methods of uprooting tea on (a) survival of P. loosi during the rehabilitation period and (b) on increase of P. loosi after replanting*—2 replicates of 2 treatments each, in compact blocks at 4 different estates—(1965)

Two quarter acre plots of infected seedling tea were uprooted by winching and 2 by chopping on Drayton, Eildon Hall, Leangawella and Kirimetiya estates. Assessments of infestation are being made every 6 months. To date, there is no significant difference in the 2 treatments. Survival appears to conform to the equation calculated for Experiment N7.

**N9**—*The increase in population of P. loosi following replanting of lightly infested soil at Tillicoultry Group, Tillicoultry*—Random sampling of soil from a new clearing—(1964)

Seven clones were planted in this new clearing. Numbers of *P. loosi* were measured immediately before planting and then after 6 and 12 months. No increase in numbers was detected over this period.

**N10**—*Control of P. loosi in mature tea by interplanting with marigolds*—Paired plots (1962 & 1963)

There were four sets of paired plots, constituting four experiments. None of these experiments have shown a significant difference in yield between the marigold and control plots during 1965. Two experiments on St Coombs involving clones TRI 2025 and TRI 777 and one on Logie Estate have been terminated. The TRI 2024 experiment on St Coombs will continue until the end of the pruning cycle.

**N11**—*The influence of different soils on P. loosi (Pot experiment)*—15 replicates of 8 soils each—(1964-1965).

Soils were collected from 8 estates, added to pots and left fallow for 4 months to reduce nematode numbers. Before planting, no *P. loosi* was detected in any soil except Eildon Hall which had 2.5 per 100 g soil. Clone DT 1 was planted in the soils and approximately 2,000 *P. loosi* from one source were added to each pot over a period of 3 months. Levels of infection were determined 8, 12 and 16 months after planting. Results are shown in Table 2. There was a very highly significant difference in nematode numbers in the different soils. This was entirely due to differences in the first 2 assessments, differences in the final assessment not being significant. It was anticipated that numbers of *P. loosi* would increase with each sampling, but highest numbers were recorded in the first sampling (154 per g root), followed by the second sampling (103) and then the third sampling (85). The reasons for this are not known but it is possible that some form of biological control is operating through a build up in the number of predators or parasites.

Various physical and chemical properties of the 8 soils were determined by the Agricultural Chemistry Division, but there was no obvious explanation for the marked difference in behaviour of *P. loosi* in the different soils. Further investigation would seem to be desirable.

TABLE 2—Level of infection of clone DT 1 in eight soils—P. loosi per g root (square root transformation)

|                |     | Estates from which soil taken |         |            |          |           |                     |             |         | LSD (P) |      |       |
|----------------|-----|-------------------------------|---------|------------|----------|-----------|---------------------|-------------|---------|---------|------|-------|
|                |     | Derryclare                    | Wootton | Gt Western | St Clair | St Coombs | Diyanilla-<br>kelle | Eildon Hall | Drayton | 0.05    | 0.01 | 0.001 |
| 1st Assessment | ... | 4.3                           | 6.0     | 11.0       | 9.4      | 15.6      | 15.0                | 18.5        | 19.4    | 5.1     | 6.9  | 9.2   |
| 2nd Assessment | ... | 4.7                           | 8.2     | 5.7        | 7.8      | 9.5       | 14.1                | 13.9        | 16.8    | 5.1     | 6.9  | 9.2   |
| 3rd Assessment | ... | 8.9                           | 8.6     | 6.4        | 10.1     | 11.4      | 9.8                 | 8.6         | 10.1    | NS      | NS   | NS    |
| Mean           | ... | 5.9                           | 7.6     | 7.7        | 9.2      | 12.2      | 12.9                | 13.7        | 15.4    | 2.5     | 3.4  | 4.4   |

**LNI**—*Adaptability of a strain of P. loosi to low-country conditions (Pot experiment at the Low-Country Station)*—10 replicates of 3 treatments each—(1964-1965)

It was reported by Kerr (1965) that damage to new clearings on Dankoluwa Estate in the low-country was associated with *P. loosi* infestation. Healthy plants were grown in pots on St Joachim Estate and inoculated with nematodes from Dankoluwa and St Coombs Estates and the level of infection assessed 12 months later. Uninoculated plants served as controls. Infection was very light in all inoculated plants and there was no significant difference between the 2 inoculation treatments. Growth was not affected and we can conclude that *P. loosi* from Dankoluwa Estate is not a strain adapted to high soil temperatures and that it does not cause damage to tea in the low-country.

### Publication

KERR, A. & VYTHILINGAM, M. K. (1966). Soil samples for eelworm assessment. *Tea Quart.* **37** : 27.

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HUTCHINSON, M. T. (1963). Report of the Nematologist for 1962. *Rep. Tea Res. Inst. Ceylon* **2** : 70-86.

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# REPORT OF THE ENTOMOLOGY DIVISION

*Entomologist* - J. E. Cranham, BA, DIC

## General

Dr W Danthanarayana returned in October from three years overseas training at the Imperial College Field Station, Sunninghill, UK, where he obtained his PhD. The Entomologist was on overseas leave from 23rd June to 23rd September and visited several research stations in the UK. Mr D. J. W. Ranaweera acted for the Entomologist during this period.

## Laboratory Investigations

### Aetiology of mite injury

Studies have been initiated on the nature of injury caused by Scarlet mite and Red Spider mite employing histological techniques. The effect on the biochemical constituents of the leaves is being studied by paper and thin layer chromatography. It is too early to report results.

E. F. W. Fernando

## Field Experiments and Trials

### Shot-hole Borer

**E1**—*Dieldrin, aldrin and Telodrin as post-pruning sprays at Gallebodde Estate, Galaboda—(1962-1965)*

The treatments are : dieldrin — 6 pt/acre  
aldrin — 6 pt/acre  
Telodrin — 3 pt/acre  
Untreated

**E2**—*Dieldrin and Telodrin as post-pruning sprays at Hantane Estate, Kandy—(1963)*

The treatments are : dieldrin — 6 pt/acre  
Telodrin — 4 pt/acre  
Untreated

**E3** *Dieldrin and aldrin at 2 levels as post-pruning sprays at Goorokoya Estate, Nawalapitiya—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
aldrin — 3 pt and 6 pt/acre  
Untreated

**E4**—*Dieldrin and Telodrin at 2 levels as post-pruning sprays at Ravenscraig Estate, Nawalapitiya—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
Telodrin — 2 pt + 2 pt ; and 2 pt/acre  
Untreated

**E5**—*Dieldrin at 1 level and aldrin and Telodrin each at 2 levels as post-pruning sprays at Meddecombra Estate, Watagoda—(1963)*

The treatments are : dieldrin — 3 pt/acre  
 aldrin — 3 pt and 6 pt/acre  
 Telodrin — 2 pt + 2 pt ; and 2 pt/acre  
 Untreated

**E6**—*Dieldrin, aldrin and Telodrin each at 2 levels as post-pruning sprays at Downside Estate, Welimada—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
 aldrin — 3 pt and 6 pt/acre  
 Telodrin — 2 pt and 4 pt/acre  
 Untreated

**E7** *Dieldrin and Telodrin at 2 levels as post-pruning sprays at Goorokoya Estate, Nawalapitiya—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
 Telodrin — 2 pt and 4 pt/acre  
 Untreated

**E8** *Dieldrin and aldrin at 2 levels as post-pruning sprays at Demodera Group, Demodera—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
 aldrin — 3 pt and 6 pt/acre  
 Untreated

**E9**—*Dieldrin and Telodrin at 2 levels as post-pruning sprays at Moolgama Estate, Panwilatenne—(1963)*

The treatments are : dieldrin — 3 pt and 6 pt/acre  
 Telodrin — 2 pt and 4 pt/acre  
 Untreated

Nine of the trials started in late 1962 and 1963 were continued throughout 1965. These trials were laid down to evaluate the effects of spraying on a field scale, with respect to Tortrix outbreaks induced as a side-effect, reported previously (Cranham 1964), and the duration of borer control obtained. Sprayed plots were 10 acres or more in size. The unsprayed control plots were mostly about two acres ; this size was used in an attempt to reduce reinfestation of the sprayed plots. Gallery counts obtained in three-monthly sampling are given in Table 1.

It is notable that in most of the trials (**E3-E9**) the unsprayed plots did not experience a typical heavy build-up of attack (a heavy attack would show 50 or more galleries by the 18th month and 100-150 by the 24th month after pruning), although all the fields selected for these trials experienced heavy attack in the pruning cycle before spraying.

In **E1** the unsprayed plots of 11 acres developed fairly heavy attack (Table 1). In **E2** and **E9**, although the unsprayed plots were only 2 acres they were facing unsprayed tea which suffered heavy attack ; and these plots also developed fairly heavy attack. But in the other trials (**E3** to **E8**) the small unsprayed plots were largely surrounded by sprayed tea and they did not develop a typical heavy attack in the late second year. These trials

TABLE 1. Results of trials E1—E9 on post-pruning of dieldrin, aldrin and Telodrin

|                             |           |      | All galleries (open and healed) per 100 units at months after pruning |    |    |     |     |     |     |     |     |     |
|-----------------------------|-----------|------|---|----|----|-----|-----|-----|-----|-----|-----|-----|
| Treatments                  |           |      | Months  | 9  | 12 | 15  | 18  | 21  | 24  | 27  | 30  | 33  |
| <b>E1</b> —                 | Dieldrin  | 6 pt | ...   | 1  | 1  | 2   | 8   | 6   | 23  | 37  | 44  | 35  |
|                             | Aldrin    | 6 pt | ...   | 5  | 3  | 5   | 8   | 23  | 46  | 51  | 99  | 128 |
|                             | Telodrin  | 3 pt | ...   | 0  | 2  | 4   | 3   | 2   | 8   | 18  | 30  | 57  |
|                             | Untreated |      | ...   | 8  | 6  | 12  | 31  | 69  | 107 | 119 | 110 | 104 |
| <b>E2</b> —(Field 13)       |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | —   | 1  | 1  | 3   | 9   | 34  | 94  | 137 |     |     |
| Telodrin                    | 4 pt      | ...  | —   | 1  | 2  | 2   | 14  | 38  | 71  | 59  |     |     |
| Untreated                   |           | ...  | —   | 52 | 68 | 112 | 163 | 173 | 97  | 122 |     |     |
| (Field 15)                  |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | —   | 4  | 11 | 34  | 52  | 115 | 150 | 98  |     |     |
| Aldrin                      | 6 pt      | ...  | —   | 6  | 10 | 45  | 82  | 123 | 140 | 120 |     |     |
| Untreated                   |           | ...  | —   | 19 | 41 | 87  | 145 | 148 | 120 | 102 |     |     |
| <b>E3</b> —(Fields 19 & 20) |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 0   | 1  | 7  | 5   | 5   | 5   | 7   | 13  |     |     |
| Dieldrin                    | 3 pt      | ...  | 7   | 4  | 2  | 11  | 7   | 5   | 15  | 25  |     |     |
| Aldrin                      | 6 pt      | ...  | 9   | 11 | 21 | 36  | 30  | 38  | 39  | 52  |     |     |
| Aldrin                      | 3 pt      | ...  | 5   | 4  | 13 | 21  | 24  | 46  | 50  | 88  |     |     |
| Untreated                   |           | ...  | 19  | 15 | 14 | 28  | 11  | 20  | 24  | 17  |     |     |
| <b>E4</b> —                 |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 1   | 5  | 11 | 20  | 21  | 25  | 51  | 74  |     |     |
| Dieldrin                    | 3 pt      | ...  | 3   | 3  | 17 | 27  | 26  | 57  | 91  | 107 |     |     |
| Telodrin                    | 2 pt+2 pt | ...  | 0   | 3  | 8  | 5   | 6   | 13  | 15  | 61  |     |     |
| Telodrin                    | 2 pt      | ...  | 3   | 2  | 5  | 7   | 8   | 11  | 25  | 82  |     |     |
| Untreated                   |           | ...  | 5   | 7  | 7  | 14  | 18  | 17  | 19  | 40  |     |     |
| <b>E5</b> —                 |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 3 pt      | ...  | 5   | 9  | 6  | 8   | 19  | 48  | 71  | 133 |     |     |
| Aldrin                      | 6 pt      | ...  | 9   | 11 | 21 | 43  | 54  | 83  | 82  | 74  |     |     |
| Aldrin                      | 3 pt      | ...  | 1   | 5  | 22 | 34  | 82  | 63  | 103 | 110 |     |     |
| Telodrin                    | 2 pt+2 pt | ...  | 0   | 1  | 0  | 0   | 3   | 3   | 16  | 19  |     |     |
| Telodrin                    | 2 pt      | ...  | 2   | 4  | 4  | 1   | 7   | 80  | 51  | 85  |     |     |
| Untreated                   |           | ...  | 17  | 16 | 19 | 21  | 59  | 46  | 62  | 61  |     |     |
| <b>E6</b> —                 |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 2   | 2  | 3  | 4   | 7   | 6   | 7   |     |     |     |
| Dieldrin                    | 3 pt      | ...  | 0   | 1  | 4  | 3   | 11  | 10  | 26  |     |     |     |
| Aldrin                      | 6 pt      | ...  | 2   | 2  | 6  | 6   | 7   | 37  | 68  |     |     |     |
| Aldrin                      | 3 pt      | ...  | 3   | 1  | 6  | 9   | 7   | 14  | 38  |     |     |     |
| Telodrin                    | 4 pt      | ...  | 0   | 0  | 3  | 4   | 7   | 6   | 10  |     |     |     |
| Telodrin                    | 2 pt      | ...  | 2   | 2  | 3  | 3   | 3   | 10  | 17  |     |     |     |
| Untreated                   |           | ...  | 2   | 4  | 7  | 3   | 17  | 11  | 63  |     |     |     |
| <b>E7</b> —(Fields 7 & 2)   |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 1   | 3  | 2  | 8   | 19  | 14  |     |     |     |     |
| Dieldrin                    | 3 pt      | ...  | 2   | 5  | 3  | 8   | 15  | 34  |     |     |     |     |
| Telodrin                    | 4 pt      | ...  | 2   | 0  | 0  | 1   | 2   | 5   |     |     |     |     |
| Telodrin                    | 2 pt      | ...  | 2   | 3  | 1  | 2   | 6   | 7   |     |     |     |     |
| Untreated                   |           | ...  | 4   | 2  | 3  | 5   | 12  | 29  |     |     |     |     |
| <b>E8</b> —                 |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 0   | 0  | 3  | 2   | 3   | 14  |     |     |     |     |
| Dieldrin                    | 3 pt      | ...  | 11  | 19 | 23 | 22  | 40  | 56  |     |     |     |     |
| Aldrin                      | 6 pt      | ...  | 1   | 5  | 5  | 15  | 31  | 92  |     |     |     |     |
| Aldrin                      | 3 pt      | ...  | 5   | 15 | 14 | 31  | 42  | 87  |     |     |     |     |
| Untreated                   |           | ...  | 8   | 2  | 11 | 7   | 34  | 52  |     |     |     |     |
| <b>E9</b> —                 |           |      |   |    |    |     |     |     |     |     |     |     |
| Dieldrin                    | 6 pt      | ...  | 3   | 16 | 5  | 14  | 48  | 122 |     |     |     |     |
| Dieldrin                    | 3 pt      | ...  | 0   | 2  | 10 | 11  | 23  | 42  |     |     |     |     |
| Telodrin                    | 4 pt      | ...  | 5   | 5  | 7  | 8   | 36  | 85  |     |     |     |     |
| Telodrin                    | 2 pt      | ...  | 5   | 4  | 4  | 15  | 20  | 40  |     |     |     |     |
| Untreated                   |           | ...  | 4   | 24 | 17 | 42  | 103 | 132 |     |     |     |     |

suggest the reinfestation from nearby infested tea is an important factor in the build-up of attack ; and that in such trials it is desirable to use unsprayed plots of 10 acres or more in size, as were used in the 1960-64 dieldrin trials, to provide a sound comparison.

This aspect of the present trials unfortunately renders the comparison of sprayed with unsprayed plots invalid in most of them. However, the relative performance of the three insecticides, judged from the duration of control, is generally consistent throughout the trials ; Telodrin usually gave slightly better control than dieldrin and dieldrin often gave appreciably better control than aldrin. Thus, comparison of the larger sprayed plots appears to be valid, although the extent to which widespread dieldrin spraying on the estates may have affected the results cannot be determined.

Dieldrin gave more lasting control than aldrin in trials **E1, E3, E5, E6** and **E8**. In **E2** (Field 15) neither aldrin nor dieldrin gave good control, for unknown reasons. Telodrin often gave slightly better control than dieldrin, with lower counts at 24 months, as in trials **E1, E4** and **E7**. In **E2** (Field 13) there was no appreciable difference at 24 months but the Telodrin counts were lower in the third year. In **E5**, Telodrin at 4 pints (double round of 2 pints) gave markedly better control than dieldrin at 3 pints, but Telodrin at 2 pints was not appreciably better. In **E6** both insecticides gave very good control to the 27th month and in **E9** both gave fair control to the 24th month.

Thus, Telodrin 15% EC at 4 pints, and often at 2 pints per acre usually effected control comparable with 6 pints dieldrin 20% EC. However, because of the high mammalian toxicity of Telodrin and other factors, it was considered impractical to recommend it for use on tea estates.

