THE

# Tea Research Institute

OF

# Ceylon

## Annual Report for the Year

## 1962

## Part II

Published by
THE TEA RESEARCH INSTITUTE OF CEYLON
ST COOMBS, TALAWAKELE, CEYLON
1963

# The Tea Research Institute of Ceylon

## Staff as at 31st December 1962

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| Assistants ... ... | ... | U. L. M. de Silva |
| | | J. I. H. Bandaranayake (Endane) |
| | | K. H. G. Gunapala (Kottawa) |

*Working overseas

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# PREFACE

In view of unavoidable delays consequent on the auditing of accounts, the Board decided to issue without further delay the technical sections of the report of the Institute for 1962 as Part 2. The section dealing with the Board's report and accounts will be published as Part 1, as soon as the Auditor General's approval is received for the latter.

A. W. R. JOACHIM
DIRECTOR.

# REPORT OF THE DIRECTOR FOR 1962

D. L. Gunn, C.B.E., D. Sc.

**Staff.**—The year was a difficult one in regard to heads of divisions. Dr Mulder left the Island on October, on completion of his four-year contract, but arrangements were made for his replacement by Dr. A. Kerr on secondment from the Waite Agricultural Research Institute, Adelaide, Australia, though his arrival is to be delayed until late in 1963. In the mean time, Dr Shanmuganathan is to act as head of the Pathology Division. Dr Visser left at the same time, and Dr Pethiyagoda is acting as head of the Plant Physiology Department pending a more permanent appointment. Mr H. J. Balmond left to take up a University post in Nigeria and he was replaced temporarily as Chief Administrative Officer by Mr W. J. A. van Langenberg, M.B.E. Mr Elias also left to take up an appointment overseas; he was replaced by Mr J. G. G. Tennekoon as Superintendent of St Coombs.

On 1st August, 1962, Mr G. A. D. Kehl retired from the senior-staff post of Administrative Secretary after 31 years of service to the T.R.I. His benign and dependable presence will be much missed. His post has been abolished and the accounting work now comes under Mr P. Pathmanathan, as Assistant Administrative Officer.

Early in 1963 there are to be new appointments in Biochemistry (Dr G. W. Sanderson), in Agronomy (Dr L. H. Fernando), the latter primarily in the low country, and the Superintendent (Mr C. Andrews) of St Joachim Estate.

My own resignation, to take up a post at the headquarters of the Agricultural Research Council in London, takes effect at the end of February 1963 and Dr Joachim will once more take over.

In the Intermediate Grades, Mr R. R. Selvendran was appointed in Biochemistry. Another appointment of the same sort became effective on 1st January 1963, while Dr R. L. Wickremasinghe went to Cambridge as Research Fellow in Biochemisty. With the appointment of Dr Sanderson as Head of the Division, and in spite of the loss of Mr S. Ramaswamy to the CeyTea Company, Biochemistry should now acquire a new impetus in its new quarters. Mr P. Sivapalan (Nematology) and Mr W. Danthanarayana (Entomology) went overseas for advanced research, while Dr N. Shanmuganathan (Pathology) and Dr D. Calnaido (Entomology) returned with doctorates. Messrs. R. L. de Silva (Pathology) and D. Kirthisinghe (Technology of Tea Manufacture) continued advanced research in the University of London.

In the Junior Grade, Mr L. M. de W. Tillekeratne (Advisory) returned from the United States of America with the degree of Master of Education (Calif.). Mr S. Nagarajah went to U.S.A. for special training. Losses of staff in the Junior grades totalled three and gains ten, making a nett increase of seven.

The results of all these changes were that the scientific staff within 1962 decreased from 24 to 23 in the Senior and Intermediate grades and increased from 36 to 40 in the Junior Grade. Of all these, 33 are graduates, compared with 32 at the end of 1961.

**Buildings.**—Good progress has continued. The new headquarters building was occupied by the Administration upstairs and the library downstairs in August but the biochemical laboratories had not been completely

fitted out, pending the arrival of Dr Sanderson. The first meeting (of the Experimental and Estate Committee) was held in the new Board Room on 13th October 1962. The consequent changes were begun in the old building, so as to accommodate the Advisory and Agronomy Divisions more suitably.

Two semi-detached houses for Senior Officers made only slow progress, but the two pairs of Intermediate Grade flats were completed and seventeen Junior houses and two minor staff and servants quarters were completed and occupied. Late in the year the building of more new houses for Intermediate and Junior Staff was approved.

**Outlying stations.**—St Joachim Estate continued to be managed through the Saffragam Company. Owing to the necessity of going through tender procedure, the houses, the laboratory, and the factory were not built, but there is good hope of visible progress in 1963. The site for the laboratory and houses had been almost cleared by the end of 1962.

At Hantane, two houses were completed and occupied. One of these was for the officer in charge of clonal testing; the other was intended for an outstation advisory officer, but was used for an entomologist to study Shot-hole Borer in that favourable location.

**Finance.**—The estate, with a profit of about Rs. 233,443.03 on revenue account, less Rs. 130,902.74 spent on capital account, yielded a contribution of about Rs 102,540.29 to the research aspects of the Institute. The effective acreage of tea still remained low because of the replanting programme and production is not expected to rise much for some years.

**Visits.**—There were many visits by planters, other members of the Ceylon tea industry, government officials, scientists from Ceylon and overseas, and other distinguished persons. Professor G. E. Blackman, F.R.S. (Agriculture, Oxford) came in August as a member of the Scientific Advisory Committee in the U.K. Professor F. G. Young, F.R.S., (Biochemistry, Cambridge) Professor G. C. Varley (Entomology, Oxford), Professor L. J. Audus (Botany, London), Professor J. R. Raeburn (Economics, Aberdeen), Dr D. J. Watson (Botany, Rothamsted) and Dr G. A. S. Cooke (Chemistry, Rothamsted) were among the scientific visitors.

A member of the staff visited South India but the Tocklai (Assam) Scientific Conference was postponed because of the approach of the Chinese army.

**Instant Tea.**—The CeyTea factory made excellent progress and early experimental manufactures were actually better than the best made in the development stages in the T.R.I. The matter is now entirely in commercial hands.

**Publications.**—*The Tea Quarterly* and the *Annual Report* were published. For internal reasons the later numbers were delayed, but it is hoped to return to prompt publication by March 1963.

**Trends.**—In order to enable readers of these Annual Reports to see for themselves how the crude total tea production of Ceylon is changing, it is shown in a graph (Fig. 1) which allows further entries to be made. The figures are taken from the reports of the International Tea Association in London, to which thanks are tendered.

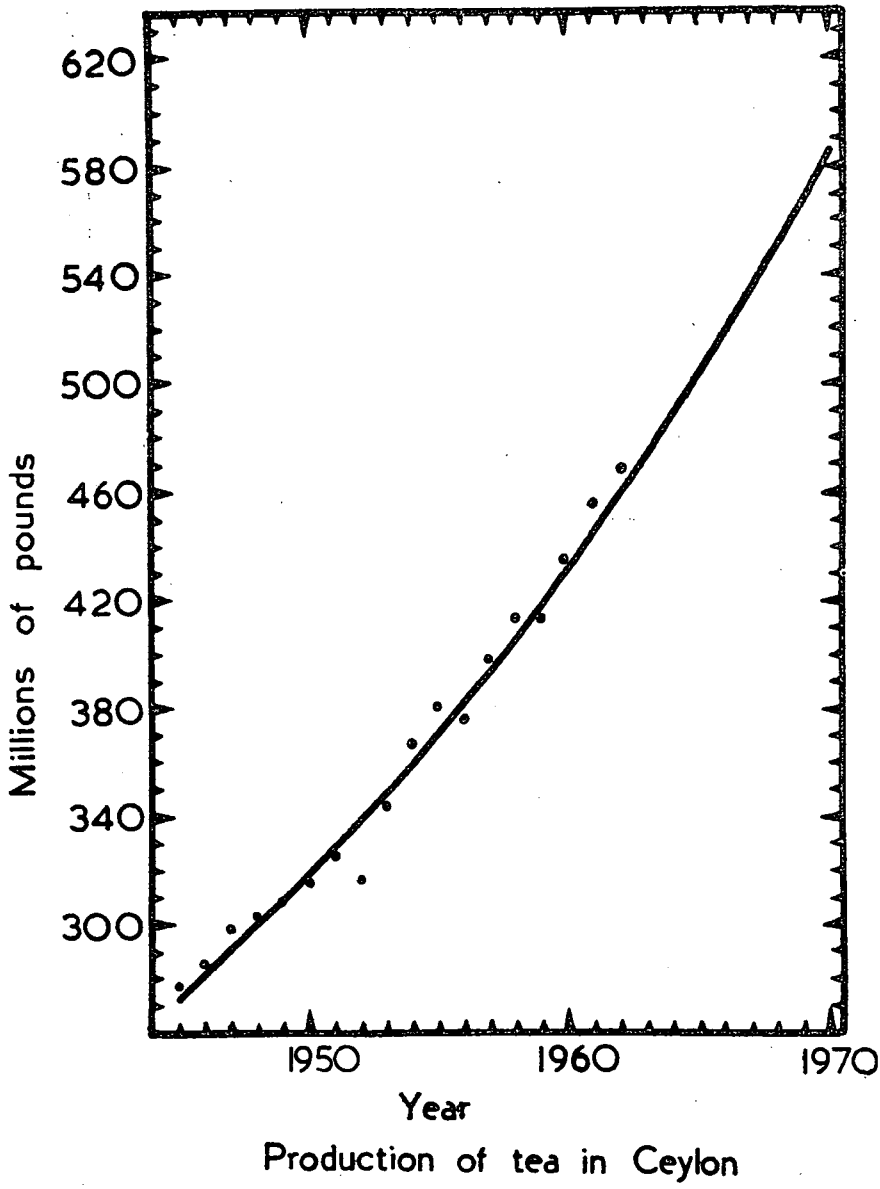


**Fig. 1:**—The line is the semi-logarithmic plot of best fit from 1945 to 1960, namely log yield = 0.01316 (years from 1945) + 0.43707. The stub lines enable subsequent years' yields to be inserted, to show if there is any marked divergence later.

A discussion of some of the implications of the facts shown in the graph was given in the Annual Report for 1961. Since then the new advisory policy on fertilizer nitrogen has come into force and about a hundred estates have been given individual advice; other estates are increasing their nitrogen dosage without consulting us on details. It is not to be expected that the resulting increase in nitrogen application will have an immediate dramatic effect on production from the high country, but some effects should be evident even there by 1964. It will, of course, be impossible to separate, in the crude production figures, the effects of increased nitrogen, of shot-hole-borer control and its interaction with increased nitrogen, of increased acreage, and of any changes in practice. What we may hope for is an upward kink in the total production curve of Fig. 1. We may further hope that the opening of new markets by CeyTea will help to take off the increase of production.

The importance of production per acre in cost of production was referred to in the 1961 Annual Report. Replanting with highly productive clonal tea is one way of achieving a high production per acre, and increased rates of nitrogen can also help. Dr Joachim refers to a replanted acre that produced nearly 5,500 lb of tea in a year using 500 lb of nitrogen. But the rate of replanting has been disappointing. It may increase if the replanting subsidy is increased, as it seems likely to be in 1963. But the rate of replanting would have to increase to an impossible level in order to check the rise in average age of Ceylon's tea.

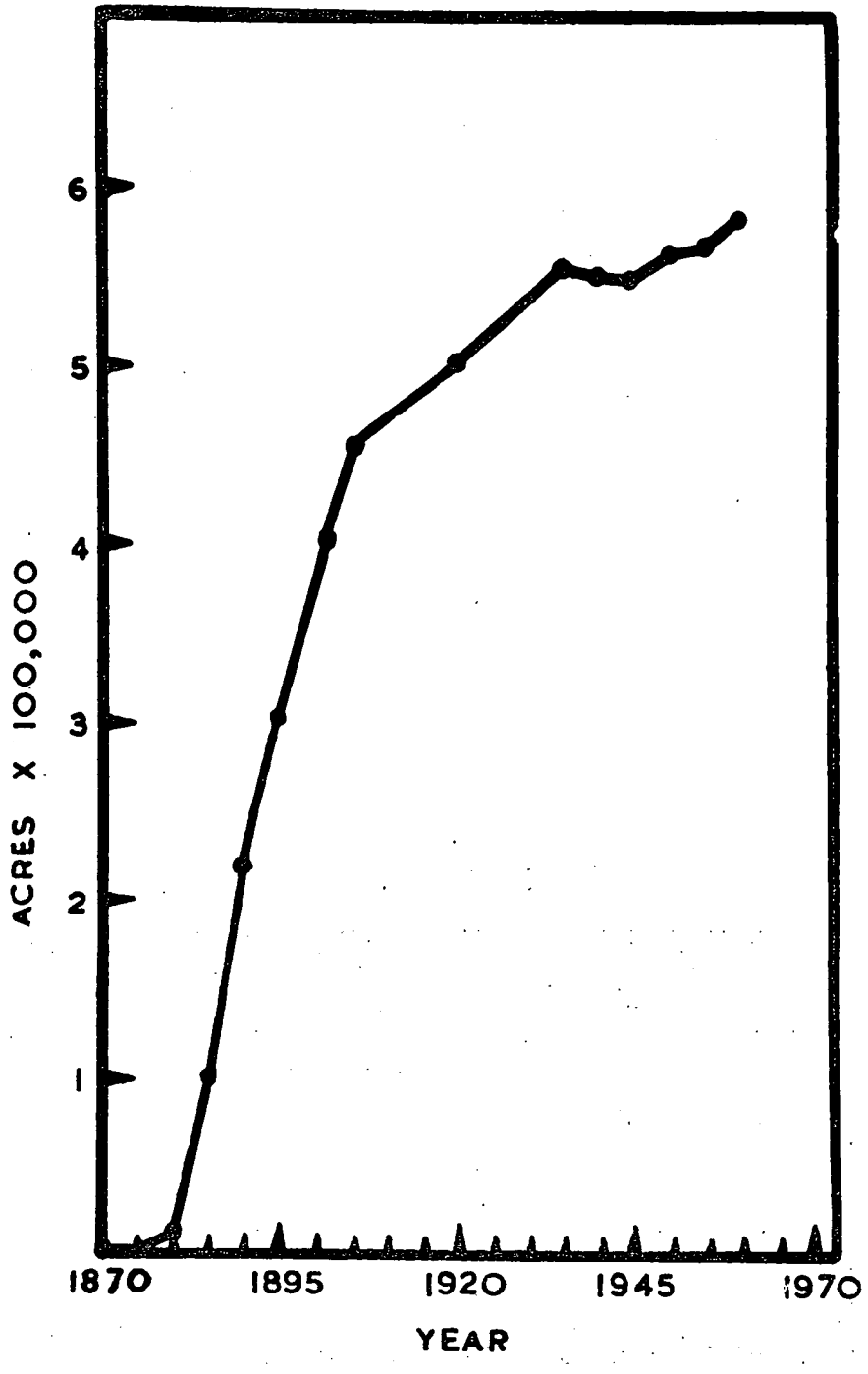


**Fig. 2.**—Acreage under tea in Ceylon.

Figure 2 shows the acreage of tea in Ceylon, from the start of the industry. In 1890, there were, in round figures, 200,000 acres of tea; by 1901, the total exceeded 400,000 and the present total is just short of 600,000. Abandonment and replanting probably does not greatly exceed a total of 10,000 acres, and may be neglected for rough purposes. That is to say, one third of Ceylon's tea today is over 70 years old and another third is between 60 and 70 years old. Nobody knows what is the economic life of a tea bush; if it is 100 years, on a steady programme 1% should be replanted annually. But it should not be a steady programme because of the outburst of planting from 1880 to 1900. Even 6,000 acres of replanting per annum is not being done, so we have to envisage an ageing population of tea.

What is to be done about this? It is not even certain that high age, of itself, is detrimental to production. It is, however, a general property of populations that the number of individuals in a particular birth-date group tends to decline as that group gets older. As the group approaches the end of its natural life, the decline in numbers steepens. In terms of tea bushes the original population declines, through casual accidents and diseases; there are no data to show whether or not the decline is steepening. What is well known is that some of the early tea was planted at low density and many gaps have appeared in it. And it is this old tea which will form the bulk of the Island's acreage for a long time.

One way of arresting this tendency to decline is, of course, to persuade each bush that survives to yield more; this is evidently being done, for the yield per acre is rising far more rapidly than can be explained by new tea coming into bearing. An additional way may be to fill in the gaps in the tea. This practice has virtually ceased in most parts of the Island, for large sums have been spent on it with little success. But there is at least one low-country estate that is very successfully filling vacancies with clonal tea. If practical methods of doing this can be worked out and accepted by the industry in all parts of the Island the resulting increase in bush population, combined with steadily increasing manuring, may be sufficient to keep total production rising well, until replanting can take over the burden of progress, as the fertilizer increases on old tea begin to fade out during the next decade or so. Perhaps some of the Tea Replanting Subsidy Fund could be used to encourage infilling, at perhaps 50 cts per successful bush.

The T.R.I. of Ceylon, under the influence of Dr T. Eden from Rothamsted, led the way with plot trials of fertiliser dosage. In the last decade or so, this lead has been lost and it will take some years to catch up with other Tea Research Institutes. Today, in order to provide material for sensitive experiments, there is at St Coombs an annual programme of uprooting 15 acres of old tea for replacement by uniform clonal tea. St Joachim Estate in the low country is expected to proceed similarly and there is good hope that many of the controversial questions of today will be settled in the future, when these trials come to fruition.

# REPORT OF THE SUPERINTENDENT OF ST COOMBS ESTATE FOR 1962

J. G. G. Tennekoon

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**Staff.**—Following the departure of Mr A. L. Elias, I assumed duties as Superintendent of St Coombs on the 15th December, 1962. I arrived on St Coombs on the 1st of December and worked together with Mr Elias until he left.

The Assistant Teamaker, Mr B. F. Mendis left the estate on 30th July, having obtained the post of Head Teamaker on a neighbouring estate. A new Assistant Teamaker, Mr W. G. Rajapakse was appointed on 1st August to fill the vacancy.

All other appointments remained unaltered.

The new re-survey Plan of St Coombs estate was obtained during the middle of the year and the new acreage figures will be in effect as from the 1st January, 1963.

**Acreage as at 31st December, 1962:**

| | Old Survey | | | New Survey | | |
|---|---|---|---|---|---|---|
| | A. | R. | P. | A. | R. | P. |
| Tea in bearing ... | 199 | 2 | 00 | 222 | 0 | 33 |
| Tea under experiment (Plucking only) ... | 22 | 1 | 00 | | | |
| *New Clearings:* | | | | | | |
| Field No. 1—1960 planting ... | 2 | 0 | 01 | | | |
| Llan Thomas and 14B area—1961 planting ... | 8 | 1 | 00 | 8 | 3 | 17 |
| Field No. 7 and No. 8—1962 planting ... | 10 | 0 | 00 | 10 | 1 | 00 |
| Field No. 7 and No. 8 T.R.I. experimental planting ... | 10 | 0 | 00 | 12 | 1 | 14 |
| *Areas under rehabilitation:* | | | | | | |
| Field No. 2 and No. 7—1963 planting ... | 14 | 3 | 00 | 15 | 1 | 00 |
| Field No. 3—1964 planting ... | 15 | 0 | 00 | 15 | 0 | 00 |
| Field No 8—T.R.I. experimental planting | 2 | 2 | 00 | | | |
| —do— area to be given in exchange for Mattakelle estate land ... | 1 | 1 | 25 | 1 | 1 | 25 |
| Area reserved for Clonal cuttings ... | 2 | 2 | 00 | 2 | 2 | 00 |
| Tea seed bearer areas ... | | | | 0 | 0 | 09 |
| Land suitable for planting tea ... | 6 | 0 | 10 | | | |
| Nurseries in Field Nos. 1, 12, and 14A ... | 3 | 0 | 00 | 3 | 0 | 08 |
| Guatemala grass clearing ... | 9 | 0 | 15 | | | |
| Fuel Clearings *etc.* ... | 25 | 3 | 12 | 29 | 1 | 38 |
| Buildings, roads, garden *etc.* ... | 53 | 3 | 14 | 60 | 3 | 37 |
| Land unsuitable for planting ... | 38 | 0 | 00 | 40 | 3 | 22 |
| Total ... ... ... | 423 | 3 | 37 | 422 | 1 | 03 |

During the year tea was uprooted on 15 acres in Field No. 3 for replanting purposes. After approximately 18 months rehabilitation under Guatemala grass, this area will be planted in April—June 1964.

**Weather** (Estate gauge)

| | Rainfall inches | Wet days | Sunshine hours |
|---|---|---|---|
| Registered in 1962 ... | 86.04 | 214 | 1,710 |
| Registered in 1961 ... | 86.56 | 206 | 1,382* |
| Registered in 1960 ... | 106.48 | 250 | 1,686 |
| Registered in 1959 ... | 92.80 | 212 | 1,996 |
| Registered in 1958 ... | 80.08 | 229 | 1,842 |
| Decennial averages (1952–1961) ... | 91.41 | 225 | 1,779* |

(*January 1961—no record was maintained and February maintained for 19 days only).

Rainfall was fairly well distributed throughout the year and no serious drought was experienced. Rainfall recorded during the first three months was 8.04 in., 34 wet days, *i.e.* January 2.50 in., 15 wet days, February 1.79 in., 9 wet days and March 3.75 in., 10 wet days. Scattered showers fell during January, February, and March. Cold nights and gusty winds were experienced during this period. Weather conditions throughout the period April-December have been favourable in every respect except for a freak period in June, when there was one dry spell which lasted from 7th to 15th June inclusive. The rainfall of 3.49 in. in June is the lowest on record for that month since 1929. The south-west monsoon was not particularly severe.

The total recorded rainfall for the year was 86.04 in. which was .52 in less than in 1961 and 5.37 in. less than the decennial average. There were 214 wet days, 8 days more than in 1961 and 11 days less than the decennial average.

**Crop**

| | 1962 lb | 1961 lb | 1960 lb |
|---|---|---|---|
| Estimate ... ... ... | 278,000 | 255,000 | 270,000 |
| Total crop (including off grades) | 305,847 | 296,197 | 323,331 |
| Yield per acre on 215 acres ... | 1,350 | — | — |
| Yield per acre on 215½ acres ... | — | 1,286 | — |
| Yield per acre on 251½ acres ... | — | — | 1,286 |

The estimated crop of 278,000 lb of made tea was exceeded by 27,847 lb and the yield per acre for the year was 1,350 lb. The yield of 1,350 lb per acre constitutes a record for St Coombs. The previous best yield was 1,286 lb per acre in 1961 and 1960. A notable feature was the even monthly intake of crop throughout the year as follows:—

| Month | | Made Tea lb | Yield per acre |
|---|---|---|---|
| January | ... | 25,092 | 108 |
| February | ... | 23,695 | 100 |
| March | ... | 19,956 | 87 |
| April | ... | 30,320 | 131 |
| May | ... | 36,735 | 158 |
| June | ... | 27,895 | 121 |
| July | ... | 19,838 | 85 |
| August | ... | 18,948 | 83 |
| September | ... | 20,418 | 91 |
| October | ... | 26,328 | 117 |
| November | ... | 26,005 | 125 |
| December | ... | 30,617 | 144 |
| | | 305,847 | 1,350 |

The highest monthly crop was harvested in May when the average yield for the estate was 158 lb per acre. Cash plucking and Sunday plucking was not resorted to on any single occasion during the year under review due to the large acreage of tea being uprooted for replanting. The quality of leaf brought into the factory was good throughout, and all teas fetched reasonably good prices.

**Prices and Total Crop Sold:**

| Year | Total crop sold lb | Gross price cents | Nett price cents |
|---|---|---|---|
| 1962 | 285,794 | 268 | 223 |
| 1961 | 292,870 | 268 | 220 |
| 1960 | 320,521 | 270 | 225 |

These prices compared favourably with the high-grown average and with those of neighbouring estates.

The best invoices were:—

| Invoice No. | Month | Rs per lb |
|---|---|---|
| 2 | January | 3.50 |
| 6 | February | 3.86 |
| 7 | March | 3.80 |

**Cost of Production:**

| | | 1962 Cost per lb | 1961 Cost per lb | 1960 Cost per lb |
|---|---|---|---|---|
| | | cents | cents | cents |
| Estimate | ... | 156 | 165 | 173 |
| Actual | ... | 145 | 154 | 148 |

**Profits on Estate Working:**

| | | | |
|---|---|---|---|
| 1962 | ... | ... | Rs 233,619 |
| 1961 | ... | ... | Rs 220,198 |
| 1960 | ... | ... | Rs 266,783 |

**Capital Expenditure:**

| | | |
|---|---|---|
| 1962 | ... | Rs 130,902.43 cents per lb |
| 1961 | ... | Rs 82,528.28 cents per lb |
| 1960 | ... | Rs 149,967.47 cents per lb |

The main items of capital expenditure were:—

| | Rs Cts |
|---|---|
| Water supply to lines ... | 2,497.00 |
| Buildings ... ... | 23,466.00 |
| *New Clearings:* | |
| 1960 planting— 2 acres | |
| 1961 planting— 8¼ ,, | |
| 1962 planting—15 ,, | 68,687.00 |
| 1963 planting—14¾ ,, | |
| 1964 planting—15 ,, | |
| Ravines to be cleared ... | 2,060.00 |
| Factory ... ... | — — |
| Furniture ... ... | 3,100.51 |
| Factory Machinery ... | 30,367.00 |
| Playground ... ... | 725.00 |

**Plucking.**—7-8 day plucking rounds were maintained throughout the year and the standard of leaf harvested was always of fairly high quality. The average per plucker for the year was 30 lb compared with 25 lb in 1961 and 27 lb in 1960. It is possible that the present system of norms has had a good effect on pluckers.

**Estate Roads and Paths.**—The usual routine maintenance of field roads, footpaths and estate roads was carried out. Terracing of road side drains was done where necessary. Some work was also done on widening the road past the No. 10 clonal area. A motorable road was cut through the 14B area and Field No. 14B leading towards the new cadday.

**Fuel Clearings.**—Routine maintenance work was carried out during the year. The main drain leading out of the estate through Kowlahena estate to the main river was cleaned throughout its length and deepened wherever necessary. All subsidiary drains flowing into the main leader drain were cleaned out. Supplies of firewood were adequate and the demands of all estate and institute Staff were met.

**Boundaries and Ravines.**—All boundaries are in good order and were regularly cleaned and maintained throughout the year. Regular checks for weeds and cootch were maintained. Many small ravines were reclaimed during the year and were planted up with mana grass.

**Weeding.**—The over-all cost of weeding for the year was Rs 8/78 per acre. Weeding contracts continued to be popular. A regular monthly round was completed, 174 acres being weeded on contract and the remainder on estate account. All weeds were transported to a central compost shed and turned into compost. Weeds presented no problem during the year.

**Pests and Diseases**—*Blister Blight:*—Regular spraying rounds were carried out during the period under review, stopping only when favourable weather conditions prevailed. Mist-blowers were used throughout with 4 ounces of Colloidal copper in two gallons of water per acre. This was increased to 6 ounces in all fields recovering from pruning.

*Scarlet and Yellow Mite:* No attacks of any severity were observed during the year.

*Tortrix:* No attacks of any severity were observed during the year.

*White Grub:* No infestations of any severity were observed during the year.

*Poria:* Isolated *Poria* patches in Fields Nos. 3 and 4 received special attention during the year.

*Loranthus:* All loranthus growing on grevilleas have been removed in all fields.

*Pruning:* The following fields were pruned during the months indicated against each field:—

| | | | |
|---|---|---|---|
| No. 6 | – 9½ acres | ... | May-June |
| ,, 11 | – 17 ,, | ... | June-July |
| ,, 1 | – 6½ ,, | ... | July |
| ,, 14A | – 11 ,, | ... | July-August |
| ,, 14B | – 2¼ ,, | ... | August |
| | 46¼ acres | | |

All good wood was left and a medium prune carried out all over. In Field No. 1, the 1955-56 clonal planting (6½ acres) comprising Block Nos. 26, 28, 30, 43, 44, 46, 48, 49, 55, 56, and 59 were pruned in July, for the first time. All pruning and tipping was done on the slope and recovery, generally was good all over. Pruning began on the 17th May and the programme was completed on the 11th August.

**Supplying and Nurseries.**—The nurseries in Fields No. 1 and 12 continued to be used by the Nematology Division for experimental purposes.

The V.P. nursery in the gum clearing between Llan Thomas Field and Field No. 14A was used as the main nursery for St Coombs. Putting out cuttings in polythene bags for the following year's planting commenced in June. Altogether there are 101, 137 bags at 2 cuttings per bag, *i.e.* 101, 137 potential plants comprising the following clones:

| Clone | No. | No. of plants |
|---|---|---|
| TRI | 777 | 19,697 |
| TRI | 2022 | 6,500 |
| TRI | 2023 | 13,000 |
| TRI | 2024 | 20,450 |
| TRI | 2025 | 22,010 |
| TRI | 2026 | 6,500 |
| TRI | 2027 | 6,480 |
| TRI | 2039 | 3,860 |
| TRI | 2142 | 2,640 |
| | | 101,137 |

The polythene cylinders were filled with a soil mixture of one part tea fluff to five parts of sub-soil by volume, and shaded with woven coir matting. An experiment is being carried out for the first time under tall shade firstly and polythene covers under this tall shade.

Manure T.65 is applied at 1 oz/gal/sq.yd/fortnight, and is watered on.

**Mossing and Ferning.**—Pruned fields were treated with "Limbux" to control moss and lichen @ 1½ cwt per acre, using Birchmeir Senior Sprayers with No. 2 lime-washing jets. Ferns were removed by weeding contractors and this method was found to be successful. Moss, lichen and ferns are well under control.

**Manuring.**—The practice of applying T. 700 mixture on a "ratio basis" was changed in accordance with T.R.I. policy to "efficiency manuring" in June. In 1961, an average of 140 lb of nitrogen per acre was applied. During 1962, it was decided to increase this to an average of 170 lb of nitrogen for 1962. On individual fields, the increases were to vary up to 40 lb. Including the very heavily manured Field No. 12, where an average of 184 lb per acre was applied.

Only broadcasting of manure in both rows is done. The number of applications averaged four per field during the year.

The area in Field No. 10 reserved for clonal cuttings received five applications of T. 200 mixture @ 2 ounces per plant.

All fields pruned during the year received one application of dolomite against magnesium deficiency. Top dressings of ground dolomitic limestone were given at an application rate of 400 lb per acre.

**Green Manure and Shade Trees.**—All stunted *Albizzia moluccana* trees in Field No. 14A were removed. Low shade in the form of dadaps and *acacia pruinosa* was lopped twice during the year and is well regulated.

2,100 gum plants have been planted in the swamp adjoining the nursery, interplanted with 720 grevillea plants and *Sesbania* plants.

**Cootch and Illuk.**—Isolated patches of cootch grass and illuk in all mature tea areas received attention during the year and are under control.

**New Clearings**

*Field No.* 1—1953, 1954, 1955, 1956, 1959 *clonal planting.*—These areas are receiving routine treatment.

1960 *Clonal Planting-Blocks* 8*A and* 8*B*—2 *acres—Planted June* 1960—*Rehabilitation Period* 3 *years.*—Routine weeding and spraying was done. Manuring was done six times during the year, using T. 175 mixture @ 1 oz per plant per application. Drains were cleaned out, dadaps lopped twice during the year and boundaries and ravines were attended to. Some of the blocks handed back to the estate by the Physiology Division were not in good condition and 986 bed plants of TRI 777 were put out in vacancies. The entire area was thatched with broken down Guatemala grass and except for a few

vacancies, most plants are in good health. This area will be brought into revenue account in 1963.

1961 *Clonal Planting—Llan Thomas area* 3¾ *acres.*—Routine weeding and spraying was done. Manuring was done six times during the year using Sterameal 'A' mixture @ 1 oz per plant per application. Drains were cleaned, dadaps lopped and all *Tephrosia vogelli* was uprooted. *Sesbania* in all the experimental blocks were removed on the instructions of the Agricultural Chemist. Of 24,248 plants put out in this area, 6,000 plants were in polythene sleeves and the balance 18,248 were bed plants, the clone being TRI 2024. Regular thumb-nail pruning was carried out. Bed plants were put out in vacancies. Very light plucking at 24 in. after light cut across at this height was done. This clearing has filled up nicely and now shows signs of good health, except for some weak patches in the centre of the area.

14 *B area*—4½ *acres.*—Routine weeding and spraying was done. Manuring was done six times during the year, using Sterameal 'A' mixture @ 1 oz per plant per application. Drains were cleaned, dadaps lopped and all *Tephrosia vogelli* was uprooted. Of a total of 28,841 plants put out, 3,000 plants of clone TRI 777 were in polythene sleeves and 15,841 of the same clone were bed plants. The rest were made up of 10,000 bed plants, 5,000 each of TRI 2024 and TRI 2025. Regular thumb-nail pruning was carried out. Bed plants were put out in vacancies, but there have been a number of casualties, particularly in the experimental blocks. Very light plucking at 24 in. after a light cut across was done.

1962 *Clonal Planting—Field No.* 7—6½ *acres and Field No.* 8—8½ *acres.*—A final application of Guatemala grass mixture @ 5 cwt per acre was given in January. A part of this area earmarked for replanting was taken over by the Physiology Division from the 3½-acre block in Field No. 8 and the grass in this experimental area was lopped instead of cutting to ground level. The rest of the area was cut to ground level during March in preparation for planting and we were at least a month behind field operations such as lining, holing and draining for a south-west monsoon planting. A second grass cutting was necessary to remove shoots which had sprouted subsequently. It is a mistake not to cut the Guatemala grass down to ground level, in late December or early January, in order that the drought may kill off the roots. Another part of this area was taken over by the Nematology and Agronomy Divisions for experimental planting. Thus the actual acreage left over for commercial planting was 6 acres in Field No. 7 and 4 acres in Field No. 8. All lining and pegging, wind-breaks, and shade-tree rows were marked out and planting operations commenced on 18th May. The planting distance was 4 ft × 1½ ft. All lateral drains were traced approximately 40 feet apart, wherever possible on a gradient of 1′ : 120′. Good progress was made in spite of a late start. In one block, approximately ¼ acre in extent, 1,989 polythene bag plants were put out. This area will make an excellent multiplication plot. From 29th May onwards, 5,966 plants of clone DT 95 were put out. Weather conditions remained ideal for planting, except for a strong wind but precautions were taken to guard against wind damage by using prunings to protect the young plants. There are five wind-breaks in the main body of this clearing, two have been planted in V.P. clones 3 ft apart in the row, one each in *Acacia decurrens*, *pruinosa* and *elata* also 3 ft apart in the row. There are also green manure rows 25 feet apart and consist of dadaps, *Sesbania* and grevillea grown in alternate rows. Regular spraying against Blister Blight was carried out, drains were re-cleaned, weeding done and the plants were manured in June, August, October and December, using Sterameal 'A' @ 1 oz per plant over the whole area.

A full detail of the entire operation is given below:

### May Planting

| Clone | No. | No. of Plants |
|---|---|---|
| TRI | 2039 | 277 |
| ,, | 2043 | 210 |
| ,, | 2142 | 292 |
| GMT | 9 | 400 |
| K | 145 | 165 |
| K | 150 | 207 |
| DK | 8 | 153 |
| DK | 16 | 99 |
| GL | 48 | 77 |
| GW | 21 | 45 |
| W | 14 | 64 |
| | Total ... | 1,989 |

### June Planting

| | | |
|---|---|---|
| TRI | 2024 | 14,248 |
| ,, | 2025 | 2,214 |
| DT | 95 | 11,427 |
| | Total ... | 27,889 |

### July Planting

| Clone | No. | No. of Plants |
|---|---|---|
| TRI | 2026 | 782 |
| ,, | 2025 | 7,437 |
| ,, | 2024 | 3,606 |
| ,, | 2023 | 2,118 |
| ,, | 1114 | 2,639 |
| ,, | 777 | 4,057 |
| ,, | 777–1960 bed plants | 7,392 |
| DT | 1 | 3,812 |
| TRI | 2025–1960 bed plants for hedges.... | 960 |
| W | 3 | 600 |
| W | 14 | 188 |
| K | 145 | 141 |
| DK | 1 | 1,092 |
| DK | 8 | 431 |
| DK | 19 | 1,434 |
| HBD | | 403 |
| | Total ... | 36,132 |

**August Planting**

| | | |
|---|---|---|
| TRI | 2024 | 557 |
| ,, | 2025 | 63 |
| ,, | 2043 | 70 |
| ,, | 2075 | 193 |
| ,, | 2079 | 296 |
| ,, | 2145 | 165 |
| GMT | 9 | 239 |
| DT | 1 | 1,050 |
| K | 145 | 112 |
| OK | 1 | 232 |
| OK | 3 | 227 |
| OK | 4 | 230 |
| | Total ... | 3,434 |

**September Planting**

| | | |
|---|---|---|
| TRI | 2024 | 3,200 |
| ,, | 1114 | 120 |
| ,, | 777 | 400 |
| DT | 1 | 1,100 |
| | Total ... | 4,820 |
| | Grand Total ... | 74,264 |

All plants are growing well, with a few vacancies noticeable.