Aldrin 20% EC at 6 pints generally afforded less lasting control than dieldrin 20% EC at the same dosage. As a post-pruning spray it appears to offer some promise on short pruning cycles of 2 years such as are practised in the low-country (see below) but in 3-year cycles it is probably best used to advantage as a 'mid-cycle' spray (see below).

C. Shanmugam

**E10**—*Aldrin at 2 levels as a mid-cycle spray at Moolgama Estate, Panwilatenne (1964)*

The treatments are : aldrin—3 pt and 6 pt/acre  
untreated

**E11**—*Aldrin as a mid-cycle spray at New Peacock Estate, Pussellawa—(1964)*

The treatments are : aldrin—6 pt/acre  
untreated

**E12**—*Aldrin at 2 levels as a mid-cycle spray at Blackwater Estate, Gimigathena—(1964)*

The treatments are : aldrin—3 pt and 6 pt/acre  
untreated

These trials were started in 1964 to evaluate the effect of aldrin sprays applied to the basal parts of the bush frames about a year after pruning. This is termed 'mid-cycle' spraying to distinguish it conveniently from post-pruning spraying. The sprayed plots were 10 acres or more in size and in **E10** and **E11** the unsprayed plots were also large. In **E12** the unsprayed plots were 2 acres and did not develop a heavy attack (as in **E3-E8** above). The results obtained from two-monthly sampling are listed in Table 2.

TABLE 2—Results of trials on mid-cycle sprays of aldrin

|                    |           |      | All galleries (open and healed) per 100 units at months after spraying |    |     |     |     |     |     |     |     |     |     |     |
|--------------------|-----------|------|--|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Treatments         |           |      | ...  | 12 | 14  | 16  | 18  | 20  | 22  | 24  | 26  | 28  | 30  | 32  |
| <b>E10</b> —Aldrin | 6 pt      | ...  | —  | —  | 19  | 23  | 37  | 30  | 45  | 58  | 37  | 67  | 79  |     |
|                    | Aldrin    | 3 pt | ...  | —  | —   | 77  | 63  | 96  | 71  | 91  | 110 | 91  | 134 | 122 |
|                    | Untreated | ...  | —  | —  | 42  | 96  | 135 | 103 | 111 | 140 | 111 | 153 | 145 |     |
| <b>E11</b> —Aldrin | 6 pt      | ...  |  | 25 | 22  | 45  | 44  | 39  | 26  | 57  | 58  | —   |     |     |
|                    | Untreated | ...  |  | —  | 105 | 163 | 179 | 159 | 164 | 76  | 67  | 61  |     |     |
| <b>E12</b> —Aldrin | 6 pt      | ...  | 6  | 13 | 13  | 21  | 19  | 25  | 22  | 31  | 66  |     |     |     |
|                    | Aldrin    | 3 pt | ...  | 16 | 6   | 8   | 10  | 5   | 14  | 5   | 10  | 14  |     |     |
|                    | Untreated | ...  | 14   | 31 | 27  | 22  | 43  | 38  | 22  | 38  | 33  |     |     |     |
|                    | Aldrin    | 6 pt | ...  | 0  | 0   | 2   | 4   | 15  | 16  | 23  | 19  | 57  |     |     |
|                    | Aldrin    | 3 pt | ...  | 3  | 2   | 2   | 29  | 7   | 18  | 16  | 33  | 59  |     |     |
| Untreated          | ...       | 4    | 2  | 7  | 18  | 22  | 46  | 65  | 74  | 111 |     |     |     |     |

Aldrin spraying caused a useful reduction of the second-year peak attack of Shot-hole Borer, performing well at 6 pints of Aldrin 20% EC per acre in all three trials. The results at 3 pints per acre were also good in **E12** but not in **E10**.

This type of spraying is a practicable alternative to post-pruning sprays of dieldrin but only in fields where the cover of tea is not complete and the frames are accessible for spraying. Aldrin is less liable than dieldrin to induce severe Tortrix outbreaks and if the spray can be applied between mid-March and May (in the South West zone) then in the ensuing months of the South West monsoon period the climatic conditions are least suitable for a build-up of Tortrix. On the basis of these results and those of earlier trials, mid-cycle spraying was recommended to estates.

#### *Low-country trials on post-pruning spraying*

In co-operation with the Low-country Station, a series of large-scale estate trials were started in order to compare post-pruning sprays of aldrin and dieldrin under low-country conditions, where generally two-year pruning cycles are practised. Spray treatments were applied by mistblower, the most convenient method on the large pruned frames typical of the low-country. Dosages were dieldrin 20% EC at 6 pints in 10 gallons water per acre (one round) and aldrin 20% EC at 3 pints in 15 gallons water per acre, in two spraying rounds. Plots were of 5-10 acres in size and were replicated generally 3 times on each estate, the unsprayed control plots were also large. On several of the estates, yield assessments are being carried out by TRI staff on six 200-bush plots within each large plot.

Trials started between May and July 1965 are included in the report of the Low-country Station (**XLE1-XLE7**). It is as yet too early to report results.

J. V. Sabanayagam & H. H. Samarakoon

#### *Yield Experiments*

**E13**—Yield following dieldrin application at Hantane Estate, Kandy—Split-plot—8 replicates of 2 treatments, dieldrin-sprayed and unsprayed, split on 2 levels of N—(1962)

**E14**—Yields following dieldrin application at Bandarapola Estate, Matale—Split-plot—8 replicates of 2 treatments, dieldrin-sprayed and unsprayed, split on two levels of N—(1962)

**E13** and **E14** on the effect of chemical control of Shot-hole Borer on yield were continued. **E14** was pruned in May and **E13** in October; both being continued for a further pruning cycle. The results over the three years of the 1962-1965 pruning cycle at Bandarapola (**E14**) are of particular interest (Table 3), in that the data show a much better response to additional fertilizer on the sprayed plots than on the unsprayed. This was most marked in the third year, and greatly improves the yield trend through the cycle.

TABLE 3—Yield of treatments expressed as lb made tea per acre per annum (**E14**)

|                         | Year 1      | Year 2      | Year 3      |
|-------------------------|-------------|-------------|-------------|
| <i>Dieldrin-sprayed</i> |             |             |             |
| 120 lb N ..             | 1048 (112%) | 1231 (141%) | 1155 (142%) |
| 80 lb N ..              | 1081 (115%) | 1132 (130%) | 983 (121%)  |
| <i>Unsprayed</i>        |             |             |             |
| 120 lb N ..             | 1009 (108%) | 967 (108%)  | 820 (100%)  |
| 80 lb N ..              | 937 (100%)  | 874 (100%)  | 813 (100%)  |
| LSD at P=0.05 ..        | —           | 299 (34%)   | 281 (34%)   |

*NB—The percentage comparisons (in brackets) are made with the lowest-yielding treatment = 100%*

In contrast, in the third year at Hantane (**E13**) there was no significant difference due to dieldrin spraying or to fertilizer.

A. Kathiravetpillai

**E15—Control by insecticides at Mount Vernon Estate, Patana—5 replicates of 5 insecticides + control in randomized blocks—(1965)**

The plots were approximately 1/50th acre on an even stand of clone TRI 2025 at an elevation of 3000 ft. The treatments (Table 4) were carbaryl (Sevin 85% WP), 'Metacil' 80% WP, Methoxychlor (24% EC) and Bidrin (85% concentrate) compared with dieldrin (20% EC) as standard, and with unsprayed control plots. 25 sample units were taken from each plot initially before spraying and at 2, 4, 7 and 8 weeks after spraying. None of the experimental treatments produced an effect comparable with dieldrin, which alone was significantly better than the unsprayed control.

C. Shanmugam & A. Kathiravetpillai

TABLE 4—Control of Shot-hole Borer with insecticides

| Treatment<br>(lb active<br>ingredient<br>per acre) | Counts of live beetles per 100 units (and of immature stages<br>in brackets) after spraying (weeks) |          |          |           |          |
|--|---|----------|----------|-----------|----------|
|  | Precount  | 2        | 4        | 6         | 8        |
| Sevin  | 3.4 68 (178)  | 38 (70)  | 46 (57)  | 78 (218)  | 76 (134) |
| Metacil  | 3.4 72 (124)  | 50 (128) | 48 (134) | 66 (152)  | 64 (160) |
| Methoxychlor                                       | 3.6 68 (120)  | 64 (212) | 50 (164) | 48 (140)  | 53 (72)  |
| Bidrin   | 1.1 100 (208)   | 82 (180) | 60 (154) | 108 (222) | 94 (182) |
| Dieldrin   | 1.5 84 (208)  | 20 (50)  | 10 (80)  | 12 (12)   | 12 (32)  |
| Unsprayed  | 98 (212)  | 86 (168) | 64 (138) | 94 (302)  | 82 (234) |

**E16—Control by insecticides at Moolgama Estate, Panwilatenne—5 replicates of 3 insecticides each at 2 levels—(1964)**

Fenitrothion (Sumithion 50% EC), Heptachlor (20% EC) and aldrin (40% WP) each at two dosages of active ingredient where used and the results are given in Table 5. Counts in this case were made initially and at 4, 8, 16 and 31 weeks. Both Heptachlor and aldrin showed promising activity and were significantly better than fenitrothion in the 8 and 16 weeks counts.

TABLE 5—Control of Shot-hole Borer with insecticides

| Treatment<br>(lb active<br>ingredient<br>per acre) | Counts of live beetles per 100 units (and<br>immature stages in brackets) after spraying<br>(weeks) |         |         |         |          |
|--|---|---------|---------|---------|----------|
|  | 4   | 8       | 16      | 31      |          |
| Sumithion 2½                                       | 100 (133)   | 32 (54) | 34 (48) | 14 (38) | 15 (19)  |
| Sumithion 1½                                       | 122 (191)   | 71 (87) | 37 (69) | 30 (42) | 43 (118) |
| Heptachlor 2                                       | 131 (131)   | 17 (15) | 6 (8)   | 6 (4)   | 14 (41)  |
| Heptachlor 1                                       | 102 (153)   | 24 (24) | 11 (2)  | 7 (5)   | 8 (40)   |
| Aldrin 2   | 68 (100)  | 17 (11) | 9 (6)   | 7 (19)  | 23 (58)  |
| Aldrin 1   | 116 (106)   | 21 (30) | 16 (22) | 7 (6)   | 17 (52)  |

**E17—Dieldrin spray volume at Beaumont Estate, Pussellawa—Split-plot—5 replicates of 3 spray volumes + control, one volume split on 3 concentrations—(1965)**

Each plot was approximately 1/14th acre. The treatments were dieldrin 20% EC at 6, 3 and 1½ pints in 80 gallons water per acre applied by knapsack sprayers, and 3 pints in 40 gallons and 1½ pints in 20 gallons applied by mist-blowers, together with unsprayed control plots. The results are not yet available.

C. Shanmugam & A. Kathiravetpillai

**Tea Tortrix**

As in 1964, a limited survey by postal questionnaire was carried out in order to obtain further information on the incidence of Tortrix outbreaks on unsprayed tea in relation to the intensity of dieldrin spraying in the districts. The results are summarized in Table 6 for the Dimbula, Gampola and Pussellawa Districts.

TABLE 6—Some results of a survey by questionnaire on the relation between the intensity of dieldrin spraying and the occurrence of Tortrix outbreaks on unsprayed tea (comparing July 1963-June 1964 with July 1964-June 1965)

| District   | Percentage of trial acreage<br>reported as sprayed with<br>dieldrin |        | Reported acreage of unsprayed<br>tea suffering Tortrix out-<br>breaks |            |
|------------|---|--------|---|------------|
|            | 1963-4  | 1964-5 | 1963-4  | 1964-5     |
| Dimbula    | 1   | 1.2    | 2656 (9.4%)   | 938 (4%)   |
| Gampola    | 18  | 15     | 202 (3.5%)  | 0 (0%)     |
| Pussellawa | 6.7   | 5      | 1703 (13.9%)  | 1389 (13%) |

Judging from the occurrence in Dimbula, natural outbreaks were appreciably less severe in the 1964-1965 period than in the 1963-1964 period. In both periods the attacks have been least in the Gampola district, although dieldrin spraying there was the most intensive. The incidence of outbreaks on unsprayed tea seems to be influenced by natural control factors.

**E18—Control by insecticides at Waltrim Group, Lindula—6 replicates of 6 treatments in randomized blocks—(1965)**

Several insecticides which have little or no effect in increasing mite numbers were tested for their efficiency in Tortrix control. These included 'Perthane', 'Metacil', 'Dibrom', formothion ('Anthio') and fenitrothion ('Sumithion'), and ethion. DDT and Perthane gave a good initial kill but other treatments were only partially effective. Heavy rain appeared to reduce the effectiveness of all treatments, but increased natural mortality from disease.

D. J. W. Ranaweera

**E19—Effect of insecticides on *Macrocentrus homonae*—4 replicates of 3 insecticides + control in randomized blocks—(1965)**

In view of interest in Heptachlor as an alternative insecticide for the control of Shot-hole Borer a field experiment was started in October, in order to compare the effect on the Tortrix parasite of this insecticide with that of aldrin and dieldrin. Each plot covered  $\frac{1}{4}$ -acre. For each insecticide the 20% ECs at 6 pints per acre were used. All plots were bordered by unsprayed tea. Results are not yet available.

W. Danthanarayana & D. J. W. Ranaweera

**Side-effects of dieldrin spraying**

During 1965 there were several instances of localized outbreaks of caterpillar pests other than Tea Tortrix on dieldrin sprayed fields, and these appear to have arisen mainly as a side-effect of spraying. These included nettle grubs (*Macroplectra nararia* Mo. and *Narosa conspersa* Wlk.), Red slug (*Eterusia aedea congala* Mo.), Faggot-worms and Bagworms (*Clania cramerii* Wlk., *Chalia double dayi* Westw. and *Manatha albipes* Mo.) and Cutworm (*Agrotis* sp.). These, however, were mostly of minor importance except on one or two estates, but serious concern was caused by two geometrid species: the Twig Caterpillars, *Ectropis bhurmitra* Wlk. and the large Looper caterpillar, *Buzura strigaria* Mo.

Twig Caterpillar has been known from the early days of tea planting in Ceylon and serious outbreaks were noticed in 1900 and in the 1930's, on tea and *Grevilla*. Looper Caterpillar, although the species has long been known has not previously been recorded in numbers on tea in Ceylon; the same or a closely related species is a serious pest in NE India. Outbreaks in 1965 occurred on ten or more estates and nearly always on dieldrin sprayed fields about a year or more after spraying; often both species were involved but *E. bhurmitra* was far more common, except in one instance. These pests caused very serious defoliation if uncontrolled and tend to recur on the same area or nearby; on three estates there was a serious loss of crop and many deaths of bushes.

Preliminary field experiments on chemical control have shown that DDT (at the dosages used for Tortrix) provides good control of Twig Caterpillar and the young larvae of Looper, but not of the older larvae of the latter species. An intensive study of the biology and control of these pests has been started.

W. Danthanarayana & D. J. W. Ranaweera

**Mites****E20—Copper and nickel fungicides on mite numbers (see P15)**

Detailed mite counts were carried out on the field experiment (P15) of the Plant Pathology Division comparing the efficacy of cuprous oxide 50% WP (Perenox), nickel chloride, and Perezin containing both cuprous

and zinc oxides. Details of the experiment are given in the report of the Plant Pathology Division (p 55). The fungicide sprays were applied weekly from May to December 1964; Scarlet Mite began to build up in the early dry months of 1965 after spraying had ceased, and sampling was carried out in January, February and April. The results are shown in Table 7. Cuprous oxide (Perenox) brought about a more than two-fold increase in numbers compared to the untreated plots, whilst nickel chloride had a very little effect, although small significant increase occurred in April. Perezin, containing half the amount of copper present in Perenox, also caused significant increases.

In respect of the magnitude of the effect of copper, these results are similar to those of previous experiments, *ie* two or three times increase in mite numbers. However, it is not known that such an increase is sufficient to effect yield. It was noted that the plots of all treatments suffered rather severe damage and defoliation by March/April.

The counts also showed a significant increase over the control in the numbers of Red Spider Mite on the copper plots but not on the nickel plots, but the numbers were very small and damage negligible.

D. J. W. Ranaweera & E. F. W. Fernando

**E21**—*Mite, shade and fertilizer on yield at Downside Estate, Welimada*—Split-plot—6 replicates of Kelthane—sprayed and unsprayed tea split on 4 levels of N and 2 levels of shade—(1965)

Each block has 8 plots. Half the plots will be sprayed with Kelthane to keep the tea practically free of mites. Two densities of shade (no shade and light shade) and four levels of fertilizer (0, 60, 120 and 180 lb nitrogen per acre) are incorporated. Pre-assessment of yield was carried out for three months. The trial will be continued for three years in the first instance.

D. J. W. Ranaweera & E. F. W. Fernando

**E22**—*Susceptibility of clones to Scarlet mite*—Split-plot—4 replicates of 2 shade levels split on 32 clones—(1961)

Detailed sampling to assess Scarlet Mite numbers was carried out in early May. The results cannot be statistically analysed although they involve counts on 32 clones, replicated twice under dadap shade and twice under no shade. Taking the mean numbers of Scarlet Mites for all clones, the mean number under shade was 7.88 per leaf and without shade 10.70 per leaf, thus showing a relatively small effect due to shade. There were marked differences between clones which are grouped as follows into categories according to the level of mite incidence.

2-5 mites per leaf : GR 4, PO 26, KEN 15/7, TK 48, TRI 2027, seed.