*Areas under Rehabilitation for replanting.* 1963 *Replanting*—14¾ *acres* (*Field No.* 2—8½ *and Field No.* 7—6½ *acres*).—Regular weeding was carried out and the Guatemala grass was lopped three times during the year at 14 in. above ground level. Loppings were quite substantial. The area was manured three times, *i.e.* after each cut at 4 cwt per acre per application, the manure being broadcast.

1964 *Replanting*—15 *acres in Field No.* 3.—Uprooting by estate labour on contract began on 2nd October and was completed on 29th November. The Guatemala grass was planted 2 ft × 2 ft and the necessary terracing work in this area is in progress.

1965 *Replanting*—17¼ *acres in Field No.* 3.—The balance in Field No. 3, *i.e.* 17¼ acres excludes the 5¼ acres of the N.P.K. experimental area. This area is due for uprooting in September 1963 and until then, routine work such as weeding and manuring is to be carried out.

**Factory and Machinery.**—The No. 1 Marshall's roller was dismantled, completely renovated and fitted in the new No. 5 position. A new 45 in. Walker's roller was erected in August and is working satisfactorily.

Owing to the new factory extension the humidifying plant has been working in fits and starts and it has not been possible to use the fans at certain times.

Messrs H. W. Hammond & Co., made their annual inspection on the 14th of May and the recommendations contained in their report were carried out, except for repairs to Rollers Nos. 2 and 3, which are under way now.

Several sample lengths of nylon netting have been installed in the lofts. One particular material known as "Mycle" has been installed in one bank (19 tats) and spreading at 1 lb green leaf per 8 sq. ft is possible with a resulting good even wither.

**Manufacture.**—Two types of manufacture were carried out during the year as follows:—

A 4-roll programme, *i.e.* 4 rolls of 30 min. duration (120 min. rolling). Four periods of roll-breaking of 10 min. duration (40 min. roll-breaking) with 2½-3½ hrs fermentation, charges every 50 min. Order of firing 3,2,1,4, big bulk.

A 5-roll programme, *i.e.* 1st roll—40 min., 2nd roll—35 min., 3rd roll—30 min., 4th and 5th rolls—25 min. duration (155 min. rolling), 5 periods of roll-breaking of 10 min. duration (50 min. roll-breaking), with 2¾–4¼ hrs fermentation, charges every 105 min. Order of firing 3,2,1,4,5, big bulk.

The percentage of dhools obtained on the various programmes were as follows:—

| | 4-roll | 5-roll |
|---|---|---|
| 1st dhool ... | 12 | 15 |
| 2nd dhool ... | 20 | 17 |
| 3rd dhool ... | 31 | 19 |
| 4th dhool ... | 34 | 26 |
| 5th dhool ... | — | 20 |
| 6th dhool ... | — | — |
| Big bulk ... | 2 | 2 |
| | 99% | 99% |

**Grade Percentages**

| | 1962 | 1961 |
|---|---|---|
| Broken Orange Pekoe | 70.73 | 68.78 |
| B.O.P. Fannings ... | 8.87 | 8.14 |
| Flowery Pekoe ... | 2.01 | 2.25 |
| Fannings ... | 6.00 | 6.31 |
| Broken Pekoe ... | 1.63 | 2.52 |
| Broken Mixed ... | 5.53 | 7.29 |
| Dust ... | 4.83 | 4.09 |
| Experimental Teas ... | .40 | .62 |
| | 100.00% | 100.00% |
| Out-turn of made tea to green leaf ... | 23.40% | |

**Labour.**—During the year a few children over the age of 14 years were registered. All incoming brides were also registered. One male and three

female workers voluntarily retired during the year. Health was generally good and except for mild epidemics of influenza, there were no large-scale outbreaks of any kind. All children under 1 year were vaccinated against small-pox.

The labour force co-operated reasonably well with the management throughout the year. There are two Unions on the estate, namely, the Ceylon Workers' Congress and the All Ceylon United Estate Workers' Union and Union rivalry was intense during family ceremonies. There was a major clash on one occasion, when some labourers were injured. The annual sami-kumbudu was held during the week-beginning 25th, 26th and 27th March. A Sports Meet for labourers children was held on Monday 26th March and was a success.

| | Men | Women | Non-working children | Total |
|---|---|---|---|---|
| Working labourers on estate as at 31st December, 1962 ... | 255 | 240 | — | 495 |
| Non-working labourers (Pensioners) ... | 23 | 21 | — | 44 |
| Total estate population | 287 | 264 | 521 | 1,072 |

Working labourers numbered 1.65 per cultivated acre and the percentage of out-turn was 83%. 27.89% of all labour employed was used by the Institute for experimental work. During the year four families consisting of one pensioner, ten workers and seven non-working children retired to India. Some other families are also interested in immediate repatriation. Much correspondence has to be entered into by the Superintendent and the interested party and a considerable time ensues before repatriation moves are completed.

**Buildings and Lines.**—The total number of units, all up to Government standard, is 38 sets or 217 rooms. The number of workers per room is 2.28 and the number of souls per room is 4.94.

During the year annual white-washing was carried out and all necessary minor repairs completed.

One cattle shed in the upper colony was re-roofed. There are at present 51 herd of cattle and 103 goats on the estate.

Once again the fly nuisance was fully controlled by sanitary methods and by regular spraying carried out under the supervision of Mr J. E. Cranham, Entomologist, and his staff, to whom a vote of thanks is due for the able manner in which this was controlled throughout the year.

All minor buildings on the estate are in a satisfactory condition.

**Playground.**—A centre pitch for use with a coir matting cover has been completed and is now ready for use.

**Visiting Agent.**—Mr Alexander Mackie visited the estate on two occasions during the year on 19th March and 26th November.

**Clonal Blocks.**—During the year the industry's needs for clonal cuttings were met as far as possible. Altogether 2,038,975 cuttings were sold to estates

all over the island. In the case of estates in close proximity to St Coombs, collection by lorry, van or car was made. A large number of cuttings, however, were despatched by rail packed in polythene bags and open crates.

**Cart Roads.**—Further work was carried out on existing road surfaces and on the construction of new roads. Mexphalte 80/100 was used as a road surface, by applying this hot bitumen on all badly cracked surfaces and spreading by squeegee. Coarse river sand was used for blinding. This work should continue for the next few years. Further cracking appears to have taken place and only constant attention can arrest complete deterioration, which will otherwise involve considerable expenditure.

The following new roads were completed during the year:

1. road from old cadday to Maternity Ward and Dispensary (Scott's St.);
2. road to Director's and T.R.I. Garages;
3. road to reservoir bungalow and filtration plant approach road (Reservoir Road);
4. new Junior staff bungalows circular road (Scott's Street);
5. Mattakelle-Cairness outlet road.

All new roads completed in 1962 will have to be further consolidated by applying a second coat of colas early in the 1963 season.

Sign boards were painted, guard stones, bridges and culverts received close attention and all necessary repairs were carried out.

The Superintendent took over care and maintenance of all cart roads two years ago from the Engineering Division and it has been arranged that this work be handed back to the Factory.

**Factory Extension.**—The Colombo Commercial Co. Ltd., was given the contract to build the factory extension to house the withering trough and the withering drum. Foundation earth cutting began in early June and the Superintendent has supervised all work in connection with this extension, which is now complete, except for painting and a few finishing details. Satisfactory progress has been made on the building.

**General.**—During the year, the Ceylon Fire Insurance Association's Inspector visited the factory for factory inspection and sprinkler installation surveys as follows:

12 March, 4th April, 23rd May, 18th July and 26th October.

The year under review has been a very satisfactory one. The yield of 1,350 lb per acre has been the highest to date and the prices obtained have compared very favourably with those of other estates in the district.

Given favourable weather conditions, we look forward to a good season in 1963.

# METEOROLOGICAL OBSERVATIONS — 1962
## ST COOMBS
(Laboratory Gauges)

| MONTH | TEMPERATURE °F | | | | | | Mean Relative Humidity | RAINFALL | | RAINY DAYS | | SUNSHINE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Maximum | Difference from Average (25 Years) | Mean Minimum | Difference from Average (25 Years) | Adopted Mean | Mean on Grass | | Inches | Difference from Average (25 Years) | Days | Difference from Average (25 Years) | Hours | Difference from Average (25 Years) |
| January ... | 72.4 | — 1.7 | 56.7 | + 1.0 | 64.5 | 54.2 | 80 | 2.48 | — 1.12 | 12 | + 1.0 | 169.10 | — 23.60 |
| February ... | 74.5 | — 1.8 | 56.4 | + 1.8 | 65.5 | 52.3 | 73 | 1.93 | —0.42 | 4 | — 4.0 | 203.60 | — 7.08 |
| March ... | 74.5 | — 3.2 | 55.5 | — | 65.0 | 50.5 | 71 | 3.45 | — 1.09 | 6 | — 6.0 | 221.70 | — 11.31 |
| April ... | 75.0 | — 2.4 | 57.6 | — 0.2 | 66.3 | 55.5 | 80 | 6.91 | +0.54 | 16 | — | 194.20 | — 2.24 |
| May ... | 72.5 | + 0.1 | 59.8 | + 0.1 | 66.2 | 57.8 | 92 | 16.45 | +5.17 | 19 | + 1.0 | 93.90 | — 70.10 |
| June ... | 72.5 | + 1.9 | 57.0 | — 3.4 | 64.8 | 56.2 | 92 | 3.24 | —9.86 | 10 | —16.0 | 270.10 | +178.06 |
| July ... | 69.9 | — 0.3 | 57.3 | — 2.2 | 63.6 | 53.1 | 94 | 11.37 | —0.37 | 19 | — 7.0 | 92.70 | — 12.49 |
| August ... | 71.1 | + 0.1 | 56.9 | — 2.3 | 64.0 | 50.2 | 92 | 7.89 | —1.53 | 19 | — 6.0 | 132.50 | + 18.34 |
| September ... | 71.2 | — 1.0 | 57.1 | — 1.1 | 64.2 | 50.7 | 94 | 7.64 | —0.73 | 13 | — 8.0 | 94.40 | — 45.92 |
| October ... | 71.2 | — 1.9 | 56.2 | — 1.5 | 63.7 | 52.1 | 94 | 10.28 | +0.59 | 24 | + 2.0 | 91.80 | — 57.56 |
| November ... | 72.9 | — 0.6 | 55.2 | — 1.9 | 64.0 | 51.6 | 86 | 4.23 | —3.19 | 10 | — 9.0 | 149.60 | — 11.92 |
| December ... | 74.2 | + 0.7 | 55.4 | — 0.7 | 64.8 | 51.9 | 86 | 1.47 | —3.17 | 8 | — 7.0 | 186.90 | + 17.67 |
| | 72.6 | — 0.84 | 56.7 | — 0.86 | 64.7 | 53.0 | 86 | 77.34 | —15.18 | 160 | —59 | 1900.50 | — 28.15 |
| | MEANS | | | | | | | TOTALS | | | | | |

# REPORT OF THE CHIEF ADVISORY OFFICER FOR 1962

C. B. Foster-Barham, M.A.

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**1. Correspondence and Visits**—Replies were given in answer to 2,129 letters during the year, and 434 more letters were answered than in 1961. The total number of estates corresponding was 469, which is 45.1% of the number listed in Ferguson's Directory for 1962. The percentage increase was about 2% over 1961. In addition there were 356 enquiries from non-estate sources, under the following headings:—

| | |
|---|---|
| Educational Establishments ... ... ... ... | 46 |
| Research Institutes and stations other than T.R.I. sub-stations ... | 18 |
| T.R.I. Sub-stations ... ... ... ... ... | 32 |
| Government Departments ... ... ... ... ... | 54 |
| Agencies ... ... ... ... ... ... | 62 |
| Private Individuals in Ceylon including persons in mercantile business, commerce and in schools ... ... ... | 132 |
| Ditto from abroad, including U.K., India, U.S.A., New Zealand, Indonesia and Southern Rhodesia ... ... ... | 12 |

Visits were made to 165 estates during the year, these having increased by 64 over the number visited in 1961.

The general increase in the turn-over of work carried out by the Advisory Division during the year was due mainly to the extra correspondence received in connection with manuring in consequence of the introduction of a new fertilizer policy; also to the problem of survival of V.P. tea under drought condition in Uva, and last years expansion in Advisory staff, three of whom have been available at headquarters for advisory work of a generally routine nature which has included estates visits, while two have been engaged in special investigations which are referred to later in this report.

Other Divisions of the Institute have dealt with special correspondence and have made estate visits in connection with their own particular lines of research, which are not included here.

**2. Soil and Plant Specimens from Estates**—310 estates reported troubles of numerous different kinds, involving a total of about 900 separate letters, and 474 soil samples were tested for pH. Colombo Firms continue to deal with by far the greater bulk of soil samples for routine analysis.

**2.1.** *Nature of Enquiries—General Considerations.*—A classified enumeration of the various troubles diagnosed in specimens sent and other enquiries made during any particular year by a sample number of estates does not reflect anywhere near on the real extent of these conditions generally throughout the total number of Tea estates in Ceylon, as there are obviously many estates who do not always notify the Institute, also conditions which may escape notice or are of insufficient concern, and others already familiar. The sample itself may nevertheless serve as a pointer to those particular troubles which are of sufficient concern or interest to the estate to lead to its seeking Institute advice. In this connection, it appears that those particular pests, diseases or other troubles with which the Planter becomes in time entirely

familiar, becomes progressively less frequently notified or enquired about, the best known and most obvious illustrations of this being Blister-Blight, the methods of controlling which are now widely known. Completely on the opposite side of this are the extremely small minority cases where an estate submits specimens or the same enquiry over a period of time again and again and always receives exactly the same answer. In the latter case, it seems as if there is either possible inability to recognise what should have eventually become familiar symptoms, in the case of specimens, possibly no confidence except in the authority of the Institute, or merely a need for repeated reassurance. From time to time also, certain problems achieve greater prominance than others either because new systems are introduced, new approaches towards dealing with particular problems are published, side-effects may be produced following the introduction of recently adopted chemical compounds, or an outbreak of some particular pest or disease occurs. In the case of V.P., a gradually increasing acreage of a homogenous as opposed to heterogenous type of tea, introduces in time attendant problems associated with the susceptibility of certain clones to various kinds of pests, diseases and deficiencies. The advantages of high yield or excellent quality may be offset by certain disadvantages in other spheres applicable either generally or only to certain localities, and allied with this type of problem there are not only considerations of experimentation which brings sometimes spectacular results, the general adoption of a new method before it has been completely tested and questions of policy, but also chiefly the desire for still higher yields and better quality in order to balance the economy in the face of rising costs. While research aims to tip the balance onto the side of as many possible gains, there are invariably the problems which come to the forefront of attention during the initial stages of searching for solutions. To what extent the attention of the planting community is drawn towards current problems depends largely on the extent of publicity and subsequent concern felt in responsible quarters. As a reflection in the light of these foregoing observations, the extent of the response from estate sources during 1962 and subject to sampling limitations appears to have been as follows:—

## 3. Fungal Diseases

**3.1.** *Poria hypolateria* the most frequently reported fungal disease in 1962 appears, as in 1961, to have been again *Poria hypolateria.* This was reported from 37 estates in 21 different districts and included 10 estates in Dimbulla district. Fumigation against Poria, although it has not yet achieved the status of being officially recommended by the Institute, has appeared to give some promising results for a lower cost per acre than control by conventional methods in present practice. A number of estates with Poria troubles have adopted the fumigation technique experimentally and in 1962, 17 estates are known to have applied to the Institute for information in writing.

**3.2.** *Rosselinia arcuata* was reported from 20 estates in 9 districts with the greatest number of estates (5) in Haputale district.

**3.3.** *Ustulina deusta* (*or Zonata*) was reported from 23 estates 13 districts with greatest number (4) in each of Haputale and Badulla districts.

**3.4.** *Fomes noxius* was reported from 17 estates in 9 districts including 7 estates in Badulla district.

**3.5.** *Leptothyrium theae* was reported from 11 estates in 4 districts. This included 4 estates in each of Haputale and Udapussellawa, 2 in Welimada and 1 in Hewaheta Upper district. This particular disease, although it has caused some concern which has spread beyond the bounds of the particular estates which were affected, on account of its having been found attacking

Clone TRI 2024 in particular, is not nearly as widespread or as common as may be believed, nor have the local outbreaks amongst Clone TRI 2024, which were reported in 1962, in fact spread elsewhere to anything like a degree which could be classed as alarming or potentially dangerous. About 36 years of records kept at the TRI have been examined in regard to the distribution of this disease, and this has elucidated the information that occurrence is commonest at around 5,000 feet elevation and above, under conditions of mist, damp and strong winds persisting at certain times of the year, while less frequent cases may be found down to about 4,000 feet. It is therefore a disease which would never be likely to become of any major concern except in the high country, should further outbreak occur, and it is likely that if it did, it would remain confined locally to particular areas only where climatic conditions are conducive to infection. Within such local areas, there is always of course a potential chance of infection and the latest methods suggested by the Institute for dealing with this disease have now been published in the Tea Quarterly for September, 1962. It is of interest to record that in actual fact the amount of concern which reports of clone TRI 2024 having been attacked aroused during 1962, was comparatively small and the extent of correspondence entered into as a result of general enquires from sources excluding the particular estates that were concerned amounted, as far as the Advisory Division were concerned, to 5 other estates and 3 Agency Houses.

**3.6.** *Rhizoctonia solani* the black spot disease of young tea plants, continued to be a problem in the low country on many estates. Experiments on the concentration and frequency of copper spraying to control the above disease is still in progress and a definite recommendation will be made in due course.

**3.7.** All other fungal diseases in which examination of specimens was involved, were reported from less than 10 estates who were concerned in each particular case.

**4. Yellowing and inter-venal chlorosis of leaves in Gliricidia maculata.** This condition was noticed on 4 estates in the low-country. Laboratory investigations did not reveal any plant pathogen connected with this condition. Affected trees were lopped, and the new growth was found to be free of such symptom expression. The above condition is probably due to a physiological condition which the trees overcome in due course.

**5. Deficiencies in Chemical Nutrients.**

**5.1.** *Zinc.*—Examination of leaf specimens received and also examination of bushes in the field made during estate visits, enabled confirmation of the presence of this particular deficiency to be given, up to the end of 1962, in respect of 34 estates from the 1st of January, and the districts in which these estates were situated were as follows:—Udapussellawa, Pundaluoya, Dickoya and Dickoya Lower, Kelani Valley, Madulsima, Matale East, Passara, Morawak Korale, Matara, Pussellawa, Wattegama, Ramboda, Galle, Mede-Mahanuwara, Rakwana, Ratnapura, Dimbula, Haputale and Badulla. Further examinations, not reported here, have been carried out by the Agricultural Chemistry Division and may no doubt widen this distribution. A great deal more information is required yet before any idea can be gained as to how common this deficiency is, and it will probably never be fully known as there are to date many estates who have taken up routine spraying with Zinc Sulphate on a general estate scale with or without advice from the Institute. The symptoms of Zinc deficiency in tea have only recently been recognized and publicized, and have in consequence rapidly become a major topic. Experimentation on estates has featured largely as it inevitably does when something new has been discovered, and mistblowers combining both Zinc and Copper spraying, as well as Urea and Epsom salts where indicated,

have enabled larger acreages to be covered at cheaper rates than permitted by higher volume spraying within the same time.

In addition to the leaf specimen examinations noted above, there were 41 further enquiries on this subject. These were mostly of a general nature which covered the subject as a whole, but some were of a more specific nature covering such particular questions as effects on quality of manufactured leaf, cost of application, effect on yield, maximum safe concentration of the spray solution, and whether spraying in particular cases was really justified or not. Enquiries came from estates in the following additional districts which are not mentioned above:—Hewaheta Upper and Lower, Maskeliya, Kelebokke, Nuwara Eliya, Balangoda, Nilambe, Welimada and Kalutara.

5.2. *Magnesium.*—This particular deficiency was diagnosed in specimens sent by, and also on visits made to, 33 estates altogether. Most frequent cases occurred in Dickoya (7 estates) and Dimbula districts (5 estates, )while other districts involved included Dolosbage, Pundaluoya, Kelani Valley, Hantane, Hunasgiriya, Knuckles, Pussellawa, Maturata, Ramboda, Kegalle, Medemahanuwara, Haputale, Maskeliya and Badulla.

Other enquiries about Magnesium numbered 52 altogether. Prominent amongst these has been a rising tendency amongst estates and other sources, during 1962, to consider the relative merits of and indications for use of Dolomite, Kieserite and Epsom salts either as ground applications, or as sprays where practicable. Although the objective is to cure or to guard against Magnesium deficiency, the means of achieving this objective economically and expeditiously has remained much in dispute and it has also not remained unallied with to a certain extent commercial interests as there have been also considerations of straight and separate application in the case of Dolomite which costs far less per unit weight, admixture of Kieserite with NPK standard mixtures, and compatibility of Epsom salts with Copper, Zinc and Urea sprays. Advice to date is based on consideration of the following questions:—(*a*) "How urgently necessary is it to achieve a cure for a particular case of Magnesium deficiency on a particular estate?" (*b*) "How serious or widespread is this deficiency in the particular estate or area in question?" (*c*) "What is the least expensive form and method of Magnesium fertilizer application which should be used under the particular circumstances in question?" Estates will be in a better position to judge the economics of these questions for themselves as there is no Economics Division at the Institute which at present can assist in this respect. For the sake of the tea and its performance however it seems best to use the more soluble forms if the condition is serious or a more rapid cure is desired, and the less soluble cheaper form if there is no particular urgency, if it is merely a question of preventative treatment, or if perhaps finances do not permit. Views may however change in the future if ever spraying of Epsom salts comes into more widespread routine usage with increasing adoption of the mistblower. A few enquiries are already being made in this direction, but it is not possible at the moment to say to what extent the adoption of Epsom salts spraying may be likely to become a substitute for present conventional methods of applying Magnesium if it ever should become a substitute at all.

5.3. *Nitrogen.*—Diagnoses of this deficiency were made in respect of 20 estates situated in the following districts:—Dickoya, Kelani Valley, Hunasgiriya, Morawak Korale, Hewaheta Upper, Pussellawa, Ramboda, Kalutara, Galle, Dimbula, Maskeliya and Badulla, the condition being commoner on V.P. than seedling tea, notably in V.P. nurseries and early stages in clearings.

5.4. *Other deficiencies* diagnosed involved less than 10 estates in each case, namely, Boron (7 estates), and Potassium (8 estates) only.

## 6. Pests

6.1. *Tortrix.*—Outbreaks of this were notified by a total of 48 estates during 1962, and 23 districts were involved. The districts were Udapussellawa (3), Dolosbage (1), Kelebokka (1), Pundaluoya (1), Dickoya and Dickoya Lower (5), Ratnapura (3), Kelani Valley (2), Matale South (1), Nilambe (2), Kadugannawa (1), Hunasgiriya (1), Passara (1), Pussellawa (2), Maturata (1), Ramboda (1), Kalutara (1), Medemahanuwara (1), Rakwana (1), Dimbula (10), Haputale (1), Maskeliya (3) and Badulla (5). In addition 17 estates made general enquiries.

6.2. *Shot-hole Borer.*—28 estates in 20 different districts only notified this pest, and not more than 20 applied for general information or asked specific questions. This appears likely to be due to increasingly widespread knowledge about the pest and the effectiveness of Dieldrin. The Tortrix side-effect however still gives some matter for concern and alternative chemicals that do not produce a side-effect have been sought. In this particular respect, Telodrin and Aldrin which appear promising, are being investigated by the Entomology Division.

6.3. *Mites.*—Yellow Mite was reported in respect of 23 estates, Red spider 20, Scarlet Mite 12 and Purple Mite 3, amongst specimens received at the Institute. 23 districts were involved. At best, this gives only a very rough indication of the relative frequency of occurrence of each Mite species in a very small sample where attacks were evidently of sufficient concern to the estates concerned to warrant their seeking advice.

6.4. *Other pests* reported included the following: Figures given in brackets are in respect of numbers of estates in each case.

Meadow Eelworm (23), Root-knot Eelworm (7), Thrips (14), White Grub (various species) (12), Scale Insects (various species) (12), Red Borer (10), Mealy Bug (10) and Aphis (8). All other remaining reported cases involved less than 7 estates in every instance.

## 7. Physical and Cultural Conditions

7.1. *V.P. nurseries.*—The most commonly diagnosed class of trouble, under this category, was that where cuttings either failed to callus, overcallussed without putting out any or very little root growth or rotted due to either use of unsuitable textured soil, impeded drainage, overwatering or unsuitable microclimate. 38 estates were reported as having had trouble of this kind from one or more of these particular causes. In the majority of cases, soils of too clayey a texture had been used or drainage outlet from polythene bags had been insufficiently provided for. On certain estates, the problem of securing a suitably textured soil is a very difficult one to solve and periods of heavy rainfall during the Monsoon may aggravate the problem if the soil crumb-structure breaks down and the pore-spaces becomes filled with water. Estates with this particular problem may possibly find that they can grow successful cuttings in a not too clayey textured soil if they can prevent this break-down and saturation and maintain an air-filled crumb-structure intact as nearly as possible as originally filled into the bag or container without undue compressing. This would involve ensuring that there is an efficient drainage outlet and in some cases resting the bases of the bags on a sandwiched layer of small stone or coarse road metal, particularly if the nursery bed foundation is itself clayey, and the provision of an impermeable cover for temporary use during adverse weather. Such a cover might be placed over the normal shade protection, but it would need removal in dry weather, and particularly in hot sunny weather if the underneath temperature is not to become excessive. Avoidance of excessive watering would also be an

essential. There is probably a critical degree of clayeyness in a nursery soil beyond which conditions become impossible, and in any case the difficulty may not possibly be solved except by the most skilful supervision and labour and by constant attention. Fortunately a problem of this particular kind is in the minority.

**7.2.** Other relatively common types of cases included Die-back and WoodRot (30 estates), Collar rot in clearings (23 estates), Starch deficiency (17 estates), Manure Scorch (15 estates), Shallow rooting (13 estates), and Wind damage (10 estates). Here again, this is within sampling limitation only, but may possibly indicate relative commonness of reporting.

This does not include cases of drought damage, which during 1962, was of particular concern to estates in Uva. This has been a particular problem deserving close attention, and a resume of the first findings resulting from a preliminary survey questionnaire sent to a selected sample of Uva Estates is reported on later.

**8. Doubtful causes, unidentified causes and unsuitable specimens.**

Although there are many cases where the cause of a particular trouble escapes diagnosis completely, or the answer is simply not known, in spite of all available information supplied, there are still quite a number of letters received from estates in which information that could be of much material assistance is either limited or entirely lacking. Specimens may arrive also in unsuitable condition for diagnosis and in some cases can't be replaced. The importance of choice of representative specimens which are not too dry or far gone, their careful and proper packing, and trouble in providing as much information as possible which may give valuable clues to the answer, cannot be overstressed. In 1962, specimens from 51 estates were classed as suspect or probable in respect of the particular likely cause or causes; those from 69 estates were classed as unknowns or undetermined cases (some being subsequently diagnosed accurately), and those from 23 estates had to be classed as rejects owing to unsuitable condition of specimens on arrival.

**9. General Enquiries (excluding specimen examinations)**

**9.1.** *Fertilizer application, Fertilizer chemicals and Fertilizer Policy.*—A total of 174 estates made enquiries during the year on this subject, and 73 of these sought and were given advice on the new fertilizer policy after sending in yield and fertilizer data and other information, and in the majority of cases after personal consultation at the Institute. Information in regard to the recommended change-over from Nitrogen ratio application to the new system, and the reasons for discontinuing the ratio method have been published in the 1961 Annual Report (pages 59 to 61) and the Tea Quarterly dated September, 1962 (pages 122 to 133). The numbers of enquiries received under the above general heading were as follows:—

| *Subject* | *No. of Enquiries* | *Subject* | *No. of Enquiries* |
|---|---|---|---|
| General Estate fertilizer policy ... ... ... | 170 | Approval of fertilizer and mixtures ... ... ... | 21 |
| Zinc. General information | 41 | Composition of and percent of nutrients in fertilizer and fertilizer mixtures ... | 13 |
| Magnesium. General information ... ... | 52 | Urea ... ... ... | 6 |
| Boron. General information | 16 | Granulae fertilizer ... | 2 |
| | | Others ... ... ... | 42 |

**9.2.** *Vegetative Propagation and V.P. Tea.*

(i) 82 enquiries, referring to matters of general technique, the suitability of various clones for different localities, and on approved and approval of clones were received on this subject. This does not include specific manuring aspects nor the analysis of soils for pH and examination for texture, nor the examination of V.P. plant specimens.

(ii) *V.P. Tea and Drought in Uva..*—In Uva, during 1962, drought conditions in the dry months in many areas were worse than usual, and V.P. tea on several estates was reported to have suffered particularly badly. Considerable concern was expressed by the worst hit estates at the time. Accordingly a circular letter was sent out in September to a selected sample of 57 Uva estates, requesting information in regard to in which particular years plantings were carried out and if these had been successful. If not, what was the reason, and which particular year's plantings were unsuccessful. This yielded 40 replies, amongst which there was a total population of 137 clonal clearings planted in the years 1955 to 1961, inclusive. On an estate basis, 14 reported all round success throughout these years, 16 reported wilting and die-back without serious effects, and 10 reported serious casualties. Amongst these, the proportion of clearings was 61 (45%) all round successful, 52 (38%) affected, but not seriously, and 24 (17%) with serious casualties. The localities of these particular clearings could not be mapped precisely as at this preliminary stage of the enquiry the exact situations had not been called for, but it was possible to obtain a broad picture as it appeared from the sample without introducing undue mapping error as most estates or groups occupy a self contained area and separate divisions usually neighbour one upon the other.

It appeared from the map that there was a tendency for a greater amount of successes with clearings, according to this sample, to occur in regions around the eastern, south-eastern and southern general perimeter of Uva, that is to say in regions situated in Passara, Namunukula and Haputale districts, while there was a tendency for reports of less successful clearings and those with higher casualty numbers to be situated in more central and northern parts and Uva, *i.e.* in regions around Welimada, Ella, Hali-ela, Demodera, Badulla, Ledgerwatte and Kirklees areas. There were, of course, exceptions. Altitude above sea level and rainfall distribution appeared to have some effect, with higher percentage of casualties at the lower altitudes, and also in some cases with poor rainfall distribution in spite of relatively high annual rainfall.

These factors, and others related to the problem, were discussed at the Uva Planters' Association meeting held in Badulla on the 3rd of October, which four officers of the Institute, including the Director, attended, and a full report of proceedings will be appearing in the Tea Quarterly.

In the meanwhile, it has been planned to carry out as full an investigation as possible into the problem. It has been decided that the method adopted will follow the principle of sequential analysis in which positive or negative replies to certain major groups of questions asked initially are differentially classified, and according to which classification these primary answers come under further questions are asked which pursue important aspects into final details. This process eliminates a good many factors which may not apply in certain cases, and reduces the work of supplying information and of analysis appreciably.

**9.3.** *Weed Control and Arboricides.*—40 enquiries on this subject were received during the year, 23 of which came from estates and the remainder from other sources comprising mainly commercial companies and agency houses. These ranged from enquiries in regard to general information on weed control in tea to specific enquiries about chemicals including Simazine, Fernoxone, Sovicide, Dowpon, Unipon, Gramevin, Stam F-34, D.C.M.U.

Karmex, Diuron, Trioxone, Atratone and Sodium Arsenite. Owing to more pressing problems, the Institute has not carried weed control trials for a few years, (the last results being published in the 1960 Annual Report, pages 81 and 82), but, the problem has emerged again as one which has drawn deserving attention, and a special committee now exists to examine the whole question. It is likely that the Institute will resume trials with new chemicals which have since appeared in production.

**9.4.** *Advisory Literature and Leaflets.*—Other than leaflets wich were sent out in the normal course of events to estates which request diagnoses of diseases pests and other conditions, and which run into appreciable numbers, there were 126 other written requests from various sources including Government Departments, Agencies, Commercial Companies, Educational Establishments Private Individuals and elsewhere. Most of these included requests for a complete set of leaflets, while others were specific in nature. Use of these were made in some cases at exhibitions organized mostly by colleges and schools, and also for technical classes and for private study. There were also 27 postal applicants for R. L. Illangakoons booklet on Tea Cultivation and several more copies were acquired by Visitors in person.

**9.5.** *Other General Enquiries* (excluding specimen examinations and estate visits).—Remaining numbers of general enquiries not yet mentioned included the following:—Shot-hole Borer, general information (23), Eelworm, general information (17), Tea seed-bearers, tea-seed storage and supply (20), Cultivations, cultivation implements and cultivation technique (14), Rhizoctonia solani (13), Blister-blight (12), Mites (12), Rehabilitation, re-supplying and replanting (11), Ground and bush covers (10), Suitability of land for tea-planting (9), Pruning and P ucking (9), pH critical limits for tea and methods of reducing pH (8), Requests for Eelworm analysis of soils diverted to Colombo Firms (8), White-Grub (7), Termites and other ant species (6), Approved chemicals other than fertilizers (5), Mossing and Ferning (5), pH analysis, technique and apparatus (4), Bacterial stripe disease of Guatemala Grass (4), Bringing into bearing (4), Die-back and Wood Rot (5), Control of Leeches (3), Amphichaeta Disease of Grevilleas (3), Scale insects and Sooty mould fungus (3), and Leaf-hoppers, leaf-suckers and leaf-miners (2).

There were also 98 miscellaneous additional enquiries dealing with varied further subjects.

## 10. Plant Tissue Analysis

Work was begun during the year by Mr. L. M. de W. Tillekeratne in implementing a programme for the use of plant tissue analysis as a guide to fertilizer use, in co-operation with the Agronomy and Plant Physiology Divisions. Selection of the shade experiment in No. 1 field, St Coombs, and also a similar shade experiment at Palm Garden, Ratnapura, was made with the initial objective of finding a sensitive tissue which would give an indication of the nutrient status of the bush at the time of sampling, sampling to be carried out at monthly intervals. Five leaves from a pluckable shoot were selected. The initial sampling, drying, grinding and packing of the dried samples was done by Mr Tillekeratne with the help of the Agronomy and Plant Physiology Divisions. After this initial sampling, it was possible to formulate a detailed programme for this work, which was then carried on by the Agronomy Division. Assistance with the chemical work of analysis has also been given by Dr Kenworthy of Michigan State University whose help is gratefully acknowledged.

## 11. Exhibitions and Shows

The Advisory Division, in co-operation with the Ceylon Tea Propaganda Board, Tea Control Department, and other Divisions of the Institute, organized

exhibits on various aspects of tea cultivation at the exhibition held in the last week in July by Dharmaraja College, Kandy. Exhibits and photographs were also lent to other colleges and schools which held exhibitions, including Rahula College, Matara and Jaffna College. The assistance of all concerned in providing material for and helping in these exhibitions is gratefully acknowledged.

## 12. Visit to South Indian Tea Area

Mr. J. V. Sabanayagam of the Advisory Division and Dr D. Mulder the Plant Pathologist visited the Tea Experimental Stations of the U.P.A.S.I. in Coonoor and Devorshola and some tea estates in the Mysore District in early April, with particular reference to the Plant Pathological problems in the South Indian Tea areas.

The most important problem in the North eastern Hills of Mysore State are the severe root diseases in seedling tea. Red Root disease (*Poria hypolateritia*, Berk) and Brown root disease (*Fomes noxious*, Corner) occurred on a fairly widespread scale at all stages of infection.

The other problem that is worthy of mention in the Mysore District is the extremes of climatic conditions which are of a continental nature. The drought is so severe and prolonged that the establishment of clonal material or even seedlings in small areas between seedling tea poses a difficult problem.

This is of great importance in connection with the control of root diseases and the replanting of small cleaned patches after treatment. On the other hand once the rains start, they can be so heavy that tremendous damage is done by earthslips and floods.

## 13. Staff

No staff changes took place during the year.

# REPORT OF THE LOW-COUNTRY ADVISER FOR 1962

A. W. R. Joachim, O.B.E., Ph.D., F.R.I.C., Dip. (Agric.)

**General.**—Concentrated attention was devoted to matters relating to the development of the Low-country Station on St. Joachim estate. The main lines of activity were the planning of the laboratory, factory, and quarters for the staff, and the construction of bungalows needed for estate staff. Questions relating to the water and electrical supply and the installation of a telephone system also received due consideration and satisfactory arrangements were made in connection with them. Tenders were called for all buildings other than the factory towards the end of the year, and a start will be made with their construction early in 1963. The levelling of building sites by bulldozer was given out on contract and considerable progress has been made with this work.

A plan of the factory prepared by Messrs Walker Sons, Ltd. on the lines indicated by the Low-country Committee and the Technologist of the Institute was selected by the Committee from those submitted by the chief engineering firms concerned with this type of work. Our Consulting Engineers are drawing up the necessary specifications and tenders will be called for the structure in a month or two.

St Joachim estate continued under the management of the Agents of Messrs Saffragam Rubber & Tea Co. of Ceylon Ltd. (Messrs George Steuart & Co., Ltd.) during the year. Mr C. Andrews was appointed Superintendent of the estate and will assume duties early in January, 1963. The construction of four estate staff quarters was completed by July, thanks to the efforts of Messrs B. Cocking and H. D. Ross who, with the Director and the Low-country Adviser, then constituted the Low-country Buildings Committee.

Dr L. H. Fernando was appointed Agronomist to the Low-country Station and will assume duties at the beginning of January, 1963. The following staff changes were made during the year: Messrs U. L. M. de Silva and J. I. H. Bandaranayake, Technical Assistants, were transferred to Ratnapura from Kandy and Endane on 1st January, 1962 and 1st June, 1962 respectively. Mr R. I. Pereira was appointed Chief Clerk from 1st November, 1962.

Visitors to the Division included Dr S. C. Pearce, Statistician of the East Malling Horticultural Research Station, U.K., and Prof. H. S. Raeburn Prof. of Agricultural Economics, University of Aberdeen.

I acted for the Director from 11th May to 18th June and served as a member of the National Education Commission till it concluded its work in July.

**Advisory and Extension Activities.**—The number of letters sent, during the year was 1,715, an excess of 167 over that of last year. 27 meetings were attended including among others, 8 meetings of Low-country Planters' District Associations at which addresses were given, 8 of the Low-country Buildings Committee, 4 of the Experimental & Estates Committee, and 4 of the Low-country Committee. The number of visits to estates, V.P. nurseries and Government colonization schemes by the staff for advisory purposes was 67. Apart from this, regular visits were made to Palmgarden and Endane estates and Kottawa Clonal Sub-station in connection with experimental and administrative work. Among the Government schemes reported on was a tea colonization scheme for the north-western part of the Hambantota District. The

prospects for a small-scale tea industry here appeared fairly good. Some attention was directed during the year, in collaboration with the Chief Advisory Officer and the Vegetative Propagation Officer, to the question of tea seed supplies to colonization schemes in the Matara, Galle and Hambantota Districts. In all the cases investigated the tea consignments supplied appeared to contain, a proportion of mixed China-Assam jat seed. The question of the indetification of China characteristics in tea seed from recognised sources would appear to justify a practical investigation.

The number of soil and plant samples received for examination was 70. This included 58 samples of soil for pH estimation and textural classification. The number of visitors to the office for technical advice continues to increase. The Division advised on the layout of simple experimental trials relating to manuring, micro-nutrient deficiencies and soil rehabilitation.

**Kottawa V. P. Station.**—Mr K. H. G. Gunapala continued to be the Officer-in-charge of the sub-station during the year and is mainly responsible for the efficient development of the unit in such a comparatively short period. The building programme of the Station was completed during the year except for the nursery shed. The entire area was fenced with barbed wire and only the metalling of the road remains to be done. 14 acres of land have been put under crop and a start made on the remaining 11-acre block. Soil conservation work and jungle clearing have been completed in 7 acres of the latter. Thanks to the kind co-operation extended to us by the Government Agent, Galle, and his officers, an additional block of 25 acres of land was reserved for alienation to the station. The nursery was replanned to serve the requirements of the extended research programme. A large number of nursery experiments was carried out by the Vegetative Propagation Officer and will be referred to by him in his report. A point of practical importance which has emerged from these experiments is the direct planting of clonal cuttings in polythene bags with considerable success. Care has, however, to be taken to avoid over-watering.

As regards the Plant Physiologist's trials, the clonal blocks of 32 clones planted in October, 1961 were systematically brought into bearing during the year. Of these, the following were outstanding: T5/3, 2926, DG39, PO26, MT/BG, BG18, 2023, 2025, GMT9, 2151 and NL3/1.

A further lot of 16 clones was planted out in May, in four blocks; two were under shade and two unshaded.

An account of the other experiments conducted by the Plant Physiologist's will be furnished in his report.

This Division's clonal spacing and manurial trial, started in July, 1961, came into plucking in September. All plots received the same manurial treatment. At 16 months from planting a complete spread has been obtained with the clone 2024 spaced 4′ × 1½′. The initial yield results to the end of December are shown below:—

*Yield (lb per plot)*

| Spacing | Clones | | | Total |
|---|---|---|---|---|
| | 2024 | 2016 | QT4/4 | |
| 4′ × 1½′ | 33.5 | 22 | 17 | 72.5 |
| 4′ × 2′ | 27 | 20 | 15 | 62 |
| 4′ × 2½′ | 16.5 | 17 | 10 | 43.5 |
| Total | 77 | 59 | 42 | 178 |

Variety and spacing both appear to determine yield at the earliest stage of cropping.

A second spacing and clonal trial was laid out in September at the following spacings: 4′ × 14″, 4′ × 28″ and 4′ × 42″ with the colnes 2023, 2026 and 18B.

93 clonal multiplication plots have been laid out. Of those planted in August/September, 1961 all except the 2023, 2024, 2025 and 2026 plots were brought into bearing. The latter were utilised for supplying V.P. cuttings. 16 new clonal plots were planted out in May this year.

20,000 clonal shoots were sold from the station during the year, the amount realised being Rs. 2,060. The sale of green leaf was started late in September, the purchaser being an estate in the close vicinity of the station. The rates paid have been satisfactory and varied from 24 to 27 cents depending on the average market price for the month. A sum of Rs 138/50 was obtained thereby.

I have to record our sincere thanks to Mr C. Cameron of Walahanduwa Group who continued to be our Visiting Adviser on labour and financial matters except for the period when he was on overseas leave.

**Research.**—The main lines of research undertaken by the Division during the year comprised: (*i*) the manurial experiment at Endane on old seedling tea, (*ii*) manurial experiments on young V.P. tea at Palgmarden, (*iii*) a zinc-deficiency trial on St Joachim estate, (*iv*) statistical studies relating to field experiments with tea in the low country, and (*v*) studies on the relationship of yield and rainfall in the low country.

In addition, this Division collaborated very closely with the Plant Physiology Division on a shade trial which was started on St Joachim estate in April. Only passing mention will be made in this report to experimental work being undertaken by other Divisions in the low country, and for a detailed account of these experiments reference to the reports of the specialist officers in question should be made. This work includes the investigations of the Entomologist on the control of Shot-hole Borer with dieldrin, the studies of the Plant Pathologist on the maintenance-leaf fall problem, the Tea Technologist's analysis of the data of the experimental manufacturing tests carried out by the Manager of Pelmadulla Group, Kahawatte, on clonal leaf grown on the estate, the Nematologist's investigation on eelworm at Kottawa, and the Agronomist's studies on plant composition and fertilizer problems.

**(1) Manurial Experiment at Endane (5th Cycle)**—This experiment 14 months at the end of December, 1962, after 41 weekly completed pluckings. The results for the period are shown in Table 1.

TABLE 1.—*Endane*

| Treatment | lb per acre | Green leaf lb per acre | % of mean |
|---|---|---|---|
| Nitrogen | 0 | 6,321 | 98.2 |
| | 40 | 6,469 | 100.5 |
| | 80 | 6,522 | 101.3 |
| Potash | 40 | 6,417 | 99.7 |
| | 60 | 6,463 | 100.4 |
| | 80 | 6,432 | 99.9 |
| Magnesium | 0 | 6,404 | 99.5 |
| | 20 | 6,461 | 100.4 |
| | 40 | 6,447 | 100.2 |
| Phosphoric Acid | 20 | 6,429 | 99.9 |
| | 40 | 6,496 | 100.9 |
| | 60 | 6,387 | 99.1 |
| Average | | 6,437 | 100.0 |

It would appear, therefore, that even in the second cycle subsequent to the introduction of the new manurial treatments, the control with no nitrogen has, so far, yielded only slightly less than the 40 and 80 lb per acre per annum treatments respectively. No explanation can be offered for this unexpected result except that the natural fertility of the soil together with the nutrients contributed by the green manure trees and loppings have been adequate to maintain the average yield of the control at the same level as that of the nitrogen-fertilized treatments. The yields of the control plots have, however, been steadily falling with the advance of the cycle and it would be surprising if, at the end of the cycle, the control does not show a significantly lower average yield than those of the nitrogen-treated plots. There has again been no response to potash, magnesium and phosphoric acid above the lowest levels applied.

On the advice of Dr Pearce, our U.K. Statistical Adviser, phosphate treatments were introduced into the experiment without adding to the plot number. This nutrient is being applied at levels of 20, 40 and 60 lb of phosphoric acid per acre per annum. No differences in yield have so far been noted.

TABLE 2.—*Endane*

| Treatment | Weight of tippings | | Weight of leaf | |
|---|---|---|---|---|
| | lb per acre | % of mean | lb per acre | % of mean |
| Dieldrex spraying | 749 | 96.4 | 6,389 | 99.1 |
| Zinc Sulphate spraying | 831 | 107.1 | 6,555 | 101.8 |
| Control | 750 | 96.6 | 6,368 | 98.9 |
| Average | 766 | 100.0 | 6,437 | 100.0 |

As regards the spray treatments, the zinc-treated blocks, which showed a 10% increase in yield of tippings over the controls and the dieldrin-treated blocks, did not continue to maintain the beneficial effects of this treatment during the plucking period, despite the fact that four sprayings of zinc sulphate totalling 25 lb per acre were given at regular intervals. The zinc-treated blocks have now out-yielded the controls by only 2.6%. The blocks sprayed with dieldrex developed a bad attack of tortrix which was controlled by D.D.T. spraying on two occasions. The yields of these blocks suffered in consequence, but the records during the past two months indicate that these are now fast catching up on the others, and it appears likely that they will at the end of the cycle, which it is now proposed to extend to 2 years from the 18-month previously adopted, show an advance over the control and the zinc-treated blocks. Table 2 above illustrates these points.

## (2) Palmgarden V.P. Manurial Experiments

(*a*) *Nitrogen, Potash, Magnesium and Frequency Trial.*—Table 3 below shows the position in regard to the results of treatments in this experiment to the end of December. 88 pluckings were taken over a period of 15 months. The average crop yield worked out to 3,800 lb of made tea per acre per annum approximately, on a 20 per cent outturn on green leaf. The highest treatment combination gave over 4,100 lb per acre per annum.

TABLE 3.—*Palmgarden*

| Treatments | lb per acre per cycle | Green leaf | |
|---|---|---|---|
| | | lb per acre | % |
| Nitrogen | 150 | 22,491 | 100 |
| | 300 | 24,031 | 107 |
| | 450 | 24,762 | 110 |
| Potash | 100 | 23,741 | 100 |
| | 200 | 24,203 | 102 |
| | 300 | 23,340 | 98 |
| Magnesium | 0 | 23,758 | 100 |
| | 48 | 24,003 | 101 |
| | 96 | 23,523 | 99 |
| Frequency of application per cycle (times) | 5 | 23,381 | 100 |
| | 7 | 23,758 | 102 |
| | 9 | 24,144 | 103 |
| Average | | 23,761 | |

It will be observed that nitrogen at the highest level has registered a statistically significant average yield increase of 10% (about 360 lb per acre per annum) and, at the mid-level, of 7% (about 250 lb) over the lowest. There are no differences in yield between the different levels of magnesium and potassium. As regards the frequency of application, it will be seen from Table 3 that the *average* response to the highest frequency of application has been only 3% above the lowest to the end of the year. Earlier, however, this difference was as much as 7%. The cause of this marked change in response to frequency of application is not clear.

TABLE 4.—*Palmgarden*

| Treatments | Yield per acre | % | No. of fertilizer applications to date | Nitrogen applied lb per acre |
|---|---|---|---|---|
| $N_0 F_0$ | 22,078 | 100 | 4 | 119.7 |
| $N_0 F_1$ | 22,680 | 102.7 | 5 | 107.0 |
| $N_0 F_2$ | 22,718 | 102.9 | 7 | 119.7 |
| $N_1 F_0$ | 24,111 | 109.2 | 4 | 239.4 |
| $N_1 F_1$ | 23,972 | 108.6 | 5 | 214.1 |
| $N_1 F_2$ | 24,016 | 108.8 | 7 | 239.4 |
| $N_2 F_0$ | 23,959 | 108.5 | 4 | 359.0 |
| $N_2 F_1$ | 24,624 | 115.1 | 5 | 320.0 |
| $N_2 F_2$ | 25,694 | 116.4 | 7 | 359.0 |

$N_0 = 150$, $N_1 = 300$, $N_2 = 450$ } lb per acre per cycle

$F_0 = 5$, $F_1 = 7$, $F_2 = 9$ } applications per acre per cycle

An examination of Table 4 shows, however, that there is a progressive increase in yield from the lowest nitrogen—frequency combination to the highest. The effect of frequency of application appears to be most beneficial at the highest fertilizer level, the detailed statistical analysis showing that this is approaching significance at the 5 per cent probability level.

The average *true nitrogen* (*N*) *efficiencies*, as calculated from the data of these trials to date are, on the basis of a 20% outturn of made tea to green leaf, as follows:

| Between | lb crop per lb nitrogen |
|---|---|
| $N_1 - N_0$ | 2.67 |
| $N_2 - N_1$ | 1.26 |

There are indications of a reduction in the efficiency of nitrogen at the highest level, though the difference is not statistically significant. Experimental data obtained by Eden over a nitrogen range of 0 to 80 lb per acre indicate an *average* true nitrogen efficiency of 3.1 lb of made tea per lb of nitrogen over 8 cycles (Eden, 1949), but it should be pointed out that the figure was lowest in the first year of the pruning cycle and increased each successive year thereafter. In the low country, however, pruning cycles seldom exceed two years' duration and while some improvement in efficiency can be anticipated in the second year of the cycle, the large differences noted by Eden may not be obtained. As a matter of interest it may be stated that in this trial the nitrogen efficiency increased from 2.1 to 2.7 lb per unit of nitrogen as the period from pruning increased from one year to 19 months. A further point should be mentioned. The tea in this experiment is only about five years old and as the bushes age their efficiencies in respect of utilization may increase.

(*b*) *Phosphate Trials.*—The results of these trials to date are given in Table 5.

TABLE 5.—*Palmgarden*

| $P_2O_5$-lb per acre | Green leaf lb per acre | % |
|---|---|---|
| 25 | 26,049 | 100 |
| 50 | 25,878 | 99 |
| 75 | 24,624 | 95 |

There would appear to be a reduction in yield at the highest phosphate level, but a comparision of yields with the corresponding pre-treatment data shows that this decline is only apparent and not real.

(*c*) *Decline-in-Yield Trial.*—The yield results obtained in respect of the two plots to which no fertilizer was applied during the period show wide differences. One plot $G_1$ is sited at the bottom of the experimental area which is a fairly steep slope, and the other $G_2$ a little distance from the crest of

the hill. The former has shown no decrease in yield at the end of 15 months. It is clear that there has been a steady leaching of fertilizer down the slope into this plot. This factor and the manurial value of the leguminous green loppings it receives regularly, appear to have brought the yield up to its original level during the experimental period. On the other hand the plot up the slope has shown a decrease of about 25% in yield on its earlier average over the period of 15 months during which it received no fertilizer. Results are detailed in Table 6 below:

TABLE 6

| Plot | Average original yield per pluck–lb | Current average yield per pluck–lb | % fall or increase |
|---|---|---|---|
| $G_1$ (Unmanured) | 3.70 | 3.93 | +6 |
| $G_2$ (Unmanured) | 4.15 | 3.21 | –23 |
| Average of manured plots | 4.69 | 4.74 | +1 |

**(3) Zinc Deficiency Trial—St Joachim Estate.**—A $3^5$ confounded trial to determine the effects of zinc sulphate sprayed at different concentrations and frequencies on old tea showing symptoms of zinc deficiency (to be manured subsequently at three levels of nitrogen) has been planned for conduct on St Joachim estate. 36 plots each of 1/40th acre extent in three blocks were selected for the trial and their pre-treatment yields recorded from mid-September onwards as there is a considerable variation in the proportion of V.P. supplies to old seedling bushes in them. These records will be maintained until the plots are pruned in April-May, 1963. Meantime the yield data have been examined to ascertain the co-efficients of variation with plot size. The results will be referred to in a later section.

## (4) Statistical Investigations

(*a*) *Total and Periodical Plucking Yield Correlations.*—The initial pre-treatment data of the Palmgarden trial obtained from 68 pluckings over a period of about a year were used for the purpose of ascertaining for what minimum period pre-treatment pluckings should be carried out on V.P. tea in the low country so that the yields could be used with confidence in the analysis of co-variance of experimental data. Correlations were obtained between yield after 20, 36 and 48 rounds or 100, 180 and 240 days of plucking respectively and total yield. The results are shown in Table 7.

TABLE 7.—*Correlations between Total Yield and Yield during Period*

| Period | Blocks | Error | Total |
|---|---|---|---|
| 100 days | 0.80 | 0.58 | 0.63 |
| 180 ,, | 0.91 | 0.81 | 0.83 |
| 240 ,, | 0.96 | 0.93 | 0.94 |

All correlations are significant at the 1 per cent probability level. It would appear, however, that pre-plucking should be carried out for a period of at least six months if the data obtained are to be considered adequately representative of the yields of the plots in question.

(*b*) *Size of Plot and Standard Error in Low-country Seedling Tea.*—The yield data of the plots in the zinc deficiency trial to which reference has been made were examined to ascertain the coefficients of variation of old seedling tea re-supplied with V.P. tea in varying proportions. The experiment is in three blocks of level land close to but not adjacent to each other. The results are shown in Table 8.

TABLE 8.—*Coefficients of variation—St Joachim*

| Plot size | With blocks | Without blocks |
|---|---|---|
| | % | % |
| .025 acre | 6.7 | 6.5 |
| .05 ,, | 4.3 | 4.1 |
| .075 ,, | 4.1 | 3.6 |
| .1 ,, | 3.5 | 3.1 |

It will be noted that the coefficient of variation varies from 6.5% for a plot size of 1/40th of an acre to 3.1% with a plot size of 1/10th of an acre. These figures indicate that the experimental area has a good, even stand of tea. The coefficients of variation are lower than those reported by other workers for comparable plot size (Eden, 1931). They also compare very favourably with those found for V.P. tea on Palmgarden estate (Joachim, 1962).

Considering that these records were taken for a period of just over three months, it is gratifying to note that the errors are comparatively so low and the chances of significant differences being obtained between the treatments are high.

(5) **Yield and Rainfall in the Low-country.**—Further examination of the estate data obtained for yield and rainfall relationships in the low country did not reveal any features of interest other than those referred to earlier (Joachim, 1962).

(6) **Shade Trial—St Joachim Estate.**—The Plant Physiologist's trial at St Joachim estate on the effect of artificial shade of two densities (no shade and 30% shade) on a block of 2023 clonal tea receiving four manurial treatments, completed five months in December. Weekly pluckings and dry matter estimations were carried out by the staff of this Division. For a survey of the results reference to the Physiologist's report should be made.

**Observational**

(i) *Pests and Diseases.*—There were no serious outbreaks of pests and diseases reported in the low country during the year excepting on estates where dieldrin had been used for the control of Shot-hole Borer on a large scale, when tortrix attack was reported to be a problem. The control of the pest with D.D.T. was effected with two sprayings in most areas. The initial setback in yields which occurred appear to have been counter-balanced by

higher yields from 10 months to a year onwards. Sporadic outbreaks of yellow mite and red spider, aphids and thrips were reported, but these were not of a serious nature. *Rhizoctonia solani* attacks were reported to be serious in some areas during the rainy season. Control was effected with regular copper fungicide sprayings. The maintenance leaf-fall problem was markedly noticeable in areas where cut-across pruning has been adopted over a period of years, during which no bush-sanitation measures were taken.

(ii) *Deficiency Diseases.*—Zinc deficiency disease has been noted in varying degrees of intensity on a number of low country estates. Only a very few estates, however, show the deficiency to any marked degree and this is mostly in old tea. Spraying with zinc sulphate has been recommended for trial on a field or two on no less than 8 estates in the low country where the deficiency has been observed. Fields vary greatly in their apparent degree of deficiency of this minor element and the proportion of bushes showing the deficiency in any one field is also a very variable factor. The response to treatment will, therefore, depend so far as yield is concerned, on the actual number of bushes showing the deficiency symptoms which may in sum total be small.

Albizzia trees which were reported to be in very poor condition, were observed to have made a very good recovery and developed into vigorous trees some months after a light application of borax had been given to the tea in which they were growing. Borax applied to Albizzias which were affected by bark borer did not have any beneficial effect on the pest but the trees were reported to have recovered better after pruning than those which were not treated with the chemical.

(iii) *Deaths of V.P. Tea.*—Reports were received from estates of the death after pruning of bushes of V.P. tea varying in age from 4 to 10 years. Investigations revealed that in all instances there was an absence of carbohydrate reserves in the roots which normally are low under low country conditions. Great care should therefore be taken when pruning V.P. tea in the low country to leave sufficient foliage on the bushes to supplement the starch reserves while recovery is taking place. The adoption of lung pruning would be necessary in most cases and resting prior to pruning may be found desirable, if there were inadequate maintenance leaves on the bushes. A high water-table during the rainy season contributed to bush casualties in one case, and the concentration of poorly-drained clayey soil in trenches in others. Good soil drainage is, therefore, another essential condition for success with V.P. tea.

(iv) *Manuring of V.P. Tea.*—The manuring of V.P. tea in the low country has become a problem of great importance as there are comparatively large extents in bearing and much larger extents will shortly be coming into cropping. Estates generally manure their V.P. areas liberally but there is much variation in regard to the frequency and method of application. In regard to the former it is interesting to record that on one estate an acre of 4-year old V.P. tea of T.R.I. clones 2023 and 2026 was manured at the rate of 1 oz of fertilizer per bush per month. The yield obtained over a period of an year exceeded 5,450 lb of made tea over the acre, the total quantity of nitrogen applied being no less than 500 lb per acre. Some estates adopt the practice of manuring V.P. tea once in two months, the manure being broadcast between the rows; others give from 5 to 9 applications of fertilizer per acre per annum. The tendency is now to manure little and often and on general grounds this would appear to be a sound practice in a heavy rainfall zone. Our experiments at Palmgarden will furnish information on some of these points regarding manuring.

(v) *Clonal seed.*—Visits were made along with the Post-graduate Scholar in Plant Breeding to two estates where isolated seed gardens of T.R.I. 202 clones had been experimentally established. At Landsdowne, Ratnapura District, clones 2023 and 2026 were grown in pure and mixed stands respectively. Seed is being collected for experimental purposes.

At Rambukkande estate, also in the Ratnapura District, an isolated seed garden was established in the Hapurugala Division about six years ago, the clones grown being 2023 and 2026 in mixed stand, in the proportion of 10 of the former to 1 of the latter. First generation seed from this garden has been established on a field scale for both plucking and seed purposes. The tea in the clearing, about 2 years old, is of quite uniform stand and growing as vigorously as its clonal parents. The progress of this clearing will be followed with interest.

(vi) *Clonal suitability from the standpoint of low country manufacture.*—The Technologist's investigation on the data of the Pelmadulla manufacturing clonal tests reveal that clones which give the best tip are 2043 and 2045, and those which give good or very fair tip are 1530, 25 and 2046. The Nilagama seedling clearings come within this category. The T.R.I. 202 series of clones give only fair or little tip.

**Conclusion**

Tea production in the low country, like that in up-country and mid-country areas, continues to show a rise both in respect of total quantity and yield per acre. The latter has risen from 697 lb in 1960 to 718 lb in 1961. Total production has been about 113 million pounds in 1961. The figures for 1962 will even be higher with the increased use of fertilizer and the greater care and attention given to agronomic practices and management problems generally. With the coming into bearing of large acreages of V.P. tea, a comparatively steep rise in crop production could be anticipated during the next four or five years in the region. The average market price for low country tea has been low throughout the year, being only about Rs. 1.55 per lb. It is, therefore, apparent that while costs of production will be reduced somewhat when the V.P. areas on low country estates come into bearing, markets must be assured for the absorption of the increased crops or the efforts which have been made towards increasing crop output may be nullified by a market price even lower than what has recently been obtained. The safeguarding of our traditional markets in the Middle East is, therefore, a matter of the utmost importance if tea estates in the low country are to continue to give reasonable overall profits.

I have once again to thank the Superintendents of estates and others who have co-operated so closely with us in our work, and particularly Messrs H. D. Ross of Palmgarden, A. Watt and John Brodie of Endane, and J. W. Craig formerly in Pelmadulla, for the facilities kindly offered us for conducting experimental work on their estates or for collaborating with us in obtaining information on various aspects of tea cultivation and manufacture. Our special thanks are due to the members of the Low-country Buildings Committee, Messrs B. Cocking and H. D. Ross for the valuable contribution they made in solving the urgent problem of bungalow accommodation for the staff of St Joachim estate.

**References**

1. Eden, T. (1949). The work of the Agricultural Chemistry Department of the Institute. *Mono. on Tea Production in Ceylon.* **1** : 13.
2. Eden, T. (1931). Studies on the yield of tea. The experimental error of field experiments with tea. *J. Agric. Sc.* **21** : 547-573.
3. Joachim, A. W. R. (1962). Report of the Low-country Adviser for 1961. *Rep. Tea Res. Inst. Ceylon:* 40-49.
4. Mahadeva, B. (1962). Administration Report of the Tea Controller for 1961: 35-50.

# REPORT OF THE LIBRARIAN FOR 1962

Steve De Silva, B.Sc.

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**General.**—There were no changes in personnel during the year.

The move from the old building to the new block was completed in July 1962.

**Equipment.**—The periodical room has been equipped with "Simplex" steel periodical racks ordered through the Crown Agents, from M/s. Libraco Ltd., who have also supplied a double-elephant size plan cabinet for the storage of maps and plans.

Fifteen double-sided two-bay library stacks were ordered from M/s. Godrej Ltd., Bombay, for stock storage of blocks and bound periodicals.

**Library.**—One hundred and eighty nine current scientific and technical periodicals were on standing order during the year. The total number of new books purchased during the year was two hundred and eighty seven. In addition to this a number of annual reports were received from various Departments of Agriculture and Research Institutes, both in Ceylon and overseas. The Institute is grateful to those institutions and publishers who send their publications gratis or on an exchange basis.

There is on display a collection of early works on tea.

The reference and lending section of the library was once again used to advantage by the research staff. Approximately 3,000 works were used for reference and over 1,700 books issued on loan.

One of the most important tasks for 1963 is to be the compliation of an author and a subject index to all existing literature on tea. Considerable initial progress has been made with this essential undertaking.

**Publications.**—Publications issued during the year were:

*Annual Report for 1961*
*Tea Quarterly* **33**: *Parts 1—3.*

Free Mailing List for the publications of the Institute was revised during the year. All those estates whose returns were not received were deleted from this list, but some are being replaced as their returns are received. The number of copies of publications being distributed on this list totals 1485. The number of subscribers to the publications of the Institute is 486. Those on our exchange mailing list total 205.

**Monograph No. 4,** Tea Manufacture in Ceylon by E. L. Keegel is in great demand and it appears that a new edition or a reprint of this publication will have to be arranged during 1963.

# REPORT OF AGRICULTURAL CHEMIST FOR 1962

J. A. H. Tolhurst, B.Sc.

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**Staff.**—Attempts to fill the two vacancies for Research Assistant have again been unsuccessful. No changes were made in the existing staff, although sanction was given for increase in the establishment of field officers, to keep pace with our growing programme of field work.

During my absence on furlough, Dr H. N. Hasselo acted on my behalf and to him I extend my thanks. With the exception of this period, I acted also as Biochemist. After the resignation of Mr M. S. Ramaswamy, Senior Research Assistant in Biochemistry, and in the knowledge that a permanent appointment to the Senior Biochemist's post would be made early in 1963, it was decided not to initiate any new work. Preparations have been made for equipping the new biochemistry laboratories, and the staff have also assisted in the laboratory work of my own Division.

## Field Experiments

1962 was a more encouraging year in three respects. The two old trials, in Fields Nos. 3 and 13 on St Coombs, showed signs of benefiting from their rehabilitation to an extent which we had not dared to anticipate. As the team of field assistants, now numbering three, got into its stride it became possible to consider more intensive management of existing trials. Finally, we were able to contemplate an expansion of field work, on St Coombs and possibly outstation.

Managing labour on small plots is an exacting operation, unless supervisory staff are present in extravagant numbers, and we have tried to improve on existing procedure. It had been obvious for some time that the use of strands of wire to demarcate plot boundaries was unsatisfactory, even when the wire was not promptly stolen. New trials will almost certainly include buffer rows between plots, which, unless specially planted with a clone of distinctive leaf colour, will add to the difficulty of keeping a check on small gangs of labourers working in two or three plots at the same time. Therefore we introduced the idea of allowing a screen of shoots to grow unchecked from the outside edge of boundary bushes. The initiation of these screens may be rather troublesome, but after that stage they appear to be effective and simple to maintain. They allow the staff to check the position of the labourers from a distance, and they have an added value in trials where foliar spraying is included in the treatments.

Plucking in the St Coombs trials has been kept to a 7-day round whenever possible. Shoots have usually been plucked to the small fish leaf, maintaining a level, and only allowing the table to rise slowly. No attempt is made to keep adjacent bushes to the same level.

### 1. *N.P.K. Experiment: St Coombs No. 3 Field*

Growth, in most plots, had been so encouraging, after the hard prune in 1959, that it was decided to complete the rehabilitation pruning and to revise the manurial treatments.

The remaining old branches and rotted stumps were sown off in March, and the young shoots which had sprung from the trunks or stumps in 1959 were thinned out to 10 or 20 per bush. These shoots were pruned below the level of branching and subsequent tipping and plucking has been hard, in order to force the development of a spreading frame close to the ground. To date, this hard treatment, which can be mitigated whenever growth appears to be poor, seems to have served its purpose without causing damage. Subsequent prunings, for several cycles, should now be simple cut-across operations, with the minimum of cleaning.

After inspection of the yield trends in 1961, and in anticipation of a greater yield potential once the new frames had developed, it was decided to start the present, eleventh, cycle with higher levels of nitrogen and potash. This is the first change in rates of any of the three nutrients under trial since the third cycle, 1937-40. We may now hope that this trial, which had lapsed into an unfortunate state, will at last be brought into a condition which bears comparison with much up-country tea.

Previous nitrogen levels of 40, 60 and 80 lb N. per acre per annum had been associated with yields of 974; 1,165 and 1,407 lb dry weight per acre over an 18 month period of plucking. All levels, particularly after heavy-cropping periods, resulted in nitrogen-deficiency symptoms on many bushes. A change was therefore made to 120, 150 and 180 lb N. respectively.

Potash levels of 0, 20 and 40 lb $K_2O$ per acre per annum became 0, 60, 90. Damage in the zero-potash plots is irreparable and there seemed to be no point in changing this treatment. These plots have a value for scientific purposes, even though their erratic and poor yields may be troublesome when trying to evaluate the effect of nutrient interactions on yield. The 20 lb treatments, judging by the occurrence of potash deficiency symptoms in some plots, had not been sufficient even at low yield levels to prevent a drain on soil reserves.

Phosphate levels were left unchanged at 0, 30 and 60 lb $P_2O_5$ per acre per annum. Differences in yield over the same period were smaller, the three treatments giving 1,110; 1,251 and 1,176 lb dry weight per acre. No attempt will be made to correct for the fact that the zero-phosphate plots have also had no calcium since 1934, until the calcium-potash-boron question has been settled (Tolhurst, 1960).

Magnesium was introduced for the first time, 60 lb magnesia per acre being broadcast in April on three of the six blocks. Zinc was continued as an overall treatment, by incorporating zinc sulphate in the routine copper sprays.

Chemical analysis of the foliage was restricted to completion of the large number of samples taken in 1961 and early 1962 according to a pre-arranged pattern relating time of sampling to manure application. The most interesting results were shown by the boron contents of the uppermost mature leaves, sampled in February 1962, $2\frac{1}{2}$ years from pruning and $1\frac{1}{2}$ years from the start of plucking. A relation again appeared between boron accumulation and the ratio between phosphatic and potassic manurial treatments. The effect was not so great as that shown by a similar sampling in January 1959, towards the end of the 9th cycle, and it will be interesting to follow the trends now that the proportion of potash has been increased. Table I shows the boron contents, as parts per million of dry matter and the mean of six plots, for each of the phosphate/potash treatment combinations.

TABLE I.—*Boron contents of mature leaf in relation to phosphate/potash treatment combinations. N.P.K. Trial, No. 3 Field, St Coombs*

| $P_2O_5$ as lb/a/an | $K_2O$ as lb per acre per annum | | |
|---|---|---|---|
| | 0 | 20 | 40 |
| | Sampling: January 1959 | | |
| 0 | 38.1 | 44.7 | 61.7 |
| 30 | 35.0 | 32.9 | 32.3 |
| 60 | 35.5 | 29.1 | 32.3 |
| | Sampling: February 1962 | | |
| 0 | 42.3 | 46.7 | 46.5 |
| 30 | 40.1 | 38.9 | 37.3 |
| 60 | 40.7 | 36.7 | 36.9 |

This effect of phosphatic manurial treatments was significant at the 0.1% level in 1959, but only at 5% in 1962.

Relations between manurial treatments and the leaf content of major nutrients and manganese were observed. In view of the observations on widespread nitrogen-deficiency symptoms and sporadic potash-deficiency symptoms (*vide supra*) it is considered preferable to withhold comment until a comparable set of results is obtained from the bushes under more adequate levels of nutrition.

2. *Phosphate Manurial Experiment: St Coombs No. 13 Field*

This is the second of the older trials which had been put on to a rehabilitation programme, and progress has been encouraging. The whole trial averaged nearly 1,800 lbs dry weight per acre in the first year of plucking, which ended in September. A fertility gradient is noticeable, but no yield differences between treatments were apparent. Analysis of the mature foliage in November showed a significant relation between phosphate content of the leaf and the level of phosphatic manure applied, whether as super-phosphate or rockphosphate. The means of eight plots for each of the $P_2O_5$ levels, 30, 45 and 60 lb $P_2O_5$ per acre, per annum, were 0.25, 0.28 and 0.30% $P_2O_5$ on dry matter.

These differences are significant at least at the 1% level. Similarly, the calcium analyses, giving means of 1.47, 1.69 and 2.13% CaO, showed a significant relation, but only between the two upper rates of phosphatic manuring.

Of further interest is the significance of the differences of these phosphate analyses between blocks. It appears that the more vigorous areas have a generally lower phosphate content in the mature foliage.

It may be noted in passing that at a level of 180 lb N, T.700 manure would apply approximately 50 lb $P_2O_5$. It is anticipated that the NPK trial in No. 3 Field will be adequate for a study of optimum phosphate levels, and that the No. 13 Field Trial could be more usefully employed in other ways. The comparison between the two forms of phosphatic manure would seem to be only of interest insofar as the No. 3 Field Trial continues to use superphosphate.