5-10 mites per leaf : TRI 2023, TRI 2024, TRI 2025, TRI 777, TRI 2026  
DT/1 UH 9/3, T 5/35, GMT 9, EN 3, MT/BG, GT 1/5, DVS B/1,  
CY 9, T5/3.

10-15 mites per leaf : N, TRI 2151, CV 4, B 1, BG 18, DG 39.

15-19 mites per leaf : PA 22, K 150, NL 4/2, NL 3/1, K 136, KEN 16/3.

D. J. W. Ranaweera

**E23**—*The effect of DDT plus acaricides on mite numbers at Dambawinne Division, Welimada Group, Welimada—6 replicates of treatments in randomized blocks—(1965)*

No insecticide has so far been found that gives control of Tea Tortrix as good as that obtained from DDT and which does not increase mite numbers. Hence, it was desirable to check whether the addition of a low dosage of an acaricide to DDT would effectively prevent any mite build-up.

Plots measured 1/30th acre in size. The treatments used were at the equivalent of the following dosages per acre in 100 gallons water applied by knapsack sprayers :

DDT 25% EC 4 pints plus malathion 50% EC 1 pint  
 DDT 25% EC 4 pints plus ' Sumithion ' 50% EC 1 pint  
 DDT 25% EC 6 pints plus ' Kelthane MF ' (36% EC)  $\frac{1}{2}$  pint  
 DDT 25% EC 6 pints plus ' Tedion V 18 ' (8% EC) 1 pint  
 DDT 25% EC 6 pints  
 Untreated

Treatments 1 and 2 were included because it was possible that malathion and ' Sumithion ' (fenitrothion) might improve control of Tortrix whilst also providing a check on Red Spider Mite.

**TABLE 7**—*Experiment on the effect of fungicides on Scarlet mite numbers*

| Treatment                 | Mean number of mites per 100 leaves |          |         |
|---------------------------|-------------------------------------|----------|---------|
|                           | January                             | February | April   |
| Perenox 50% Cu ..         | 588***                              | 1110***  | 2549*** |
| Perezin 25% Cu ..         | 401**                               | 836**    | 2159*** |
| Nickel chloride 25% Ni .. | 238                                 | 554      | 1563*   |
| Untreated ..              | 259                                 | 417      | 1142    |

*NB—Analysis of variance was of log (n+1) values. The significance of differences from the counts on the untreated plots is shown by asterisks : \* P < 0.05 ; \*\* P < 0.01 ; \*\*\* P < 0.001.*

**TABLE 8**—*The effect of DDT plus acaricides on mite numbers*

| Treatment          | Mean number of mites per 100 leaves |        |        |                        |
|--------------------|-------------------------------------|--------|--------|------------------------|
|                    | Scarlet Mite                        |        |        | Red Spider             |
|                    | Days after spraying                 |        |        | 47 days after spraying |
|                    | 20                                  | 47     | 74     |                        |
| DDT + Malathion    | 632                                 | 1640   | 1572   | 3060*                  |
| DDT + Sumithion    | 656                                 | 1736   | 2092*  | 1832                   |
| DDT + ' Kelthane ' | 164***                              | 148*** | 192*** | 160***                 |
| DDT + Tedion       | 544                                 | 1008   | 732    | 220***                 |
| DDT                | 608                                 | 1812   | 1368   | 2104                   |
| Untreated          | 660                                 | 1192   | 1040   | 1748                   |

\* P < 0.05    \*\* P < 0.01    \*\*\* P < 0.001

Sampling was carried out initially before spraying and at 20, 47 and 74 days after spraying and the results are given in Table 8. In this instance, DDT did not increase the numbers of mites over those present on the untreated plots, but moderately high numbers of both Scarlet Mite and Red Spider developed generally. Kelthane, at the low dosage of half a pint per acre, achieved good control of Scarlet Mite and Red Spider and Tedion, at 1 pint, achieved good control of Red Spider but not of Scarlet Mite. Malathion

and Sumithion did not bring about a reduction of mite numbers ; in fact the numbers of Red Spider were slightly greater on the malathion plots (at 47 days after spraying) and the numbers of Scarlet mite slightly greater on the Sumithion plots (at 74 days after spraying). This mixture of DDT and Kelthane or Tedion show considerable promise and merit further trials.

D. J. W. Ranaweera & E. F. W. Fernando

**E24—Control of mites with soap and 'Teepol' at Welimada Group, Welimada—**  
4 replicates of 5 treatments in randomized blocks—(1965)

Several estates have reported fairly effective mite control using solutions of bar soap and the detergent 'Teepol'. These treatments were compared with Kelthane. Another treatment, ethion, was also included. Plots measure 1/30th acre. The treatments were used at the equivalence of the following dosages in 90 gallons of water per acre applied by knapsack sprayers.

BCC Bar Soap, 2 lb  
Ethion 50% EC, 1½ pints  
Teepol, 7.2 pints (1% solution)  
Kelthane, MF, 36% EC, ¾ pint  
Untreated

Sampling was carried out initially before spraying and at 14, 35 and 49 days after spraying and the results are given in Table 9.

TABLE 9—*Effect of various treatments on mite populations*

| Treatment | Mean number of mites per 100 leaves |       |     |              |       |
|-----------|-------------------------------------|-------|-----|--------------|-------|
|           | Red Spider                          |       |     | Scarlet Mite |       |
|           | 14                                  | 35    | 59  | 35           | 59    |
| Soap      | 388**                               | 340   | 68  | 1268         | 752   |
| Ethion    | 804                                 | 116** | 15* | 1252         | 824   |
| Teepol    | 772                                 | 384   | 98  | 1056         | 412   |
| Kelthane  | 628*                                | 108** | 43  | 128***       | 72*** |
| Control   | 1360                                | 548   | 47  | 1108         | 524   |

NB—Analysis of variance was of log (n+1) values. The significance of differences from the counts on the untreated plots is shown by asterisks :

\* P<0.05

\*\* P<0.01

\*\*\* P<0.001

The results show that soap solution gave the best reduction in numbers after 14 days, but no significant reduction at 35 days when Kelthane and ethion were superior to other treatments. Only Kelthane afforded control of Scarlet mite, however, and there was no reduction from soap, 'Teepol' or ethion.

D. J. W. Ranaweera & E. F. W. Fernando

### Visits, Lectures and Symposia

Mr Cranham attended a combined meeting of the Kandy, Hewaheta, and Pussellawa District Planters' Associations in Kandy in November, and a meeting organized by Messrs Carson Cumberbatch & Co Ltd for their visiting agents in Colombo on 21st October. Dr Danthanarayana attended a symposium organized by the Low Country Station for the Morawak Korale Planters' Association at St Joachim in December.

**ME1—Ecology of the Shot-hole Borer—(1962)**

A series of experiments in Field No 7 at Hantane Estate, Kandy, designed to study the factors that determine population fluctuations of the Shot-hole Borer, *Xyleborus fornicatus* Eichh., has completed the duration of one pruning cycle (May 1962-July 1965). The data collected have been analysed and the results published (Calnaido & Thirugnanasuntharan 1966). These studies have been extended to run for another pruning cycle (August 1965-1968), to provide more detailed information on populations of the borer.

*Populations in the tea bush*

The borer populations in the tea bushes were sampled monthly, by the 'standard unit' method and also by examining entire tea branches. This sampling revealed a very close relation between the growth of young wood after pruning and the growth of borer populations. This synchronous growth of the tea and the borer populations appears to be seasonal, with peaks around March-April-May and again in October-November. However, this seasonal effect is partly obscured by the increased growth of borer populations in the second year from prune, which is most likely to be due to the increased quantities of young sapful tea stems available at this period in the pruning cycle. Further, investigations to determine the relationship of the quantitative and qualitative changes in the host plant to the fluctuations of borer populations have been initiated.

*Aerial populations*

The aerial populations were sampled daily with a vertical series of suction traps. Analysis of all the data revealed that changes in aerial populations were correlated with changes in the populations in the crop. While weather factors did not appear to have a marked effect on populations in the tea, they appeared to influence the periods of maximum aerial dispersal, which occurred in two periods of the year, around April and October.

*Studies on reinfestation of sprayed tea field*

The comparative study of the growth of the borer population in a section of Field No 7 sprayed with dieldrin in the 10th month after pruning and in an unsprayed section of the same field was continued. The borer populations in the bushes were sampled by the 'standard unit' method, while the flying populations over the crop were estimated by suction traps. The line sampling in the tea bush from the unsprayed to the sprayed area, was continued to assess whether there was any progressive infestation of the sprayed area from the unsprayed area. This experiment revealed that there was no marked edge-effect (progressive infestation from the edges of a field) in infestation and that reinfestation of sprayed fields would occur mainly by way of the aerial dispersal of the borers. This also points to the possibility of the rates of reinfestation being influenced by the seasonal periods of migrations and the need for trials on the timing of chemical control measures.

*Fluctuation of attack and its relation to periods of economic damage*

The comparative study of borer populations of the sprayed and unsprayed parts of Field No 7, by the sampling with suction traps and by the standard unit method, have revealed that borer damage, estimated on the basis of the proportion of new galleries formed, was relatively little in the 1st and 3rd year in the pruning cycle and that it was in the 2nd year that the attack was severe. Table 1 illustrates this.

TABLE 1—*Relative attack of Shot-hole Borer on normal and sprayed fields, based on the content of new galleries formed (sprayed dieldrin on 10th month from prune)*

|   | Treatment | 1st year | 2nd year  | 3rd year | Total      |
|---|-----------|----------|-----------|----------|------------|
| Mean No and % of new galleries/ 100 Std units                         | unsprayed | 13 ( 8%) | 110 (67%) | 42 (25%) | 155 (100%) |
|   | sprayed   | 6 (10%)  | 20 (33%)  | 35 (57%) | 61 (100%)  |
| Estimated % of attack in sprayed area, relative to the unsprayed area | unsprayed | 100%     | 100%      | 100%     | 100%       |
|   | sprayed   | 46%      | 18%       | 83%      | 37%        |
| Control of attack;  |           | —        | Good      | Bad      | Moderate   |

The above table indicates that dieldrin spraying brought about good control, *in terms of attack*, only in the 2nd year from prune and that the control of attack in the third year was poor. Further the control of attack, based on the proportions of new galleries made, may be regarded as only moderate, when the entire length of the pruning cycle, 1st, 2nd and 3rd years, are considered. However, since the damage from galleries has been observed to have a lasting and accumulative effect (galleries gradually deteriorate to larger cavities of wood rot), it is possible that any benefit to yield brought about by the control of the second year attack in the pruning cycle could accrue to the third year in the pruning cycle too. Therefore it is most likely that once the second year attack is controlled, the small third year attack would be relatively less harmful, particularly because the next prune would remove the third year damage in the branches, which is mainly confined to upper parts of the tea stems.

### Studies on life history

Beetles collected from suction traps were bred on tea plants in the field and records maintained. It was observed that beetles preferred young sapful tea stems to older mature wood. Rain adversely affected this work and the results obtained are inconclusive. However, data collected to-date indicate that the total life span of the Shot-hole Borer, from the egg until the death of the adult, may be about four months. This includes an egg stage of 10 days a larval phase of 17 days, a pupal period of 7 days, a teneral period of 15 days and an adult life of 60 days. Newly emerged adults were found to bore into tea stems but they died before they established broods. In these breeding experiments the mortality of the males was greater than that of the females. This work will be continued to collect detailed information on several aspects of the borer's behaviour and life-history.

K. Thirugnanasuntharan

### Sampling methods

The effectiveness of the 'standard unit' method for assessing borer populations in the tea bush was investigated, by comparing it with the sampling of entire tea branches. Monthly collections of 3 groups of 100 'standard units' were compared with the sampling of 5 × 15 entire tea branches collected randomly from the same field. The 'standard unit' method was found unsuitable for ecological studies. In future studies, it is proposed to sample entire branches of tea stems collected randomly from tea fields.

**Other *Xyleborus* species**

The abundance and distribution of 17 *Xyleborus* species, including *X. fornicatus* were studied. The seasonal distribution and the diurnal flight periodicity of these species have been worked out. One curious feature of the distribution of these species was the abundance of most of them in the second year of the pruning cycle and their reduction in the third year. Where *X. fornicatus* is concerned this appears to be related to the availability of new sapful wood, but the causes of the fluctuations of the populations of other species are unknown. These studies will be continued to learn of the characteristics and causes of insect faunal changes in tea fields, in general.

**Visits, Lectures and Symposia**

Dr D. Calnaido read a paper entitled "Some practical aspects of ecological studies on Tea Shot-hole Borer" at the 21st Annual Sessions of the Ceylon Association for the Advancement of Science in December.

**Publications**

- CALNAIDO, D. (1965). The flight and dispersal of Shot-hole Borer of tea (*Xyleborus fornicatus* Eichh., Coleoptera : Scolytidae). *Ent. exp. appl.* **8** : 249-262.
- CALNAIDO, D., FRENCH, R. A. & TAYLOR, L. R. (1965). Low altitude flight of *Oscinella frit* L. (Diptera : Chloropidea). *J. Anim. Ecol.* **34** : 45-61.
- CALNAIDO, D. & THIRUGNANASUNTHARAN, K. (1966). Ecological studies on Shot-hole Borer and their relation to the control of the pest. *Tea Quart.* **37** : 28-45.
- CRANHAM, J. E. (1966). Tea pests and their control. *Ann. Rev. Ent.* **11** : 491-514.
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- CRANHAM, J. E. (1966). 'Mid-cycle' sprays of aldrin for the control of Shot-hole Borer. *Tea Quart.* **37** : 56-58.
- DANTHANARAYANA, W. (1966). Extraction of arthropod eggs from soil. *Ent. exp. appl.* **9** : 124-125.

# REPORT OF THE BIOCHEMISTRY DIVISION

*Biochemist* - G. W. Sanderson, BSc, PhD

## General

The Biochemist returned from overseas leave on the 8th March. The Division functioned exceedingly well during the year with no staff changes. A Controlled-Environment Plant Growth Chamber and a Chromatography Room were both operational before mid-year and they are both being used extensively.

## Laboratory Investigations

### Carbohydrates in the tea plant

A detailed study was made of the interference caused by the polyphenolic compounds present in tissues of the tea plant and a method was developed to remove this interference rapidly and quantitatively. The method depends on treating plant extracts with an insoluble polyphenol absorbant (*eg*, Polyclar AT, an insoluble highly cross-linked polyvinylpyrrolidone) to remove the polyphenolic compounds before carrying out the carbohydrate estimation.

An investigation of the carbohydrates present in tea roots was carried out to complement an earlier investigation, the results of which are already published, of the carbohydrates present in tea shoot tips. A summary of the results of this investigation is given in Table 1.

TABLE 1—*Carbohydrates found in tea roots*

|  |    |  |
|--|----|--|
| Carbohydrate fraction                            | .. | Sugars identified  |
| Soluble carbohydrates                            | .. | Raffinose, sucrose, glucose fructose   |
| Insoluble carbohydrates                          |    |  |
| Ammonium oxalate pectin free extract, hydrolyzed | .. | Glucose, galactose, galacturonic acid, mannose, arabinose, xylose and rhamnose         |
| Pectin, hydrolyzed                               | .. | Galacturonic acid, galactose and arabinose   |
| Starch, hydrolyzed                               | .. | Glucose  |
| Residue, hydrolyzed                              | .. | Glucose, galactose, galacturonic acid, mannose, arabinose, xylose, ribose and rhamnose |

A quantitative study of the distribution of the various carbohydrates throughout the tea plant and the effect of climate on their concentration in the different tissues is under investigation.

B. P. M. Perera

### Photosynthetic assimilation of carbon dioxide

An investigation of the patterns of photosynthetic assimilation of carbon dioxide in tea plants was initiated with the objective of determining (*a*) the relative role of the various green parts of the plant in this process and (*b*) the

source of the carbon used in the biosynthesis of the chemical constituents of the flush which are of importance in tea manufacture. A detailed report has already been published (Sanderson & Sivapalan 1966).

Further work has been carried out to determine the contribution of the different green parts of the tea plant in supplying the carbon compounds needed for the life and the growth of the developing tissues. The results to date may be summarized as follows :

- (a) Carbon assimilated by the flush remains in the flush
- (b) Carbon assimilated by mature leaves attached to stems at or very near to the attachment of developing shoots moves into the developing shoots
- (c) Carbon assimilated by mature leaves attached to stems at points which are 3 or 4 nodes below the attachment of developing shoots moves downward to the roots of the plant
- (d) Photosynthetically assimilated carbon does not move into mature leaves

Further discussion is reserved for a later date when more experimental results are available.

K. Sivapalan

### Biosynthesis of flavanols

An investigation of the factors influencing flavanol biosynthesis in tea plants was initiated with a study of the enzyme 5-dehydroshikimate reductase. A full report of this work has been prepared for publication (Sanderson 1965d). The finding of this enzyme in tea plants lends support to the contention that the shikimic acid pathway is an important source of aromatic compounds in this plant. The distribution of this enzyme in the tea plant (Table 2) suggests that all leaves on the tea plant are capable of synthesizing aromatic compounds and other studies (see section on photosynthetic assimilation of carbon dioxide) have confirmed this. The results obtained from all related studies, however, indicate that it is the immature leaves which are most active in synthesizing flavanols. Further work is designed to elucidate the pathway of flavanol biosynthesis in tea plants more fully and to determine the effect of environment of this process.