The most interesting feature of this trial is the high yield in relation to the size of the bushes. Pruning, in 1960, was hard and the frames themselves were very small. Subsequent operations aimed to allow new shoots to develop vigorously but even by the end of 1962 it was possible to walk across the rows with reasonable ease, except in the more vigorous plots. Wood development has been good and there will be no difficulty in pruning the existing frames in such a way that future frames will be much more spreading. Earlier fears that this area was inherently too poor to be of value for field trials can now be discounted. Virus-like distortions of leaf and stem remain conspicuous but we can anticipate much higher yields, in the near future, in spite of these abnormalities.

3. *New Manures' Trial: No. 9 Field: St Coombs*

This trial maintained its promise of high yields, the first year's figure being over 1,800 and 2,100 lb dry weight per acre, for nitrogen levels of 125 and 275 lb per acre per annum. It was decided to change the type of granular manure, at the start of the second cropping year, to a lower-phosphate formula. This will continue to be used when the trial is pruned in 1963, and when we may hope to attach real importance to the yield results. To-date, yield differences between the manure-type treatments have been very small in relation to the variations in plot yields in the pre-treatment period.

4. *Zinc sulphate and blister-blight control*

It has already been reported (Tolhurst, 1962), that the addition of zinc sulphate to the commoner red oxide copper fungicides leads to a blue deposit on the foliage. A trial was started in No. 9 Field, St Coombs, to investigate this problem in more detail, a 3 × 3 × 3 factorial design in twofold replication being used. Zinc sulphate rates of 0, 10 and 20 lb per acre were combined with three types of fungicide, each at either 2,4, or 6 ounces per acre per round. A red oxide, an oxychloride powder, and a colloidal oxychloride were used. The zinc sulphate rates were divided between 20 spray rounds, starting late in May.

Recording consisted mainly of assessment of blister-blight infection of the immature leaves in the plucking table. Ideas of taking yield records had to be abandoned, as the plucking tables in many areas were so irregular that it was felt that too long a period would be required to bring them back to normal. This is doubly regrettable since the trial as a whole showed no effects on fungal population arising from any treatment. Since the monsoon included very cool and dull periods and the plots were well shaded, the inference is that our spraying technique was so meticulous that all the fungicide levels were adequate. A second, smaller, trial was started elsewhere in September but had to be stopped when the unexpected drought in November and December reduced blister-blight infestation.

It is unfortunate that a considerable amount of work should have produced very little result, but it illustrates a difficulty not uncommon in our

research. Persistent reports have come in from estates, supported by a preliminary observation of my own, that the blue reaction product gives a very good control of blister-blight. It can be suspected, from observation, that large droplets of copper fungicide suspension would have their effective area on the leaf increased by virtue of the spread of a blue fringe of the zinc-fungicide reaction product. It seems that if we are to test this hypothesis in small-plot trials we shall have to aim for a poor standard of spraying, as far as droplet size is concerned. To do this, and yet not increase our sampling error within plots will be far from easy. Nevertheless, a repetition is planned for 1963.

The most useful result from the first trial was obtained from the analyses of mature leaves from two samplings; after 9 spray rounds and again after 19. The zinc accumulation was of such a magnitude that it is possible to say that the efficiency of retention of zinc, from combined zinc-copper sprays, is high and apparently unaffected by either rate or type of copper fungicide.

In October the area of the main trial came entirely under my jurisdiction, manuring having been done by my Division for some months previously, and the plots were pruned in November. Residual effects of zinc spraying will be investigated, and further investigations on methods of application of zinc will later be included.

## Plant Nutrition

1. *Zinc Deficiency*

Inevitably, with the growing interest in zinc as a routine manure in practice, this nutrient has occupied much of our time. Comprehensive trials have been planned, on St Joachim Estate as well as on St Coombs, but many qualitative and semi-quantitative trials have already been done in order to guide us as to which treatments should be included in the larger trials. So far, foliar application of zinc sulphate, either with or without copper fungicides, has been more extensively studied than any other method. It is anticipated that zinc oxide will be included in the study, also as a foliar application, and eventually long-term trials should be done to include soil applications of these compounds. To date, effects of soil application of zinc sulphate have not been detectable, for mature tea.

The question of the extent of accumulation of zinc on flush shoots has already been mentioned as causing no concern (Tolhurst, 1962). Additional analyses on black tea, made by various estates following heavy sprays of up to 12 lb zinc sulphate per acre, confirmed the earlier findings. Three of these estates, in Uva, applied heavy rates of zinc sulphate at the beginning of the 1962 dry season, to certain fields. Leaf from these fields was manufactured separately at intervals throughout the dry season and samples were sent to the Institute for submission to tasters, according to our normal procedure. The tasters were asked in this case to comment on any peculiar characteristic. No such comments were made. Some of the teas came from estates which, at that time, obtained high valuations in their usual dealings, and we feel satisfied that there is no reason to fear any adverse affect on manufacturing properties if zinc sulphate is applied in any of the ways which we suggest.

Two of the main field trials on St Coombs have been used for approximate, valuation of the nature of the yield response to frequent small applications of zinc sulphate. Treatments have been on a block basis and results have been of some value in deciding upon the design of future zinc trials.

The first of these trials to be used was the New Manures' Trial, and reports on the earlier treatments and responses have been made (Tolhurst, 1962). Here it is only necessary to comment on the findings from the later spray treatments. 1 lb of zinc sulphate in 12 gallons per acre was applied to the highest-yielding block, as well as to one of the two lowest-yielding blocks which had previously received no zinc until early 1962. Twelve such sprays were put out weekly, ending in July. The second of the lowest-yielding blocks received a soil application, in June, of 100 lb of zinc sulphate per acre. The remaining block, which had received zinc sprays in 1961, was left untreated. Yields have been plotted monthly since the start of the trial early in 1961 and the relative positions of the four blocks prior to zinc treatments appeared to be fairly settled. Zinc spraying in 1962 was associated with a rise in yield early in the monsoon, but the differences disappeared when cropping rates fell during the cool, latter months of the monsoon. In November, yields in the two recently sprayed blocks again rose, relative to those in the remaining blocks.

In the second of these trials, the No. 13 Field Phosphate Trial, the bushes were expanding laterally at an appreciable rate when the first zinc sulphate sprays were applied to two blocks in 1961. A third block had received a soil application of zinc sulphate at 150 lb per acre, also in 1961. Between May and August of 1962, the two sprayed blocks received 12 sprays, each of 1 lb zinc sulphate per acre added to the copper fungicide sprays and applied by a mistblower. An improvement in the appearance of the foliage was noted after four spray rounds but no yield response was detectable until December, when the two sprayed blocks showed a marked rise relative to the remaining blocks.

A more precise estimate was obtained from an experiment on twenty pairs of bushes, identical twins raised by splitting seeds, in Plot 8Z St. Coombs. A spray equivalent to 30 lb zinc sulphate per acre was given in January to one bush in each pair and in spite of the severe drought in subsequent weeks, yields from the twenty sprayed bushes rose very rapidly. Over twenty plucking rounds an increase of 30% was recorded. The same bushes received a further 5 lb zinc sulphate per acre in May, by which time the effect of the first spraying had vanished. Over the following six plucks an increase of 32% in yield was attributable to the zinc treatments. Both these differences were significant. Two further sprays, each of the 2.5 lb rate, were given in August and September but no effects on yield were shown until late October. The bushes were then pruned, in November, with a view to investigating residual effects.

Taking these various investigations as a whole, it seems that attention should be concentrated on the frequency of spraying, with particular reference to practice in those districts where a long dry season prevails. Yield response during drier months is physiologically understandable and agriculturally promising. If zinc sprays could be shown to give an appreciable yield return during such seasons estates might prefer to mount a separate spraying operation, rather than to rely on the residual effects from the routine fungicide sprays plus zinc supplements. Apparent lack of response to heavy soil applications does not encourage their inclusion in the immediate programme of research.

Small trials are in progress at the Clonal Proving Stations at Passara and Hantane. At Passara, zinc and boron treatments were applied to clones T.R.I. 2023 and 2024 just before pruning in November. At Hantane, two trials with zinc sulphate foliar sprays were started on one-year old plants. Zinc deficiency was known to be present in both areas.

A point which may be emphasised is that small-leaved jats of tea have been shown to respond to zinc foliar sprays in certain areas, even though the bushes show no visible symptoms of zinc deficiency. Experimental, diagnostic, spraying is simple and practicable and there need be no reason for tea of this type to escape possible benefits simply through lack of visible symptoms.

2. *Nutrient Foliar Sprays*

Many qualitative trials have been done with several fertilizers to determine the practicability of further experimentation. It is natural that, once zinc sulphate had been applied in practice in this way, Superintendents should show interest in other nutrients.

Since motorised-knapsack spraying, usually at 2 gallons per acre, is becoming increasingly common it was necessary to determine the concentrations of nutrient solutions which could be safely applied to tea. With the exception of urea, most of the fertilizers which would be considered in practice showed surprisingly little damage even when applied at high concentrations. From mistblowers, and with no wetting agent, the following concentrations have proved safe under varying conditions of weather, unless bushes were sprayed with volumes far exceeding the 2 gallons per acre rate.

1. 1 lb Zinc sulphate plus 4 lb Epsom salts
2. 6 lb Epsom salts
3. 3 lb Potassium nitrate

The above weights would, in practice, not be recommended unless the risk of incomplete solution of the fertilizer charges were acceptable. It does seem that practicable concentrations could be found for magnesium manuring to be considered in this way, and possibly for supplementary potash manuring.

Very few reports have come in from estates concerning trouble arising with mistblowers. Those which have, suggest that the nutrient plus fungicide suspension has been spilled into parts of the machine where liquid is not expected to be found. Of more interest is the observation that red cuprous oxide fungicide can react on the leaf with several fertilizer solutions. Epsom salts, potassium nitrate and sulphate, and ammonium phosphate have all given blue products. We see no reason to be concerned about this, and observation suggests that retention of such products on the leaf is excellent.

3. *Leaf Analysis.*

Most attention, under this heading, has been directed to the nine, unreplicated, plots laid down at the beginning of the year. Nitrogen uptake from three levels of sulphate of ammonia, equivalent to 120, 360 and 480 lbs N per acre per annum, is being investigated. Each level is divided between either two, three or four applications a year, and samples of flush and uppermost mature leaf are taken monthly. More recently, weekly sampling was introduced, and checks were started on other nutrients in the leaf.

The aim is to obtain a guide to the most useful manner of sampling larger field trials without expending as much time and energy as was done in the many 1961-62 samplings of, for example, the No. 3 Field N.P.K. Trial. To date, it is not possible to comment on a pattern relating nitrogen content of either of the leaf types with manure application or season. It does appear that the variation in nitrogen content from one sampling to another is small. This is of particular interest when considering the possible use of leaf analysis in interpreting experimental trends, or eventually, as a means of assisting advice to estates on manuring policy. It is hoped that it will be possible to expand this line of work to investigate nitrogen fractions which may be a more sensitive guide to nutritional status than the total nitrogen so far determined.

## General

*Chlorosis in clones*—Late in the year reports and specimens were sent from three estates, unrelated to each other, of clones which had broken down in young clearings giving bright yellow, sharply defined patches on all leaves, more pronounced on the lower and older ones. Clone TRI 2024 was affected in all three clearings, and in one estate Clones 2023 and 2025 were equally affected. Plants were very retarded, and during the drier seasons sun scorch had affected the chlorotic areas very severely.

The general appearance of the symptoms was identical to that which is commonly seen on individual bushes in old seedling tea. Several such cases have been observed on St Coombs for many years and it seems that symptoms are most pronounced early in the cycle, occasionally disappearing altogether after the second year. One of the three estates mentioned above, in Kandapola, has been under observation also for many years as the seedling tea, generally of a small-level jat, has shown a wide variety of foliar discolourations and distortions, so far unidentified.

Although it is most unlikely that nutritional imbalance, in the accepted agronomic sense, is a causative factor, I am continuing observations since in one of the clearings the symptoms are closely correlated with a small topographic feature. This may, of course, be purely fortuitous.

## Publication

TOLHURST, J. A. H. (1962). Zinc deficiency of tea in Ceylon. Tea Quart. 33: 134-137.

## References

TOLHURST, J. A. H. (1960). Report of the Agricultural Chemist for 1959. *Rep. Tea Res. Inst. Ceylon*: 36-45.

TOLHURST, J. A. H. (1961). Report of the Agricultural Chemist for 1960. *Rep. Tea Res. Inst. Ceylon*: 50-58.

TOLHURST, J. A. H. (1962). Zinc deficiency of tea in Ceylon. *Tea Quart.* 33: 134-137.

# REPORT OF THE CHIEF AGRONOMIST FOR 1962

H. N. Hasselo, Dr Ir

**General.**—Mr S. M. Kandasamy was appointed Technical Assistant and took up duties on 1st October.

**Depletion of Root-Starch Contents.**—The objective and layout of the trial was discussed in the Annual Report for 1961 (Hasselo, 1961). The treatments were applied in November 1961, while the application of a foliar spray of a chemical growth stimulant (2, 4-D) was repeated in February 1962. Samples of roots of 3/8th of an inch in diameter and of convenient length were obtained from each of the 16 plots and the carbohydrate contents of the roots assessed by Mr W. B. Manipura in accordance with the methods used by Mr Nagarajah of the Physiological Division (see also Visser, 1961).

TABLE 1.—*Root-starch contents (% dry matter)—Glenlyon Estate (Mean of 4 replicates)*

| Treatment | Root-starch contents in 1962 | | | | |
|---|---|---|---|---|---|
| | March | May | July | Sept. | Mean Mar.-Sep.* |
| No treatment ... | 14.5 | 6.8 | 12.1 | 7.9 | 10.3 |
| Slashing (low-cut pruning) ... | 6.2 | 2.4 | 2.6 | 4.9 | 4.0 |
| Foliar spray of a 10% urea solution ... | 11.6 | 10.9 | 10.5 | 11.4 | 11.0 |
| Foliar spray of 2, 4-D solution | 13.5 | 9.9 | 8.0 | 11.5 | 10.7 |
| Mean* .. | 11.5 | 7.5 | 8.3 | 8.9 | 9.0 |

*S.D. (P 0.05) : 2.0
S.D. (P 0.01) : 3.1

It will be seen from the table that the slashing treatment significantly reduced the root-starch contents. The other treatments had no effect. The highest root-starch contents were observed in March at the end of the dry season. The primary objective of this trial, namely, to reduce the root-starch content without affecting tea yields has not been achieved. This short-term trial has been discontinued.

**Fertilizing Tea in Ceylon.**—The major part of the year was spent studying problems of or connected with manuring of tea in Ceylon.

In the previous Annual Report (Hasselo, 1961) it was indicated why the principle underlying the system of ratio manuring, as adopted in Ceylon, was incorrect. This finding did not imply that the general principle of ratio manuring is invalid nor necessarily that the system of ratio manuring, as adopted in Ceylon, has adversely affected tea yields in Ceylon. It did show that reasoning based upon the incorrect Ceylon principle of ratio manuring would lead to wrong conclusions, thus creating a false picture of the (in) efficiency of manuring.

This being established, it became necessary to elucidate what the correct principle was. Generally, the correct principle is to lay down experiments in order to find out whether or not manure has had, and may have, an effect on yield and, if so, how large the effect has been and may be in terms of lb of made tea produced per lb of manure applied under the varying conditions of different estates or parts thereof; in short to encourage experimentation on tea estates. Thereto, Dr Visser collected and analysed yield and fertilizer data of a large number of estates (Visser, 1961). The results were discussed by us and studied in great detail. Dr S. C. Pearce was able with the help of some of these estate data to show statistically that manure had contributed to the yield increases obtained on those estates. A different approach, worked out by Dr Visser, showed that on estates with rising yields, increased manuring alone had not necessarily or always contributed to the yield increase. This latter finding indicated that the same reasoning as used to show why the Ceylon principle of ratio manuring was incorrect (Hasselo, 1961) could not necessarily or always be used, if at all, as a basis for advice on the manuring policy to estates, as had been advocated by Gunn *et al* (Gunn and Kanapathipillai, 1962). Detailed results will be published in due course.

This part of the work was done entirely in co-operation with Dr Visser, lately Plant Physiologist of the T.R.I. The co-operation of the Superintendents who sent their estate data is gratefully acknowledged.

**Soil-crop Relationship in Tea.**—The ability of the land to produce crops is not only dependent on the chemical fertility, but also on the profile characteristics of its soils (Hasselo, 1962). The effect of profile characteristics is presently being studied. Preliminary results show that the influence of topography, *i.e.* position on the slope, on the capability of the land to produce crops is very large and perhaps larger than any other single factor alone. In one case differences in growth of young clonal tea plants amounted to 100% over a distance of less than 100 yards along the slope. Detailed results will be published in due course.

**Field Experiments.**—The priority of the problems that need investigation in Agronomy experiments has been discussed in detail. It was decided that the factors to be studied first were:—

(*a*) levels of N, P and K fertilizing;
(*b*) the effects of shade and its inter-action with (*a*);
(*c*) the effect of spacing and its inter-actions with (*a*) and (*b*);
(*d*) differences between clones and inter-actions with (*a*) and (*c*);
(*e*) the effect of frequency of application of fertilizer and its inter-action with (*a*).

Dr S. C. Pearce designed two trials, both of the same basic form which incorporated factors *a*—*d*. Owing to circumstances beyond control only one of these trials could be laid out this year. In this trial there were three factors, namely, application of nitrogen, phosphorus and potassium fertilizers, each at three levels. There were six blocks each of ten plots. One plot in each block was allocated at random to receive no fertilizer; the other nine received one-third of the 27 treatment combinations chosen so as to confound part of the three-factor inter-actions. The design is not quite saturated: the supernumary plot in each block could, if and when required, be used to study a two-level factor reasonably precisely. The three levels of application of each of the three nutrients are:

(1) Sulphate of ammonia: 80, 160 and 240 lb N per acre per annum.
(2) Saphosphosphate: 0, 40 and 80 lb $P_2O_5$ per acre per annum.
(3) Muriate of potash (50%) 0, 50 and 100 lb $K_2O$ per acre per annum.

The manure is applied bi-monthly and the first application was made in October. The height and the number of leaves of all the plants were measured in December. As expected analysis of the results did not produce significant treatment effects, except in the case of phosphate, which would appear to have had an adverse effect on leaf number (see table). Future results will have to be awaited to see whether any importance could be attached to this solitary significant effect.

TABLE 2.—*Mean number of leaves per plant*

| No. fertilizer | N (in lb/acre/annum) | | | $P_2O_5$ (in lb/acre annum) | | | $K_2O$ (in lb/acre/annum) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 80 | 160 | 240 | 0 | 40 | 80 | 0 | 50 | 100 |
| 19.33 | 20.72 | 20.78 | 20.83 | 21.61 | 19.89 | 20.83 | 20.72 | 20.50 | 21.11 |

*S.D. (P 0.05) : 0.98

**Foliar Analysis.**—During a visit by Dr A. L. Kenworthy, Professor of Horticulture, Michigan State University, U.S.A., arrangements were made with regard to an offer to have the nutrient contents of tea leaf samples analysed under the "International Co-operative Research Programme in Plant Nutrition". This generous offer has been gratefully accepted and 1,728 dried and ground leaf samples were despatched in December for analysis at Michigan State University. These samples were collected monthly in two shade-cum-fertilizer trials (Visser, 1961), *i.e.* in the months of June to September inclusive at St Coombs and July to November inclusive at Ratnapura (Low Country Station, T.R.I.). The assistance of Mr L. M. de W. Tillekeratne of the Advisory Division is gratefully acknowledged.

## Publications.

HASSELO, H. N. (1961). Report of the Chief Agronomist for 1961. *Rep. Tea Res. Inst. Ceylon:* 59-62.

HASSELO, H. N. (1962). Tea roots show effective depth of soil. *Tea Quart.* **33:** 45.

JUDENKO, E., SHANMUGAM, C. & HASSELO, H. N. (1962). Field experiments on the chemical control of Shot-hole Borer (*Xyleborous fornicatus*, Eichh.) on tea soon after pruning. *Tea Quart.* **33:** 69-87.

## References

EDEN, T. (1949). The work of the Agricultural Chemistry department 1927-48. *Monogr. Tea Prod. Ceylon.* **No. 1:** 78 pp.

GUNN, D. L. & KANAPATHIPILLAI, P. (1962). A new look at fertilizer (N) dosage. *Tea Quart.* **33:** 122-131.

HASSELO, H. N. (1961). Report of the Chief Agronomist for 1961. *Rep. Tea Res. Inst. Ceylon:* 59-62.

VISSER, T. (1961). Report of the Plant Physiologist for 1961. *Rep. Tea Res. Inst. Ceylon.* 100-123.

# REPORT OF THE ENTOMOLOGIST FOR 1962

J. E. Cranham, B.A., D.I.C., M.I.Biol.

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**General.**—Mr A. Kathiravetpillai, B.Sc. (Cey.) joined the staff as a Technical Assistant in April. Dr D. Calnaido returned in June after three years in Britain at Rothamsted Experimental Station having gained his Ph.D. (Lond.) degree for his work on the emergence and dispersal of Frit Fly (*Oscinella frit*).

Mr W. Danthanarayana left for Britain in September for postgraduate studies at the Imperial College Field Station, Silwood Park, Sunninghill, Berks. Mr C. Shanmugam was seconded to the departmental staff as Technical Assistant in December.

Estate visits numbered 324 and were mostly in connection with the heavy programme of shot-hole-borer trials. There were 450 letters received and 689 sent out.

## Shot-hole Borer

### 1. *Large-scale dieldrin trials on estates*

With the co-operation of Superintendents, assessment of seventeen trials on mature tea and two trials on new clearings were continued on Uva Ketawella Estate, Rothschild Group, Delta Group, Choisy Estate, Meddetenne Estate, Meddecombra Group, Oodewella Estate, Hantane Estate, Balangoda Group, Endane Estate, Rye Estate, Queenstown Group, Demodera Group and Imboolpittia Estate.

Eleven of the trials on mature tea have run for over two years since pruning and spraying and it is possible to review the results. The graphs in Figure 1 are based on the average counts of infestation and galleries per 100 sample units, for each bi-monthly sampling period, for the dieldrin-sprayed plots and for the unsprayed control plots.

The data of the unsprayed plots provide a more widely-based picture of the population dynamics of the borer than any gathered hitherto. Graph 'I' in Figure 1 is plotted from the average counts of all live stages (eggs, larvae, pupae and adults) and shows the growth, peak, and decline phases in population; although most of the trials have not gone sufficiently far into the decline phase to generalise about it. The number of galleries (Graph 'G') does not decline with the infestation. Galleries do not heal up internally in the wood but remain as a record of the attack—indeed, the number of galleries per sample is a useful measure of the accumulated total of the attack. In healthy wood the vacated galleries heal over externally by growth from the cambium; the number of 'open galleries' is usually closely correlated with the infestation.

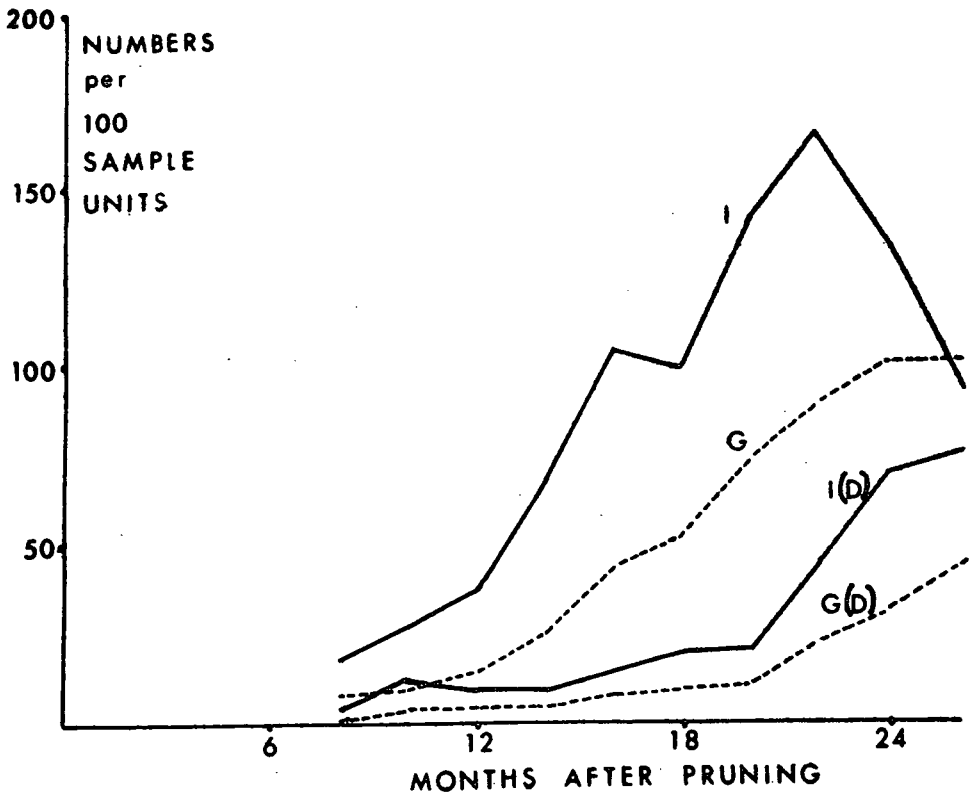


**Fig. 1.**—The results to the 26th month after pruning of eleven estate trials on the control of Shot-hole Borer: the number of live borers (I) and of galleries (G) per 100 sample units on the unsprayed plots; and the number of live borers (I(D) ) and of galleries (G(D) ) on the dieldrin-sprayed plots; based on the averages for each bi-monthly sampling period.

The graphs 'I (D)' and 'G (D)' show the average counts for infestation and galleries on the sprayed plots, which were mostly sprayed with 1.5 lb actual dieldrin per acre either as two rounds of three pints 'Dieldrex' or one round of six pints of 'Dieldrex'. The results from these two treatments do not differ appreciably. Three of the trials contained plots treated with two rounds of six pints of 'Dieldrex' (3 lb dieldrin); the results on these plots also are not markedly better and are here combined in the general average. It will be seen that there was an upward trend in the average infestation of the sprayed plots about ten months later than in the unsprayed plots. However, the control achieved within a 24-month pruning cycle was good—the accumulated attack, as represented by the number of galleries, has been reduced on an average by more than two-thirds.

It is still too early to judge from these trials whether the application of dieldrin after pruning will generally prevent serious attack by the borer for a pruning cycle of longer than two years, or whether spraying merely postpones the peak in numbers to a 'third-year build-up'. Gadd (1949) produced evidence from the Passara trial of 1940-43 that the rate of reproduction declined steadily as the wood aged after pruning and he concluded that conditions became progressively less suitable for brood-rearing. Analysis of the present data shows a decline in the number of inmates per open gallery and also in the proportion of young in the population, the effect of both being marked after the 16th-18th month when the number of galleries has reached about 0.5 per sample unit (*see* Figures 2 & 3). The data show that on an

average between 12 months and 24 months after pruning the ratio of young to adults dropped from roughly 2 : 1 to 1 : 1, and the average number of borers of all ages per open gallery (including a fairly constant proportion of those empty) from about 5.0 to below 3.0.

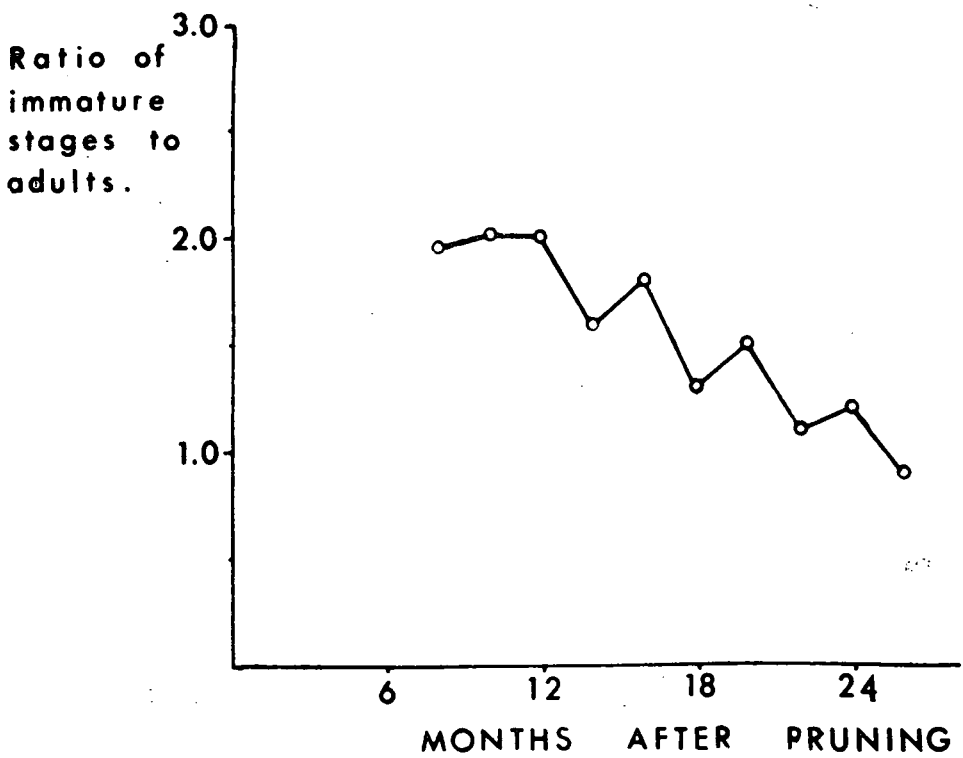


**Fig. 2.**—The ratio of the number of immature stages to the number of adult beetles in the infestation of the unsprayed plots; plotted from the average figures for each monthly sampling period.

The question now arises as to whether the wood becomes less suitable purely with age after pruning (age-of-wood factor) or as a result of borer attack (attack factor). Perhaps the effect of borer attack on the wood is to age it prematurely. In heavily attacked fields where the population rises to a normal peak in numbers, there is a ceiling on the number of galleries which the wood will carry—a *saturation density* of about 1.5 galleries per 4″ sample unit. On the face of it, there is room for more galleries between those already made, but long before the saturation density of galleries is reached the wood has lost the fresh sappy appearance of new wood and has become dull and drier in appearance. Unattacked wood of the same age has not. This condition may well be associated with reduction in the sap flow or with changes in the chemical constituents of the wood that render it less suitable for the growth of the ambrosia fungus or for the survival and development of the larvae. It seems highly probable therefore that the decline in numbers is often brought about by the accumulated attack itself rendering the wood

increasingly less suitable. Populations may in this sense be self-regulating. If however the growth of the population is much slower, numbers can go on rising into the third year to a low extended peak and a gradual decline. At this stage, it is likely that the natural aging of the wood begins to take effect.

Based on Gadd's previous findings, there was reason to hope that if dieldrin spraying would prevent the normal second-year build-up, the natural aging of the wood, would be against a build-up in the third year. It looks as though the age-of-wood factor is taking some effect in the third year but that it varies greatly, as one might expect, in different types and condition of tea. A fuller analysis of this problem will be possible when more data from the third year are available.

*Reinfestation studies*—It is clear, however, that in these trials a totally different factor has influenced the duration of control on the sprayed plots, namely, reinfestation by immigration of beetles from outside. The results given above refer to plots mostly of 5-10 acres in size which were adjacent to unsprayed plots which became heavily infested. Under such condition, reinfestation is much more marked than when the whole field or larger groups of fields are sprayed. Specific studies on the pattern of reinfestation in the Rye and Demodera trials, and general observations elsewhere, show that reinfestation works in progressively from edges adjacent to infested tea and normally rather slowly; it does not develop all over the field at once. What information we have on the aerial dispersal of the beetle indicates that the flight is weak and generally low. Judenko (1958) employed sticky traps to study the flight; 39% of the beetles caught were trapped below 3′ 7″, and two-thirds below 7 feet in height.

This observation on reinfestation is important in relation to practical control. The duration of control may be greatly improved when whole divisions or estates are sprayed, *i.e.* to the limit of such time as it takes for the few survivors on a sprayed area to build up again in numbers.

*Estate experience*—Many estates have taken up dieldrin spraying and a high proportion of them have sprayed or are in the process of spraying the whole estate or the borer-infested divisions. Good control is nearly always achieved. The main reason for any failures is spraying on wet bush-frames.

Whether or not it is necessary to repeat dieldrin spraying after each pruning hinges upon the extent of spraying and its effect upon reinfestation. This question can only be answered in time from practical experience on estates, but at present there appears to be a good chance of control lasting for two cycles of two years when large groups of fields have been sprayed.

Disappointment with the results of spraying may arise from prolonged Tortrix outbreaks (*see* section C) and this is the only reason we know for losing crop on dieldrin-sprayed fields. However, disappointment may also occasionally arise from spraying fields which in fact are no more than lightly attacked by the borer and are perhaps debilitated for other reasons; in these cases one can hardly expect a marked improvement in the tea or increased yield. This stresses the need for a simple means by which the planter himself can assess the degree of borer attack and judge whether spraying is worth while.

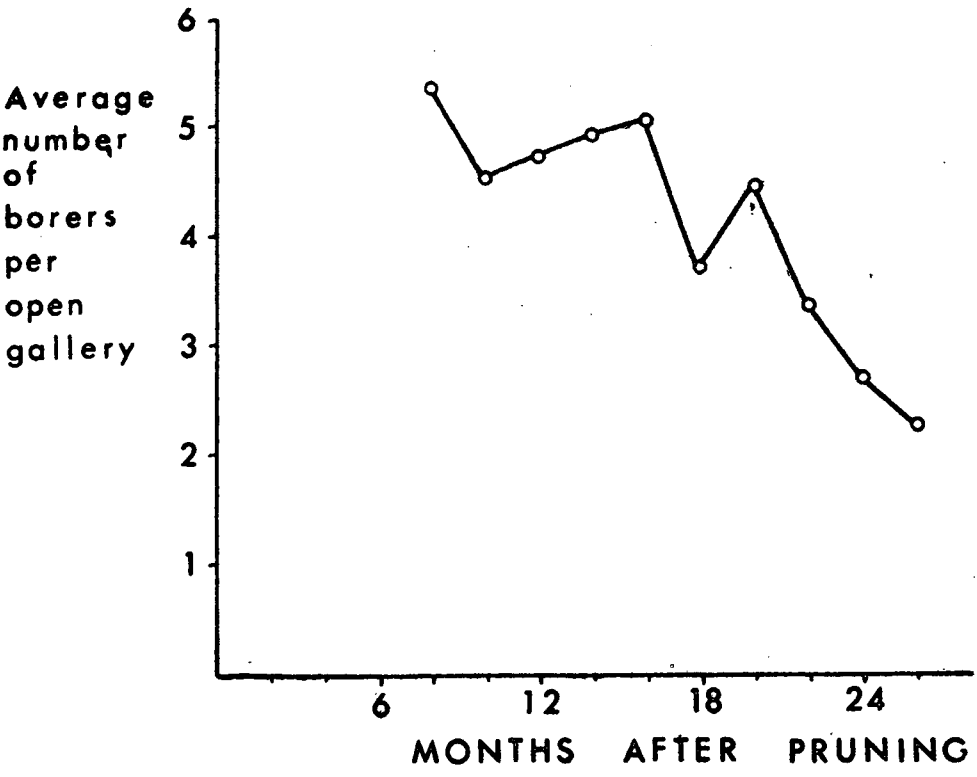


**Fig. 3.**—The average numbers of borers (all stages) per open gallery, calculated from the average bi-monthly counts for infestation and the number of open galleries.

A method of assessing the degree of attack, based on a simplification of the sample unit method to a count of the 'percentage units with galleries', has been worked out and is being written up for publication in the Tea Quarterly. Our knowledge of the yield increases, and other benefits, to be gained by controlling the borer is still in the early stages, so that it is possible only to give a provisional guide as to the likelihood of when spraying is worth while. The following summarises this provisional assessment:—

*Degree of attack* (*peak*)

% *of sample units with galleries*

| | |
|---|---|
| 50%–100% (heavy) | — Spraying considered worth while |
| 25%– 50% (Moderate) | — Spraying probably worth while |
| 15%– 25% (light) | — Spraying probably not worth while |
| Less than 15% (very light) | — Spraying considered not worth while. |

## 2. **Yield trials**

(*a*) *Trials of randomized block design*

All three trials, started in 1960 by Dr Judenko (Judenko, 1961), reached the end of the first pruning cycle in 1962; Kirimetiya (7/60) and Bandarapola

(13/60) were pruned in May, and Hantane (1/60) in July. At Hantane, on the dieldrin-sprayed plots as compared with the unsprayed, there was a significant increase in yield of 27% in the 27 months of the first cycle, most of which occurred in the second year when the borer infestation was at maximum. The close correlation between the monthly percentage yield increase (sprayed to unsprayed) and the difference in infestation is shown in Figures 4 and 5.

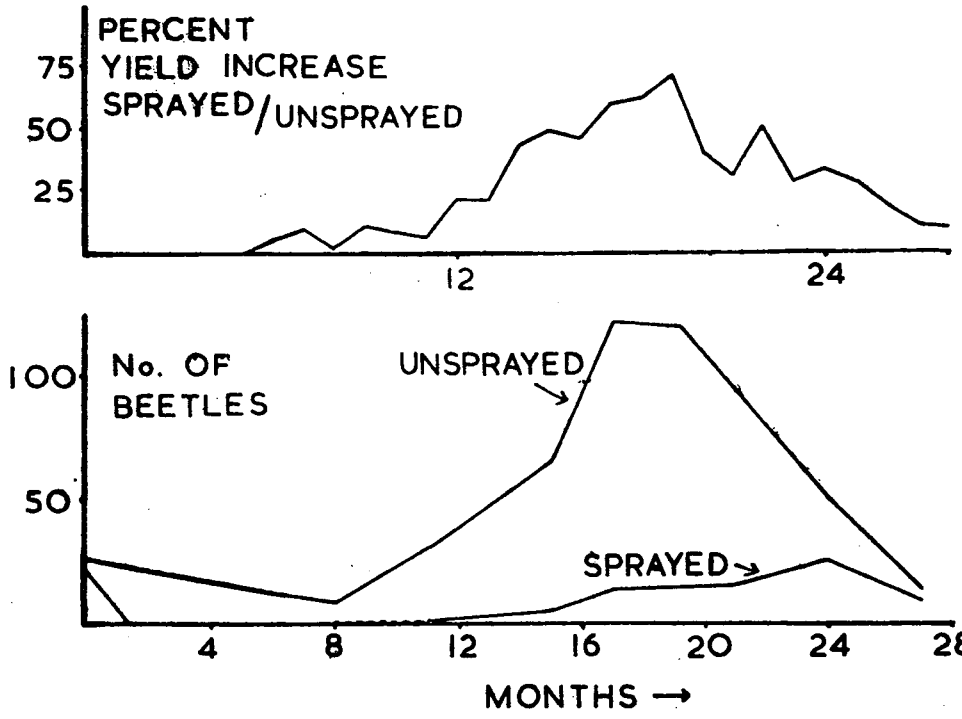


**Fig. 4** (above)—the percentage increase in yield, month by month, on the dieldrin-sprayed plots as compared with the unsprayed plots (Hantane trial).

**Fig. 5** (below)—The number of adult Shot-hole Borers per *100* four-inch sample units on the dieldrin-sprayed and unsprayed plots.

At Kirimetiya and at Bandarapola, the borer attack on the untreated plots was never more than light, reaching its maximum in the last three months of the cycle. Nevertheless there were significant yield increases of 14% at Kirimetiya (25-month cycle) and of 12% at Bandarapola (23-month cycle) most of which occurred in the last months of the cycles.

Borer sampling shows that the design of this type of trial needs modification; the unsprayed plots, being adjacent to the sprayed plots, suffer a reduction in infestation which reduces differences. With some modification, it was decided to continue all three trials into the second pruning cycle, re-spraying the original dieldrin-treated plots after pruning. In order to study the effect of borer control on the slope of the regression line of yield response on fertilizer dosage, two levels of fertilizer (T. 725 or T. 750) were introduced into each trial, corresponding to 40 lb and 80 lb N at Hantane and Kirimetiya, and 80 lb and 120 lb N at Bandarapola. The trials are in the early months of the second pruning cycle.

(*b*) *Large-scale trials*

Assessment was continued on the trials at Rye (16/60), started by Dr Judenko (Judenko, 1961), Demodera (18/60), and Queenstown (17/60), which have run two years from pruning and which are not yet due for pruning again. Each of these trials has two dieldrin-sprayed plots and two unsprayed control plots, each of about 9 acres.

At Rye, a very heavy attack developed early on the unsprayed plots. Control remained excellent on one sprayed plot to the 25th month but the other plot suffered a moderate attack after 21 months. The yield difference in favour of the sprayed plots was 11% in the first twelve months and 22% in the next 11 months, averaging 16% so far.

At Demodera also, there was heavy attack on the untreated plots with good control on the sprayed plots, which broke in one plot after the 23rd month. The yield difference in favour of the treated plots was 11% in the first twelve months and 33% in the next eleven months, averaging 21% so far.

At Queenstown, control was initially good but moderate reinfestation of the sprayed plots occurred after 21 months. Confusion regarding the delineation of the plots rendered the yield records invalid.

The yield records and borer attack are being carefully followed on eight other estate trials of similar design, which are as yet too early to report on. On some of them the borer attack on the untreated plots is unusually low, or late in developing.

It must be remembered that the above data are based on plots of less than ten acres in size which are subject to reinfestation more rapidly than whole fields or larger groups of fields. Data from estates which have done extensive spraying is also being studied and some show remarkable yield increases which are, however, complicated by other factors, such as removal of high shade and increased fertilizer.

Judging from the trial results, the yield increases to be gained in the first cycle without cultural changes or increased fertilizer are generally substantial and more than repay the cost of spraying. However it is likely that on many estates Shot-hole Borer has been a key limiting factor to yield (*see* Gunn and Kanapathipillai, 1962) and the effect of borer control on the response to fertilizer in the longer term may well prove to be even more striking. In addition, borer attack has been an important factor in preventing the success of in-filling to improve poor bush stands in the mid-country.

The economics of borer control must therefore in the long run be considered in relation to the economics of increasing yields by fertilizer, shade removal, in-filling, or other means, with all that this implies, and would appear to merit study by an economist.

## 3. **Developments in the control method.**

### 1. *Mist-blowing*

The results from mist-blower spraying have been studied on large plots and whole fields at Meddetenne, Uva Ketawella and Endane Estates and in a replicated trial at Kataboola Group. So far these appear to be as good as the results from high-volume (100 gal per acre) spraying.

2. *Inclusion of lime with dieldrin*

The effect of including lime in the dieldrin spray has been studied on the Kataboola trial. There was no reduction of the initial kill but the long-term result has yet to be seen. This method has been used by several estates and the results appear to be generally good.

3. *Alternative insecticides*

A replicated plot trial was carried out on a V.P. new clearing at Downside estate to study the short-term effects of certain possible alternative insecticides:

Endrin at 3 pints and 6 pints of 'Endrex 20' per acre.
Aldrin at 3 pints and 6 pints of 'Aldrex 2' per acre.
Telodrin (1) at 2 pints and 4 pints of 'Telodrin 15% E.C.' per acre.
Thiodan (2) at 2 pints and 4 pints of 'Thiodan 35% E.C.' per acre.
Gamma-B.H.C. at 4 lb and 8 lb of 'Gamma-Cereclor D.P.' per acre.
Dieldrin (standard) at 3 pints and 6 pints of 'Dieldrex 20' per acre.

The results of counts made 2, 4 and 8 weeks after spraying are given in Table 1.

TABLE 1.—*Control of Shot-hole Borer (Downside trial)*

(*a*) **Adult beetles**

| Treatment (lb active per acre) | Number of live adults per 100 sample units (in brackets, number of dead beetles) after | | |
|---|---|---|---|
| | 2 weeks | 4 weeks | 8 weeks |
| Dieldrin, 0.75 lb ... | 169 (170) | 47 (114) | 23 (40) |
| Dieldrin, 1.5 lb ... | 112 (149) | 18 (114) | 26 (79) |
| Aldrin, 0.75 lb ... | 60 (145) | 71 (80) | 15 (60) |
| Aldrin, 1.5 lb ... | 32 (178) | 16 (154) | 3 (167) |
| Telodrin, 0.375 lb ... | 74 (222) | 31 (168) | 10 (99) |
| Telodrin, 0.75 lb. ... | 32 (273) | 14 (144) | 11 (99) |
| Endrin, 0.75 lb ... | 152 (95) | 96 (92) | 33 (37) |
| Endrin, 1.5 lb ... | 179 (100) | 94 (54) | 22 (35) |
| B.H.C., 1 lb ... | 152 (50) | 76 (59) | 32 (26) |
| B.H.C., 2 lb ... | 192 (95) | 118 (47) | 49 (20) |
| Thiodan, 0.88 lb ... | 199 (105) | 160 (56) | 45 (16) |
| Thiodan, 1.75 lb ... | 201 (84) | 115 (49) | 65 (24) |
| Untreated Control (Avg) ... | 407 (1) | 141 (17) | 44 (14) |

Endrin, Thiodan and Gamma-B.H.C. gave markedly poorer kills than dieldrin but with aldrin and Telodrin the reduction in numbers within the first two weeks was faster than with dieldrin and after 8 weeks quite as good. With aldrin, dieldrin and Telodrin, large numbers of adult beetles were found dead within the galleries and there was also a massive reduction in the number

(1) Telodrin—Trade name, Shell Co.

(2) Thiodan—(Hoechst, A. G.)—6, 7, 8, 9, 10—hexachloro—1, 5, 5a, 6, 9, 9a—hexahydro—6, 9—methane—2, 4, 3,—benzo(e) dioxathiepene 3—oxide.

(*b*) **Immature stages**

| Treatment | Number of live immature stages (eggs larvae and pupae) per 100 sample units, after: | | |
|---|---|---|---|
| | 2 weeks | 4 weeks | 8 weeks |
| Dieldrin, 0.75 lb. ... | 95 | 28 | 77 |
| Dieldrin, 1.5 lb ... | 51 | 7 | 11 |
| Aldrin, 0.75 lb ... | 19 | 29 | 18 |
| Aldrin, 1.5 lb ... | 12 | 8 | 16 |
| Telodrin, 0.375 lb ... | 44 | 7 | 0 |
| Telodrin, 0.75 lb ... | 23 | 5 | 1 |
| Endrin, 0.75 lb ... | 90 | 42 | 61 |
| Endrin, 1.5 lb ... | 96 | 30 | 61 |
| B.H.C., 1 lb ... | 33 | 27 | 51 |
| B.H.C., 2 lb ... | 129 | 67 | 78 |
| Thiodan, 0.88 lb ... | 94 | 81 | 106 |
| Thiodan, 1.75 lb ... | 77 | 91 | 119 |
| Untreated control (Avg) ... | 468 | 86 | 88 |

N.B.—*The untreated control samples were taken from a large block outside the trial proper; close comparison with the untreated count is not therefore valid, but the results in numbers of dead beetles, and the numbers of live immature stages after two weeks suggest that all treatments had some effect. Comparatively few dead immature stages were found, though more with the effective treatments; dead immature stages very quickly disintegrate.*

of living larvae, particularly marked with Telodrin even at 0.375 lb per acre, *i.e.* one quarter of the standard dosage of dieldrin. The results, together with those of a further investigation at Drayton Estate, suggest that the insecticides have a marked fumigant effect on the gallery inmates, presumably from deposits on the bark or just in the openings of the galleries. The effect is more rapid with aldrin and Telodrin than with dieldrin, which is in line with the respective vapour pressures of these insecticides. Nevertheless, mortality of adult beetles in the dispersal phase outside the galleries, by contact with insecticide residues on the bark, is likely to be an important additional factor which may operate over a longer period and may be more important in the action of dieldrin. Clearly, the duration of control is influenced not only by the early percentage mortality but also by residual effects and by the rate of reinfestation. Knowledge of the last two factors is far from adequate.

Earlier work suggested that aldrin is not likely to induce Tortrix outbreaks so badly as dieldrin, and this alone is sufficient reason to merit study of it as an alternative to dieldrin. Telodrin is as yet an unknown quantity in this respect.

Further trials with aldrin and Telodrin have been started at Carolina and Gallebodde Estates to study the effect on Tortrix and *Macrocentrus homonae* and on longer-term borer control and reinfestation. It is planned to carry out six to eight trials to compare aldrin and Telodrin with dieldrin as post-pruning sprays; these trials will have to run two years. The possibility of using aldrin on the frames of bushes in full foliage, put temporarily out of plucking, is also being investigated and work on aldrin residues in made tea is being carried out. With the co-operation of estates, aldrin is being tried out in new clearings not in plucking.

4. *Biology, Behaviour and Dispersal of the Adults*

Our information on the biology of *X. fornicatus* is far from extensive. Because of the probable value of such basic information in designing control measures, plans were made for Dr D. Calnaido, after his return from Rothamsted Experimental Station in July, to carry out work at Hantane sub-station. Johnson suction-traps and other types of traps have been constructed and installed at Hantane to study the aerial dispersal of *X. fornicatus* with special reference to the reinfestation of dieldrin-sprayed areas. Dr Calnaido will also be engaged on other aspects of the biology of the borer, including the effect of temperature and moisture on the development and survival of the insect, the chronology of adult life and longevity, and the emergence and behaviour of beetles outside their galleries.

**Tea Tortrix.** (*Homona coffearia* Nietner).

1. *Natural outbreaks*

Natural outbreaks were about as common up-country in January to April as in 1961. In certain districts where dieldrin spraying was done, there were some Tortrix attacks on unsprayed fields at higher elevations, in certain cases dieldrin spraying at the mid-country elevations may well have upset the balance of Tortrix and parasite *Macrocentrus homonae* Nixon more generally. However, most of the true up-country outbreaks—in Dimbula, Dickoya, Maskeliya and Udapussellawa—have nothing to do with dieldrin spraying. From our records, the increased frequency of up-country outbreaks started in 1958, possibly earlier, and thus before more than a very few acres had been sprayed with dieldrin in the mid-country. Further, if the present limited use of dieldrin were to upset the balance of Tortrix and parasite so much as to cause frequent Tortrix outbreaks on unsprayed areas, one would expect this to occur widely in the mid-country (which is not the case) as well as in the up-country. The natural cause is likely to be the particular climatic pattern of the last few years acting through important natural control factors such as virus and fungus diseases of Tortrix, and possibly the parasite. This, however, is speculation based on work done on other tortricids elsewhere, and a better knowledge of the factors which control Tortrix numbers will only be obtained after long-term ecological studies. The population study on No. 13 Field, St Coombs, was continued as a preliminary study in this subject.

2. *Outbreaks following dieldrin spraying*

In estate spraying of dieldrin for shot-hole-borer control, DDT was generally effective on most estates in averting Tortrix outbreaks, although several estates had to spray two or three times, over a period of up to six months after pruning, to control Tortrix. Our impression is that it is hardly ever necessary to spray more than twice, if spraying is well done and properly timed. Some failures in Tortrix control were believed to be due to one or more of the following reasons: spraying too late; using much less than the recommended DDT dosage; spraying on wet foliage; poor spray coverage; or spraying only in patches instead of the whole field. Dieldrin spraying of tea can also result in outbreaks of Tortrix in shade trees—particularly *Albizzia moluccana* and *Gliricidia*—and this is sometimes a complicating factor in control. It can be tackled by mist-blower applications on trees up to 20 feet in height.

There is clearly a need for a suitable alternative to dieldrin which interferes less with *Macrocentrus homonae*. Meanwhile it was recommended that estates should not spray more than a quarter of their acreage with dieldrin within a six-month period. Careful and detailed advice on Tortrix control was issued in an advisory leaflet and an addendum to it later in the year.

The effect of DDT in increasing mite numbers was more in evidence in 1962 and the trials to find a suitable alternative insecticide were urgently pursued. Work culminating in the provisional recommendation of 'Dipterex S.P. 80' has been published in the December 1962 Tea Quarterly.

Initial tests were carried out with malathion, Dipterex[1], Sevin[2], dimethoate ('Rogor'), phosphamidon ('Dimecron') and a commercial preparation of *Bacillus thuringiensis* Berliner ('Thuricide 30-W.P.'). The last is one of the first commercial formulations of a microbial insecticide; the bacillus is pathogenic to several insects but harmless to warm-blooded animals. Of these materials, only Dipterex and Sevin gave promising results; and like DDT they did not appear to hinder the re-establishment of control by *Macrocentrus* after spraying.

The standard recommendation is for 1½ lb of 'Dipterex S.P. 80' (*ex* Messrs Hayleys Ltd., Colombo), in 50 gallons of water per acre by knapsack sprayers. The 1½ lb dosage per acre costs Rs. 9/-, which compares favourably with DDT. 'Dipterex' is a low-toxicity insecticide which did not taint or affect quality in tea made from leaf plucked one week after spraying. It is clearly a suitable insecticide for use on tea which could usefully be tried for some other occasional pests, notably Nettle grubs, Bagworm larvae, Army worms, *Lygus* bug and *Helopeltis*. Several estates used Dipterex for Tortrix control and the results appear to be generally satisfactory.

Sevin, which is also available in Ceylon (*ex* Shell Co. of Ceylon Ltd.), is likely to be effective in controlling Tortrix at a dosage of 2 lb 'Sevin 85% Sprayable' per acre. Sevin is a low-toxicity carbamate insecticide which is often considered preferable to DDT on many crops from the aspect of insecticide residues in foodstuffs. It was not recommended for estate trials in 1962 because the first taint tests left doubt concerning its liability to taint. In a second test, no taint was apparent after seven days; further work is planned (*see* section F).

**Mites**

1. *The effect of insecticides on mite numbers*

It is notable that observations over the years 1959-1961 on DDT spraying revealed very few instances of a marked increase in numbers of Red Spider as a result. During the dry season of 1962, reports of DDT stimulating the numbers of Red Spider and Scarlet Mite became sufficiently common to cause concern, and they occurred in some up-country districts where Red Spider is unusual. With the increased use of DDT for Tortrix control, this unwanted side-effect assumed greater economic importance. It would appear to be essential that all insecticides for use on tea should be screened for their effect on mite numbers.

Trial results in 1961 were reported previously (Cranham, 1962) which demonstrated the effect of DDT in increasing mite numbers. A further trial

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(1) Dipterex (Bayer Leverkusen) 0, 0—dimethyl (2, 2, 2—trichloro—1—hydoxyethyl) phosphonate.

(2) Sevin (Union Carbide Corporation) 1—naphthyl *N*-methylcarbamate.

was carried out in 1962 to include, with DDT as a standard comparison, further treatments of interest (*see* Table 2). Sevin, Dipterex and Perthane[1] were of interest for Tortrix control; Thiodan for shot-hole borer and possibly yellow-mite control. Zinc sulphate spraying is being widely used as a nutrient for foliar spraying.

The counts for June and July, and likewise for August and September, were of a similar order and have been averaged in Table 2. The data for Sevin were very variable and enlarge the standard error disproportionately. Omitting the Sevin data in the analysis of variance, the count for DDT for August-September was significantly different from the remaining five treatments (including the untreated control), which did not differ significantly amongst themselves. The result for DDT is indeed very similar to the 1961 result, *i.e.* there were roughly three times more mites compared to the untreated control in the period 3-4 months after spraying.

The trial was inconclusive concerning the effect of Sevin on Scarlet Mite and further tests are required. Dipterex produced no increase in the number of mites, and zinc sulphate produced no change.

The numbers of Red Spider Mite were extremely low for all treatments (less than 10 mites per 100 leaves) with the exception of DDT which carried a low but significantly higher population (over 100 per 100 leaves) in the period two to three months after spraying.

TABLE 2.—*The effect of insecticides on Scarlet Mite numbers*

| Treatment (lb active per acre) | Mean* number of Scarlet Mites per 100 leaves (400 counted) | | | |
|---|---|---|---|---|
| | Precount May | Avg June/July | Avg August/ September | Oct. |
| DDT (1.5 lb) ... | 160 | 660 | 2492 | 360 |
| Sevin (1.7 lb) ... | 416 | 872 | 2020 | 376 |
| Dipterex (1.6 lb) ... | 172 | 732 | 956 | 448 |
| Thiodan (1.75 lb.) ... | 176 | 572 | 592 | 304 |
| Perthane (1.25 lb) ... | 320 | 604 | 1464 | 204 |
| Zinc Sulphate (10 lb) ... | 164 | 616 | 752 | 404 |
| Untreated (Average) ... | 204 | 568 | 904 | 220 |

*Antilog of mean log number.

2. *Chemical control of Yellow Mite* (*Hemitarsonemus latus*, Banks).

Further proof of the value of the non-tainting acaricide Kelthane, and comparison with other chemicals, was desirable. A randomised block trial of four replicates with 100-bush plots, was arranged at Gonamotava estate on a field which was recovering from pruning and affected by Yellow Mite.

1 Perthane (Rohm & Haas Co.)—1, 1—dichloro—2, 2—bis (p-ethylphenyl) ethane.

The acaricides chosen for test included two formulations of Kelthane[1], a 36% E.C. (Kelthane M.F.) and the available Kelthane 18.5% W.P. Endrin (Endrex 20% E.C.) was used as a standard in preference to sulphur, which taints; for toxicological reasons, Endrin is not practicable on tea in plucking but as an experimental standard it is known to give control at least as good as sulphur. Other materials tested were reported or believed to have useful activity against tarsonemid mites; Tedion[2] 8% E.C. (N. V. Philips-Roxane, Holland), Animert[3] E.C. (Philips-Roxane); Thiodan 35% E.C. and Acrizid[4] 25% W.P. (Hoechst A.G., W. Germany) and 'Sandoz J. 38' experimental acaricide, Sandoz Ltd., Switzerland).

Assessment of control was made by counting the percentage of shoots with Yellow Mite in two samples of 50 shoots per plot taken 6 and 16 days after the first spraying. Analysis of variance was applied to the transformed data (angular transformation of Bliss). The back-transformed mean percentages are given in Table 3. The first six treatments listed gave promising results which suggest practical value. Sixteen days after treatment the results for these acaricides were not significantly different, and all six were significantly better than Acrizid, 'Sandoz J38' and the untreated controls. Kelthane M.F. gave the lowest count on both occasions.

The rest of the field where the trial was carried out was afterwards sprayed with Kelthane by mist-blower, applying 2 lb Kelthane W.P. in 4 gallons of water per acre; good control was achieved.

TABLE 3.—*The control of Yellow Mite (Gonamotava trial)*

| Treatment | Mean* percentage of shoots with Yellow Mite | |
|---|---|---|
| | Count after . . . | |
| | 6 days | 16 days |
| Kelthane M.F. ... | 3.3 | 0.9 |
| Endrin ... | 7.5 | 1.5 |
| Animert ... | 8.3 | 2.5 |
| Thiodan ... | 6.2 | 2.5 |
| Tedion ... | 14.2 | 4.0 |
| Kelthane W.P. ... | 7.1 | 4.0 |
| Acrizid ... | 17.5 | 12.8 |
| Sandoz J. 38 ... | 33.2 | 23.2 |
| Untreated ... | 67.1 | 61.6 |

*Analysis by angular transformation of Bliss.
These are back-transformed mean percentages.

### 3. *Control of Scarlet Mite and Red Spider Mite*

A randomised block trial with 100-bush plots was arranged on a field at Holmwood Estate, Agrapatna, which had suffered an outbreak of both the above mites due to DDT spraying for Tortrix control. Applications were made by knapsack sprayers in 100 gallons of water per acre of the following treatments at the given dosages per acre: Kelthane 36% M.F. at 0.75 pints

1 Kelthane (Rohm & Haas Co.)—1, 1,—bis (p-chlorophenyl) 2, 2, 2—trichloroethanol.
2 Tedion (Philips-Roxane)—2, 4, 5, 4′—tetrachlordiphenyl sulphone.
3 Animert (Philips-Roxane)—2, 4, 5, 4′—tetrachlorodiphenyl sulphide.
4 Acrizid (Hoechst, A. G.)—dinitro-alkyl-phenyl acrylate.

(0.37 lb active); Kelthane 18.5% E.C. at 1½ pints (0.35 lb active); Kelthane 18.5% W.P. at 2 lb (0.37 lb active); Tedion 8% E.C. at 1½ pints (0.15 lb active); Tedion 20% W.P. at 2 lb (0.4 lb active); 'Akar 338' 25% E.C. at 1½ pints (0.47 lb active Chlorobenzilate); and a sulphur W.P. ('Thiovit') at 4 lb per acre. Spraying was repeated at the same dosage after fourteen days on two of the four blocks. Assessment was done, by mite-brushing machine, of the number of mites on 50 leaves from each plot, initially before spraying and 14, 32, 64 and 113 days after treatment. The results for single and double spraying were very similar as were the results for the three formulations of Kelthane and the two formulations of Tedion. The counts given in Table 4 are the mean figures for each acaricide.

TABLE 4.—*The control of Scarlet Mite (Holmwood trial)*

| Treatment | Mean* number of Scarlet Mites per 100 leaves (200 counted) | | | | |
|---|---|---|---|---|---|
| | Precount March | Count after . . . days | | | |
| | | 14 | 32 | 64 | 113 |
| Kelthane ... | 3628 | 288 | 60 | 36 | 32 |
| Tedion ... | 4220 | 1096 | 1088 | 656 | 476 |
| Akar ... | 3080 | 396 | 76 | 504 | 236 |
| Sulphur ... | 3820 | 476 | 48 | 124 | 320 |
| Control ... | 4256 | 4200 | 4248 | 1732 | 728 |

*Antilog of log mean number.

Kelthane gave the best control of Scarlet Mite; there was no significant difference between Kelthane, Akar and Sulphur after 32 days but Kelthane was markedly better in the duration of control achieved. Mite numbers were reduced naturally by the onset of the monsoon rains, particularly Red Spider Mite, for which the differences between treatments were obscured by May; however, by 32 days after treatment, Kelthane and Sulphur had given significantly better control than Akar and Tedion (*see* Table 5).

TABLE 5.—*The control of Red Spider Mite (Holmwood trial)*

| Treatment | Mean* number of Red Spider Mites per 100 leaves (200 counted) | | | |
|---|---|---|---|---|
| | Precount March | Count after . . . days | | |
| | | 14 | 32 | 64 |
| Kelthane ... | 3856 | 616 | 48 | 20 |
| Tedion ... | 4456 | 1376 | 224 | 32 |
| Akar ... | 4832 | 972 | 104 | 20 |
| Sulphur ... | 4064 | 496 | 24 | 24 |
| Untreated ... | 3452 | 3060 | 684 | 44 |

*Antilog of log mean number.

On larger duplicate plots, Kelthane E.C. and Tedion E.C. were sprayed by a motorised knapsack mist-blower; both were used at 1½ pints in 10 gallons and 1½ pints in 20 gallons per acre. The spray was directed down into the bushes by the customary method of insecticidal mist-blowing, *i.e.* there was no attempt to spray from below the foliage. The results are given in Table 6. Kelthane gave encouragingly good control of both Red Spider and Scarlet Mite (95% after 9 and 16 weeks). There was no appreciable difference between 10 and 20 gallons of spray fluid per acre but the higher volume may prove to be advantageous. Tedion gave a fair control of Red Spider after 32 days (numbers then declined naturally) but, as with the high-volume spraying, control of Scarlet Mite was poor.

TABLE 6.—*The control of Scarlet Mite and Red Spider by mist-blowing (Holmwood trial)*

| Treatment | Mean* number of mites per 100 leaves (200 counted) | | | |
|---|---|---|---|---|
| | Count after . . . days | | | |
| | 14 | 32 | 64 | 113 |
| **Scarlet Mite** | | | | |
| Kelthane ... | 1300 | 224 | 124 | 80 |
| Tedion ... | 1592 | 1680 | 1108 | 408 |
| Untreated ... | 3076 | 2752 | 3144 | 2024 |
| **Red Spider Mite** | | | | |
| Kelthane ... | 684 | 184 | 52 | — |
| Tedion ... | 1108 | 308 | 36 | — |
| Untreated ... | 1896 | 1632 | 64 | — |

*Antilog of mean log number.

**4.** *A general non-tainting acaricide*

From the above trials, and previous work, Kelthane emerges as the best all-round acaricide of those tested in the past few years, and so efficient and suitable that tests on other new materials will now hardly be justified in the present position of mite incidence. For tea not in plucking, sulphur W.P. is the obvious choice on cost; but on tea in plucking at least 3-4 plucking rounds must be discarded to avoid taint after spraying sulphur. The use of the non-tainting Kelthane in these circumstances is economically sound. It is reasonably cheap (Rs. 5/50 per lb for the W.P.) and of low toxicity.

An article on the recognition and control of mite pests of tea was published in the December 1962 Tea Quarterly.

**5.** *Yield trial (Gonamotava estate)*

This trial, started in 1960, was continued throughout 1962, the last year of the 4-year pruning cycle. Half of the plots were kept almost free of mites throughout the season by the use of Kelthane. In 1961 this resulted in numbers dropping to non-injurious levels on the untreated plots also; in order

to accentuate differences artificially in 1962, the untreated plots were sprayed with DDT, which resulted in Red Spider attack, an unusual occurrence in this field, as well as Scarlet Mite. The attack by both mites was moderately bad and resulted in rather bad loss of maintenance foliage from July onwards. The Kelthane-treated plots gave 10% more in crop over the eleven months to November 1962, a significant difference, but not as large as one might expect from the visible appearance of the untreated plots in the mite season. Yellow Mite, which caused a very marked loss of crop over about six weeks during 1961, was negligible during 1962. It would appear that attack by Scarlet Mite and Red Spider has to be unusually heavy and prolonged to cause a severe loss of crop. The debilitating effect of mite attack, year after year, is another matter, which cannot be assessed from this trial. Full analysis of the data is not yet completed.

**White grubs** (*Chafer larvae*)

1. *Chemical control*

Work on the control of *Holotrichia disparillis* Arr. was continued. As in previous years, the early detection of new clearings with sufficient infestation for trials was difficult. Trials were arranged at Brookside Estate (from May), at Concordia Group (from August) and at Lindula Estate (from October).

TABLE 7.—*Control of White grub* (*Concordia trial*)

| Treatment | Count per 100 samples holes | | |
|---|---|---|---|
| | Precount | count after . . . | |
| | | 6 weeks | 12 weeks |
| 1. B.H.C. injected ... | 202 | 74 | 64 |
| 2. B.H.C. sprayed and soil forked over ... | 218 | 73 | 25 |
| 3. B.H.C. sprayed and raked in ... | 167 | 72 | 69 |
| 4. Soil forked over ... | 125 | 126 | 127 |
| 5. Untreated (avg) ... | 189 | 110 | 116 |

TABLE 8.—*Control of White grub* (*Lindoola trial*)

| Treatment | Count per 100 sample holes | |
|---|---|---|
| | Precount | After six weeks |
| B.H.C. W.P. ... | 87 | 27 |
| Embathion E.C. ... | 86 | 32 |
| Sumithion E.C. ... | 88 | 36 |
| Untreated ... | 92 | 78 |

Trials were of randomized block design with five or six replicate plots, of 10 × 10 square yards, per treatment. The unit sample hole was one foot square on the soil surface and one foot deep; usually sampling involved 20 sample holes per plot taken in a systematic fashion over the plot.

In the Brookside trial, the following treatments, at the given dosages per acre, were compared: 'Aldrex 2' at 2 gallons (4 lb aldrin); 'Gamme-Cereclor 26% D.P.' at 30 lb (7.5 lb gamma B.H.C.); Thiodan 35% E.C. at 1 gallon (3.5 lb Thiodan); Telodrin 15% E.C. at 1 gallon (1.5 lb Telodrin); and 'Folidol' 46% E.C. (4.6 lb parathion). Treatments were applied by knapsack sprayers in the equivalent of 100 gallons of water per acre and raked into the top three inches. Sampling was done initially before treatment and at 3, 6 and 13 weeks after treatment. There were no significant differences between the treated and untreated plots; at 13 weeks, the only appreciable reduction in numbers was on the B.H.C. plots where the count was 56% of that on the untreated plots—but this difference was not significant.

In the Concordia trial, work was concentrated on B.H.C. The same dosage of 30 lb of 'Gamma-Cereclor D.P.' was applied in the following three ways:—

1. injected to a depth of 6″ using the Birchmeier 'Terra-gun' injector attached to pressurised knapsack sprayers. Injection was done on a lattice pattern of 6″ intervals employing 0.6 lb in 15 gallons of water per 100 sq yd plot;

2. sprayed on the soil surface at 0.6 lb in 2½ gallons of water per plot, and the soil turned over by mammoty forks;

3. sprayed on the soil surface at the same dilution and raked into the top three inches with garden rakes.

Three sets of plots were not chemically treated. One set of these was forked over well to see whether soil disturbance itself had an effect.

Sampling was done initially and at 3, 6 and 12 weeks after treatment. The mean values for 6 and 12 weeks are given in Table 7. Three weeks after treatment there were no differences. Six weeks after treatment the difference between the B.H.C. plots and the non-B.H.C. plots was highly significant. Twelve weeks after treatment, No. 2 (B.H.C. sprayed and the soil forked over) was significantly better (79% reduction compared with the control average) than the other B.H.C. treatments which gave about 40% reduction. The difference between the B.H.C. plots taken together and the non-B.H.C. plots was very highly significant ($P = 0.01$).

At Concordia, various other treatments also were tried on a smaller scale, at the following dosages per acre: Thiodan 3.5 lb; ethion (5 lb); Sumithion[1] 5 lb; malathion 5 lb; parathion 4.6 lb; endrin 2 lb; and Nemagon[2] 0.75 gal actual (1½ gal 50% E.C.). Treatments were watered on in a volume of water equivalent to 1,000 gallons per acre and deeply raked into the soil, in an attempt to improve distribution. With Nemagon the soil was turned over by forking after treatment, sampling was carried out initially and 3, 6 and 12 weeks after treatment. Ethion, Sumithion, parathion and Nemagon gave about 50% reduction in numbers after six weeks.

In the Lindoola trial started late in the year, B.H.C. was compared with ethion ('Embathion' 50% E.C.) and Sumithion 50% E.C. Treatments were sprayed on the soil surface and raked in. Counts were made after 3 and 6 weeks (*see* Table 8). The 3-week count showed no appreciable reduction in numbers due to treatment; in the 6-week count there was a significant reduction in numbers for all three treatments which was of the order of 55-65% of the control figure. Treatments did not differ significantly.

(1) Sumithion (Sumitomo Chemical Co.) 0, 0—dimethyl—0—(3-methyl—4-nitrophenyl) phosphorothioate.
(2) Nemagon (Shell) 1, 2—dibromo—3—chloropropane.

*Conclusions*

The results for B.H.C. agree generally with the results obtained in 1961. This insecticide has given as good a reduction as any, averaging about 60% after 6-12 weeks. This, of course, is useless as a commercial control but it at least shows an appreciable activity compared to aldrin and other chlorinated hydrocarbons. It seems probable that the limited initial distribution of the insecticide in the soil and a slow rate of dispersion limits the kill that can be achieved within the season. Dispersion is possibly largely dependent upon adequate rainfall. The Concordia trial was designed to see whether better admixture with the soil would improve the result. The result when B.H.C. was sprayed on and the soil forked over—about 80% reduction after 12 weeks —is more encouraging. This method would be practical. Because the action is slow, early season treatment (May-June) would be desirable; the younger grubs may also be more susceptible.

There was an indication of comparable activity from parathion and the less toxic organo-phosphorous insecticides ethion and sumithion, which merits further investigations.

It is felt that further trials should attempt to assess the practical usefulness of the following possible control measures:—

1. B.H.C. sprayed on to the soil surface and the soil turned over by forking; this to be done early in the season (May-June) preferably before planting.

2. B.H.C. well admixed with the soil of the planting hole with the aim of preventing damage to the plants rather than achieving a high mortality of grubs. Work will be necessary to determine whether such a high concentration of B.H.C. around the plant can have any inhibitory effect on root growth.

3. D.D. fumigation before planting, which in 1961 gave a near 90% control. This is expensive at the rate normally recommended for nematode control (about Rs. 300/- per acre) but lower dosages are worth trying for white-grub control. This treatment would have to be applied after the egg-laying period of *H. disparillis* (March to May) and a month before planting. It is a distinctly possible approach in districts that plant in the later months of the year.

4. Through digging-over of the soil and hand-collection of the grubs. This appears to require about 40 man-days per acre and the cost is comparable with that of B.H.C.

*Taxonomy and biology*

The identity of the larvae of six common species of chafer beetles has been established. The larval characters have been figured and described for publication.

Work on the adult emergence periods, by light trapping was continued at St Coombs, Mooloya and High Forest. Work on the larval development periods was carried out at Brookside Estate.