TABLE 2—*Distribution of 5-dehydroshikimate reductase in tea plants*

| Part of plant            | Specific activity | Total activity as % of activity in 2nd leaf |
|--------------------------|-------------------|---|
| Buds .. ..               | 0.12              | 21  |
| 1st leaves .. ..         | 0.15              | 46  |
| 2nd leaves .. ..         | 0.18              | 100   |
| 3rd leaves .. ..         | 0.27              | 129   |
| Stem, unligified .. ..   | 0.22              | 54  |
| Maintenance leaves .. .. | 0.07              | 199   |
| ' Old ' leaves .. ..     | 0.05              | 115   |

### Peroxidase in tea plants

Additional work on this problem which was started in 1964 showed that, like catechol oxidase this enzyme could be extracted in a soluble state by incorporating an insoluble polyphenol absorbant into the extraction medium (see Table 3).

TABLE 3—*Effect of polyamide (Woelm) on the extraction of peroxidase from tea shoot tips*

| Level of polyamide<br>(Woelm) in the extrac-<br>tion media (g/g fresh<br>wt tissue) | Peroxidase activity<br>(units/g fresh wt tissue) |                          |             | Protein in supernatant<br>fraction<br>( $\mu$ g/ml) | Flavanols in super-<br>natant fraction<br>( $\mu$ g-ml) |
|---|--|--------------------------|-------------|---|---|
|   | Crude extract                                    | Fractions<br>Precipitate | Supernatant |   |   |
| 0   | 3.0  | 6.1                      | 0.0         | 0.05  | 6,030   |
| 1.0   | 24.9   | 7.2                      | 27.2        | 1.74  | 240   |

Studies of the distribution of this enzyme showed that the amount of activity was generally directly related to the age of the tissue (see Table 4). Fleshy roots were found to contain very high levels of activity of this enzyme.

TABLE 4—*Distribution of peroxidase in tea plants*

| Plant part*            | Peroxidase activity** |                     |                     |                         |
|------------------------|-----------------------|---------------------|---------------------|-------------------------|
|                        | Expt I                |                     | Expt II             | Expt III                |
|                        | Banji long shoot      | Flushing long shoot | Flushing long shoot | Flushing plucking shoot |
| Bud .. ..              | 22.4                  | 14.2                | —                   | 12.4                    |
| 1st leaf .. ..         | 12.5                  | 13.1                | 18.9                | 20.6                    |
| 2nd leaf .. ..         | 29.6                  | 20.1                | —                   | 26.2                    |
| 3rd leaf .. ..         |                       |                     | 30.0                | 35.7                    |
| 5th leaf .. ..         |                       |                     | 43.9                | —                       |
| 7th leaf .. ..         |                       |                     | 48.4                | —                       |
| Stem, unligified .. .. |                       |                     |                     | 41.5                    |
| Maintenance leaf .. .. |                       |                     |                     | 31.2                    |
| ' Old ' leaf .. ..     |                       |                     |                     | 57.5                    |
| Fleshy roots .. ..     |                       |                     |                     | 155.7                   |

\*For description of samples see Sanderson & Sivapalan (1966)

\*\*Activity is given as E485/min/mg protein. The reaction mixture contained 2.6 ml 0.1 M citric acid—phosphate buffer pH 6.2; 0.2 ml 1% (w/v) p-phenylenediamine hydrochloride; 0.2 ml 0.01 N H<sub>2</sub>O<sub>2</sub>; and 0.01 ml enzyme preparation (containing 5 to 12 /u protein)

It was necessary to drop this investigation early in the year due to insufficient personnel. However, in view of the probable importance of this enzyme in regulating growth *via* the indoleacetic acid oxidase system (Hare 1964), it would be desirable to continue this investigation in the near future.

### Effect of environment on the chemical composition of tea shoot tips

It was previously established in 1964 that rain passing through tea bushes does leach chemical constituents out of the tea plant tissues. The investigation was continued with an attempt to assess the importance of this phenomenon in tea cultivation by determining the magnitude of the losses due to leaching which occur under field conditions. The results (Table 5) showed that leaching does decrease the level of soluble constituents of the flush, but that the effect tends to be rather small (as evidenced by the low level of significance of differences found between leached and unleached flush). It remains to be established whether or not the losses by leaching are of importance in determining the quality potential of flush in the field.

TABLE 5—Effect of leaching by (A) rain or by (B) sprinklers on the content of certain chemical quantities in tea shoot tips

A—During the monsoon season leaching was effected by natural rainfall. Flush was collected only after periods of 24 hours of nearly continuous rainfall. Unleached flush was obtained by placing polythene covers over the tea bushes at least 24 hours before collection of the flush

B—During the dry season leaching was effected by sprinkling tea bushes with a fine spray for 48 hours prior to collection of the flush. Unleached flush was taken from bushes which had not been sprinkled

| Chemical quantity       | No of samples | Content in flush<br>(% of dry wt of flush) |           | LSD (P) |
|-------------------------|---------------|--|-----------|---------|
|                         |               | Leached                                    | Unleached |         |
| <b>A—Monsoon season</b> |               |  |           |         |
| Ash                     | 7             | 5.30                                       | 5.44      | 0.05    |
| Total soluble solids    | 7             | 46.94                                      | 46.96     | NS      |
| <b>B—Dry season</b>     |               |  |           |         |
| Ash                     | 4             | 4.99                                       | 5.20      | NS      |
| Total soluble solids    | 4             | 47.78                                      | 50.09     | NS      |
| Flavanols               | 4             | 25.87                                      | 29.16     | 0.02    |

TABLE 6—Progressive changes in the levels of amino acids during manufacture of black tea  
(Results given in mg amino acid/100 g dry material)

| Amino Acid              | Fresh Leaf | Withered 9 hr | Withered 18 hr | Fermented 1½ hr | Fermented 3 hr | Black Tea |
|-------------------------|------------|---------------|----------------|-----------------|----------------|-----------|
| Aspartic acid ..        | 109        | 102           | 176            | 156             | 178            | 176       |
| Glutamic acid ..        | 215        | 265           | 394            | 305             | 310            | 267       |
| Serine ..               | 68         | 62            | 102            | 90              | 78             | 51        |
| Asparagine ..           | 28         | 63            | 116            | 101             | 124            | 75        |
| Glutamine ..            | 30         | 25            | 53             | 41              | 35             | 30        |
| Tyrosine ..             | 04         | 25            | 28             | 31              | 21             | 21        |
| Threonine ..            | 20         | 29            | 43             | 33              | 27             | 26        |
| Alanine ..              | 20         | 20            | 35             | 34              | 32             | 25        |
| Valine ..               | 08         | 22            | 50             | 52              | 49             | 40        |
| Leucine + isoleucine .. | 11         | 33            | 84             | 62              | 62             | 62        |
| Phenylalanine ..        | 02         | 10            | 41             | 31              | 30             | 34        |
| Theanine ..             | 930        | 830           | 625            | 650             | 590            | 520       |
| Total ..                | 1445       | 1486          | 1747           | 1586            | 1546           | 1327      |

### Nitrogen metabolism in tea

Investigation of the changes undergone by free amino acids during tea manufacture was continued. A full report of this investigation has been prepared for publication (Roberts & Sanderson 1966) and the results may be summarized as follows: The free amino acids generally increase in amount during the withering stage in tea manufacture and then decrease during fermentation and firing (see Table 6). Theanine, the most abundant amino acid present, is an exception in that it decreases in amount throughout tea manufacture. Temperature and, to some extent, method of storage have an affect on the rate of the changes taking place during the withering process. The full importance of these results as regards the role of free amino acids in determining quality in black teas is not known at present, but it was found that the free amino acid content of flush tends to show a negative correlation with the quality classification of the clone from which it was obtained.

Investigations using glycine labelled with radioactive carbon-14 showed that the amino acids are actively metabolized in tea flush and that theanine undergoes a steady turnover. There was also a synthesis of caffeine from labelled amino acids during withering. These results are shown in Table 7.

TABLE 7—*Distribution of radioactivity in free amino acids and caffeine in shoot tips at different times after feeding  $^{14}\text{C}$ -glycine*

|                          | Specific Activity<br>(Radioactivity / $\mu$ mol) |                                     |                                      |   |
|--------------------------|--|-------------------------------------|--------------------------------------|---|
|                          | Sample 1<br>(3 hr after<br>feeding)              | Sample 2<br>(8 hr after<br>feeding) | Sample 3<br>(11 hr after<br>feeding) | Sample 4<br>(Sample 2<br>withered<br>for 15 hr) |
| Asparatic acid ..        | 73   | 11.5                                | 25                                   | 8.5   |
| Glutamic acid ..         | 184  | 17.5                                | 15.8                                 | 8.5   |
| Glycine .. ..            | 41   | 31                                  | 30.5                                 | 18  |
| Serine .. ..             | 2500   | 160                                 | 118                                  | 138   |
| Threonine .. ..          | 138  | 0                                   | 0                                    | 0   |
| Glutamine .. ..          | 91   | 38                                  | 26                                   | 28  |
| Alanine .. ..            | 84   | 0                                   | 29                                   | 25  |
| Unknown 1 .. ..          | 50   | 0                                   | 35                                   | 20  |
| Valine .. ..             | 26   | 48                                  | 94                                   | 97  |
| Leucine + iso leucine .. | 0  | 0                                   | 24                                   | 0   |
| Theanine .. ..           | 37   | 27.5                                | 10                                   | 8   |
| Caffeine .. ..           | 62   | 118                                 | 93                                   | 199   |

The assimilation of inorganic nitrogen and its conversion to amino acids within the tea plant are presently under investigation.

**Field Experiment****B1—Effect of irrigation on yield and quality—3 clones duplicated—(1965)**

This experiment was designed to give preliminary information on the effect of irrigation on the yield and quality of tea under up-country conditions. Pre-treatment plucking of the plots (replicated in clones TRI 777, TRI 2024 and DT 1) was started in November. The experiment will be completed in March 1966 and the results should be available shortly thereafter.

L. A. Seevaratnam & D. Kirtisinghe

**Visits, Lectures and Symposia**

*Visits*—The following visits were made by Dr G. W. Sanderson while he was on overseas leave :

- 1—The chemistry laboratories at the University of Sheffield, England, in March, to discuss tea biochemistry with Prof W. D. Ollis, Prof R. D. Haworth, Dr E. Haslam and Dr C. P. Falshaw
- 2—The biochemistry laboratories at the University of Cambridge, England, in March, to discuss tea biochemistry with Dr D. S. Bendall

*Lectures*—The following lectures were given during the year :

- 1—‘The action of polyphenolic compounds on enzymes’ by Dr G. W. Sanderson at the Biochemical Society meeting in London in February
- 2—‘Metabolism of nitrogenous compounds during tea manufacture’ by Mr G. R. Roberts at the TRI staff seminar in April
- 3—‘Present day knowledge of the chemical basis of quality in black tea’ by Dr G. W. Sanderson at the Dimbula Planters’ Association meeting in August
- 4—‘On the chemical basis of quality in black tea’ by Dr G. W. Sanderson at the TRI staff seminar in November
- 5—‘The biology of tea manufacture’ by Dr G. W. Sanderson at the Ceylon University Botanical Society meeting in November
- 6—‘Effect of leaf age on the photosynthetic assimilation of carbon dioxide in tea plants’ by Dr G. W. Sanderson and Mr K. Sivapalan at the Ceylon Association for the Advancement of Science meeting in December
- 7—‘The changes undergone by free amino acids during the manufacture of black tea’ by Mr G. R. Roberts and Dr G. W. Sanderson at the Ceylon Association for the Advancement of Science meeting in December
- 8—‘5-dehydroshikimate reductase in tea plants’ by Dr G. W. Sanderson at the Ceylon Association for the Advancement of Science meeting in December.

### Acknowledgements

The gift of generous quantities of several fine chemicals by Messrs Thomas J. Lipton Inc, USA, is acknowledged with thanks. The assistance of Dr E. C. Cocking of Nottingham University, England, in obtaining some seed and reprints is gratefully acknowledged.

The gift of tobacco seedlings for use in our research programme by the Ceylon Tobacco Company is acknowledged with thanks. Dr P. P. G. L. Siriwardena, Mr D. A. Weerasekera and Mr S. D. Samuel of the Radioisotope Centre, University of Ceylon, Colombo and Dr A. H. Al Abbas, IAEA expert in Ceylon, gave advice and assistance in the radiochemical work carried out by this Division. For this we express our gratitude.

### Publications

ROBERTS, G. R. & SANDERSON, G. W. (1966). Changes undergone by free amino acids during the manufacture of black tea. *J. Sci. Fd Agric.* **17**: 182-188.

SANDERSON, G. W. (1965a). The action of polyphenolic compounds on enzymes. *Biochem. J.* **95**: 24-25P.

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# REPORT OF THE BIOCHEMISTRY (TEA MANUFACTURE) DIVISION

*Biochemist* - R. L. Wickremasinghe, BSc, PhD, FRIC

## General

Dr A. S. L. Tirimanna, Research Officer, joined the Division on 14th January, and Mr V. H. Perera, Technical Assistant, took up his appointment on 1st April. Mr M. T. Subramaniam, Technical Assistant, was transferred to the Technology Division on 17th February.

## Laboratory Investigations

### Analyses of made tea samples

Qualitative and quantitative analyses were made of samples of tea manufactured by different processes. Polyphenolic groupings were estimated by the methods described by Swain and Hillis (1959), amino-acids according to Moore and Stein (1948), and chlorophylls, spectro-photometrically. Qualitative analyses of polyphenols and amino acids were done by two-dimensional chromatography, and of chlorophylls by a thin-layer chromatographic method devised in this laboratory. All samples were extracted first with absolute methanol and the residue then re-extracted with aqueous methanol. This method of differential extraction afforded a means of separating the highly polymeric and chemically bound compounds from other material. The results of analyses of samples of Japanese green tea, three samples of instant tea, (hot-soluble 'Ceytea', cold-soluble 'Ceytea' and 'Nestea'), and black tea manufactured by conventional, Rotorvane, CTC and Clivemeare processes have been published (Wickremasinghe *et al* 1965). In addition to these, analyses have been carried out of samples of made tea manufactured at Lethentey Estate (Legge Cut), Bowhill Estate, (flour mill), Aislaby Estate (Rotorvane with oxygen injection), as well as Darjeeling and Formosa teas. The results indicated that drastic maceration of the leaf during manufacture tends to produce teas containing relatively high concentrations of unchanged polyphenols and unchanged chlorophylls. The injection of oxygen during rotorvaning did not appear to have an appreciable effect on the oxidation of the polyphenols, but possibility of any effect on the transformations of chlorophylls has yet to be ascertained. It appears from our results that teas containing a high proportion of unchanged chlorophylls tend to be brown.

K. P. W. C. Perera & V. H. Perera

### Effect of hydrogen peroxide on the blackness of teas

Since unchanged chlorophylls appeared to detract from the blackness of tea, experiments were carried out to determine whether the addition of chlorophylls by hydrogen peroxide would result in the production of blacker teas. Only two experiments have been carried out so far, and both of these showed that treatment with hydrogen peroxide increased the blackness of the teas. The second of these experiments indicated that it was preferable to add the hydrogen peroxide prior to rolling, rather than after fermentation. Chemical analyses of the made teas showed that the hydrogen peroxide treated samples had a lower content of unchanged chlorophylls than the untreated samples. It is too early to assess whether the use of hydrogen peroxide is economical and practicable, but these experiments, which were carried out in collaboration with the Technologist and Tea Taster, serve to indicate the importance of chlorophyll breakdown to the blackness of tea.

### **Gallotannins and ellagitannins of tea**

Careful examination of the polyphenol chromatograms show the presence of six compounds which had not been observed previously. Three of these have been identified as glucogallin, corilagin and chebulagic acid respectively. The first belongs to a group of substances known as gallotannins and the latter two to the group of ellagitannins. Identifications were based firstly, on elution of the compounds from the chromatograms, followed by acid hydrolysis and chromatography of the products of hydrolysis and secondly, on co-chromatography with authentic markers, which were kindly supplied by Professor Otto Schmidt of Heidelberg, Germany. The presence of these compounds in tea has not been reported earlier and they are of interest because of their ability to 'tan' enzymes and other proteins. Thus, corilagin formed an insoluble complex with the protein gelatin, and it was found that this complex was dissociated on the addition of caffeine. Work is now in progress on the effect of gallotannins and ellagitannins on the enzyme systems involved in tea fermentation and the possible role of caffeine in preventing insolubilization of the enzyme systems.

K. P. W. C. Perera

### **Browning reactions in tea manufacture**

Roberts and Smith (1961) have shown that theaflavins and thearubigins contribute to the liquoring characteristics of tea, and in this laboratory, we have found that chlorophylls play a part in determining the blackness of made tea and the nature of the infused leaf. However, on extracting all the chlorophylls of black tea with chloroform, infusing the residue (which was remarkably coppery), with boiling water, and extracting the theaflavins and thearubigins from the infusion, the residual aqueous infusion was still very brown. Chromatographic analysis of this residue showed that it consisted of several brown complexes and a study of three of these complexes revealed the following components :

Complex 1—Theanine + ellagic acid + gallic acid + galactose + unidentified compounds

Complex 2—Theanine + ellagic acid + gallic acid + corilagin + galactose

Complex 3—Theanine + ellagic acid + theogallin + galactose + unidentified compounds

This work is being continued and should give us a better understanding of the factors responsible for the colour of tea liquors.