**Scale insects**

Over the past two years, small-scale trials have been done on the control of the commonest scale insects which are occasional pests of Ceylon Tea—Green bug (*Coccus viridis* Green) and Brown bug (*Saissetia coffeae* Wlk.). The

standard control has been a summer white-oil emulsion of 1% oil concentration ('Albolineum', Volck', etc.). Some of the insecticides tried out, without success, have been diazinon, malathion (and mixtures of these two with white-oil), dimethoate (Rogor 40), phosphamidon (Dimecron 50) and Phosdrin[1].

TABLE 9.—*Control of Green bug* (*Coccus viridis* L)

| Treatment | Average number of live nymphs per leaf (80 counted) | | | |
|---|---|---|---|---|
| | Precount | After..... 8 days | 14 days | 30 days |
| Sevin ... | 124 | 13 | 4 | 0.04 |
| White-oil ... | 158 | 51 | 58 | 65 |
| Untreated ... | 183 | 131 | 112 | 66 |

TABLE 10.—*Control of Brown bug* (*Saissetia coffeae* Wlk.)

| Treatment | Average per sample shoot 1½" long | | |
|---|---|---|---|
| | Precount | After: 8 days | 14 days |
| Sevin ... | 100 | 14 | 2 |
| White-oil ... | 113 | 75 | 62 |
| Untreated ... | 122 | 112 | 86 |

In a trial at Gonamotava estate, 'Sevin 85% Sprayable' (W.P.) at 2 lb in 100 gallons per acre was compared with a 50% white-oil emulsion ('Arakol', Shell Co. of Ceylon) at 2 gallons in 100 gallons of water per acre, and unsprayed control plots. The results given in Tables 9 and 10 show that Sevin gave an excellent control, far better than white oil. It looks more promising than any other insecticide tested so far.

**Publications** (Also quoted as references in the text).

CRANHAM, J. E. (1962). Report of the Entomologist for 1961. *Rep. Tea Res. Inst. Ceylon*: 71-80.

CRANHAM, J. E., DANTHANARAYANA, W. & RANAWEERA, D. J. W. (1962). The chemical control of Shot-hole Borer with dieldrin: interim report on estate trials, 1960-1961. *Tea Quart.* **33**: 5-33.

CRANHAM, J. E., RANAWEERA, D. J. W. & RAJAPAKSE, G. B. (1962). An alternative to DDT for Tortrix control: Dipterex. *Tea Quart.* **33**: 196-200.

CRANHAM, J. E., RANAWEERA, D. J. W. & RAJAPAKSE, G. B. (1962a). The mite pests of Ceylon tea: Recognition and control. *Tea Quart.* **33**: 189-195.

RANAWEERA, D. J. W. (1962). Termites on Ceylon Tea estates. *Tea Quart.* **33**: 88-103.

(1) Phosdrin (Shell Co.)—1—methoxycarbonyl—1—propen—2—yl dimethyl phosphate.

By Dr E. Judenko (previously Entomologist, Special Research on Shot-hole Borer) *et al.*

Judenko, E., Shanmugam, C. & Hasselo, H. N. (1962). Field experiments on the chemical control of Shot-hole Borer (*Xyleborus fornicatus* Eichh.) on tea soon after pruning. *Tea Quart.* **33:** 69-87.

**Acknowledgements**

A great deal of help from the Superintendents of estates and from Colombo agencies in connection with estate trials is most gratefully acknowledged.

The Technologist, T.R.I., co-operated on the manufacture of samples of made tea for taint and residue tests, and the organization of taint tests. The Agricultural Chemist co-operated on analysis of soil samples (White grub work).

The following firms kindly carried out analysis of tea samples for insecticide residues: Messrs Bayer Leverkusen, W. Germany, (for Dipterex); Messrs Rohm & Haas Co., U.S.A. (for Kelthane); and Messrs Shell International Chemical Co., Ltd. (for Aldrin). Samples of certain insecticides tested were received from Messrs Hoechst A.G., W. Germany (Thiodan & Acrizid); Messrs A. Baur & Co., Ltd., Colombo ('Dimecron 50' *ex* Ciba Ltd. and 'Sandoz J. 38' *ex* Sandoz Ltd., Switzerland); Imperial Chemical Industries Ltd. ('Gamma-Cereclor D.P.'); Messrs May & Baker Ltd. ('Embathion'); Messrs Sumitomo Chemical Co. of Japan (Sumithion); Messrs N. V. Philips Roxane, Holland (Tedion and Animert); and Messrs Rohm & Haas Co., U.S.A. ('Kelthane M.F.' and 'Kelthane E.C.').

**References.**

Gadd, C. H. (1949). Studies of Shot-hole Borer of tea. V. Borer population. *Tea Quart.* **20:** 66-76.

Gunn, D. L. & Kanapathipillai, P. (1962). A new look at fertiliser (nitrogen) dosage. *Tea Quart.* **33:** 122-131.

Judenko, E. (1959). The appearances of adult Shot-hole Borer (*Xyleborus fornicatus* Eichh.) outside their galleries under natural conditions. *Tea Quart.* **29:** 104-111.

Judenko, E. (1961). Report of the Entomologist (Special Research on Shot-hole Borer) for 1960. *Rep. Tea Res. Inst. Ceylon:* 66-69.

# REPORT OF THE NEMATOLOGIST FOR 1962

M. T. Hutchinson, Ph.D.

**Staff.**—Mr S. Samarajeewa was recruited to the staff as a junior technical assistant on 1st October. Mr P. Sivapalan proceeded in September to the United States for a 3 year course of training in Nematology at Rutgers University. Otherwise, the staff remained the same.

**General.**—During the year, 15 advisory visits were made to estates; 191 letters were received and 267 were sent.

## Projects

Host range of the root-lesion nematode, *Pratylenchus loosi.* The importance of determining conclusively whether or not Guatemala grass and mana grass were susceptible to *P. loosi* led to tests that have been reported in detail (Hutchinson, 1963), wherein it was shown that these two rehabilitation crops were reliably immune. Marigold was also shown to be immune. A similar test was carried out using the following plants: Napier (elephant) grass (*Pennisetum purpureum* Schum.), Guinea grass (*Panicum maximum* Jacq.), and khus-khus (*Veteveria zizanoides* Nash), which were obtained through the courtesy of Dr L. H. Fernando. The procedure was similar to that used in the first test, with 9 replications of each plant, and tea as a control. Sixteen separate inoculations with *P. loosi* in water suspension were made into the pots, compared to 20 inoculations in the first test. However, the time elapsed between the last inoculation and the examination of the plant roots was less in the second test (47 days as compared with 63) which may explain the survival of a few nematodes in the roots of the plants under test (Table 1). The entire root systems were processed in 50 gm. lots, and the concentration of the nematodes found in the grass roots is actually very low, averaging 0.18 per gm. for Napier grass, 0.083 per gm. for Guinea grass, and 0.22 per gm. for Khus-khus grass, as compared with 398 per gm. for tea. (In the first test, tea roots contained an average of 312 *P. loosi* and the grass roots contained none). Therefore, it is not unlikely that the grasses noted above are also immune to *P. loosi* and that the nematodes found in the roots are recent entries that would have died out within 2 weeks or so. Since the total duration of the test was 7 months, as compared with 5 months for the first test, the root weights of plants in both tests cannot be directly compared. However, it is reasonable to suppose that Napier grass, while less productive of roots than guatemala grass, is superior in this respect to mana rass. Napier grass, Guinea grass, and Khus-khus all have leaf margins that lacerate the hands quite readily, and the growth habit of Napier and Guinea grass is outward rather than upright. If, however, these grasses are ever considered to be useful in rehabilitating tea soils, a final determination of their susceptibility to *P. loosi* would be desirable.

TABLE 1.—*Susceptibility of plants, possibly useful for rehabilitating tea soils, to the root-lesion nematode, Pratylenchus loosi.*[1]

| Plant | Weight of roots gm. | *P. loosi* | |
|---|---|---|---|
| | | total | per gm. |
| Napier grass ... | 7736 | 1383 | 0.18 |
| Guinea grass ... | 4035 | 333 | 0.083 |
| Khus-khus ... | 1563 | 336 | 0.22 |
| Tea ... | 51.5 | 20470 | 398 |

[1]Totals for 9 replicates.

A test to determine the length of time necessary for eradication of *P. loosi* from soil was initiated, using Guatemala grass, marigold, bare fallow, and tea as a control. Five plants of each species will be removed at monthly or bi-monthly intervals and healthy tea will be planted, as also in the fallowed pots, to pick up any nematodes surviving. Six such plantings will be made over a 9 month period, and the tea left in the pots for 3 months before the roots are processed. A total of 120 pots is involved.

Several shade and cover crops interplanted with tea were tested for their susceptibility to *P. loosi*. Seeds were sown directly into infected soil obtained from each of 4 estates. Where germination was poor, the seeds were germinated in Petri dishes containing moist filter paper and the seedlings were transferred to the pots. The number of plants of the same species in each pot averaged from 11 to 46. The plants were reinoculated thrice with *P. loosi* obtained from 21 additional sources, 3 months after the first sowing. The total exposure of the plants to the nematodes was 7 months and the pots were kept weeded during this period. The results (Table 2) show that *Sesbania*, *Albizzia*, *Cassia*, and *Acacia* spp. are all hosts of this nematode, while the 2 *Crotalaria* spp. and *Stylosanthes* appear to be immune. These results are in general agreement with those obtained by Gadd (1945) who also carried out inoculations in pots, and with those of Visser (1959), who sampled roots of field grown plants. The only apparent discrepancy is in the result with the dadap, *Erythrina lithosperma*, since Gadd and Visser both recovered moderate numbers of *P. loosi* from the roots of this species. The seed for the test herein reported were obtained from a single tree on Balangoda Group, and it might be that another seed lot would have given different results. Of the susceptible plants in the test, *Albizzia*, and especially *Sesbania*, showed symptoms of injury, *i.e.* lack of growth and defoliation.

TABLE 2.—*Susceptibility of Shade Trees, Bush and Cover Crops to Pratylenchus loosi*(1)

| Plant | Number of Nematodes per gram of root | | | | Plants per repl. av. |
|---|---|---|---|---|---|
| | Repl. 1 | Repl. 2 | Repl. 3 | Repl. 4 | |
| Crotalaria anagyroides | 0 | 0 | 0 | 0 | 37 |
| Crotalaria clarkei ... | 0 | 0 | 1 | 0 | 28 |
| Sesbania cinerascens ... | 10 | 33 | 80 | 43 | 46 |
| Cassia didymobotryia ... | 15 | 71 | 41 | 14 | 25 |
| Calpurnia aurea ... | 1 | 3 | 3 | 1 | 17 |
| Albizzia sumatrana ... | 22 | 6 | 94 | 24 | 30 |
| Stylosanthes gracilis ... | 0 | 0 | 1 | 1 | 29 |
| Acacia decurrens ... | 4 | 2 | 13 | 35 | 25 |
| Acacia pruinosa ... | 11 | 50 | 4 | 12 | 11 |
| Erythrina lithosperma | 0 | 0.4 | 3 | 0 | 13 |

(1) Seeds sown in infected soil March 28th, and resown April 20th-May 3rd. Additional *P. loosi* inoculated 3 times between July 5th and July 20th. The roots were processed between November 15th and November 24th.

Other plants currently being tested for susceptibility to *P. loosi* include *Grevillea robusta*, *Gliricidia maculata*, *Flemingia congesta*, *Oxalis corymbosa*, *Oxalis latifolia*, *Tecoma stans*, *Crotalaria usaramoensis*, *Crotalaria brownei*, *Tephrosia vogelii*, *Tithonia diversifolia*, *Drymaria mcordata*, *Albizzia oluccana*, *Desmodium ovalifolium*, and *Indigofera endacaphylla*.

An additional phase of the host range studies is to determine if the hosts of *Pratylenchus loosi* correspond to those of *P. coffeae*, from which the former nematode was recently distinguished (Loof, 1960). Among the hosts cited for *P. coffeae* are coffee, banana, potato, and strawberry. These plants were therefore tested against 8 different collections of *P. loosi*, contained in soils taken from 8 different estates. Two varieties of corn (Golden Bantam, and Golden Sunshine) were also tested since corn is a host of many species of *Pratylenchus*. In addition, tomato (Marglobe var.) and *Tephrosia vogelli* were tested. The coffee seeds used were obtained from Great Western Estate and are tentatively identified as *Coffea robusta* × *C. arabica*. The banana suckers used were obtained from a single clone on St Coombs Estate. The potato varieties were Profijt, Luctor and Gineke. The strawberry plants were from a single clone of *Fragaria* having moderately sized fruit, originated in England. A total of 80 cement pots were used in this test, and a single uninfected tea plant of clone DT 1 was grown in each pot. The results are shown in Table 3. The counts of nematodes in the roots of each of the test plants have been averaged, and compared with the average number of nematodes in the roots of the respective tea plants. While it is evident that no plant tested is as suitable a host for *P. loosi* as is tea, it seems likely that all plants tested, except tomato, may be hosts. Duration of the test was 11 weeks for the potato varieties, 12 weeks for banana, 13 weeks for tomato, 14 weeks for the corn varieties, 14 weeks for strawberry, 15 weeks for *Tephrosia* and 21 weeks for coffee.

TABLE 3.—*Host range of Pratylenchus loosi*

| Plant tested | Mean number *P. loosi* per g. root | |
|---|---|---|
| | test plant[1] | tea[2] |
| Potato (3 var.) | 16 | 40 |
| Banana (1clone) | 12 | 104 |
| Tomato (Marglobe) | 0.13 | 136 |
| Strawberry (1 clone) | 36 | 344 |
| Corn (2 var.) | 18 | 274 |
| Coffee (seedlings) | 48 | 376 |
| *Tephrosia vogelii* (seedlings) | 40 | 72 |

1 8 pots for *each* variety or clone of test plant.
2 Clone DT 1, planted in each pot.

There were, in addition, considerable apparent differences among the 8 populations as regards ability to colonize the roots of test plants. Of all populations tested, that obtained from Chrystlers Farm Estate was most successful in colonizing roots of these plants, and has therefore been used for a confirmatory test in which 4 potato varieties, *i.e.* Hilla, Eigenheimer, Gelderserode, and I.V.P. 654, 1 strawberry variety (Blakemore), 1 banana clone, and one corn variety (Golden Sunshine) are being tested over a period of 6 months. After the initial 3 months of this test, the potato varieties were harvested prior to replanting, and the roots yielded the following numbers of *P. loosi* per gm root: Hilla (540), Eigenheimer (374), Gelderserode (326), I.V.P. 654 (855). Such large numbers of nematodes recovered indicate that potatoes are a very suitable host plant. However, none of the nematodes can be found in the tubers, as is reported for *P. coffeae*.

Mahogany seedlings (*Swietenia mahogani*) did not grow well in the tests, but of those that survived, only 2 *P. loosi* per gm root could be recovered, compared with 178 per gm for the associated tea.

Coffee seedlings are being retested against 15 collections of *P. loosi;* each collection in a single cement pot. This test will also continue 6 months.

The original host plants of *P. loosi* are not known, but probably include jungle trees, other jungle plants, and patna grasses, as nematodes of the same genus (*Pratylenchus*) have occasionally been recovered from jungle and patna soils. These nematodes, however, do not appear to be *P. loosi.* To determine whether or not *P. loosi* from tea can colonize roots of jungle plants, seeds were collected from up-country jungle areas and were germinated in cement pots containing soil infected with *P. loosi.* Of the seeds so far tested, only the following have germinated: *Impatiens* sp., *Osbeckia* (*Walkeri*) ?, *Myristica* sp., *Eugenia*? sp., and a tree probably belonging to the family Myrtaceae. These seedlings, will be grown for a period of at least 6 months in the infected soil, and will be re-inoculated with the nematodes during this time. Other jungle seeds, and seeds and specimens of patna plants, will be tested in a similar manner.

*Resistance and tolerance of clones to the root-lesion nematode.*—Final evaluation of the second series of pot tests, wherein 9 clones were tested for their resistance to 25 collections of *P. loosi*, has shown that no clone tested (of DT1 DT 95, K 145, DK 1, DK 8, DK 10, TRI 2135, TRI 2025, TRI 2024) is immune to any of the 25 collections of the nematode, as the nematodes entered and reproduced within the roots of all clones. However, clone DT 95 was very significantly more resistant than TRI 2024, as judged by terminal populations of *P. loosi*, and clone DK 1 was very significantly more resistant than DT 95 in the 19 of the 25 collections for which data was reasonably complete.

TABLE 4.—*Susceptibility of selected clones to different collections of P. loosi*

| Estate from which collection was made | Clone, and mean number of *P. loosi* per gm root[1] | | | Duration of test, months |
|---|---|---|---|---|
| | DK 1 | DT 95 | TRI 2024 | |
| St Clair | 845 | 687 | 3018 | 9¼ |
| Eildon Hall | 393 | 907 | 1783 | 9¼ |
| Diyanilakele | 395 | 1263 | 2238 | 9½ |
| Ferham | 258 | 251 | 1253 | 9½ |
| Great Western | 65 | 329 | 396 | 10½ |
| Drayton | 156 | 646 | 498 | 11 |
| Ellamulle | 372 | 462 | 676 | 10½ |
| Mooloya | 115 | 341 | 1374 | 10½ |
| Campion | 46 | 66 | 825 | 11½ |
| Wootton | 447 | 848 | 1162 | 12½ |
| Laxapana | 218 | 161 | 1525 | 12 |
| Blairlomond | 57 | 351 | 851 | 12½ |
| Glenugie | 20 | 64 | 651 | 12½ |
| Chrystlers Farm | 186 | 101 | 500 | 14½ |
| Adams Peak | 58 | 142 | 384 | 13½ |
| Loinorn | 180 | 91 | 117 | 14¾ |
| Kirkoswald | 95 | 85 | 228 | 15¼ |
| Chapelton | 23 | 48 | 202 | 16 |
| St Coombs | 112 | 136 | 383 | 15¼ |

1 Five replications, i.e. 5 pots for each collection, with the 3 clones growing together in each pot.

Mean no. *P. loosi* per gm. root DK1 (213), DT95 (370), TRI2024 (962)
Sig: Diff: ($P < 0.001$) 127

with no significant interaction between the clones and the locations.

The clones were planted 5 to a pot, in two groups. In one group were clones DK 8, DK 10, K 145, DT 1, and TRI 2024, and in the other group were clones DK 1, DT 95, TRI 2135, TRI 2025, TRI 2024. There were five replications of each group, exposed to each of the 25 collections of *P. loosi*, making 250 pots in all. The ten pots for each collection were randomized within themselves. However, each collection was maintained separately. Thus, there were 25 groups of 10 pots. Within each pot, the respective clones were not randomized, but were uniformly planted in the same arrangement in order to assure accuracy in planting. In this arrangement, clone TRI 2024 was always planted in the central position.

This experiment, although quite suitable for its primary purpose of determining possible immunity to *P. loosi*, was thus biased in terms of assessing the relative growth of clones. Since the planting within each pot was not randomized, certain clones had permanently more favourable conditions of light than did others with clone TRI 2024 having the least favourable position. Despite this bias, however, certain conclusions may be reached regarding the relative growth of clones. As noted in Table 5, clone DT 95 made much better growth than did any other clone planted in the infected soils. This clone also realized a greater percentage of what might be considered its potential growth under these circumstances, as determined by its growth in the control pots. The control pots were filled with soil taken from under Guatemala grass, and subsequently fumigated to eliminate any *P. loosi* that might have been present. Arrangement of clones within each control pot was the same as for the other pots with 12 pairs of these pots being distributed throughout the experiment.

Thus, clone DT 95, growing so well in a wide range of soil types, exposed to a wide range of collections of *P. loosi*, and in close competition with 4 other clones in the same pots, should be given serious consideration for infilling vacancies in fields of mature tea infected with *P. loosi*, or in new clearings infected with *P. loosi*.

TABLE 5.—*Growth of tea clones in soils from different estates, infected with P. loosi*[1]

| Estate | Clones, Series one | | | | | Clones, Series two | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DK8 | K145 | DK10 | DT1 | 2024 | 2135 | 2024 | DK1 | 2025 | DT95 | |
| Ellamulle | — | 1.2 | 1.2 | 1.5 | 2.3 | — | 2.1 | 2.4 | — | 2.1 | 1.8 |
| Mooloya | — | 1.5 | 1.3 | 2.1 | 3.0 | 1.1 | 2.1 | 1.9 | 1.4 | 4.3 | 2.1 |
| Glenugie | — | 2.0 | 3.1 | 2.6 | 1.8 | 1.5 | 1.5 | 2.7 | 1.4 | 3.4 | 2.2 |
| St Clair | — | 1.6 | — | 22. | 1.6 | — | 1.1 | 1.9 | — | 5.6 | 2.3 |
| Great Western | — | — | — | 1.7 | 2.4 | 1.2 | 2.1 | 3.5 | 1.6 | 3.3 | 2.3 |
| Campion | — | 2.6 | 2.0 | 3.4 | 2.1 | 2.0 | 2.6 | 3.2 | 2.6 | 3.4 | 2.7 |
| Chapelton | 1.7 | 2.7 | 1.4 | 2.8 | 2.6 | 1.5 | 2.7 | 3.6 | 3.3 | 4.6 | 2.8 |
| Laxapana | — | 1.6 | 2.5 | 3.7 | 2.0 | 2.7 | 1.9 | 2.8 | 5.0 | 3.6 | 2.9 |
| Ferham | 1.8 | 4.3 | 2.7 | 2.6 | 1.6 | 1.4 | 3.3 | 4.0 | 4.8 | 5.1 | 3.2 |
| Kirkoswald | — | 3.1 | 1.5 | 3.3 | 4.4 | 3.5 | 3.1 | 3.1 | 4.9 | 3.9 | 3.4 |
| Eildon Hall | 2.3 | 3.8 | 3.2 | 4.5 | 2.7 | 3.0 | 2.7 | 6.1 | 3.7 | 5.4 | 3.7 |
| Diyanilakelle | 3.8 | 5.2 | 3.3 | 5.2 | 3.5 | 4.3 | 3.0 | 6.3 | 3.4 | 5.3 | 4.3 |
| Adams Peak | 1.6 | 4.4 | 8.9 | 3.2 | 4.0 | 3.0 | 4.2 | 5.7 | 5.4 | 3.9 | 4.4 |
| Loinorn | 3.8 | 5.4 | 5.0 | 4.2 | 8.6 | 3.7 | 5.7 | 4.3 | 7.7 | 7.2 | 5.6 |
| Mean | 1.1 | 2.8 | 2.6 | 3.1 | 3.1 | 2.1 | 2.7 | 3.7 | 3.2 | 4.4 | |
| CONTROL | 4.2 | 6.0 | 7.2 | 6.4 | 5.4 | 6.2 | 7.8 | 6.1 | 12.1 | 5.6 | 6.7 |

1 The numbers represent the growth increment of each clone, *i.e.* the number of times increase in the number of leaves during the course of the test. A dash indicates that growth was negative. Each number is the mean of 5 plants, except in the CONTROL, where each number is the mean of 12 plants.

Table 5 also shows clearly the wide variation in the total growth of all clones in the various collections, as measured by leaf increments between the start and completion of the test. In some collections, the clones hardly grew at all, and in at least one, the growth was comparable to that in the controls. The search for an explanation of this variation demonstrates a second type of bias in the experiment, *i.e.* that both the soils and the nematode population differ among the collections. Thus, it is not possible to determine if the nematodes from some collections are more pathogenic, or if it is the soils that are less suitable for plant growth. However, one fact emerges very clearly, *i.e.* for most tea soils infected with *P. loosi*, replanting is likely to be more rewarding than extensive resupplying.

The data given in Table 5 include only those collections for which at least 45 out of a possible 50 pieces of data (from 10 clones × 5 replications) are available. However, the trends in the other 11 collections are similar to those obtaining for the 14 collections for which data is given.

To finalize this question of the relative importance of nematode population and soil type on plant growth, a complex experiment has been initiated in which clone TRI 2024 will be exposed to 5 nematode populations, contained in the soil in which they were originally found, and in Guatemala grass soil, respectively. The soil-nematode combinations being investigated are those that produced poor growth of clones as well as good growth (see Hutchinson 1962).

Another interesting result of the examination for *P. loosi* in roots of the 9 clones was the discovery of a wide variation in sex ratio of the nematodes. Counts made at random of adults obtained from roots of clone TRI 2024 showed sex ratios varying from 39 to 58 percent males (Table 6). There was no apparent correlation of percent males with the concentration of the nematodes in the roots at the time of sampling. Sex ratio may therefore prove to be an important tool in distinguishing populations of *P. loosi*.

TABLE 6.—*Sex ratio of P. loosi as obtained from roots of clone TRI* 2024 *grown in infected soils from* 8 *estates.*

| Estate | *P. loosi*, number & Percent[1] | | | *P. loosi* av. concentration per gm. roots |
|---|---|---|---|---|
| | Female | Male | Percent Male | |
| Adams Peak | 235 | 265 | 53 | 76 |
| Chapelton | 336 | 214 | 39 | 211 |
| Chrystlers Farm | 93 | 107 | 54 | 634 |
| Dambatenne | 84 | 116 | 58 | 1175 |
| Glenugie | 136 | 114 | 46 | 862 |
| Kirkoswald | 195 | 255 | 57 | 295 |
| Loinorn | 216 | 284 | 57 | 104 |
| Mooloya | 219 | 281 | 56 | 1112 |

1 Adults examined at random from those recovered.

Still another interesting result of the second pot test demonstrates the possibility of distinguishing populations of *P. loosi* by means of a series of clones. Data for clones exposed to three of the 25 collections were selected for analysis, since the data were nearly complete and because the clones had been exposed to the collections for a similar length of time. As shown in Table 7, the clones in the Series II pots distinguished among the collections. For example, multiplication of the nematodes from Adams Peak and Chapelton estates was

greater in clone TRI 2025 than in clone DK 1, whereas the reverse was true for the collection from Loinorn. These results are only indicative, however, since the experiment was not intended for the purpose of distinguishing among populations of the nematode, *i.e.* as noted previously, the experiment is confounded because both soils and nematodes vary. To finalize this question, therefore, an experiment has been initiated to determine the relative ability of *P. loosi* from 4 populations to colonize 4 clones growing in the same type of soil.

TABLE 7.—*Differentiation of collections of P. loosi by means of tea clones.*

| Estate from which collection made | Series I Clone & P. loosi/g.root[1] | | | | | Series II Clone & P. loosi/g.root[1] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | DT1 | K145 | DK10 | DK8 | 2024 | 2025 | DK1 | 2135 | DT95 | 2024 |
| Adams Peak | 141 | 181 | 527 | 482 | 567 | 119 | 58 | 676 | 142 | 384 |
| Loinorn | 34 | 98 | 452 | 93 | 155 | 22 | 180 | 60 | 91 | 117 |
| Chapelton | 107 | 113 | 232 | 246 | 219 | 116 | 23 | 154 | 48 | 202 |

[1]Mean number of nematodes in 5 replicates. Duration of test:
Adams Peak 13½ months, Lionorn 14¾ months, Chapelton 16 months.

*Transformed data for Series II clones.*

| Estate | Clones and *P. loosi*/gm. root | | | | |
|---|---|---|---|---|---|
| | 2025 | DK1 | 2135 | DT95 | 2024 |
| Adams Peak ... | 54 | 36 | 125 | 53 | 96 |
| Loinorn ... | 22 | 63 | 30 | 44 | 53 |
| Chapelton ... | 52 | 23 | 62 | 32 | 56 |

There is a highly significant interaction between clones and locations ($P < 0.001$).

Laboratory tests in Petri dishes, to determine resistance of newly-rooted clonal cuttings, were not continued. However, inoculations were made onto roots of young clonal plants growing in polythene bags of similar soil. Five clones were tested, and cuttings were struck directly into the bags. After 4 months, 5 plants of each clone were inoculated with 25 adult *P. loosi* and 5 plants were inoculated with 25 larval *P. loosi*. All nematodes were from the same population. After 3 months, the roots of each plant were processed and all nematodes present were counted. The results, shown in Table 8, do not so much indicate differences among the clones, but indicate that larvae entered into and matured within roots of all clones tested. This method, however, does not recover eggs present, as does the staining technique used in examining the tests in Petri dishes. Neither test, however, is likely to be adequate, either as a measure of resistance or tolerance of clones, since the conditions do not approximate extended field exposure to different populations of *P. loosi*

TABLE 8.—*Results of inoculating clones, contained in polythene bags, with adult and larval P. loosi.*

| Clone | *P. loosi* recovered from plants inoculated with | | | |
|---|---|---|---|---|
| | Adults[1] | | Larvae[2] | |
| | Adults | Larvae | Adults | Larvae |
| DK 8 ... | 10 | 11 | 6 | 4 |
| KW 16/3 ... | 26 | 23 | 6 | 2 |
| DT 95 ... | 11 | 18 | 8 | 5 |
| TRI 2135 ... | 58 | 25 | 31 | 14 |
| TRI 2024 ... | 45 | 34 | 2 | 1 |

1 Totals for 5 plants, each inoculated with 25 adults, after 3 months.
2 Totals for 5 plants, each inoculated with 25 larvae, after 3 months .

NOTE:—Five plants of each clone were maintained as uninoculated controls. A total of 2 adults and 5 larvae were obtained from these plants.

A test has, however, been devised for the evaluation of clones that does approximate field conditions. A first usage of this test, described in the report of the Nematologist for 1962, has now been completed. Casualties of various sorts, including theft of plants and spread of the nematodes into the fumigated area of one of the beds, make the data recovered rather spotty even though each clone under test was represented by a total of 24 plants. However, the growth of some clones in infested soil was significantly better than was others—when compared with growth of these same clones in fumigated soil (Table 9). Clone TRI 2142 appears to be outstanding for tolerance, *i.e.* it grows well even though colonized by large numbers of nematodes. Fig. 1 shows the difference between plant growth in the fumigated and non-fumigated areas of one of the beds. A single buffer row of clone TRI 2024 extends completely around each of the two areas.

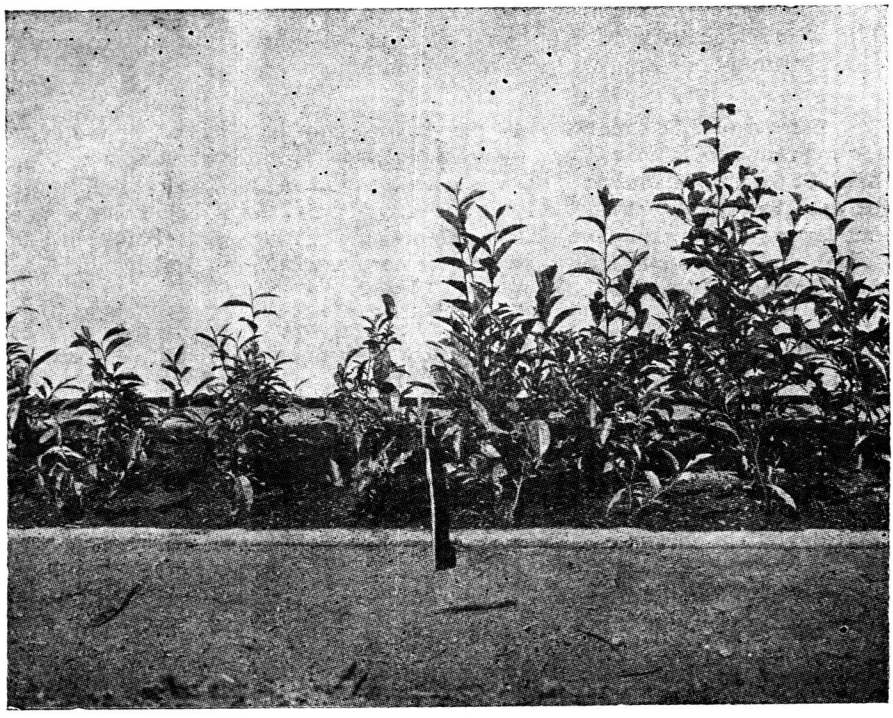


**Fig. 1.**—*First test of clones for tolerance to P. loosi.* The center section of one of the 4 beds is shown. To the left, the plants are growing in infected soil. On the right, the soil has been fumigated to kill the nematodes. The cement-board divider extends 3 feet into the soil.

TABLE 9.—*First test of clones for tolerance, using beds of infected and fumigated soil*

| Criterion of tolerance | Clones tested | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TRI 2142 | DT 95 | DK 16 | DA 434 | DK 26 | K 150 | TRI 2025 | DK 8 | TRI 2135 | TRI 2024 | K 145 | DT 1 |
| Root weight 1 | 3.2 | 8.7 | 11.5 | 15.0 | 20.2 | 22.5 | 22.7 | 24.3 | 30.6 | 32.5 | 37.3 | 42.2 |
| Shoot weight 1 | 26.2 | 12.0 | 40.9 | 57.6 | 56.0 | 66.8 | 95.3 | 51.1 | 91.0 | 146.7 | 98.8 | 123.7 |

1 Mean difference between plants growing in fumigated and infected soil respectively.

Sig: Diff: ($P < 0.05$) 22.1 (root weight)
78.0 (shoot weight)

The site has been prepared for the 1963 tolerance test, and precautions have been taken to avoid the mistakes of the 1962 test. Fumigation of the subsoil is being undertaken prior to filling the beds, and the beds are widely separated from one another. In each half of each bed, 4 plants of each of 18 clones will be randomized within a border of plants of clone DT 95. The clones being tested include: CH33, DK1, 14, 17, DR12, GMT9, MO114, 116, 146, 208, 209, 241, TRI2027, 2117, 2151, W3, and TRI2024 and DT95 as controls. Leaf areas of all test plants will be taken after the plants are established, to determine growth at the beginning of the test.

Of the 4 tea bushes selected from Derryclare Estate in 1961 for possible tolerance to *P. loosi*, only 2 have performed well in nursery tests. These have been designated as DR6 and DR12. As noted, clone DR12 is being tested in the 1963 tolerance tests, and DR6 will be tested at a later time. The four selections from Wootton Estate are still under test in the nursery. However, only one appears to be making satisfactory growth.

A total of 2,583 plants of 23 clones known to be tolerant, or under test for tolerance to *P. loosi*, were planted out in a multiplication area of No. 8 field, St Coombs, in July. The plants are establishing well and will ultimately be used to provide cuttings for the industry. St Coombs Estate has also set out large numbers of some of these clones during the year. Plants of additional clones are being grown by the Nematology Division and by the Estate for planting out in 1963.

*Marigold for control of P. loosi.*—In a continuation of tests, *P. loosi* was found to enter the roots of young marigold plants contained in polythene bags of soil, when examination of roots was made at intervals of 3, 8, and 30 days after the first of three inoculations. The number of nematodes recovered from marigold roots was very significantly less than the number recovered from tea roots, and the number of nematodes recovered from tea roots growing alone was significantly greater than the number recovered from roots of tea planted in the same bags with marigold (Table 10). Fig. 2 shows one of the polythene bags that contained tea and marigold. The nematodes apparently enter the marigold roots freely, but are soon killed, whereas they survive in the tea roots.

TABLE 10.—*Entry of P. loosi into marigold roots, and effect of the presence of marigold roots on the entry of P. loosi into roots of tea plants*

| Treatment | *P. loosi* in roots | |
|---|---|---|
| | Total[1] | Mean no. nematodes (transformed data) |
| Tea grown alone ... | 137 | 2.81 |
| Marigold grown alone ... | 25 | 1.43 |
| Tea grown with marigold ... | 65 | 2.02 |
| Marigold grown with tea ... | 17 | 1.32 |
| Sig: Diff: ($P < 0.05$) ... | | 0.384 |

1 Six replications for each of three times of sampling, *i.e.* 4th day, 8th day and 31st day after the first of three inoculations. Inoculations of approximately 600 nematodes per each polythene bag were made on the first, fourth, and seventh days, respectively.

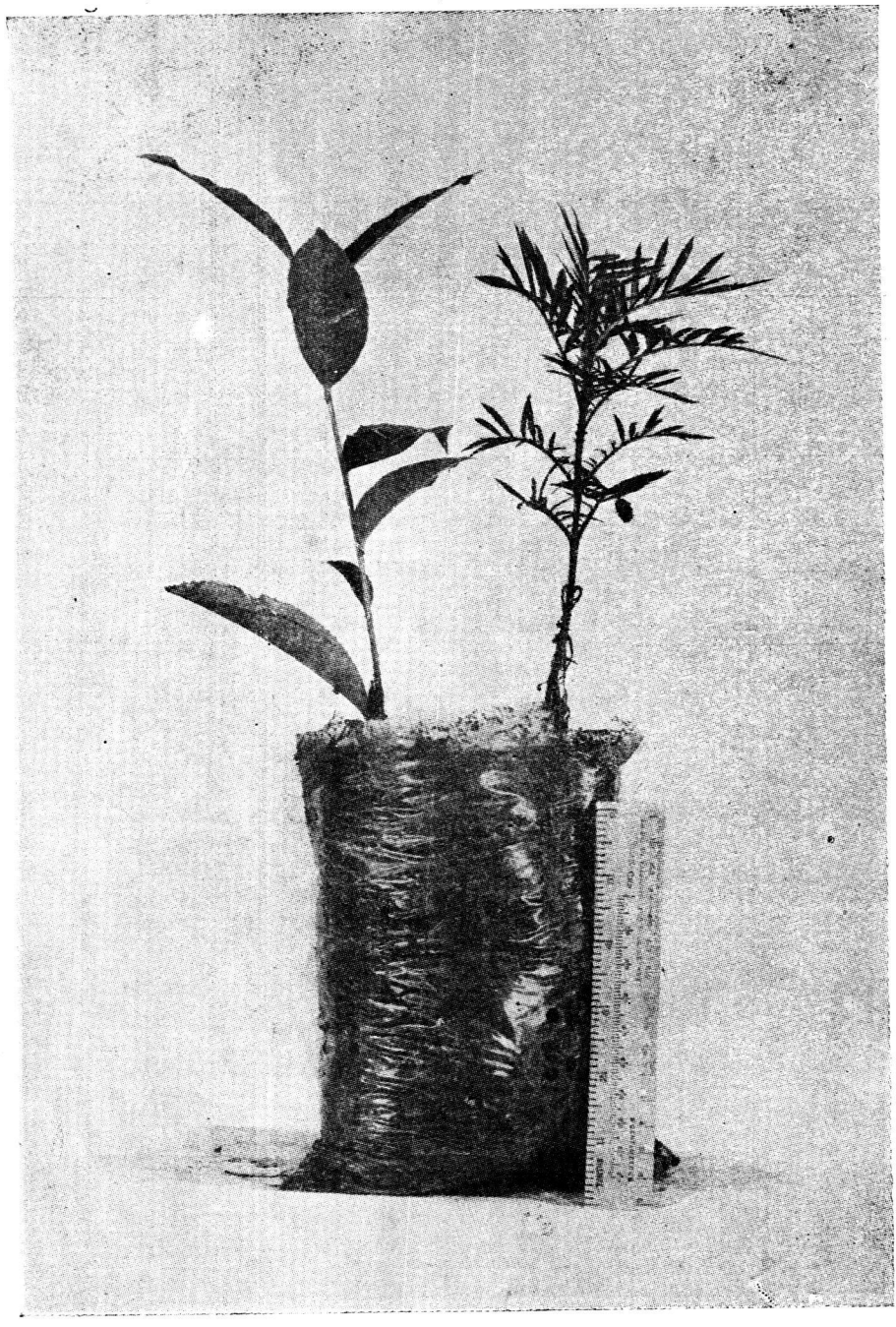


**Fig. 2.**—Test to determine relative entry of *P. loosi* into tea and marigold. Two additional treatments were used, *i.e.* marigold alone, and tea alone.

In tests of plants growing in cement pots (Fig. 3), marigold had no significant effect on the number of *P. loosi* entering tea roots, but had a very significant effect in reducing the number of *P. loosi* in the soil around tea roots (Table 11). Nematodes were found in trace numbers in the roots of only one of the 20 marigold plants in the test.

TABLE 11.—*Effect of the presence of marigold roots on the entry of P. loosi into roots of tea.*[1]

| Treatment | Mean number of nematodes | |
|---|---|---|
| | per gm. root | per 100 gm. soil |
| Tea with marigold ... | 580 | 25 |
| Tea alone ... | 808 | 86 |
| Sig: Diff: ... | 280 ($P < 0.05$) | 41 ($P < 0.001$) |

1 Contained in cement pots. Nematodes inoculated 8 times at 3 day intervals. Twenty replications. Duration of test, 4 months.

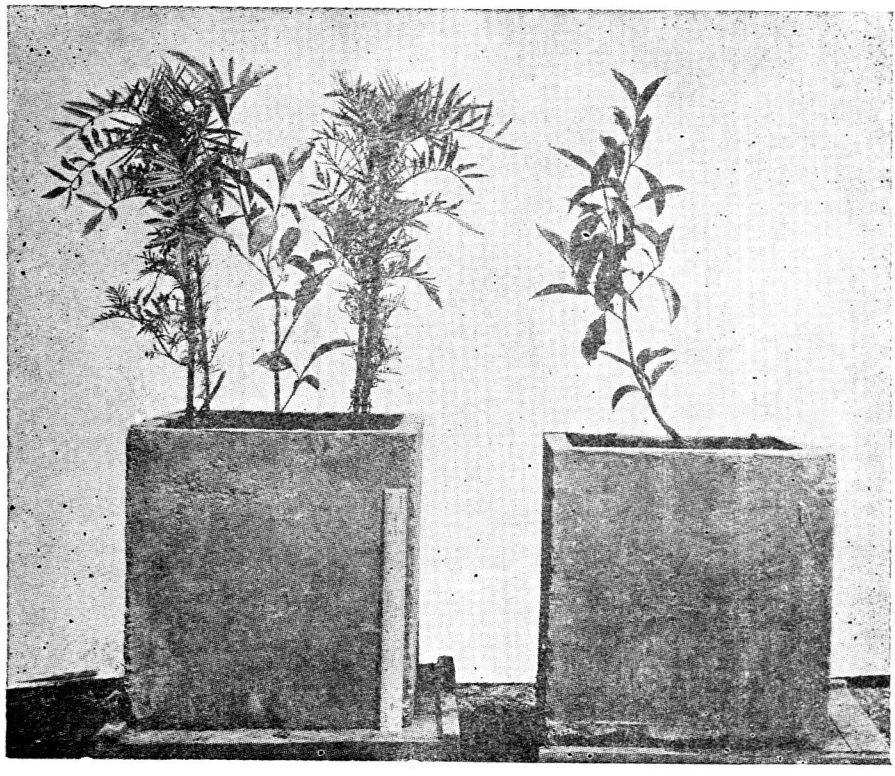


**Fig. 3.**—Test to determine the effect of marigold on the numbers of *P. loosi* in soil, and in the roots of adjacent tea plants. The pots shown represent the two treatments used.

Two series of tests demonstrated that if marigolds do secrete substances into the soil, that such substances are not directly toxic to *P. loosi*. In the first test, the nematodes were contained in soil beneath a nylon screen, above which marigold plants were growing (Fig. 4). In the second test, roots of marigold plants, macerated in water, were drenched over soil containing the nematodes. Nemagon at a rate approximating 5 gallons per acre treatment, was used as a control in the second test. In neither test was there a significant reduction of nematodes attributable to marigold.

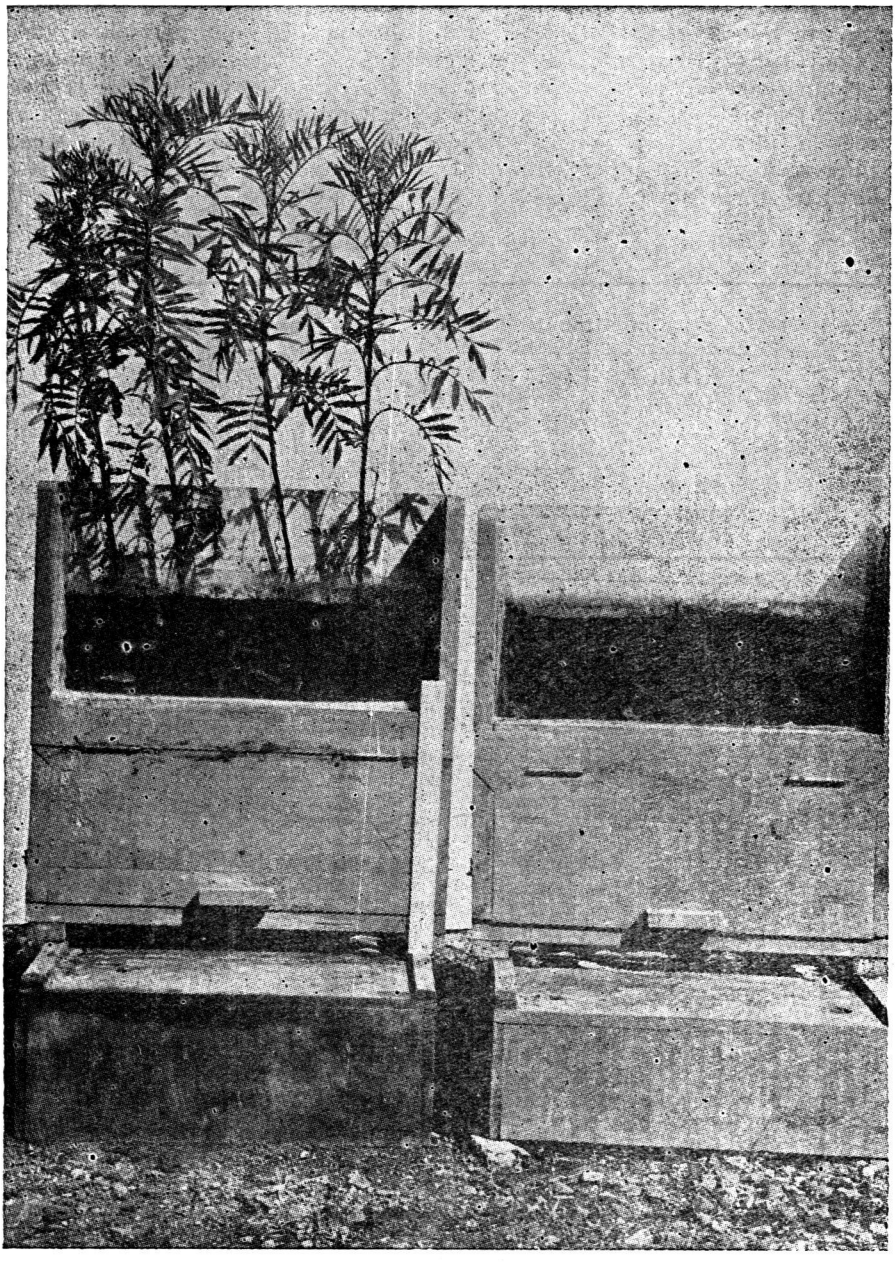


**Fig. 4.**—Test to determine if roots of marigold secrete nematoxic substances into the soil. The plants are growing in fumigated soil, below which is soil infected with *P. Loosi*. Tightly-stretched nylon cloth separates the two soils. The doors give access to the infected soil for purposes of sampling.

Interplanting marigolds in the field at Derryclare estate significantly increased the yield of green leaf (Table 12). The treatment with nemagon at a rate of 10 gallons per acre (American) was significantly superior to marigold, indicating that the increase produced by marigold was due to the nematicidal action of its roots rather than to an effect as a cover crop. The increased crop with marigold was 7.4% and with Nemagon, 12.1% (corrected with regard to pre-plucks). Marigold was maintained in the field for 13 months, by allowing it to self-seed. This was possible because there were approximately 30 percent vacancies. Twenty pre-plucks were made from March 17th to July 28th, 1961. The field was then pruned, and marigold seed was planted in rows one foot apart at a rate of 8-10 lbs per acre, as soon as the prunings were removed. Nemagon was injected at 1 foot intervals at a rate of 10 gallons per acre. The field was then tipped twice, and brought into regular plucking on January 29th, 1962. Plucking continued at weekly intervals until September 24th. All plots received the same applications of fertilizer during the trial, *i.e.* 15 lbs T.700 twice yearly.

TABLE 12.—*Effect of interplanting marigold, in a tea field infected P. loosi, on the yield of tea*

| Treatment | Mean lbs. green leaf per pluck[1] |
|---|---|
| Untreated ... | 3.24 |
| Marigold ... | 3.55 |
| Nemagon ... | 3.77 |
| Sig: Diff: . . | 0.20 ($P < 0.05$) |

1 35 post-plucks, taking into account 20 pre-plucks to establish the yielding capacity of each plot. Ten replications of plots measuring 40 × 50 feet.

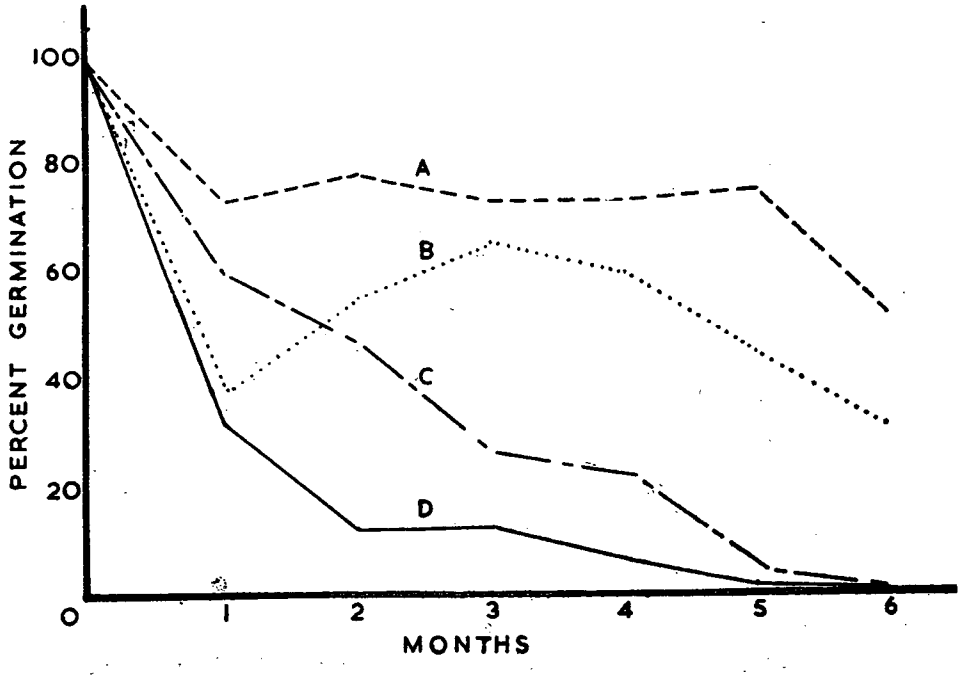



**Fig. 5.**—*Germination of marigold seed, Tagetes erecta* L. Treatments: A—Factory-dried and factory-stored. B—Sun-dried and factory-stored. C—Factory-dried and room-stored. D—Sun-dried and room-stored. Results from lots of 100 seed, examined monthly.

Although the planting of marigold can thus be recommended in fields of mature tea having vacancies, it cannot be recommended in new clearings, as the marigold may compete with the establishing tea.

Marigold seed often fails to germinate, and this question was investigated by using newly-harvested seed. One lot of seed was sun-dried and the other was dried in the firing room of St Coombs factory. Each lot was then divided again in two, and half was stored under room conditions (av. temp. 70°F) and half in the factory (av. temp. 80°F) respectively. One hundred seeds from each of the four lots were then germinated at monthly intervals. The results showed that seed, originally 98 percent germinable, had zero germination after 6 months when stored under room conditions. Seed that was sun-dried and factory-stored had 31 percent germination, and seed that was factory-dried and factory-stored had 52 percent germination (Fig. 5).

Estates wishing to receive 2 oz. samples of marigold seed, gratis, are requested to contact the Nematologist.

*Chemicals to kill meadow nematodes in tea roots.*—A standard procedure was adopted for further screening of chemicals. A 1-1000 suspension of the emulsion concentrate in water is drenched onto 12-18 months old nursery plants of clone TRI 2024 contained singly in square cement pots containing approximately ½ cu. ft. soil underlaid with several inches of crushed stone. The plants have been previously infected with *P. loosi* by several inoculations with infected soil or with the nematodes contained in water suspension. Four applications of 1L. of the diluted emulsion concentrate are made at bi-weekly intervals. Where a granular formulation is used, 5 gm. is applied at bi-weekly intervals; each application being followed by 1L. water. Assessment of *P. loosi* in the roots of the plants is made at least 2 weeks after the final application.

Information as to the chemicals used is given in Table 13.

TABLE 13.—*Chemicals used in tests to eliminate P. loosi from roots of nursery tea plants*

| Trade name | Standardized name | Formulation | Manufacturer |
|---|---|---|---|
| Nemagon ... | DBCP | technical | Shell |
| Nemaphos ... | cynem | 45 EC 10% granular | American Cyanamid |
| Thimet ... | phorate | 47.5 EC | American Cyanamid |
| Phosdrin ... | — | 24 EC | Shell |
| Rogor ... | dimethoate | 40 EC | Fisons |
| Ekatin ... | dithiodemeton | 25 EC | Sandoz |
| Dimecron ... | phosphamidon | 50 EC | Ciba |
| Sumithion ... | — | 50 EC | Sumitomo Chemical Co., Ltd., Osaka, Japan |
| Bayer 4741 (S 410) | methyl demeton sulfoxide | 25 EC | Bayer |

The technical Nemagon was applied with a micro-pipette calibratedt to deliver a drop of .006 ml. Sixteen drops were applied in a total of 4 holes made in the soil surrounding each plant to be treated. The number of applications of Nemagon ranged from 1 to 4, and the equivalent amount of Nemagon

per acre was calculated to be 1¼, 2½, 3¾ and 5 gallons (American), respectively. The results, shown in Table 14, indicate that of all the chemicals so far tested, only Nemaphos can be considered as promising. This material is being re-tested, using nursery plants, infected with *P. loosi*, and contained in polythene bags.

TABLE 14.—*results of chemical tests to eliminate P. loosi from roots of nursery tea plants.*

| Test | Treatment | Nematodes per plant | Wt plant roots, gm[1] |
|---|---|---|---|
| I | Nemagon 1¼ gal | 166[2] | 48.3[2] |
| | Nemagon 2½ gal | 213 | 53.1 |
| | Nemagon 3¾ gal | 779 | 16.1 |
| | Nemagon 5 gal | 921 | 30.2 |
| | Dimecron | 8953 | 55.7 |
| | UNTREATED | 10361 | 65.7 |
| II | Nemaphos (EC) | 267 | 16.9 |
| | Thimet | 189 | 12.7[3] |
| | Nemaphos (granular) | 570 | 17.3 |
| | Phosdrin | 3315 | 15.9 |
| | UNTREATED | 6675 | 15.9 |
| III | Rogor | 7842 | 67.6 |
| | Ekatin | 14138 | 78.0 |
| | Bayer 4741 | 11775 | 94.5 |
| | Sumithion | 6483 | 77.9 |
| | UNTREATED | 10429 | 68.4 |

1 Mean of 8 replications, except where noted.

2 Mean of 7 replications.

3 Roots of plants noticeably darkened and injured. However, the reduction in root weight was not significant over the time tested.

NOTE:—Test I—duration 12 months. Evaluation 10 months after 4th application
II— ,, 2 ,, Evaluation 2 weeks ,,
III— ,, 2½ ,, Evaluation 5 weeks ,,

Several chemicals, said to have systemic action in plants, were not available for testing because, according to the manufacturers, they are no longer in commercial production. These include Tetram (ICI), o, o-diethyl S-(2-ethyl-N, N-diethyl amino) phosphorothiolate hydrogen oxalate; Pestox III (Fisons), octamethylpyrophosphoramide; CP-10502 (Monsanto), 1-(dimetho oxyphosphinyl) vinyl dimethyl phosphate; and O.S. 1836 (Shell),o, o,-diethyl 2-chlorovinyl phosphate.

*Effect of fertilizer mixtures on tolerance of tea to P. loosi.*—It has been occasionally reported that additional amounts of potassium or phosphorus in the fertilixer mixture applied to plants infected with endoparasitic nematodes results in improved growth of the plants. Therefore, a preliminary experiment was initiated to determine if extra applications of phosphorus or potassium would produce increased growth in plants infected with *P. loosi*. The three treatments used were T-200 8 gms per pot of ½ cu ft soil, T-200 with an added increment of potash equivalent to that already present in T-200, and

the same for phosphorus. The treatments are applied monthly. The experiment is replicated 12 times, with 6-month old plants of clone TRI 2024 growing in square cement pots. The plants were originally taken from infected soil and were additionally inoculated with *P. loosi* on one occasion. A leaf count of each plant was made at the outset, and will be continued at intervals. The plants are growing well and the test will continue for one year.

*Survey for the distribution of P. loosi.*—This work has been completed, and prepared for publication. The conclusions reached are that high soil temperatures are detrimental to the nematodes, and for this reason, only small numbers are found in the low country. The long droughts experienced in most of Uva Province and subsequent soil heating are probably responsible for the lesser numbers of *P. loosi* recovered in this region. Occasionally atypical climatic conditions, or the planting of highly susceptible clones may result in marked injury attributable to this nematode at elevations as low as 2500-3000 feet. Severe injury to new clearings, particularly those planted with clone TRI 2024, has been noted on 5 occasions during the year. The selection of tolerant clones therefore takes on added importance for up-country estates.

A final experiment, to determine if *P. loosi* present in soils of low-country estate will multiply under up-country conditions, was initiated in December. Soil was taken from estates believed to harbour low levels of the nematode, and was planted with nematode-free plants of clone TRI 2024. Five locations were sampled on each of 5 estates. The soil from each location was divided into 2 lots, one of which was left at the low-country estate, and the other of which was taken to the Institute at St Coombs Estate. After 6 months' exposure, the roots of all plants will be examined for nematodes.

*Other nematodes associated with tea.*—An attempt was made to determine if the spiral nematode, *Helicotylenchus dihystera* (formerly *H. nannus*) could multiply on tea roots. In the first preliminary test, the nematodes were inoculated in water suspension onto the roots of 3 clones of tea, dadap, and Guatemala grass. In the second preliminary test, the following plants were grown in soil that contained this nematode as the only plant parasitic species present: 3 clones of tea, *Sesbania cinerascens*, marigold, coffee and dadap. The tests were continued for 7½ months and 5 months, respectively. Results indicate that dadap is an excellent host, *Sesbania*, coffee, and perhaps Guatemala grass, are fair hosts, and that tea and marigold are non-hosts. Further work is planned, using *Albizzia sumatrana*, *A. moluccana*, *Grevillea robusta*, *Gliricidia maculata*, and dadap (*Erythrina lithosperma*), compared with tea.

A paper was prepared for publication, summarizing the distribution of all nematodes found in tea soils.

An interesting experiment was carried out by Mr Vythilingam, to determine if root-knot nematodes (*Meloidogyne arenaria*), taken from roots of *Tephrosia vogelli*, would colonize roots of seedling and clonal tea. Ten clones were used (See Table 15), and the seedling plants were all obtained from seeds originated at Illuktenne estate, Dehiowita. Square cement pots were used, and 4 plants of the same clone, or 4 seedlings, were grown in each. There were an equal number of pots containing clones and seedlings, respectively, and each pot containing clones was paired with another containing seedlings. The pairs were randomized into 2 series. The roots of one series were examined when all plants were approximately 8 months old (3½ months after the plants were placed in the infected soil containing chopped up nematode galls from *Tephrosia* roots). The results (Table 15) show that roots of both clonal plants and seedling plants are subject to colonization by *M. arenaria*, and that the nematodes can complete their life cycle in these young plants. The seedling plants, however, were superior hosts. Moreover, there appear to be differences in

the susceptibility of the various clones, with clone TRI 2135 being perhaps the most susceptible of those tested. The second series will be examined when all plants are 15 months' old, at which time they should be resistant to the nematodes, according to Loos (1951).

TABLE 15.—*Test of clones and seedling tea plants for susceptibility to the root-knot nematode, Meloidogyne arenaria.*

| Clone and paired seedlings[1] | Wt roots gm | Galls, total number | Females with eggs per 20 galls[2] | Total females with eggs per gm roots (estimated) |
|---|---|---|---|---|
| DK8 | — | 44 | 7 | — |
| seedlings | — | 44 | 14 | — |
| DT 95 | 14.9 | 67 | 2 | 0.45 |
| seedlings | 10.0 | 294 | 31 | 45.5 |
| GMT 9 | 38.5 | 237 | 9 | 2.8 |
| seedlings | 9.5 | 250 | 18 | 25.0 |
| K 150 | 22.1 | 56 | 6 | 0.76 |
| seedlings | 8.6 | 112 | 13 | 8.5 |
| MO 16 | 13.6 | 121 | 2 | 0.89 |
| seedlings | 5.3 | 84 | 5 | 4.0 |
| MO 146 | 35.3 | 70 | 7 | 0.69 |
| seedlings | 7.6 | 117 | 17 | 13.1 |
| MO 208 | 3.6 | 82 | 4 | 4.6 |
| seedlings | 6.6 | 253 | 15 | 28.8 |
| TRI 2024 | 26.6 | 43 | 4 | 0.32 |
| seedlings | 16.6 | 243 | 13 | 9.5 |
| TRI 2118 | 3.3 | 39 | 0 | 0.00 |
| seedlings | 5.4 | 137 | 16 | 20.3 |
| TRI 2135 | 18.1 | 130 | 39 | 14.0 |
| seedlings | 6.5 | 43 | 8 | 2.7 |

1 Total of 4 plants each.
2 Selected at random.

In an attempt to determine if clones might be immune to *Meloidogyne brevicauda*, the root-knot nematode of mature tea, 21 clones were planted out in July in an infected field at Oliphant Estate, immediately after uprooting of the old tea, A total of 1062 plants were set out.

**Publications**

HUTCHINSON, M. T. (1962). Rehabilitating tea soils. I Susceptibility of plants now in use to the root-lesion nematode, *Pratylenchus loosi*. Tea Quart. **33**: 138-140.

**References.**

GADD, C. H. (1945). Report of the Mycologist. Rep. Tea Res. Inst. Ceylon for 1944: 23-30.
HUTCHINSON, M. T. (1962). Report of the Nematologist. Rep. Tea Res. Inst. Ceylon for 1961: 84-92.
LOOF, P. A. A. (1960). Taxonomic studies on the genus *Pratylenchus* (Nematoda). T. Pl. Ziekten 66: 29-90.
LOOS, C. A. (1951). Pathological problems. *Tea Quart.* **22**: 27-30.
VISSER, T. (1959). Report of the Acting Nematologist. Rep Tea Res Inst. Ceylon for 1958: 67-73.

# REPORT ON PLANT BREEDING FOR 1962

A. R. Sebastiampillai, B.Sc.

**General**—Dr D. Mulder resigned in October 1962. Dr U. Pethiyagoda was appointed as my supervisor at the Tea Research Institute from that time under the general direction of Professor Chandraratna.

**1. Hybridisation**—It is yet too early to predict the results of hybridisation work of the past year. The aim of hybridisation is to produce clones which combine the desirable qualities of the selected clonal parents. A greater proportion of crosses was made during this period than in the previous year. The production of a large F1 population is necessitated by the fact that tea is largely cross pollinated and, therefore, highly heterozygous in most of its characters.

It was also decided to include clone DT 1 into the breeding programme, because of its superior quality and tolerance to eelworm attack, in the hope of combining high yield with these other properties.

**1.1.** *Cross pollination*—The results of controlled crosses made during the year 1962 is given below in table 1 and 2.

TABLE 1.—*The percentage fruit-set in cross-pollinated flowers observed at four months after pollination. Pollination was carried out one day before the anticipated date of opening of the flower*

| ♀ + ♂ | T.R.I. 1114 | T.R.I. 777 | Ass. 4/10 | DT 1 |
|---|---|---|---|---|
| T.R.I. 1114 ... | — | — | — | 31/100<br>31% |
| T.R.I. 777 ... | — | — | 6/26<br>23% | 32/75<br>43% |
| T.R.I. 2024 ... | 44/100<br>44% | 20/80<br>25% | — | 43/100<br>43% |

TABLE 2.—*The percentage fruit-set in cross-pollinated flowers observed at four months after pollination. Pollination was carried out on the day of opening of the flower*

| ♀ + ♂ | T.R.I. 1114 | T.R.I. 777 | Ass. 4/10 | DT 95 | T.R.I. 2024 |
|---|---|---|---|---|---|
| T.R.I. 1114 ... | — | 19/71<br>27% | 9/54<br>17% | 20/100<br>20% | — |
| T.R.I. 777 ... | 47/96<br>49% | — | — | — | 35/76<br>46% |

**1.2.** *Self pollination*—The problem of self-sterility in tea was further investigated to ascertain any clonal differences. However the results presented below are inconclusive.

TABLE 3.—*Fruit-set observed in self-pollinated flowers at four months after pollination*

| Nature of the Self | Treatment | Number of flowers pollinated | Number of fruits set | % fruit set |
|---|---|---|---|---|
| T.R.I. 1114 × T.R.I. 1114 | Pollen of the same flower | 52 | 2 | 4 |
| T.R.I. 1114 × T.R.I. 1114 | Pollen from a different flower, different tree | 50 | 2 | 4 |
| T.R.I. 777 × T.R.I. 777 | Pollen of the same flower | 100 | 0 | 0 |

## 2. Floral biology

**2.1.** *Receptivity of the stigma*—The work on this problem initiated in 1961 was followed up in 1962. Pollination was carried out in the bud stage, just one day before the anticipated date of opening of the flower.

The results seem to indicate that the receptivity of the stigma is greatest in the bud stage. It is possible that the stigma becomes receptive a few days before the opening of the flower bud. This needs further investigation. The results are presented in the table below.

TABLE 4.—*Fruit-set in cross-pollinated flowers observed at four months after pollination*

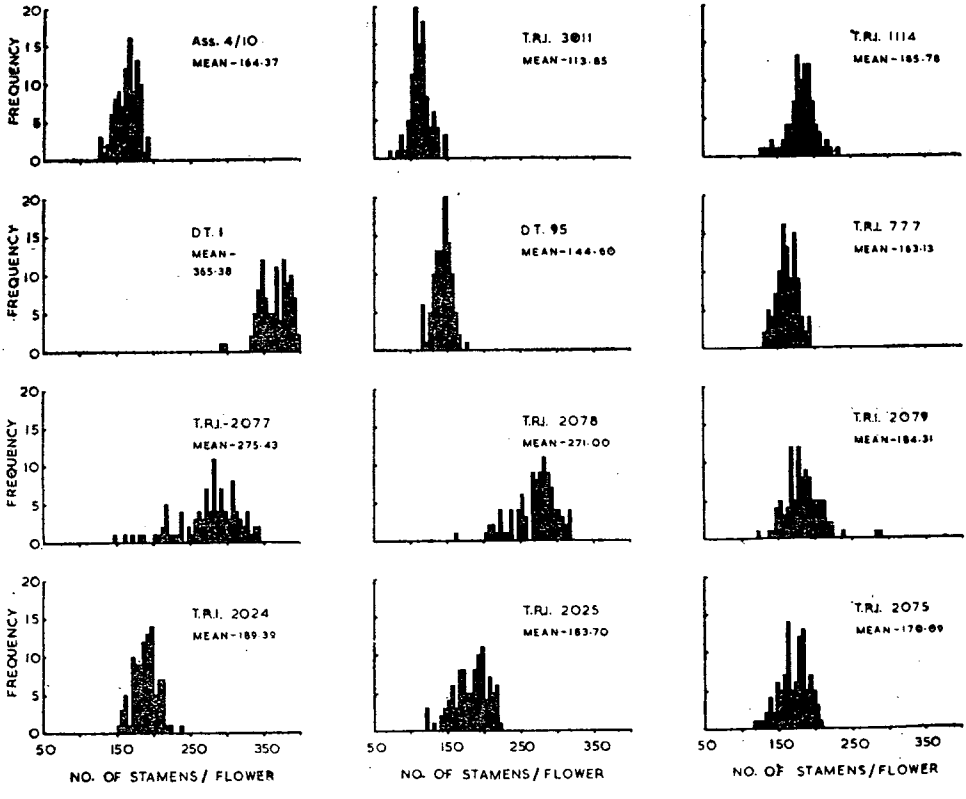
| Nature of the Cross | Treatment (Time of pollination) | Number of flowers pollinated | Number of fruits set | % fruit set |
|---|---|---|---|---|
| T.R.I. 1114 × T.R.I. 2024 | 1 day before opening of flower | 50 | 20 | 40 |
| ,, | On day of opening | 25 | 8 | 32 |
| ,, | 1 day after opening of flower | 50 | 9 | 18 |
| ,, | 2 days after opening of flower | 38 | 3 | 8 |
| ,, | 3 days after opening of flower | 46 | 0 | 0 |

**2.2.** *Interval between pollination and fertilisation*—This experiment involved the excision of styles at intervals after pollination varying from 6 to 30 hours. It was thereby hoped to find out the minimum time that must elapse between pollination and removal of the style so as not to interfere with seed set.

The results were all negative in that the severing of the style up to 30 hours after pollination have consistently resulted in a failure to set seed. Further work with longer time intervals would be necessary to obtain positive results.

**3. Clonal identification**—An attempt is being made to correlate morphological characters with clones.

**3.1.** *Stamen numbers*—Preliminary studies on stamen numbers of 14 clones have been completed. The results point to the fact that although the stamen number per flower within a clone is variable, still it is possible to group these clones into different categories, depending on their mean stamen numbers. Statistical analysis of the data is in progress.




*Frequency Histogram of Stamen Numbers of Twelve Clones*
*(100 flowers per clone)*

**3.2.** *Leaf areas*—Areas of individual leaves of different clones have been measured in order to classify them on the basis of their leaf sizes. Further work is in progress.

**4.** *Clonal seed*—Open pollinated seeds of 14 clones were collected and tests on the germination of these seeds have been completed. The more vigorous seedlings have been selected and planted out in the field on St Coombs for further studies.

# REPORT OF THE ACTING PLANT PATHOLOGIST

N. Shanmuganathan, Ph.D., B.Sc.

## General

The Pathologist, Dr Mulder, resigned his post and left the service of the Institute on October 17th, and I was appointed to act as Pathologist. I had returned to the Island on June 20th after successfully completing three years' post-graduate work at the East Malling Research Station in Kent. Mr J. P. Herat, Technical Assistant, resigned his post on September 30th and was replaced by Mr W. R. F. Rodrigo on October 15th.

There were 156 letters received and 241 sent out. Altogether 140 estate visits were made by members of the staff; except for a few visits to the low country, which were of a general investigatory nature, most of these were concerned with experimental work on estates.

## Fungal Diseases

### 1. **Blister Blight** (*Exobasidium vexans*)

#### 1.1. *Fungicide investigations—South-West Monsoon Trial.*

In this trial at St Coombs, five fungicides, namely, Perenox, Duphar Colloidal Copper, Zineb, Dithane and Copper Curit (a mixture of copper oxychloride and Zineb), were tested at concentrations of ½, 1, 2, and 4 oz per acre. Low concentrations were chosen deliberately in order to bring out differences between fungicides more distinctly.

The monsoon was erratic and average field infestation was low (26.9%) compared with that of previous years (37.5% in 1961; 40.3% in 1960). Sixteen assessments for blister infection were carried out during the trial and the results are summarized in Table 1.

TABLE 1.—*Percentage infection by Blister Blight sprayed protectively with various materials*

| | Untreated Control | Copper Curit | Zineb | Dithane | Duphar Colloidal Copper | Perenox |
|---|---|---|---|---|---|---|
| Mean Percentage Infection | 26.9 | 21.0 | 20.7 | 20.3 | 18.7 | 17.7 |

Significant difference 1.5 (P=0.05)
Non-significant differences are bracketed.

In agreement with previous observations, the inorganic copper compounds proved superior to the organic thiocarbamates despite the general decrease in infection.

The effect of doses was also significant (P=0.05); one, two and four-ounce doses gave better control than a dose of half-ounce. However, there was no significant difference in efficacy between one, two and four-ounce

doses, thus indicating that in experimental conditions and with low field infestation, copper fungicides could give adequate protection at concentrations far below those normally in use (4-6 oz/acre).

Brestan, an organo tin compound (triphenyl tin acetate) proved ineffective even at a concentration 5 times that recommended for copper compounds.

*North-East Monsoon Trial.*—In this trial, attempts to evaluate the comparative efficiency of Perenox, Duphar Colloidal Copper, Brestan, Zineb and Copper Curit proved inconclusive because of the low field infestation (23.7%—mean for three months). All fungicides were about equally effective at all doses treated.