K. P. W. C. Perera

### **Seasonal variations in the amino acids, polyphenols and chlorophyll contents of different clones**

Quantitative analyses at fortnightly intervals of the amino acids and polyphenols of 5 clones (DT 1, TRI 2024, TRI 26, CV 5 B 1 and PA 22), have been completed and the results will be statistically analysed and published shortly.

K. P. W. C. Perera

The variations in chlorophyll contents of clones DT 1, TRI 777, TRI 2024, CH 13, TRI 26, TRI 2026, CV 5 B 1 and PA 22 are being studied at 4-weekly intervals. Considerable seasonal variations are evident in the amino-acid and chlorophyll contents.

V. H. Perera

### Chemical analyses of NPZn Experiment (A2)

Quantitative analyses were made of the amino-acids and polyphenols in flush from the NPZn trial laid down by the Agricultural Chemistry Division. The flush from 10 different fertilizer treatments were analysed at 6-weekly intervals. Analysis of variance by the Statistician showed a significant difference in the amino acid contents of flush in plants treated with 300 lb N/acre/annum as compared with those treated with 100 or 200 lb N/acre/annum. There was no significant effect of N on the quantities of various polyphenols in the flush. Made tea samples from the control and the three different N treatments were obtained with the assistance of the Technologist, and these were examined by the Tea Taster, who reported no difference in valuation between the samples from the treated plots, but gave a higher valuation for the tea made from the untreated plot. However, the yield from the latter was considerably lower than those from the treated plots.

V. H. Perera

### Changes during manufacture

A study was made of the changes during manufacture of the carotenoids, keto-compounds and chlorophylls. The results on the carotenoids and chlorophylls have been published and those on the keto-compounds presented at the 21st Annual Sessions of the Ceylon Association for the Advancement of Science.

### Carotenoids of tea

The results of an investigation of the carotenoids of tea has been published (Tirimanna & Wickremasinghe 1965). The compound tentatively identified as rhodoxanthin was found to occur in high concentration in clones susceptible to attack by Red Spider Mite, and it was also found that extracts of the mite contained this carotenoid. Any correlation between the presence of this carotenoid and mite attack is being studied in collaboration with Mr E. F. W. Fernando of the Entomology Division.

### Sterols and terpenoid compounds of tea

Thin layer chromatographic studies have been used for the study of the compounds present in ethanolic extracts of black tea. Twenty different samples of Uva made teas, which were obtained with the assistance of the District Advisory Officer, Uva, have been analysed. The ethanolic extracts were saponified and extracted with ether before analysis. Of the terpene alcohols trace amounts of linalool were detected using an anisaldehyde-sulphuric acid spray. Geraniol, farnesol, citronellol and  $\alpha$ - and  $\beta$ -ionone were not present in the extracts. A sterol, separated by precipitation with digitonin was also detected and tentatively identified as spinasterol. Two other compounds which have been identified as  $\alpha$ - and  $\beta$ -tocopherols (vitamin E) were also detected. A triterpenoid,  $\beta$ -amyirin, was found to be present in high concentration, and was identified by comparison with an authentic marker, kindly supplied by Dr R. O. B. Wijesekera of the Medical Research Institute, Colombo. Also present in high concentration was a triterpenoid acid, which was found to occur in even higher concentration in the bark of the tea plant.

A number of other compounds present in the ethanolic extracts of black tea have not been identified as yet—six of these are carbonyl compounds, since they form yellow dinitrophenylhydrazones.

### Flavour of tea

Ether extracts of stem distillates of black tea contained several compounds which have been separated by thin layer chromatography but not identified as yet, although many of their chemical reactions are known. The main difference observed between flavoury and non-flavoury teas was the multiplicity of steam distillable compounds in the non-flavoury teas as compared to the flavoury teas. It is presumed that the larger number of compounds in the non-flavoury teas are either breakdown products or intermediates in the biosynthesis of the characteristic flavoury constituents of tea. The identification of these compounds, as well as of those present in the ethanolic extracts of black tea, should throw some light on the basis of tea flavour and this study is being continued.

Experiments carried out with tea leaf juice indicated that (a) the substances responsible for the production of tea flavour are dialysable, (b) the amino acid leucine could act as precursor of at least some of the substances contributing to tea flavour and (c) carbon dioxide was necessary for the production of flavour.

### Visits, Lectures and Symposia

TIRIMANNA, A. S. L.—Some new amino-acids and related compounds in plants—lecture to the Chemical Society of Ceylon in March.

TIRIMANNA, A. S. L.—Carotenoids of the tea leaf and their changes during manufacture—TRI Seminar in June.

TIRIMANNA, A. S. L. & WICKREMASINGHE, R. L.—Thin layer chromatographic studies of the carotenoids of tea—Paper presented at the 21st Annual Sessions of the Ceylon Association for the Advancement of Science in December.

WICKREMASINGHE, R. L.—Keto-compounds in tea manufacture—Paper presented at the 21st Annual Sessions of the Ceylon Association for the Advancement of Science in December.

### Publications

WICKREMASINGHE, R. L. (1965). Studies on the quality and flavour of tea—1—The polyphenols and low-boiling volatile compounds. *Tea Quart.* **36** : 59-63.

TIRIMANNA, A. S. L. & WICKREMASINGHE, R. L. (1965). Studies on the quality and flavour of Ceylon tea—2—The carotenoids. *Tea Quart.* **36** : 115-121. (*Reprinted Assam Rev. Tea News* **54** (10) : 495-500 (1965).

WICKREMASINGHE, R. L., KIRTISINGHE, D., PERERA, K. P. W. C. PERERA, V. H. (1965). Effect of method of manufacture on the oxidation of polyphenols and chlorophylls. *Tea Quart.* **36** : 167-171.

WICKREMASINGHE, R. L. & SWAIN, T. (1965). Studies on the quality and flavour of Ceylon Tea. *J. Sci. Fd Agric.* **16** : 57-64.

WICKREMASINGHE, R. L. & SWAIN, T. (1965). The accumulation of  $\gamma$ -aminobutyric acid in bean callus tissue. *Phytochem.* **4** : 687-691.

BELL, E. A. & TIRIMANNA, A. S. L. (1965). Associations of amino-acids and related compounds in the seeds of forty seven species of *Vicia* : their taxonomic and nutritional significance. *Biochem. J.* **97** : 104-111.

**References**

- MOORE, S. & STEIN, W. H. (1948). Photometric ninhydrin method for use in the chromatography of amino-acids. *J. biol. Chem.* **176** : 367-388.
- ROBERTS, E. A. H. & SMITH, R. F. (1961). Spectrophotometric measurements of theaflavins and thearubigins in black tea liquors in assessment of quality in teas. *Analyst* **86** : 94-98.
- SWAIN, T. & HILLIS, W. E. (1959). Phenolic constituents of *Prunus domestica*  
1. Quantitative analysis of phenolic constituents. *J. Sci. Fd Agric.* **19**: 63-68.

# REPORT OF THE TECHNOLOGY DIVISION

*Technologist* – D. Kirtisinghe, BSc, PhD, DIC

## General

Mr C. H. Wickremesinghe was appointed Tea Taster in June. Mr W. Joseph, assumed duties as Research Assistant in January and proceeded to the UK in April on a post-graduate scholarship awarded by the Federation of British Industries. Mr K. G. A. Dharmawardene, Research Assistant assumed duties in July but resigned in September. Mr M. T. Subramaniam, Technical Assistant was transferred to this Division from Biochemistry to fill in the vacancy created by Mr L. S. Weragoda's resignation. Mr T. F. Saldin was appointed as Technical Assistant in April and is due for transfer to the Low-Country Station. Mr T. A. Munasinghe was appointed Technical Assistant in November.

Manufacture at St Coombs factory was brought under the control of the Technologist from April. The Agriculturist will, however, be responsible for the housing and general welfare of the factory staff and operatives, and the estate office will help with routine matters and correspondence arising from the factory.

With the appointment of the Tea Taster the scope of the advisory work of this division has been considerably widened. Samples are replicated and tasted blind without consideration for trade marks. All clonal quality assessments are being done on the basis of Mr Wickremesinghe's reports. Research has also been considerably speeded by the immediate presence of a taster.

## Factory Experiments

**T1**—*Blending of clonal teas*—9 replicates of 11 treatments completely randomized—(1965)

This experiment is being carried out to determine whether two or more clones mixed during the rolling process will produce an effect, different from that of blending the same clones after manufacture and different from that expected on the basis of the individual reports on each clone.

This investigation is for the present limited to three clones WY, CY 9 and TK 2, supplied from Tangakelle Group. The leaf is given a 10 minute pre-conditioning roll in a conventional roller followed by two rotorvane passes to reduce the big bulk of 10%.

The trial is being continued. No conclusions have yet been drawn.

C. Kandappah

**T2**—*The effect of live shade in the field on the liquoring characteristics of tea*—Split-plot—14 replicates of 2 treatments split on 6 clones—(1965)

The object of this study is to determine the effect, if any, that live shade in the field would have on the liquoring characteristics of tea. In this experiment, shade is provided by dadap trees planted at a spacing of 14' x 14'. The field layout (VP1) was arranged by the Plant Propagation Division. The manufacturing properties of six selected clones planted in June 1961 and grown under shade and without shade were tested.

The experiment is in progress and it is hoped to have some results in mid-1966.

W. C. A. de Silva & S. Samarasingham

**T3—Irrigation of clones—8 replicates of 3<sup>2</sup>—(1965)**

This investigation is being made to determine whether the quality and flavour of made tea will be affected in any way, when growth is artificially stimulated by irrigation, other weather conditions being unaltered. Three high quality clones, each from two different plots (**B1**) are being examined. Pre-treatment tests are now being carried out to determine whether the selected plots have inherent differences.

Results should be available in 1966.

G. W. Sanderson & C. Kandappah

**T4—Quality assessment of new clonal materials—(1965)**

The quality assessments of some of the more interesting clones of the 934 samples tasted and reported this year are as follows :

TABLE 1—Quality classification of some new clones tested in 1965

| Classification Group | Clones                                 | Estate             |
|----------------------|--|--------------------|
| A 1                  | TC 9                                   | Bearwell           |
| A 2                  | PW 14, KP 9, HS 10A, UR 1<br>13/7, 1/5 | Concordia<br>Pedro |

S. Samarasingham & C. H. Wickremesinghe

**T5—The effect of some foliar fungicidal sprays on liquoring character—6 replicates of 3 treatments in randomized blocks with nominated comparisons—(1963)**

Manufacturing tests conducted with teas sprayed with copper and nickel fungicides (**P17**) as well as on teas left unsprayed indicate that the copper sprayed teas have duller infusions but that valuations have not been affected as a consequence. Results have been published (Kirtisinghe & de Silva 1965). The experiment is being conducted over a whole pruning cycle.

R. L. de Silva & S. Samarasingham

**T6—Some comparisons between tat and trough withers—Paired comparison—(1964)**

Experiments were carried out to compare quality and other liquoring characteristics of tat and trough withered high grown leaf (*a*) for equal periods of wither and (*b*) relatively short trough withers *vs* longer tat withers. A large number of samples were taken for moisture determinations in order to assess the relative evenness of tat and trough withered leaf.

Experiments have revealed that there are no significant differences between the quality and valuations of tat and trough withered leaf. Moreover, it has also helped to establish that it was possible to obtain a wither as even in the trough as on hessian tats.

The fuel cost of operating this trough which was coupled to its own heat exchanger was 1.80 cents per pound of made tea. Over the same period the fuel cost of tat withering was twice as much.

C. Kandappah

**T7—Rate of withering—Observational trial—(1965)**

A trial is being conducted to determine the relative importance of air-flow-rates and relative humidities in governing the over-all rate of withering.

Statistical analysis of the data now available indicates that the air flow rate controls rate of withering at humidities ranging from 70 to 85%.

T. F. Saldin

**T8—Coarse leaf separation—(1965)**

A mechanical arrangement which would fit onto a withered leaf sifter is being developed for the purpose of separating coarse leaf. A good separation can be affected but the output is yet too small to find practical application.

T. F. Saldin

**T9—The effect of vane combinations, rotor shaft speed and pressure exerted by the end-plate on made tea characteristics—Split, split-plot—6 replicates of 2 treatments split on 3 speeds, which are themselves split on 2 vane combinations—(1964)**

This trial was laid down to investigate the influence of the Iris end-plate, rotor shaft speed and some vane combinations on the dhool and grade outturns and the made tea characteristics. This trial has been concluded and detailed results have been published (de Silva 1965).

W. C. A. de Silva

**T10—The effect of the degree of wither on rotorvanned teas—8 replicates of 3 treatments in randomized blocks—(1965)**

A direct comparison was made between soft medium and hard withered leaf, corresponding to approximate outturns of 42, 45 and 48% made tea to withered leaf, respectively.

Eight replicates were carried out according to programme 1 (de Silva and Sanderson 1964) and the results are now being analysed statistically. The means of the made tea characteristics obtained from the three different withers as evaluated by the TRI taster and by the Colombo and London tasting panels are presented in Table 2.

TABLE 2—*The effect of the degree of wither on the characteristics of a rotorvanned tea*

| Characteristic         | Grade | TRI Taster |        |       | Colombo Panel |        |       | London Panel |        |       |
|------------------------|-------|------------|--------|-------|---------------|--------|-------|--------------|--------|-------|
|                        |       | Soft       | Medium | Hard  | Soft          | Medium | Hard  | Soft         | Medium | Hard  |
| Brightness of Infusion | BOP   | 5.25       | 5.25   | 5.08  | 5.34          | 5.10   | 4.93  | 6.15         | 5.46   | 5.50  |
|                        | BOPF  | 5.38       | 5.21   | 5.04  | 5.31          | 5.24   | 5.10  | 5.87         | 5.73   | 5.39  |
| Colour                 | BOP   | 5.25       | 5.55   | 5.08  | 5.41          | 5.17   | 4.90  | 5.53         | 5.28   | 4.61  |
|                        | BOPF  | 5.54       | 5.42   | 5.17  | 6.03          | 6.24   | 5.93  | 6.17         | 6.07   | 5.66  |
| Strength               | BOP   | 5.21       | 5.42   | 5.25  | 4.86          | 4.86   | 4.86  | 5.42         | 5.25   | 4.82  |
|                        | BOPF  | 5.17       | 5.00   | 5.29  | 5.52          | 6.03   | 5.93  | 6.24         | 6.34   | 5.93  |
| Quality                | BOP   | 5.38       | 5.50   | 5.34  | 5.14          | 5.07   | 5.17  | 5.11         | 4.95   | 4.84  |
|                        | BOPF  | 5.12       | 5.00   | 5.21  | 4.66          | 4.76   | 5.07  | 5.45         | 5.51   | 5.16  |
| Flavour                | BOP   | —          | —      | —     | 1.86          | 1.86   | 1.72  | 1.85         | 1.78   | 1.74  |
|                        | BOPF  | —          | —      | —     | .152          | 1.38   | 1.34  | 1.97         | 2.08   | 1.78  |
| Valuation              | BOP   | 207.7      | 209.5  | 208.7 | 230.7         | 227.3  | 222.2 | 51.45        | 50.22  | 50.01 |
|                        | BOPF  | 225.5      | 224.6  | 228.1 | 229.5         | 227.7  | 230.8 | 55.30        | 55.11  | 54.29 |

cents

pence

Conclusions can only be drawn after the complete analysis.

W. C. A. de Silva

**T11—Rotorvane manufacture of china jat leaf and the effects of the floral and Iris end-plates—15 replicates of 3 treatments in randomized blocks with nominated comparisons—(1965)**

This experiment was started in order to determine whether the small leaf, China-jat type of leaf could be rotorvanned with as much success as was observed earlier with a medium-jat leaf. This experiment was replicated 15 times with medium withers and manufacture was carried out as in programme 1 already described (de Silva & Sanderson 1964).

At the time of analysis only 13 reports were available from the TRI tester and 11 from the Colombo panel. Hence no statistical evaluation has been attempted, but some tentative conclusions have been drawn below on the basis of the means of each characteristic.

Two rotorvane treatments were compared with teas rolled in an orthodox manner. The rotorvane treatments corresponded to the incorporation of the Iris end-plate (minimum pressure position) and the floral end-plate into the Rotorvane. The vane combinations for both treatments were eight forwards with a single reverse vane placed centrally.

The means of each characteristic from the reports now available are presented in Table 3.

TABLE 3—*Rotorvane manufacture of China-jat leaf compared with that of the same leaf given four thirty minute rolls in conventional rollers*

| Characteristic         | Grade    | TRI Taster |        |          | Colombo Panel |        |          |
|------------------------|----------|------------|--------|----------|---------------|--------|----------|
|                        |          | Iris       | Floral | Orthodox | Iris          | Floral | Orthodox |
| Brightness of Infusion | ... BOP  | 4.86       | 4.78   | 4.94     | 5.47          | 5.40   | 5.46     |
|                        | ... BOPF | 5.12       | 5.17   | 5.12     | 5.50          | 5.36   | 5.53     |
| Colour                 | ... BOP  | 5.02       | 4.84   | 4.84     | 4.89          | 4.90   | 4.44     |
|                        | ... BOPF | 5.23       | 5.28   | 4.99     | 6.64          | 6.69   | 6.05     |
| Strength               | ... BOP  | 4.51       | 4.53   | 4.71     | 4.96          | 4.95   | 4.82     |
|                        | ... BOPF | 4.92       | 5.20   | 5.15     | 6.23          | 6.43   | 6.23     |
| Quality                | ... BOP  | 4.92       | 4.98   | 4.99     | 4.95          | 4.69   | 4.95     |
|                        | ... BOPF | 4.99       | 5.03   | 4.97     | 5.15          | 5.14   | 5.43     |
| Flavour                | ... BOP  | —          | —      | —        | 1.06          | 1.9    | 1.30     |
|                        | ... BOPF | —          | —      | —        | 1.45          | 1.43   | 1.57     |
| Valuation (cts)        | ... BOP  | 212.2      | 216.2  | 216.0    | 225.3         | 220.4  | 224.8    |
|                        | ... BOPF | 239.6      | 244.3  | 240.9    | 241.7         | 238.5  | 240.9    |

The differences in the means of each characteristic appear to be sufficiently small to be within the limits of experimental error. It would, therefore, seem as though there has been no detectable improvement in liquor or valuation as a result of rotorvanning the China-jat leaf.

W. C. A. de Silva

**T12—Feeding rates and residence times of leaf within the Rotorvane—Observational trial—(1965)**

An experiment has been started to determine the influence of feeding rates and the residence times of leaf within the rotorvane barrel as controlled by shaft speed, vane combination and type of end plate, on liquoring characteristics. No results are available.

W. C. A. de Silva

**T13—***Period of fermentation and its effect on liquoring properties of some clonal material*  
6 replicates of 6 treatments in randomized blocks—(1965)

This investigation was first conducted with clone TRI 2024, to determine the optimum period and the permissible range in fermenting times under both 'quality' and 'off season' conditions. Preliminary indications are that the peak quality with medium withers is after 2½ hours fermentation and that a 4½ to 5 hour period of fermentation produces an improvement in both colour and strength. Overall valuations were consequently unaffected over fermentation periods ranging from 2½ to 5 hours. These results need not necessarily be applicable when flavour is present.

M. T. Subramaniam

**T14—***Fermenting dhools on a porous surface—Split-plot—12 replicates of 2 treatments split on 3 types of surfaces—(1964)*

This investigation was carried out to compare the relative merits of fermenting dhools on a porous mesh of a synthetic material as compared with fermenting dhools on PVC sheets and on a concrete rack. 2½" and 3½" thicknesses of spread have been tried out with each material and the interaction between the nature of the surface and thickness of spread has also been examined. Indications are that the overall valuations of twelve replicated experiments are no different for the three surfaces but that there is an interaction for quality between the nature of the surface and the thickness of spread. This experiment is being continued.

C. Kandappah

**T15—***Suitability of fibreglass as a fermenting surface—Paired comparisons—(1965)*

Teas from dhools fermented on a fibreglass surface were compared with teas which had been fermented under comparable conditions on a concrete surface.

Reports from the Tea Taster indicate that there are no differences between the liquoring characteristics of teas fermented on these surfaces. There is also no indication of any taint being imparted by the fibreglass surface.

T. F. Saldin

**T16—***The suitability of some locally available timber as battens for tea chests—(1965)*

Fifteen species of locally available wood, approximately two years from the date of sawing into planks, were tested for suitability as battens for tea chests. Teas were stored in direct contact with the wood for periods ranging upto a maximum of three months. A summary of these findings are presented in Table 4.

TABLE 4—*The suitability of some timber species as battens for tea chests*

| Species     | Botanical name                   | Tendency to taint                             |
|-------------|----------------------------------|---|
| Aridda      | <i>Camposperma zeylanica</i>     | } Taint free                                  |
| Kolon       | <i>Adina cordifolia</i>          |   |
| Helamba     | <i>Mitragyna tubulosa</i>        |   |
| Thimbiri    | <i>Diospyros malabarica</i>      |   |
| Polhunna    | <i>Axinandra zeylanica</i>       | } Inconclusive—Could possibly lead to a taint |
| Palen       | <i>Kurrima zeylanica</i>         |   |
| Etamba      | <i>Mangifera zeylanica</i>       |   |
| Godakirilla | <i>Holoptelea integrifolia</i>   |   |
| Panaka      | <i>Pleurostlia opposita</i>      |   |
| Welanga     | <i>Pterospermum canescens</i>    |   |
| Katuboda    | <i>Cullenia zeylanica</i>        |   |
| Wal-jambu   | <i>Syzygium aqueum</i>           |   |
| Madol       | <i>Garcinia echinocarpa</i>      |   |
| Mora        | <i>Euphoria longana</i>          |   |
| Dorana      | <i>Dipterocarpus glandulosus</i> | A strong tendency to taint                    |

W. C. A. de Silva

**T17—The suitability of rubberwood hardboard as panels for tea chests—6 Split-plot replicates of 2 treatments split on 4 types of packing materials—(1965)**

This experiment was designed to test rubberwood hardboard, imported hardboard, imported plywood and local plywood both lined and unlined with metal foil, for each of the following characteristics :

- (a) the possibility of absorbing a taint over storage periods ranging from 3 to 14 weeks
- (b) moisture absorption by the tea and
- (c) keeping properties

None of these materials showed any tendency to taint when they were lined with metal foil. After a period exceeding 10 weeks of storage, teas packed in the unlined chests were frequently reported as plain or soft while some tasters have even reported a slight cardboard or woody taint. All four materials were found to be equally good in keeping out moisture. In every instance the unlined chests contained 1-2% extra moisture than their lined counterpart. It can, therefore, be concluded that the rubberwood hardboard is as suitable as imported plywood for tea chest panels with regard to the above mentioned properties.

W. C. A. de Silva

**Visits, Lectures & Symposia**

Dr Kirtisinghe addressed the Morawak Korale Planters' Association on 'Certain aspects of Rotorvane Manufacture' and the Dimbula Planters' Association in August on 'Factors affecting Quality'. He also participated in a symposium for the Morawak Korale Planters' Association at St Joachim in December.

### Acknowledgements

Our thanks are due to Mr T. B. Pethiyagoda and Mr G. B. Middleton for their assistance and the personal interest taken with the rotorvane experiments on China jat leaf and on clonal blending, respectively. Assistance given by Mr P. Kanapathipillai in statistical layout and analysis is also acknowledged with thanks.

Invaluable assistance willingly given by the panels of tasters in London and Colombo in evaluating and reporting on our experimental teas is gratefully recorded.

### Publications

DE SILVA, W. C. A. (1965). The importance of feeding rates in Rotorvane manufacture. *Tea Quart.* **36** : 151-166.

KIRTISINGHE, D. & DE SILVA, R. L. (1965). Investigations on the effect of some foliar fungicidal sprays on certain properties of made tea. *Tea Quart.* **36** : 112-114.

WICKREMASINGHE, R. L., KIRTISINGHE, D., PERERA, K. P. W. C. & PERERA V. H. (1965). The effect of the method of manufacture on the oxidation of polyphenols and chlorophylls. *Tea Quart.* **36** : 167-182.

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DE SILVA, W. C. A. & SANDERSON, G. W. (1964). Rotorvane manufacture techniques. *Tea Quart.* **35** : 230-234.

# REPORT OF THE STATISTICS DIVISION

Statistician - P. Kanapathipillai, BSc, FSS

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There were no changes in staff. An attempt to recruit a graduate technical assistant during the year was not successful as none of the applicants were found suitable.

## Designs

All the designs were randomized blocks or standard factorial designs. These have all been included in the reports of the various Divisions. The Palmgarden 3<sup>4</sup> trial (LA 2) was examined for the possibility of superimposing three levels of phosphate on the blocks. As one three-factor interaction was completely confounded, it was found that this superimposition could be done on whole blocks at random, without affecting the sorting out of any of the previous treatments of importance.

## Analyses

Routine statistical analyses including covariance and regression analyses, wherever pre-treatment data were available, were performed. The volume of data analysed increased by over 100% as compared with that of last year and almost the entire burden of processing these data fell on my assistant Mr K. Seevaratnam.

## Trials on estates

The designs used were the simplest types, viz, randomized blocks or split-plots on single factors like 'shade'. Pre-treatment yield records which are being taken will be used in covariance analyses on all these trials.

## Statistical interpretation

The statistical interpretation of the results of trials, particularly where there was a large number of treatments and where no specific comparison was nominated at the start of the experiment, was not always easy. A modified 't' test, using Quenouille's version of Tukey's test has been applied and satisfactory results obtained.

## Publication

KANAPATHIPILLAI, P. (1965). Extension experiments—their nature and meaning. *Tea Quart.* 36 : 141-143.

# REPORT OF THE ADVISORY DIVISION

Chief Advisory Officer - C. B. Foster-Barham, MA

## General

No staff changes took place during the year. Liason with estates was generally more extensive than in 1964. The total number of estates which made use of Advisory Division services rose from 482 in 1964 to 530 in 1965, an increase to approximately 60% of all estates listed in files. The remainder had not corresponded for a year or more. This expansion appears to have been mainly associated with modifications in certain specific aspects of fertilizer policy, for example the reduction or omission of phosphate and reduction of potash in NPK fertilizer mixtures consequent upon economic necessity; also the substitution of calcium ammonium nitrate in lieu of sulphate of ammonia in specific cases of unduly high soil acidity.

## Pests and Diseases

These continued to be reported with a frequency differing little, generally from those of last year. This report, and also ones for future years, will not detail cases occurring in differing districts, except where they are new or otherwise of particular interest, but if any details of occurrence are particularly required by District Planters' Associations, these will be supplied to them on request.

Amongst new occurrences reported during the year were outbreaks of the small Twig Caterpillar *Ectropis bhurmitra* (= *Boarmia bhurmitra*) and the large Looper Caterpillar, *Buzura strigaria*, on more than a dozen estates situated in the Dolosbage, Hantane, Lower Hewaheta, Kotmale, Kalutara, Kelani Valley and Ratnapura districts. Further information about these outbreaks is given in the report of the Entomology Division.

A first case of Oilspot Disease on clonal tea was noted in January in the Haputale District. The clone effected was Nayabedde 3. The disease had previously been reported only on seedling tea.

## New control measures

### Red root disease (*Poria hypolateritia*)

Soil fumigation with methyl bromide against this disease was recommended to estates following successful experimentation carried out by the Plant Pathology Division. This has brought down the cost of treating one acre of infected tea to less than Rs 1000/-, and contrasts with about Rs 2000/- per acre for soil fumigation with DD. Several demonstrations of the method of soil fumigation were carried out by the Plant Pathology Division.

## Weed control

As a result of effective control and substantial reduction in cost per acre reported from East Africa, a method using both Simazine and Gramoxone has been suggested to a fairly large number of Ceylon tea estates on an experimental basis. Details of this may be had on application to the Institute, but it is stressed that until the method has been proven in Ceylon tea, it remains experimental and should not be accepted as a firm recommendation. Estates which are trying out this method already, are requested to report their results to the Institute.

### **Extension Experiments**

A notice, giving details of various types of shade and fertilizer estate extension experiments was circulated through District Planters' Associations and Agency Houses in June, and requested that those estates interested in partaking should communicate directly with the Institute. This produced a gratifying response from over 130 estates, involving more than 270 separate experiments, and a special note of appreciation and thanks for this response is extended to all those concerned. A number of these experiments have already been laid down on various estates. The shade experiments are directly under the jurisdiction of the Plant Physiology Division, and the fertilizer experiments under that of the Agricultural Chemistry Division in whose annual reports details are given. Additional details are also given in the reports on the Low-country Station and the Passara Sub-station. Mr L. M. de W. Tillekeratne, Mr J. V. Sabanayagam, Mr R. K. Nathaniel and Mr D. N. R. Wijewardena of the Advisory Division are working in co-operation with these two divisions in the laying-down and administration of the Institute's part in these experiments. While every effort will be made to establish the experiments on more estates as rapidly as possible, the rate at which this can proceed is necessarily governed by the adequacy of staff available to operate the programme which is expected to gain impetus following the recent recruitment of additional personnel.

### **Symposia, meetings and instruction courses**

Symposia were held for the Dimbula Planters' Association at Talawakele on the 27th of January, and the Morawak Korale Planters' Association at St Joachim, Ratnapura, on the 7th of December. Additional meetings were also attended in Colombo and Kandy at the invitation of Messrs Carson Cumberbatch & Co Ltd and the Kandy, Pussellawa and Hewaheta Planters' Associations on the 20th October and 16th November respectively.

Refresher courses were held at St Coombs, at the request of the Tea Control Department, for groups of District Field Officers of the Smallholdings Department and for Tea Inspector/Instructors during November and December. These officers were instructed by Heads of Divisions and Research Officers of the Institute on the various aspects of tea cultivation and manufacture including latest developments.

### **Industrial Exhibition**

The Institute, in co-operation with the Tea Control Department and the Ceylon Tea Propaganda Board, participated in the Industrial Exhibition held in Colombo during February.

*District Advisory Officer (Uva) – L. M. de W. Tillekeratne, BSc, MEd*

### **General**

The staff position remained almost the same, except that Mr A. M. Abeysinghe was promoted to the Junior technical assistant grade in June, and Mr T. N. Buhar was appointed as permanent driver attached to the Sub-station. Temporary clerical assistance continued to be available.

The extension to the District Advisory Officer's bungalow is almost completed. Work started on the new Technology unit in October, and should be completed in early 1966.

There was an increase in the advisory correspondence over 1964, and more Superintendents visited the Sub-station on advisory matters. With the introduction of extension experiments on estates, the number of visits to estates increased considerably.

The climatic conditions throughout the year have been rather severe. Following on the failure of the North East monsoon, a prolonged drought was experienced in June and July. The cumulative effect of the North East monsoon failure, and the very dry months of June and July resulted in a considerable drop in crop during the latter period, and also unexpected casualties in new-clearings especially those planted in December/January 1964/65. A number of estates resorted to watering of clearings, and from reports the use of the "Solinject" lance gave satisfactory results.

### Fertilizer policy

With the suggestion for a possible decrease in the quantities of potash and phosphate to be applied to tea in bearing, the number of inquiries regards fertilizer programmes for purposes of estimation for 1966, increased considerably during the latter half of the year. As the policy was to have the same amount of potash and phosphate without any increment applied over an estate, with different levels of nitrogen for different fields, the use of the standard fertilizer mixtures was not possible for practical reasons. The introduction of basal mixtures to supply **all** the potash and phosphate in one application per year along with some of the nitrogen, or with Dolomite so as to give sufficient bulk, was resorted to. With the possibility of replacing ammonium sulphate with calcium ammonium nitrate as a source of nitrogen, so as to avoid over-acidifying of the soil, many estates have decided to have a pH survey and the soil samples sent in for pH determinations increased considerably during the latter part of the year.

### Field Experiments and Trials

#### UA1—Zinc Sulphate at Demodera Group, Demodera—(1964)

The experiment was pruned in October 1965

The five treatments are :

Control (no zinc sulphate)

10 lb  $ZnSO_4$ /acre/year in 2 applications

10 lb  $ZnSO_4$ /acre/year in 4 applications

20 lb  $ZnSO_4$ /acre/year in 2 applications

20 lb  $ZnSO_4$ /acre/year in 4 applications

#### UPH1—Plucking frequency—3 replicates of 3 frequencies $\times$ 3 clones—(1965)

Three TRI clones, 2024, 2025 and 2026 were used. The three different frequencies were 6, 8 and 10 day rounds. The results obtained to the end of December are given in Table 1,

TABLE 1—*Effects of different plucking rounds on yield*

Mean Yields calculated on made tea per acre are not corrected against pre-treatment plucking means

| Clone    | Number of rounds | Yield (lb/acre/annum) |              |               |
|----------|------------------|-----------------------|--------------|---------------|
|          |                  | 6 days<br>49          | 8 days<br>38 | 10 days<br>30 |
| TRI 2024 |                  | 1663                  | 1473         | 1285          |
| TRI 2025 |                  | 1451                  | 1544         | 1352          |
| TRI 2026 |                  | 1630                  | 1602         | 1422          |
| Mean     |                  | 1581                  | 1540         | 1353          |

A. Abeysinghe

*Time and type of pruning experiments*

From the preliminary results obtained on the Queenstown and Ury pruning trials, pruning experiments were started in May on five estates.

**UPH2**—*Time and type of pruning at Batawatte Group, Madulsima—*

Split plot—3 replicates for time of pruning (each month), split on type of pruning—(1965)

D. N. R. Wijewardena

**UPH3**—*Time and type of pruning at Dammeria Group, Passara—*

Split plot—3 replicates for time of pruning (each month), split on type of pruning—(1965)

D. N. R. Wijewardena

**UPH4**—*Time and type of pruning at Hopton Group, Lunugala—*

Split plot—3 replicates for time of pruning (each month), split on type of pruning—(1965)

D. N. R. Wijewardena

**UPH5**—*Time and type of pruning at Demodera Group, Demodera—*

Split plot—3 replicates for time of pruning (each month), split on type of pruning—(1965)

D. N. R. Wijewardena

**UPH6**—*Time and type of pruning at Dyraaba Group, Bandarawela—*

Split plot—3 replicates for time of pruning (each month), split on type of pruning—(1965)

D. N. R. Wijewardena

Two types of pruning (*a*) clean prune (*b*) with lungs, were done every month of the year. The first pruning on all locations was done in May, except on Dammeria Group because there was a strike. Pruning on the latter estate started in June. On each location, four rows of 50 bushes each, making a total of 200 bushes per main plot were pruned every month of the year. Each of these plots are divided into half for the sub-treatments (type of pruning). Number of bushes to be pruned every month per location are  $200 \times 3 = 600$ .

At the time of pruning a bush-count per plot was done. Bark and soil moisture were recorded for bushes in each plot at the time of pruning and for 3 months afterwards. All plots were tipped 168 days after pruning and at the time of tipping the following assessments are made :

Tipping weights, number of shoots on 10 bushes selected at random per sub-plot, the number of casualties and the extent of die-back.

Results to-date are given in Tables 2-4.

TABLE 2—Mean tipping weights per plot (lb)

|              | MAY   |       | JUNE  |       | JULY  |       |
|--------------|-------|-------|-------|-------|-------|-------|
|              | Lungs | Clean | Lungs | Clean | Lungs | Clean |
| Dyraaba ..   | 63.3  | 43.0  | 72.6  | 50.7  | 89.8  | 59.8  |
| Batawatte .. | 89.0  | 60.3  | 82.3  | 64.7  | 96.7  | 85.7  |
| Hopton ..    | 47.5  | 40.3  | 56.3  | 48.0  | 40.0  | 32.0  |
| Demodera ..  | 33.3  | 22.0  | 46.0  | 46.7  | 69.3  | 46.3  |
| Dammeria ..  | —     | —     | 79.0  | 60.3  | 88.3  | 66.7  |
| Mean ..      | 58.2  | 41.4  | 67.2  | 54.1  | 76.8  | 58.1  |

TABLE 3—Mean casualties per plot

|              | MAY   |       | JUNE  |       | JULY  |       |
|--------------|-------|-------|-------|-------|-------|-------|
|              | Lungs | Clean | Lungs | Clean | Lungs | Clean |
| Dyraaba ...  | 2.0   | 16.3  | 2.0   | 15.3  | 0.0   | 4.3   |
| Batawatte .. | 3.3   | 9.7   | 0.7   | 5.0   | 0.0   | 2.0   |
| Hopton ..    | 1.0   | 3.3   | 0.0   | 3.0   | 0.0   | 2.9   |
| Demodera ..  | 5.0   | 16.7  | 5.0   | 10.3  | 0.0   | 0.0   |
| Dammeria ..  | —     | —     | 5.7   | 5.3   | 0.3   | 2.7   |
| Mean ..      | 2.8   | 11.5  | 2.6   | 7.8   | 0.0   | 2.4   |

TABLE 4—Mean die-back on 10 bushes per plot (lb)

|              | MAY   |       | JUNE  |       | JULY  |       |
|--------------|-------|-------|-------|-------|-------|-------|
|              | Lungs | Clean | Lungs | Clean | Lungs | Clean |
| Dyraaba ..   | 4.16  | 5.94  | 3.72  | 4.50  | 1.84  | 3.09  |
| Batawatte .. | 2.81  | 2.02  | 2.29  | 2.69  | 1.42  | 1.50  |
| Hopton ..    | 1.36  | 1.75  | 1.35  | 1.83  | 0.69  | 0.77  |
| Demodera ..  | 3.65  | 5.11  | 4.42  | 4.08  | 1.79  | 3.67  |
| Dammeria ..  | —     | —     | 2.39  | 2.69  | 0.91  | 1.33  |
| Mean ..      | 3.00  | 3.71  | 2.84  | 3.16  | 1.33  | 2.07  |

D. N. R. Wijewardena

**UVP4**—Monthly Pruning of mother bushes at Cannavarella Group, Namunukula—(1965)

**UVP5**—Monthly pruning of mother bushes at Mahadowa Group, Madulsima—(1965)

Five mother bushes of CV4/B, on Cannavarella Group, and 10 bushes of TRI 2023, on Mahadowa Group were pruned every month of the year starting from January. The purpose of these experiments is to find out (a) what month is best suited for pruning mother bushes (b) what month is best for taking cuttings. The last pruning was done in December. Cuttings were taken and planted out at the Sub-station nursery for subsequent assessment of growth. The experiments are continuing.

**UVP6**—*Performance of clones in soils of high acidity at Hugoland Estate, Udapussellawa—4 replicates of 20 clones in randomized blocks—(1965)*

The experiment was laid down in late 1965.

**UVP7**—*Levels and clones at Mahadowa Group, Madulsima—split plot—2 replicates of 3 levels of N split on 4 clones—(1965)*

The three levels of N are 160, 200 and 240 lb/acre/annum. Each of the 24 plots contain 100 bushes. The levels of  $K_2O$  and  $P_2O_5$  are 120 lb and 35 lb per acre per year respectively. All treatments will get 4 applications of fertilizer per year. Pre-treatment plucking records are being kept at present.

### Extension Experiments

The following experiments under the extension experiments have been laid down, and pre-treatment plucking records are being kept.

**XUA1** —*3 types of N at 3 levels at Aislaby Estate, Bandarawela—(1965)*

**XUA2** —*NPK each 3 levels + control in all combinations at Aislaby Estate, Bandarawela—(1965)*

**XUA3** —*3 types of N at 3 levels at Hugoland Estate, Udapussellawa—(1965)*

**XUA4** —*NPK each at 3 levels and control in all combinations at Hugoland Estate, Udapussellawa—(1965)*

**XUA5** —*3 types of N at 3 levels at Telbedde Estate, Badulla—(1965)*

**XUA6** —*3 levels of N at 3 levels of Limbux at Telbedde Estate, Badulla—(1965)*

**XUA7** —*Guatemala, Mana and Napier as rehabilitation species at Telbedde Estate, Badulla—(1965)*

**XUA8** —*3 types of N at 3 levels at Nayabedde Estate, Bandarawela—(1965)*

**XUA9** —*Guatemala, Mana and Napier as rehabilitation species at Nayabedde Estate, Bandarawela—(1965)*

**XUA10** —*3 levels of N  $\times$  3 levels of Limbux at Cannavarella Group, Namunukula—(1965)*

**XUA11** —*3 types of N at 3 levels at Cannavarella Group, Namunukula—(1965)*

**XUA12** —*NPK each at 3 levels—control in all combinations at Spring Valley Group Namunukula—(1965)*

**XUA13** —*3 types of N at 3 levels at Spring Valley Group, Namunukula—(1965)*

**XUPH1**—*Shade vs no shade at Aislaby Estate, Bandarawela—Paired fields—(1965)*

**XUPH2**—*Shade vs no shade at Nayabedde Estate, Bandarawela—Paired fields—(1965)*

**XUPH3**—*Shade vs no shade at Gonakelle Estate, Passara—Paired fields—(1965)*

**XUPH4**—*Shade vs no shade at Rookatenne Group, Hali-ela—Paired fields—(1965)*

**XUPH5**—*Shade vs no shade at Neluwa Estate, Bandarawela—Paired fields—(1965)*

### **The new Uva Station**

A survey of the proposed Uva Station on Agratenne Division of Ury Group, Passara has been completed, and negotiations for the purchase of this land is underway. In this connection our sincere thanks are due to the Manager, Ury Group for his kind co-operation in getting the survey completed.

### **Extension activities**

Arrangements have been completed for an experimental study programme for Assistant Superintendents in the Passara district. The programme hopes to cover the scientific aspects of tea cultivation, and the first meeting will be held in January 1966. In this connection our thanks are due to the Managers of Mahadowa, Hindagalla and Gonakelle Groups, for agreeing to sit in on the discussions for purposes of evaluating their usefulness. Meetings will be held twice a month for three to four months.

### **Acknowledgements**

Our sincere thanks are due to the Managers of Batawatte, Hopton, Dammeria, Demodera and Dyraaba Groups for their kind co-operation in carrying out the time and type of pruning experiment, to the Managers of Mahadowa and Cannavarella for the monthly pruning of mother bushes experiment, and to all Managers and Superintendents who have come into the extension experiment scheme. A special word of thanks to the Manager of Gonakelle Group and his staff for all their help and guidance in maintaining the present Sub-station and to the Heads of Research Divisions for their co-operation.

### **Publication**

FOSTER-BARHAM, C. B. (1965). Major benefits to the Ceylon Tea industry resulting from the work of the Tea Research Institute. *Industrial Ceylon* 5 : 75-77.

# REPORT ON ST COOMBS ESTATE

*Agriculturist* – L. A. Seevaratnam, BSc

## General

Mr J. G. G. Tennekoon relinquished his post as Superintendent of St Coombs Estate on the 30th April 1965. We wish him all success in his new appointment. Mr L. A. Seevaratnam was appointed as Agriculturist and took over the estate from Mr Tennekoon on the 1st May 1965. Mr V. A. Fernandez was appointed Head Factory Officer from 1st April.

Supervision of manufacture in the factory was taken over by the Technology Division.

Mr C. W. C. Mossop of Waltrim Group, Lindula over-looked St Coombs Estate from 1st May 1965 to 31st December 1965.

## Acreege as at 31st December 1965

|  | A          | R        | P         |
|--|------------|----------|-----------|
| Seedling tea in bearing .. .. .                                    | 195        | 1        | 32        |
| Clonal tea in bearing .. .. .                                      | 32         | 1        | 17        |
| Clonal tea not in bearing .. .. .                                  | 49         | 0        | 00        |
| Land under rehabilitation .. .. .                                  | 7          | 0        | 00        |
| Area reserved for clonal cuttings and nurseries .. .. .            | 7          | 0        | 17        |
| Other land (Fuel clearings, buildings, roads, gardens etc) .. .. . | 131        | 1        | 17        |
| <b>Total .. .. .</b>   | <b>422</b> | <b>1</b> | <b>03</b> |

## Crop

Our estimated crop of 336,000 lb was exceeded this year by 281 lb. The yield per acre for the year being 1,510 lb. This is the highest yield ever recorded on St Coombs.

The yield per acre month for St Coombs Estate from 1961-1965 ; total rainfall, the number of wet days and the average quantity of N applied for each year is given in Table 1.

TABLE 1—Yield of tea per acre per month for St Coombs Estate from 1961 to 1965—  
Rainfall, number of wet days and the average quantity of N applied for each year

| Month                | 1965        | 1964        | 1963        | 1962        | 1961        |
|----------------------|-------------|-------------|-------------|-------------|-------------|
| January .. .. .      | 136         | 152         | 106         | 108         | 117         |
| February .. .. .     | 88          | 112         | 92          | 100         | 98          |
| March .. .. .        | 97          | 114         | 124         | 87          | 131         |
| April .. .. .        | 183         | 145         | 138         | 131         | 133         |
| May .. .. .          | 177         | 147         | 171         | 158         | 127         |
| June .. .. .         | 129         | 168         | 149         | 121         | 90          |
| July .. .. .         | 108         | 77          | 111         | 85          | 75          |
| August .. .. .       | 87          | 112         | 124         | 83          | 104         |
| September .. .. .    | 106         | 95          | 105         | 91          | 79          |
| October .. .. .      | 125         | 115         | 98          | 117         | 72          |
| November .. .. .     | 137         | 76          | 117         | 125         | 152         |
| December .. .. .     | 137         | 117         | 110         | 144         | 108         |
| <b>Total .. .. .</b> | <b>1510</b> | <b>1430</b> | <b>1445</b> | <b>1350</b> | <b>1286</b> |

|                              | 1965  | 1964  | 1963  | 1962  | 1961  |
|------------------------------|-------|-------|-------|-------|-------|
| Total rainfall (inches) ..   | 93.21 | 79.76 | 83.50 | 86.04 | 86.56 |
| No of wet days .. ..         | 204   | 198   | 231   | 214   | 206   |
| Average N/acre annum (lb) .. | 184   | 162   | 180   | 185   | 140   |

**Total crop sold and prices**

| Year       | Total crop<br>(lb made tea) | Nett price per lb<br>(cents) |
|------------|-----------------------------|------------------------------|
| 1965 .. .. | 419,376*†                   | 228*                         |
| 1964 .. .. | 306,717                     | 243                          |
| 1963 .. .. | 314,204                     | 219                          |
| 1962 .. .. | 305,980                     | 223                          |
| 1961 .. .. | 296,196                     | 220                          |

**Cost of production**

| Year       | Estimated COP<br>(cents) | Actual COP<br>(cents) |
|------------|--------------------------|-----------------------|
| 1965 .. .. | 153                      | 148*                  |
| 1964 .. .. | 153                      | 157                   |
| 1963 .. .. | 147                      | 141                   |
| 1962 .. .. | 156                      | 145                   |
| 1961 .. .. | 165                      | 154                   |

**Profits**

| Year       | Profit        |
|------------|---------------|
| 1965 .. .. | + Rs 289,724* |
| 1964 .. .. | + Rs 252,074  |
| 1963 .. .. | + Rs 222,077  |
| 1962 .. .. | + Rs 233,443  |
| 1961 .. .. | + Rs 220,198  |

**Cultural operations**

The year 1965 saw several changes taking place on St Coombs. These were the removal of shade, the use of calcium ammonium nitrate instead of sulphate of ammonia, the use of herbicides on a field scale and the use of Perezin for Blister Blight control in large scale field trials. These are reported upon below :

**Shade**

Many of the shade trees on St Coombs were removed in order to investigate to what extent if any yields would be enhanced. The shade trees (*Grevillea robusta* and *Erythrina lithosperma*) in Field Nos 1, 6 and 10 have been retained for experimental purposes. The *G. robusta* in all other fields except No 12 have been ring-barked out and are not yet dead. Some of these were felled before they died for experimental purposes at pruning. All dadáps on other fields have been completely removed.

† Includes 83,095 lb of crop secured on bought leaf

\* Subject to verification by the auditors

*Fertilizers*

It was decided that certain fields on St Coombs Estate should have calcium ammonium nitrate (CAN) instead of sulphate of ammonia (S/A) as the source of nitrogen. The application of CAN commenced at the beginning of June on Field Nos 4, 15 and 16.

Field No 4 received 84 lb N per acre in the form of CAN given in two applications, while Field No 15 received 46 lb N every other month. On Field No 15 the estimated quantity of N was exceeded by 84 lb per acre, as a result of the introduction of CAN. Field No 16 which had its first prune in June 1965 received 62 lb N as S/A given in February and 218 lb N as CAN given in three applications in September, October and November. The fields which were receiving CAN did not receive any additional phosphate or muriate of potash.

Table 2 gives the monthly yields of these fields and other fields from June to December, but it is premature to draw any firm conclusions.

TABLE 2—*Monthly yields of fields from June to December 1965, the type of fertilizer and the total N applied since June*

| Field No | Type of Fertilizer | Total N (lb) from June | Monthly yields (lb) |      |     |      |     |     |     |  |
|----------|--------------------|------------------------|---------------------|------|-----|------|-----|-----|-----|--|
|          |                    |                        | June                | July | Aug | Sept | Oct | Nov | Dec |  |
| 1        | ...                | 90                     | 144                 | 111  | 136 | 128  | 164 | 206 | 183 |  |
| 3        | ...                | 72                     | 50                  | 68   | 55  | 81   | 111 | 130 | 145 |  |
| 4        | ...                | 84                     | 156                 | 143  | 107 | 127  | 149 | 130 | 149 |  |
| 5        | ...                | 60                     | 116                 | 106  | 72  | 99   | 87  | 122 | 135 |  |
| 6        | ...                | 72                     | 198                 | 240  | 114 | 135  | 232 | 198 | 193 |  |
| 7        | ...                | —                      | —                   | —    | —   | —    | —   | —   | —   |  |
| 8        | ...                | —                      | —                   | —    | —   | —    | —   | —   | —   |  |
| 9        | ...                | 80                     | 70                  | 124  | 87  | 131  | 136 | 131 | 128 |  |
| 10       | ...                | 102                    | 155                 | 81   | 132 | 135  | 158 | 188 | 160 |  |
| 11       | ...                | 76                     | 151                 | 135  | 112 | 152  | 186 | 158 | 154 |  |
| 12       | ...                | 140                    | 146                 | 11   | —   | —    | 10  | 50  | 77  |  |
| 13       | ...                | 70                     | 143                 | 182  | 117 | 143  | 147 | 185 | 147 |  |
| 14       | ...                | 84                     | 145                 | 160  | 125 | 134  | 211 | 146 | 146 |  |
| 15       | ...                | 138                    | 214                 | 199  | 174 | 273  | 225 | 215 | 204 |  |
| 16       | ...                | 218                    | 23                  | —    | —   | —    | 15  | 176 | 104 |  |
| 17       | ...                | 211                    | 23                  | —    | —   | —    | —   | 73  | 56  |  |

*Dolomite application*

The application of Dolomite to pruned fields was started this year. All pruned fields received 5 cwt per acre of Dolomite (broadcast in every row) immediately after pruning.

*Herbicides*

Gramoxone was tried out this year for the control of weeds in mature tea, and also for the control of ferns in pruned fields. On Field No 12 which was pruned in July, Gramoxone at different concentrations was tried out for control of moss and ferns. Concentrations of  $\frac{1}{2}$ ,  $\frac{1}{4}$ th,  $\frac{1}{8}$ th and  $\frac{1}{16}$ th of a pint per acre with equal quantities of 'Teepol' dissolved in 45 gallons of water were sprayed using knapsacks on the frames of the pruned bushes. The initial control obtained with  $\frac{1}{2}$  pint was spectacular, but the control did not persist beyond a five-week period after which there was renewed growth. The other dosages were not as effective. Recovery from pruning was apparently not adversely affected after the use of Gramoxone.

## Pests and diseases

### Blister Blight (*Exobasidium vexans*)

A new fungicide Perezin containing 25% copper and 30% zinc was tried out on a field scale in collaboration with the Division of Plant Pathology (XP7). Perezin sprayed at the rate of 6 oz in 2½ gallons of water per acre, was compared against Perenox (50% copper) at the rate of 4 oz in 2½ gallons of water per acre. Satisfactory control of Blister Blight was obtained with both fungicides. Zinc sulphate spraying was done on areas sprayed with Perenox but was omitted in areas sprayed with Perezin. The spraying of all experimental areas was taken over in November by the estate and the spraying is done under the supervision of the Division of Plant Pathology.

### Red root disease (*Poria hypolateritia*)

Methyl bromide was used for the first time this year instead of DD for the eradication of *Poria* root disease in certain fields, with much success.

### The spread of root diseases from shade tree stumps

The removal of shade trees on St Coombs is being carried out in experiments in order to make observations on the occurrence of root diseases (P20).

The following treatments have been applied:

- Fell shade trees below ground level
- Fell shade trees below ground level and apply tarpap on the stumps
- Fell shade trees above ground level
- Ring-bark and fell shade trees after they are dead
- Ring-bark and fell shade trees after 4, 6, 8, 10 and 12 months

Ring-bark shade trees and apply arboricides at 6 and 12 months

This is being done in collaboration with the Division of Plant Pathology.

### Nursery

The estate nursery is now being managed with supervision from the Division of Plant Propagation. The estate nursery is to undertake the propagation of cuttings both for the use of the estate and for experimental work.

### Other changes

The following field works which were estimated to be done in 1965 were omitted:

- Application of Limbux on pruned fields,
- Deep forking of pruned fields,
- Drench spraying of fields with magnesium sulphate and zinc sulphate,

### Visiting Agent

Mr P. R. U. Eastal visited the estate thrice in 1965,

# REPORT ON ST JOACHIM ESTATE

Superintendent - G. S. Muttettuwegama

## General

Mr D. D. Pathinayake was appointed Field Officer and Mr R. Navaratne, Assistant Factory Officer, both appointments being from 1.1.65. Manufacture of estate leaf in the new factory began on 1.1.65 with due ceremony.

## Acreege as at 31st December 1965

|  | A          | R        | P         |
|--|------------|----------|-----------|
| Seedling tea in bearing .. ..  | 266        | 0        | 14        |
| Clonal tea not in bearing .. ..                                      | 17         | 1        | 00        |
| Land under rehabilitation .. ..                                      | 28         | 2        | 35        |
| Nurseries .. ..  | 1          | 3        | 11        |
| Other land (Rubber, paddy, build-<br>ings, roads, gardens etc) .. .. | 102        | 1        | 06        |
| <b>Total .. ..</b>   | <b>416</b> | <b>0</b> | <b>26</b> |

## Crop

The yield of 1191 lb/acre was the highest ever recorded on St Joachim. The total crop was 331,974 lb. In spite of the unusually dry and adverse weather conditions that obtained in the first half of the year, the harvest for 1965 was good. The overall increase was 24 lb made tea per acre over the previous year. A total of 20½ acres of old tea in No 3 field was uprooted for replanting. As a result there was a deficit of 2209 lb made tea at the end of the year, compared with 1964. A severe drought was experienced in January and February. The yields per acre per month for St Joachim estate from 1962-1965 are shown in Table 1.

TABLE 1—Yield of tea per acre per month for St Joachim estate from 1962-1965—  
Rainfall, number of wet days and the average quantity of N applied each year

| Month              | 1965        | 1964        | 1963        | 1962       |
|--------------------|-------------|-------------|-------------|------------|
| January .. ..      | 94          | 117         | 99          | 75         |
| February .. ..     | 57          | 70          | 91          | 62         |
| March .. ..        | 121         | 115         | 111         | 74         |
| April .. ..        | 88          | 109         | 114         | 76         |
| May .. ..          | 100         | 113         | 96          | 78         |
| June .. ..         | 101         | 114         | 92          | 67         |
| July .. ..         | 91          | 94          | 102         | 80         |
| August .. ..       | 102         | 85          | 90          | 63         |
| September .. ..    | 101         | 87          | 94          | 67         |
| October .. ..      | 116         | 91          | 92          | 72         |
| November .. ..     | 110         | 89          | 98          | 78         |
| December .. ..     | 110         | 83          | 95          | 98         |
| <b>Total .. ..</b> | <b>1191</b> | <b>1167</b> | <b>1174</b> | <b>881</b> |

|                           | 1965   | 1964   | 1963   | 1962            |
|---------------------------|--------|--------|--------|-----------------|
| Total rainfall (inches)   | 166.15 | 185.28 | 174.22 | 134.79          |
| No of wet days            | 223    | 208    | 246    | 213             |
| Average N/acre/annum (lb) | 143.80 | 140.16 | 123.00 | (not available) |

### Total crop sold and prices

The sale of green leaf to Palmgarden Group was discontinued on 31.12.64.

| Year | Total Crop Sold<br>(lb made tea)                        | Nett price per lb<br>(cents) |
|------|---|------------------------------|
| 1965 | 331,974*<br>(lb green leaf sold<br>to Palmgarden Group) | 168*                         |
| 1964 | 1,623,833   | 20                           |
| 1963 | 1,725,986   | 19/20                        |
| 1962 | 1,423,178   | 20                           |

### Cost of production

| Year | Estimated COP<br>(cents) | Actual COP<br>(cents) |
|------|--------------------------|-----------------------|
| 1965 | 148                      | 141*                  |
| 1964 | 24.15 (green leaf)       | 22.69 (green leaf)    |
| 1963 | 31.84 (green leaf)       | 36.00 (green leaf)    |

### Profits

For the first year since acquisition by the TRI a profit was made on St Joachim Estate.

| Year | Profit       |
|------|--------------|
| 1965 | +Rs. 77,381* |
| 1964 | —Rs 47,955   |
| 1963 | —Rs 22,798   |
| 1962 | —Rs 21,308   |

### Cultural Operations

All cultivation work programmed for the year were completed except for the supplying of vacancies in the mature tea. An extent of 68½ acres was estimated for the year for supplying vacancies, but due to insufficient planting material it was possible to supply only 24½ acres.

#### Fertilizers

The T 750 mixture was applied in the mature tea, application being at intervals of three months commencing two months after pruning, on a replacement basis of 12 lb N for every 100 lb of crop harvested. On this basis the tea received an average of 143.8 lb N, 38.39 lb P, 125.67 lb K.

#### Herbicides

Nearly two thirds of the estate is now being sprayed with Gramoxone which has controlled the weed growth, and also brought down the cost of weeding considerably.

\* Subject to verification by the auditors

*Pests and Diseases*

No incidence of any major types of pests or diseases were noticed except for a slight attack of Blister blight which occurred in the latter part of November and in December. No treatment was given as the infection as not serious.

**New Clearings**

*1964 new planting—10 acres (old Rubber Land)*

In this clearing only 5½ acres were planted up by the estate in 1964, and the vacancies were supplied in 1965. This is a very backward clearing and as much as 50% of it was supplied in 1965.

*1965 new planting—6½ acres (old Rubber land)*

This clearing was planted in June with the following clones :

| <i>Clone</i> |    |          | <i>Number of Plants</i> |
|--------------|----|----------|-------------------------|
| TRI 2021     | .. | ..       | 640                     |
| TRI 2023     | .. | ..       | 10900                   |
| TRI 2026     | .. | ..       | 4675                    |
| TRI 2043     | .. | ..       | 8725                    |
| TRI 2016     | .. | ..       | 1000                    |
| MT 18        | .. | ..       | 900                     |
| N 3          | .. | ..       | 900                     |
| KEN 16/3     | .. | ..       | 900                     |
| NL 3/1       | .. | ..       | 300                     |
| MT/BG        | .. | ..       | 1280                    |
|              |    | Total .. | 30220                   |

The condition and progress of this clearing is most satisfactory. A census of the number of vacancies was taken at the end of December and it was found to be only 2%.

*Field No 3—8½ acres replanting*

This area which has been under Guatemala Grass from August 1963 was due to be planted in 1965, but due to sufficient planting material not being available, the clearing was allowed to remain under Guatemala Grass for a further year and will be planted in 1966.

*Field No 3—20½ acres replanting*

Old tea to an extent of 20½ acres in No 3 field was uprooted for replanting in 1967. The soil in this area will be reconditioned under *Crotalaria brownei* for a period of one year.

**Factory**

Manufacture commenced on 1.1.65. As expected, the usual teething troubles were there. The rollers were running at 40 rpm and were later reduced to 36 rpm. The roll-breakers too, were found to be running too fast and their speeds have now been reduced.

A most disturbing factor, has been the number of power failures that have occurred on the Government power supply right through the year. These power failures have interrupted manufacture on numerous occasions and have lasted on certain instances for as long as two days. It is intended to install a standby power unit, but this has been deferred for the time being as it is hoped that the power failures would be less frequent and that the position would improve.

**Visiting Agent**

Mr J. W. Craig visited the estate thrice during the year.

METEOROLOGICAL OBSERVATIONS — 1965

ST. COOMBS

Laboratory Gauges

| MONTH     | TEMPERATURE °F |                                    |              |                                    |              |               |                        | RAINFALL |                                    | RAINY DAYS |                                    | SUNSHINE |                                    |
|-----------|----------------|------------------------------------|--------------|------------------------------------|--------------|---------------|------------------------|----------|------------------------------------|------------|------------------------------------|----------|------------------------------------|
|           | Mean Maximum   | Difference from Average (25 years) | Mean Minimum | Difference from Average (25 years) | Adopted Mean | Mean on Grass | Mean Relative Humidity | Inches   | Difference from Average (25 years) | Days       | Difference from Average (25 years) | Hours    | Difference from Average (25 years) |
| January   | 76.2           | +2.1                               | 52.7         | -3.0                               | 64.5         | 51.2          | 78                     | 0.58     | -3.02                              | 6          | -5                                 | 234.00   | +41.30                             |
| February  | 75.8           | -0.5                               | 55.2         | +0.6                               | 65.5         | 54.2          | 81                     | 2.72     | +0.37                              | 7          | -1                                 | 185.50   | -25.18                             |
| March     | 74.6           | -3.1                               | 52.7         | -2.8                               | 63.7         | 51.6          | 84                     | 5.85     | -1.31                              | 11         | -1                                 | 213.25   | -19.76                             |
| April     | 74.8           | -2.6                               | 56.3         | -1.5                               | 65.6         | 56.1          | 92                     | 10.66    | +4.29                              | 25         | +9                                 | 167.40   | -29.04                             |
| May       | 73.9           | +1.5                               | 58.7         | -1.0                               | 66.3         | 57.7          | 89                     | 19.47    | +8.19                              | 27         | +9                                 | 99.00    | -65.00                             |
| June      | 71.1           | +0.5                               | 58.9         | -1.5                               | 65.0         | 57.0          | 92                     | 6.54     | -6.56                              | 20         | -6                                 | 144.70   | +52.66                             |
| July      | 74.2           | +4.0                               | 57.1         | -2.4                               | 65.7         | 54.1          | 92                     | 2.97     | -8.77                              | 20         | -6                                 | 181.10   | +75.91                             |
| August    | 72.6           | +1.6                               | 58.4         | -0.8                               | 65.5         | 56.9          | 94                     | 12.77    | +3.35                              | 30         | +5                                 | 71.40    | -42.76                             |
| September | 72.9           | +0.7                               | 58.3         | +0.1                               | 65.6         | 55.6          | 92                     | 6.72     | -1.65                              | 19         | -2                                 | 133.10   | -7.22                              |
| October   | 76.9           | +3.8                               | 57.9         | +0.2                               | 67.4         | 55.2          | 95                     | 9.15     | -0.54                              | 22         | 0                                  | 164.40   | +15.04                             |
| November  | 74.8           | +1.3                               | 57.5         | +0.4                               | 66.2         | 56.0          | 92                     | 7.46     | +0.04                              | 20         | +1                                 | 159.90   | -1.62                              |
| December  | 74.8           | +1.3                               | 56.9         | +0.8                               | 65.9         | 54.9          | 92                     | 6.57     | +1.35                              | 22         | +7                                 | 129.30   | -39.93                             |
|           | 74.3           | +1.2                               | 56.7         | -0.9                               | 65.6         | 55.0          | 89                     | 91.46    | -4.06                              | 229        | +10                                | 1883.05  | -45.60                             |
|           | Means          |                                    |              |                                    |              |               |                        | Totals   |                                    |            |                                    |          |                                    |

METEOROLOGICAL OBSERVATIONS — 1965  
PASSARA SUB-STATION

Laboratory Gauges

| MONTH     | TEMPERATURE °F |                                    |              |                                    |              |               |                        | RAINFALL |                                    | RAINY DAYS |                                    | SUNSHINE |                                    |  |
|-----------|----------------|------------------------------------|--------------|------------------------------------|--------------|---------------|------------------------|----------|------------------------------------|------------|------------------------------------|----------|------------------------------------|--|
|           | Mean Maximum   | Difference from Average (25 years) | Mean Maximum | Difference from Average (25 years) | Adopted Mean | Mean on Grass | Mean Relative Humidity | Inches   | Difference from Average (25 years) | Days       | Difference from Average (25 years) | Hours    | Difference from Average (25 years) |  |
| January   | 72.5           | +0.1                               | 61.2         | —                                  | 66.8         | 59.3          | 82                     | 4.09     | +5.30                              | 11         | +6                                 | 151.43   | +27.54                             |  |
| February  | 73.0           | +1.5                               | 62.6         | +1.5                               | 67.8         | 58.5          | 76                     | 10.97    | -4.53                              | 14         | -3                                 | 125.32   | -3.7                               |  |
| March     | 77.3           | +0.3                               | 60.8         | +2.0                               | 69.0         | 58.5          | 70                     | 6.12     | +0.72                              | 7          | +6                                 | 182.51   | +1.23                              |  |
| April     | 76.6           | +2.0                               | 62.4         | +2.5                               | 69.5         | 60.7          | 78                     | 15.68    | +4.84                              | 20         | +1                                 | 115.9    | +51.40                             |  |
| May       | 78.8           | +1.4                               | 62.8         | +0.8                               | 70.8         | 63.3          | 74                     | 8.66     | -2.45                              | 17         | -3                                 | 146.24   | +17.51                             |  |
| June      | 81.1           | -1.0                               | 65.8         | +0.2                               | 73.4         | 62.0          | 65                     | 0.06     | +2.18                              | 2          | +5                                 | 207.43   | -19.61                             |  |
| July      | 80.7           | -0.7                               | 65.2         | -0.4                               | 73.0         | 61.2          | 72                     | 3.26     | +1.45                              | 6          | +4                                 | 216.51   | -53.14                             |  |
| August    | 76.7           | +2.7                               | 64.3         | +0.2                               | 70.5         | 61.8          | 80                     | 11.57    | -6.07                              | 19         | -8                                 | 117.56   | +50.56                             |  |
| September | 77.2           | -1.4                               | 64.5         | +3.0                               | 70.8         | 60.6          | 76                     | 3.19     | +0.18                              | 12         | -1                                 | 140.30   | -5.53                              |  |
| October   | 75.6           | +0.9                               | 64.9         | -1.1                               | 70.2         | 61.0          | 80                     | 12.15    | -0.59                              | 19         | -1                                 | 100.36   | +23.34                             |  |
| November  | 74.0           | -0.2                               | 64.2         | -1.0                               | 69.1         | 61.2          | 83                     | 21.84    | +9.62                              | 23         | +2                                 | 56.31    | +25.52                             |  |
| December  | 73.3           | -1.1                               | 63.0         | -1.0                               | 68.2         | 61.8          | 86                     | 14.14    | -2.31                              | 18         | -3                                 | 69.23    | +37.57                             |  |
|           | Means          |                                    |              |                                    |              |               |                        | Totals   |                                    |            |                                    |          |                                    |  |

## INDEX OF FIELD EXPERIMENTS, TRIALS AND FACTORY EXPERIMENTS

All field and factory experiments carried out by the TRI in 1965 on St Coombs Estate, St Joachim Estate, the TRI Sub-stations at Passara, Hantane and Kottawa and on other estates are listed below. The year of commencement of each experiment is given in brackets. The following letters indicate the nature of experiment :

- A** — Agricultural Chemistry and Agronomy
- ATT** — Agricultural Chemistry and Agronomy experiments on young tea
- VP** — Plant Propagation
- PH** — Plant Physiology
- P** — Plant Pathology
- N** — Nematology
- E** — Entomology
- B** — Biochemistry
- T** — Technology
- S** — Statistics
- W** — Experiments on Weeds and Herbicides
- X** — Extension experiments.

Experiments on St Coombs and other estates in Dickoya, Dimbula, Nuwara Eliya and elsewhere will have no additional letters, if they are supervised by officers of the TRI at St Coombs. The centre from which each experiment is supervised is indicated by a preceding letter as follows :

- L** — Low country (The Low-country Station at St Joachim Estate ; the Kottawa Sub-station and estates in the low-country)
- M** — Mid-country (The Hantane Sub-station and other estates in the Kandyan mid-country)
- U** — Uva (The Passara Sub-station and estates in the Uva Province)

An extension experiment in Plant Physiology at the Passara Sub-station for example, will have the letters **XUPH** or, an Agronomy experiment at St Joachim will carry the letters **LA**.

*This list is complete up to 31-12-65*

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