Efforts to obtain a dosage-response curve were also vitiated by the severe decrease in infection.

1.2. *Epidemiological Studies*

An automatic, volumetric, spore trap of the Hirst type was sited on Field No. 9 at St Coombs, and was in operation throughout the year. The catches consisted predominantly of basidiospores of *Exobasidium vexans* (more than 90%); other spores included several hyaline and coloured basidiospores, few ascospores, and spores of Fungi Imperfecti. Spores of mosses and ferns, and pollen were comparatively rare.

Scanning of slides from the spore trap was carried out daily, but only spores of *E. vexans* were enumerated. Results showed a certain seasonal periodicity, but this was not very marked. The highest catch was recorded in July and in November, coincident with the two monsoons, the South-west and the North-east, when the spores reached a mean concentration of 10,500 and 9,600 respectively per cubic metre of air. The lowest catch was recorded in March (2,000 per cubic metre). An interesting feature was that considerable numbers of spores were trapped even during the comparatively dry months of February, March and April, when field infestation was negligible. It was not possible to relate the variation in atmospheric spore content to field infestation because of the difficulty of separating the contributions from local and from distant sources; a further complication was caused by spray applications during critical periods, applications which considerably affected natural field infestation.

Two-hourly concentrations obtained on 10 days in November indicated a very pronounced diurnal rhythm in the atmospheric spore content. Spores of *E. vexans* reached the highest concentration in the early hours of the morning between midnight and 4.00 hr., and in this respect *E. vexans* seems to resemble several other Basidiomycetes which show a similar nocturnal pattern. The diurnal periodicity could, however, be greatly altered by weather conditions. For instance, a heavy thunderstorm at approximately 13.00 hr. on the 24th and 25th December resulted in two peak catches on those two days, high concentrations occurring in the first hour and second hour after the onset of the rain, and again in the early hours of the morning.

Prolonged rain, on the other hand, always resulted in a drop in the mean daily catch.

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

2.1. *Fumigation Trials.*—The large scale fumigation trials to determine the effect of DD (1,3-dichloropropene and 1,2-dichloropropane) on Poria

control were continued on eight estates. The results of the two completed trials indicate that a dosage of 2,000 lbs per acre (approximately 165 imperial gallons) was the most effective; on one estate this dosage gave complete control while on the other residual infection was very small and near the edge. Results were assayed using *Tephrosia vogelli* as indicator crop, but tea has now been planted on the experimental plot and is under observation.

An application rate of 1,000 lbs per acre proved to be inadequate, while 3,000 lbs per acre was no better than 2,000 lbs.

Injection at two levels, viz. 6 and 24 inches below ground level, show that better fumigation is obtained by injecting at 6 inches than at 24 inches. Injection at both 6 and 24 inches by splitting the dose into two was not superior to injection at 6 inches.

Fumigation with DD followed by inoculation with a spore suspension of *Trichoderma viride* resulted in slightly better control than fumigation alone, but the difference was not significant.

A trial to test the efficacy of Vapam (sodium dimethyl dithiocarbamate) when used as a soil fumigant to control *Poria* has been started on St Coombs estate. In this trial three rates of application, 100, 150 and 200 gallons per acre, and two depths of injection, 1 ft and 2 ft, are being compared. Results will not be known until late in 1963.

2.2. *Field experiments*

During investigations carried out to study the vertical distribution of *P. hypolateritia* on the root surface of infected tea bushes, to determine the effective depth of penetration of DD required for complete control, 80 diseased bushes in an advanced state of defoliation, collected from 8 different estates, were examined. This revealed that the fungus was mainly confined to the top 30 inches of the root system. Although the depth of the root-system varied from 1 ft 6 in to 6 ft 6 in only in one case had the fungus colonized a depth of more than 30 inches. The average depth of the root-system was 3 ft 0 in and the average vertical distribution of *P. hypolateritia* 1 ft 9 in.

Investigations are in progress to study the survival of *P. hypolateritia* in infected tea roots of varying thickness in the absence of other substrates in tea soil.

A field experiment has also been started using artificially infected tea roots buried at different depths to determine the depth of penetration of DD when injected at two levels, viz. 9 and 18 inches below ground level.

A pot experiment is also in progress to assess the potentialities of Vapam and Trapex, a new formulation, as soil fumigants for *Poria* control.

Results of these experiments are not yet available.

2.3. *Tolerance tests*

Twenty-three clones planted out in pots and artificially inoculated with *P. hypolateritia* are under observation.

2.4. *Laboratory studies*

In nutritional studies in the laboratory, attempts to culture *P. hypolateritia* on purely artificial inorganic media were unsuccessful. The addition of

organic materials such as yeast or malt extract resulted in luxuriant growth; good growth was also obtained on sterilized root and stem segments of tea. Growth in Knop's solution with 10 g per litre of glucose and added thiamine was very poor unless asparagine too was added.

The inability of *P. hypolateritia* to grow in purely synthetic inorganic culture media and its ability to grow on materials such as roots and stems and in synthetic media incorporating malt or yeast extract indicate that it requires specific vitamins for growth. The nature of these requirements is now under investigation.

In a study of the growth requirements of *P. hypolateritia* using 6 isolates collected from areas of varying elevations, the optimum temperature was found to be between 25 and 30°C, and the optimum pH between 5.5 and 6.5; the latter corresponds closely with the average pH of tea soils.

3. **Collar and Branch Canker** (*Leptothyrium theae* and *Macrophoma theicola*)

During the year several outbreaks of Collar and Branch Canker in clonal tea were reported from the Udapussellawa, Welimada, Badulla and Haputale Districts. Examination of specimens received from six estates all yielded a fungus that closely resembled *L. theae*, but was not quite identical with it or with *M. theicola*, and type cultures have, therefore, been sent to the Commonwealth Mycological Institute at Kew, Surrey, for complete identification and confirmation of the causal organism.

The popular notion that the Clone TRI 2024 is uniquely susceptible to Collar Canker does not appear to be true for, in addition to TRI 2024, Clones Tillicoultry 10, UD 30, TGK 2, TRI 2025, Downside 686 and 740, Dambatenne 434, NB 3, Brunswick M 9, Kennilworth 16/3 and several other unidentified clones were also reported to have been attacked. The reason why clone TRI 2024 appears to suffer more may be due to the undoubted fact that it is used very widely in the Tea Replanting Subsidy Scheme.

The mode of entry of the fungus into the stem of young tea plants is not clear, and experiments are now in progress to find out. Once a successful inoculation technique has been worked out, it is hoped to conduct a tolerance test using young clonal tea, with a view to choosing immune or highly resistant clones for future replanting.

With regard to control of the disease, as an interim measure copper sprays have been recommended, and certain modifications in the method of bringing into bearing young tea have also been advised (Mulder, 1962).

A randomized five-fold replicated spraying trial is being conducted at Nayabedde Estate, Bandarawela, to test the effect of 4 different fungicides on the control of Collar and Branch canker in young tea. In this experiment, 1½-year-old TRI 2024 tea is sprayed at fortnightly intervals with either Perenox, or Perenox and Limbux (lime), or Captan, or Tillex.

Results are not yet available.

4. **Oil-Spot Disease**

The disease has now been definitely identified in 10 estates in the high-country, mostly around Nuwara Eliya, Kandapola and Agrapatana Districts, and field observations indicate that it is on the increase on certain fields in these estates.

A programme of weekly sprays with a number of insecticides and acaricides carried out on diseased bushes recovering from pruning has failed to control the disease. Recurrence of Oil-Spot was apparent on several of the bushes under all kinds of treatments and it became evident, therefore, that no insect or mite was connected with this disease.

Attempts to transmit the disease by sap inoculations to herbaceous plants like French bean and cucumber were unsuccessful, and grafting experiments also proved to be failures mainly due to incompatibility between different types of tea and inability of diseased buds to establish on healthy shoots.

A reconsideration of the symptoms of the disease which range from tiny oil-spots to severe scorching of the entire leaf, in some instances, and the fact that the disease appears on the same side of the bush after pruning led us to the supposition that a toxic substance moving up in the bush, either from the soil or from the frame, was responsible for the disease, as suggested earlier (Mulder, 1960).

In renewed efforts to identify the cause of this disease, a slow-growing, parasitic fungus has now been isolated from the collar and branches of affected bushes and it appears to be the causal organism of the Oil-Spot Disease. This fungus remains for the most part in the basal portions of the tea bush, being confined mainly to the wood of the frame, and experiments indicate that it produces a toxin which acts at a distance from the site of infection and gradually destroys the entire plant.

Culture filtrates of the fungus were found to induce typical symptoms of Oil-Spot in tea shoots, and wilting, desiccation and necrosis of tomato shoots and young bean plants.

Work is now in progress to isolate and characterize this toxin.

The fungus has so far remained sterile on a number of artificial media and has thus defied all attempts to identify it. Search for fruiting-bodies of the fungus continues.

Several healthy bushes in an up-country estate have also been inoculated with this fungus, but no symptoms are apparent as yet.

### 5. **Maintenance-leaf fall in the low country**

The experiment at Millakande Estate, Bulathsinhala, to test the effect of improved 'field sanitation', viz., cleaning of the frames after pruning, burning prunings, periodical application of fungicidal sprays, etc., on premature fall of maintenance-leaf was continued. Six treatments are involved in this experiment.

At the end of the year, the experiment had been in progress for nearly 18 months and five monthly assessments had been made to estimate the amount of leaf fall. The extent of fungal colonization on the experimental plots show no significant difference between treated and untreated plots, although there were slight indications that both leaf fall and fungal mycelium were less on treated plots. These assessments were made on visual observation. There was also no significant difference with regard to yield between any of the treatments and the control.

Towards the end of the year the method of assessment was improved so as to obtain a direct measure of the leaf fall; this was achieved by placing traps under experimental bushes and weighing the droppings monthly.

The experiment is expected to run until next June when the field is due for pruning, and it is hoped that the incidence of leaf fall would be high in the next six months, as this often happens towards the end of the pruning cycle, so that differences between treatments would become more apparent.

### 6. **Black Blight** (*Rhizoctonia solani*) **in the low country**

Reports of fresh outbreaks of Black Blight in 2-3-year-old clonal tea came from a few estates in the low country with the onset of wet weather, and a spraying trial was therefore initiated at the Pelawatte State Plantation in the Kalutara District to determine the concentration and frequency of spray applications necessary for the control of this disease. In this trial three fungicides, Perenox, Zineb and Dithane, were applied at the rate of 2, 4 and 6 ozs in 30 gallons of water per acre of tea.

Unfortunately, as the monsoon was erratic and the *Rhizoctonia* attack sporadic and low in intensity, the spraying had to be discontinued soon after the commencement of the experiment. The experiment will, however, be taken up again next year.

### 7. **Marginal Scorch or Rim Blight**

Severe marginal scorch and subsequent invasion by Brown and Grey Blight fungi resulted in intense defoliation of young clonal plants in a low country estate. The cause of this condition is not quite clear, though potash deficiency was considered a contributory factor.

On two other estates, severe marginal scorch accompanied by considerable leaf deformation resembling insect attack was noticed on clonal tea recovering from pruning. In the absence of insect pests, the probable cause appeared to be application of chemical manure before leaf growth had taken place following pruning.

## Virus and Virus-like Disorders

1. **Phloem Necrosis.**—Further work on this virus disease is now in abeyance.

2. **Virus-like Disorders.**—Dr. Mulder who made a special study of these disorders has now published an article on this subject which will appear in the March issue of the Tea Quarterly (1963).

## Deficiency Diseases

### Magnesium deficiency in tea

The magnesium deficiency trial at Court Lodge Estate, Kandapola, was continued. During the year no further magnesium was applied but assessments for lower-leaf chlorosis, magnesium content of the leaves, and yield, were carried out. Results showed that considerable reduction in lower-leaf chlorosis could be obtained by the application of either Dolomite, Kieserite or Epsom salt. There was also a significant increase in the magnesium content of the leaves in the Kieserite and Epsom salt-applied plots as compared with untreated plots, but this diffrence was not evident in the Dolomite-applied plots. There was no significant difference in yield between treated and control plots.

## Disease of Cover Crops and Shade Trees

### 1. Guatemala Grass (*Tripsacum laxum*)

#### 1.1. *Spikiness Disease*

Further observations made on this disease indicate that the symptoms are reminiscent of a leaf-hopper transmitted virus disease, although no proof of such transmission is available yet. However, the insect responsible for the transmission must be rather rare as the spread of the disease in the field is slow. In one experiment, healthy and diseased plants were planted out alternately in blocks of 10 ft. × 10 ft. and examination of the originally healthy plants showed that at the end of 12 months they were completely free of all symptoms.

Loppings taken from these plants also showed that the yield from healthy grass was significantly higher than that obtained from infected grass.

Results of heat inactivation experiments were somewhat inconclusive though there were indications that by immersing cuttings taken from diseased, plants in water at 49°C for 10 minutes it might be possible to raise healthy plants.

#### 1.2. *Bacterial leaf-stripe* (*Xanthomonas* sp.)

More reports of the occurrence of the disease continue to come from several estates, but so far the disease has not caused any serious damage.

Several isolates of the causal bacterium have now been obtained with a view to determining the susceptibility of other rehabilitation crops like Mana, Napier and other grasses to the disease.

### 2. Gliricidia (*Gliricidia maculata*)

A condition of inter-veinal chlorosis leading to intense yellowing of the leaves of *Gliricidia* was reported from four estates in the low-country. This condition has not been previously noticed. In one instance, water-logging was suspected but could not be proved, and the cause, therefore, remains obscure. An interesting point is that this condition passes off with lopping as the new growth appears to be free of symptoms.

Two other estates reported marginal scorch and defoliation of the lower leaves of *Gliricidia* and in one case this was ascribed to excessive manuring, while the cause on the other estate remained unknown.

## Miscellaneous

*Decay of Shade Tree Stumps*

In a trial at St Coombs, attempts were made to hasten the decay of shade tree stumps by covering them with earth, weeds or plastic. Examination of these stumps after a year showed that stumps of both *Grevillea* and *Albizzia* were more readily attacked by termites, ants and saprophytic fungi when covered with earth or other material than when left uncovered. But how far this is feasible in practice is open to doubt for two reasons: firstly, the shade trees will have to be felled at or near ground level, which is very often not done, and, secondly, it is not easy to keep a stump covered with soil particularly when it is situated on a slope.

Plans are now afoot to effect rapid decay of stumps by inoculating them with a fast-rotting saprophytic fungus.

Contrary to opinion, *Grevillea* stumps appeared to rot faster than *Albizzia* stumps.

## Publications

VISSER, T., SHANMUGANATHAN, N. & SABANAYAGAM, J. V. (1962). The influence of sunshine and rain on tea blister-blight fungus, *Exobasidium vexans* Massee, in Ceylon. *Tea Quarterly* **33**: 34-43. Reprinted from the *Ann. appl. Biol.*, **49**: 306.

MULDER, D., REDLICH, W. W. & SABANAYAGAM, J. V. (1962). "Black Blight": a leaf spot disease of tea in the low-country caused by *Rhizoctonia solani* Kuhn. *Tea Quart.* **33**: 105-109.

MULDER, D. (1962). Ring-barking of shade trees, its use and consequences with root diseases. *Tea Quart.* **33**: 146-147.

MULDER, D. (1962). The symptoms of chlorosis due to high light intensity on tea leaves at high elevation. *Tea Quart.* **33**: 148-149.

MULDER, D. (1962). The vein-banding virus disease of the dadap tree (*Erythrina lithosperma*). *Tea Quart.* **33**: 150-151.

MULDER, D. (1962). Collar canker caused by *Leptothyrium theae* Petch. *Tea Quart.* **33**: 152-155.

## References

MULDER, D. (1960). Report of the Plant Pathologist for 1959. *Ann. Rep. Tea Res. Inst. Ceylon:* 67-72.

# REPORT OF THE ACTING PLANT PHYSIOLOGIST FOR 1962

U. Pethiyagoda, B.Sc., Ph.D., D.I.C.

1. **General.**—Mr D. N. R. Wijewardena resigned from his post as Technical Assistant in September 1962. Dr T. Visser relinquished his post as Plant Physiologist on 15th October, since when I have been in charge of the Division. Mr S. Nagarajah continued his studies abroad.

135 letters have been sent out during the year. About 30 visits have been made by members of the staff to estates and sub-stations.

## 2. Field Experiments

2.1. *Shade Experiment (St Coombs).*—This trial, designed to test the combined effects of manuring and artificial shade on mature tea, was described in the Annual Report for 1961 (Visser, 1962). Each of the twelve shaded or unshaded blocks was 19½ ft × 38 ft; each block consisted of four equal-sized plots for the fertilizer treatments. The shade had been erected in May 1961 and the manurial applications made in July 1961, November 1961, March 1962 and July 1962. The tea was pruned in September-October 1962 and is now recovering.

The results so far obtained indicate that only the higher nitrogen levels have increased yield while the shade has had no significant effect. (Table 1).

TABLE 1.—*St Coombs shade trial. Yields of crop for the period May 1961 to September 1962. Each figure represents the sum of four replicates and is expressed as dry weight yield in pounds and calculated to 52 plucks (from a total of 69 plucks)*

| Fertilizer treatment | % Light intensity | | | Mean |
|---|---|---|---|---|
| | 100 | 60 | 40 | |
| $N_1K_1$ | 21.56 | 26.14 | 23.21 | 23.64 |
| $N_1K_2$ | 22.51 | 24.85 | 23.13 | 23.50 |
| $N_2K_1$ | 28.82 | 28.88 | 24.54 | 27.41 |
| $N_2K_2$ | 27.80 | 26.88 | 24.82 | 26.50 |
| Mean | 25.17 | 26.69 | 23.93 | |

| | Lb/year | Dry Wt. yield lb/4 plots/52 plucks | |
|---|---|---|---|
| $N_1$ | 100 | 23.57 | 0.58 (P=0.1%) |
| $N_2$ | 200 | 26.96 | |
| $K_1$ | 50 | 25.53 | not significant |
| $K_2$ | 100 | 25.00 | |

The trial is now due to start its first complete pruning cycle and a more complete picture may begin to emerge.

Concurrent observations have also been made on growth rates of marked flush shoots and on proportions of banji and active flush shoots in each pluck. At the same time, moisture recordings have been made at weekly intervals from gypsum blocks sunk in all shade blocks at depths of 1½, 3 and 6 ft. The results indicate that fluctuations are smaller under shade than in the exposed areas and that, as the depth increases, so also does the moisture level. The variations too are smaller at the greater depths.

At the time of pruning this trial, the following assessments were made for each plot separately:—

(*a*) total weight of prunings;
(*b*) weight of pruned wood and leaf separately;
(*c*) total leaf area (estimated);
(*d*) number of leaves (estimated);
(*e*) the maximum leaf area attained.

Estimations of dry weight were also made for (*b*), and on summation yield a value for (*a*). The results are presented in Tables 2 and 3.

TABLE 2.—*St Coombs shade trial. Assessments made at pruning (September-October 1962). Each figure represents the mean of four replicate plots. Results are tabulated on the basis of shade treatments*

| | % Light intensity | | | Sig. diff. at |
|---|---|---|---|---|
| | 100 | 60 | 40 | |
| Pruning weight (lb) ... | 33.08 | 31.31 | 27.17 | not sig. |
| Wood weight (lb) ... | 23.22 | 22.63 | 19.54 | not sig. |
| Leaf weight (lb) ... | 9.66 | 8.70 | 7.63 | not sig. |
| Leaf numbers ... | 22364 | 18688 | 15322 | 1% level=5534 |
| Leaf area $m^2$ ... | 45.63 | 45.52 | 41.35 | not sig. |
| Maximum leaf area $cm^2$ | 48 | 62 | 71 | 0.1% level=9.30 |

TABLE 3.—*St Coombs shade trial. Assessments made at pruning (September-October 1962). Each figure represents the mean of four replicate plots. Results are tabulated on the basis of fertilizer treatments.*

| | $N_1K_1$ | $N_1K_2$ | $N_2K_1$ | $N_2K_2$ |
|---|---|---|---|---|
| Pruning weight (lb) ... | 28.39 | 28.40 | 32.76 | 32.52 |
| Wood weight (lb) ... | 20.03 | 20.33 | 23.70 | 23.13 |
| Leaf weight (lb) ... | 8.39 | 8.07 | 9.06 | 9.12 |
| Leaf number ... | 17662 | 17834 | 19758 | 19911 |
| Leaf area $m^2$ ... | 42.70 | 41.09 | 46.18 | 46.70 |
| Maximum leaf area $cm^2$ | 59 | 61 | 60 | 61 |

| | $N_1$ | $N_2$ | Sig. diff. at | $K_1$ | $K_2$ | Sig. diff. at |
|---|---|---|---|---|---|---|
| Pruning weight (lb) | 28.40 | 32.64 | 0.1%level=3.47 | 30.58 | 30.46 | not sig. |
| Wood weight (lb) | 20.18 | 23.42 | 0.1%level=2.94 | 21.87 | 21.73 | not sig. |
| Leaf weight (lb) | 8.23 | 9.09 | 1%level = 0.83 | 8.73 | 8.60 | not sig. |
| Leaf number | 17748 | 19839 | not sig. | 18710 | 18873 | not sig. |
| Leaf area $m^2$ | 41.90 | 46.44 | not sig. | 44.44 | 43.90 | not sig. |
| Maximum leaf area $cm^2$ | 60 | 61 | not sig. | 60 | 61 | not. sig. |

These results indicate the following:—

1. The shade has not had a significant effect on total weight of prunings, weight of pruned wood, leaf weight and total leaf area. The total leaf number is, however, significantly decreased with increasing shade. It may be inferred from this that the average leaf area must increase with shade. Determinations of the maximum leaf area obtained at each level of shade confirm that the shaded plots have larger leaves.

2. The level of potash seems without effect on any of the assessments. The higher nitrogen level, however, has significantly increased the total weight of prunings and the weights of pruning wood and leaf separately. Leaf number, total leaf area and maximum leaf area are not significantly affected.

This result may suggest that the higher nitrogen level increases leaf thickness (or density). It should, however, be noted that the total leaf area is an estimated figure whose accuracy may be relatively low. No estimates of leaf thickness were obtained.

The results of tests of manufacture on samples drawn from this experiment are presented in the Report of the Technologist for 1962 (Keegel, 1963).

2.2. *Shade experiment (St Joachim Estate, Ratnapura).*—This trial, also briefly reported in the Annual Report for 1961 is based on the one at St Coombs. It includes two levels of light intensity (70% and 100% sunlight) and the same four fertilizer treatments, replicated four times. The plots are of approximately the same size as at St Coombs. The shade was erected in April 1962 and the first manure applied in July. The tea was pruned in November 1962.

Yield has been recorded for all plots from December 1961 until pruning in November 1962. The results indicate the absence of any shade or manurial effects—both factors probably having been operative for too short a period. The results are presented in Table 4.

TABLE 4.—*St Joachim shade trial. Yields of crop for the period April to November 1962. Each figure represents the sum of four replicates and is expressed as dry weight yield in pounds and calculated to 52 plucks (from a total of 30 plucks)*

| Fertilizer treatment | % Light intensity | | Mean |
|---|---|---|---|
| | 100 | 70 | |
| $N_1K_1$ ... | 60.5 | 62.0 | 61.3 |
| $N_1K_2$ ... | 61.3 | 61.2 | 61.3 |
| $N_2K_1$ ... | 64.3 | 68.8 | 66.6 |
| $N_2K_2$ ... | 62.6 | 62.2 | 62.4 |
| Mean ... | 62.2 | 63.6 | |

| | lb/year | Dry Wt. yield/4 plots/52 plucks. |
|---|---|---|
| $N_1$ | 100 | 61.3 } not significant. |
| $N_2$ | 200 | 64.5 } |
| $K_1$ | 50 | 64.0 } not significant. |
| $K_2$ | 100 | 61.9 } |

At the time of pruning, assessments similar to those on the St Coombs trial (see above) were carried out. In accordance with low country practice, pruning was of the 'rim-lung' type and similar figures at the time of removal of the lungs are now awaited for an evaluation of any effects.

2.3. *Mulch estimations under tea and shade trees (St Coombs)*:—This trial was initiated in 1961 and was described in the Annual Report for that year. The results of annual estimations are presented below (Table 5).

TABLE 5.—*Annual estimations of mulch from shaded and unshaded tea*

(*a*) *Shaded: Mean area per plot=497 sq. ft.*

| Period | Fresh wt/plot | Dry wt/plot | Tons/acre |
|---|---|---|---|
| Up to 20-12-60 ... | 136.3 | 108.9 | 4.26 |
| 20-12-60—8-1-62 ... | 49.8 | 35.2 | 1.38 |
| 8-1-62—8-1-63 ... | 113.1 | 73.9 | 2.80 |

(*b*) *Unshaded: Mean area per plot=841 sq. ft.*

| Period | Fresh wt/plot | Dry wt/plot | Tons/acre |
|---|---|---|---|
| Up to 3-11-61 ... | 206.5 | 129.5 | 3.04 |
| 3-11-61—6-11-62 ... | 162.5 | 82.1 | 1.90 |

Since yearly mulch estimations must be expected to yield low figures due to decay of the litter, monthly assessments are now in progress. The results so far obtained indicate, as expected, that considerably higher estimates than obtained hitherto in this experiment are likely by increasing the frequency of estimation (Table 6).

TABLE 6.—*Monthly collections of mulch from unshaded plots (as above).*

| Period | Fresh wt/plot | Dry wt/plot | Tons/acre |
|---|---|---|---|
| 6-11-62—6-12-62 ... | 29.5 | 19.1 | 0.44 |
| 6-12-62—7-1-63 .. | 34.4 | 16.6 | 0.38 |
| | | Total for two months: | 0.82 |

### 3. Studies on growth

3.1. *Reconditioning and growth.*—This experiment has been laid down at St Coombs to determine whether a single crop of potatoes prior to reconditioning with Guatemala has an effect on the subsequent growth of young tea plants. An area of land under Guatemala from May 1960 was selected and the plots meant for potato cultivation cleared in February 1961. The potato crop was raised in the months March to June. New Guatemala was planted out on these plots in July 1961. The grass on all plots was removed in March 1962 and tea (clone TRI 2025) planted in June 1962 after deep forking all of the plots.

The experiment thus compares the growth of tea on a randomized arrangement of six plots that had been continuously under Guatemala from May 1960 to June 1962 and of six plots which had an interpolated cultivation of potatoes from March to June 1961. Each plot was 12 ft × 18 ft in size.

Superimposed on this were three mutilation treatments on the tea plants, carried out at the time of planting.

(*a*) Control plants (intact);
(*b*) An estimated 1/3rd of shoot removed;
(*c*) An estimated 1/3rd of root removed;
(*d*) Estimated 1/3rd shoot plus 1/3rd root removed.

Each plot had 48 plants arranged in groups of four representing one of each mutilation treatment and control. Sampling was at fortnightly intervals with one such group being removed from each plot. Plants with similar mutilation treatments from the six "Guatemala plots" and the six "potato plots" were pooled for growth assessments (leaf weight, stem weight and root weight with corresponding dry weight estimations—summated to give total plant weights). The results are presented in Table 7.

TABLE 7.—*The effect of an interpolated crop of potatoes during reconditioning on the subsequent growth of tea (clone TRI 2025) subject to mutilation treatments at planting, (St Coombs). Results expressed as total dry weight in grams per plant (mean of values obtained for 10 separate fortnightly assessments).*

| | Potato | Guatemala | Sig. diff. at 5 % level=6.53 |
|---|---|---|---|
| | | | Mean |
| Control | 51.00 | 63.12 | 57.06 |
| 1/3 top removed | 45.78 | 54.53 | 50.16 |
| 1/3 root removed | 39.92 | 51.25 | 45.56 |
| 1/3 (top + root) removed | 32.95 | 46.95 | 39.95 |
| Mean | 42.41 | 53.96 | 48.18 |
| Sig. diff at 5 % level = 7.61 | | | |

3.1. (*b*) *Reconditioning experiment—Hantane.*—An experiment similar to the one described above (for St Coombs) was conducted concurrently at Hantane.

Two points of difference at this site were:—

(*a*) In place of the mutilation treatments, 5 clones were tested for their growth (clones A, N, DG 7, TRI 1530 and TRI 2024).

(*b*) All plants were assessed only on one occasion (30 weeks after planting).

The results presented in Table 7 (*b*) indicate that while there were marked differences in the gowth of the different clones, the planting of a crop of potatoes was without significant effect on the subsequent growth of tea.

TABLE 7.—(*b*) *The effect of an interpolated crop of potatoes during reconditioning on the subsequent growth of five clones* (*Hantane*). *Results expressed as total dry weight in grams per plant* (*assessed 30 weeks after planting*)

| Clone | Potato | Guatemala | Sig. diff. at 5 % level=9.17 |
|---|---|---|---|
| | | | Mean |
| A | 23.46 | 24.20 | 23.88 |
| N | 47.98 | 50.72 | 49.35 |
| TRI 2024 | 31.12 | 30.26 | 30.75 |
| TRI 1530 | 29.70 | 32.78 | 31.24 |
| DG 7 | 41.85 | 43.40 | 42.63 |
| Mean | 36.30 | 34.84 | 35.57 |

Difference between treatment means is not significant at the 5% level.

The results may be summarised as follows:—

(*i*) Unmutilated (control) plants were superior in their growth to all the mutilation treatments. The order being, control; 1/3rd shoot removed; 1/3 root removed; and 1/3 shoot and root removed. The last treatment resulted in considerably more casualties than the other three. These results are in accord with previous experience at St Coombs (Annual Report 1961).

(*ii*) Over the period of assessment (26 weeks) there was a significant superiority of the "Guatemala plots" over the "potato plots". This conclusion however, is made with reservation since, in the one case, the interruption of the grass cover for potato cultivation did not allow a fair chance for the establishment of the Guatemala.

The period of assessment was possibly also too short to bring out maximum effects as attention has been confined to a region of the growth curve considerably ahead of the period of most rapid increase (see Visser, Annual Report 1961). Two final assessments have therefore been delayed and remain to be made.

3.2. *Observations on production of 'banji' shoots.*—An examination of past records and field observations are in progress to determine the factors responsible for the onset of apical dormancy (banji production) in tea.

Some preliminary trials have also been carried out on the effects of leaf removal on banji shoots. The indications are too tentative in nature to warrant report at this stage.

3.3. *Growth studies on Guatemala and Mana grasses:*—This trial has been laid down at five locations—Kottawa (200—300 ft), Hantane (2,500 ft), Passara (3,400 ft), St Coombs (4,600 ft) and Oliphant estate (6,800 ft). It is intended to compare the performance of these two grasses that are commonly used as reconditioning crops, at the five elevations. The plots were planted in October-November 1962. After assessing the growth over about one year, tea is to be planted on the plots. Periodic sampling will furnish growth curves for tea at these five locations. It is hoped that the information gained will, in addition to showing any differential effects of the two reconditioning grasses, also indicate suitable time intervals for the assessment of tea in future studies on growth.

## 4. Laboratory studies

4.1. *Carbohydrate estimations:*—The main lines of investigation indicated in the Annual Report for 1961 continued. It has, however, become apparent that the results show evidence of marked inconsistencies. Accordingly, the sampling and method of estimation are now under scrutiny with a view to their standardization.

4.2. *Photosynthesis in tea shoots:*—Preliminary work is under way for a study of the photosynthetic activity of flush shoot components by a relatively crude dry weight method. It is hoped that such studies will mark the beginning of an attempt to understand more completely the nutritional status of flush shoots and their role in food manufacture, prior to plucking.

5.5. **Potato trials.**—Four trials have been carried out during the year at St Coombs and Mattakelle estates. They were two fertilizer trials, one variety trial with different manurial levels and one variety trial with two different spacings.

5.1. *Potato fertilizer trial (St Coombs and Mattakelle):*—Two potato varieties, Tedria and Eigenheimer were grown, each at two levels of N, P, K and Mg. The experiment was a $2^4$ design arranged in blocks of 4 plots each. The layout was the same at both sites and the fertilizer levels are as indicated below:

| Nutrient | Lb per acre at level | | |
|---|---|---|---|
| | 1 | 2 | |
| N | 80 | 160 | (as ammonium sulphate.) |
| $P_2O_5$ | 80 | 160 | (as ordinary super-phosphate.) |
| $K_2O$ | 80 | 160 | (as sulphate of potash.) |
| MgO | 30 | 60 | (as epsom salts.) |

The yields obtained are summarised in Table 8.

TABLE 8.—*(a) Potato fertilizer trial (St Coombs)—yield is expressed as tons per acre calculated on the basis of number of tubers planted; each figure being calculated from sixteen plots*

| Fertilizer treatments | $N_1$ | $N_2$ | $P_1$ | $P_2$ | $K_1$ | $K_2$ | $Mg_1$ | $Mg_2$ |
|---|---|---|---|---|---|---|---|---|
| Mean yield (tons/acre) | 2.81 | 2.89 | 2.46 | 3.25 | 2.88 | 2.83 | 2.77 | 2.93 |
| Yield as percentage of lower fertilizer level | 100 | 102.8 | 100 | 132.1 | 100 | 98.3 | 100 | 105.8 |
| Percentage of casualties | 28.8 | 33.5 | 36.1 | 26.2 | 31.4 | 30.9 | 30.2 | 32.1 |

The difference in yield between treatments $P_1$ and $P_2$ alone is significant at the 1% level.

All the other treatments have been without significant effect. All first order fertilizer interactions were worked out and only the P × Mg proved significant at the 1% level (see below).

| | $P_1$ | $P_2$ |
|---|---|---|
| $Mg_1$ | 2.77 | 2.78 |
| $Mg_2$ | 2.15 | 3.72 |
| | − 0.62 | +0.94 |

(*b*) *Potato fertilizer trial* (*Mattakelle*) *yield expressed as above*

| Fertilizer treatments | $N_1$ | $N_2$ | $P_1$ | $P_2$ | $K_1$ | $K_2$ | $Mg_1$ | $Mg_2$ |
|---|---|---|---|---|---|---|---|---|
| Mean yield (tons/acre) | 2.92 | 2.73 | 2.67 | 2.98 | 2.91 | 2.74 | 2.80 | 2.80 |
| Yield as percentage of lower fertilizer level | 100 | 93.5 | 100 | 111.6 | 100 | 94.2 | 100 | 100 |
| Percentage of casualties | 15.3 | 17.5 | 16.5 | 16.3 | 17.0 | 15.8 | 16.5 | 16.3 |

None of the treatments was significant.

The yields obtained in this experiment are quite low.

5.2. *Variety trial at different manurial levels* (*Mattakelle*):—Nine different varieties of potato were grown at three manurial levels in a randomized experiment with three replications.

The manurial mixture was that provisionally recommended for potatoes and was made up as follows:—

| | | |
|---|---|---|
| Ammonium sulphate | ... | 660 lb |
| Ordinary superphosphate | ... | 550 lb |
| Sulphate of potash | ... | 260 lb |
| Epsom salts | ... | 250 lb |
| | | 1720 lb per acre. |

The manurial treatments were as follows:—

$M_1$ ... No manure

$M_2$ ... Above mixture at the rate of 1,290 lb/acre (*i.e.* 3/4 normal rate).

$M_3$ ... Above mixture at the rate of 2,580 lb/acre (*i.e.* 1½ normal rate).

The yields obtained are given in Table 9.

TABLE 9.—*Variety trial at three manurial levels* (*Mattakelle*) *yields expressed as tons per acre, calculated on the basis of number of tubers planted; each figure being calculated from 27 plots* (*for each manurial level*) *and from 9 plots* (*for each variety*).

| Manurial level | $M_1$ | $M_2$ | $M_3$ | Sig. diff. |
|---|---|---|---|---|
| Mean yield (tons/acre) | 1.98 | 2.93 | 3.25 | 0.84 (at 0.1% level) |
| Percentage casualties | 5.2 | 4.2 | 4.7 | — |

The manured plots have yielded very much better than the unmanured. As between the two levels of manuring, the higher dosage has not resulted in a significantly better yield than the lower dosage (SD = 0.37 tons per acre at P = 0.05).

| Variety | Percentage casualties | Yield (tons/acre) |
|---|---|---|
| Voran | 8.1 | 1.77 |
| Eigenheimer | 6.6 | 1.83 |
| Noordeling | 1.5 | 1.86 |
| Gineke | 2.5 | 2.25 |
| Luctor | 5.6 | 2.29 |
| Extase | 15.2 | 2.32 |
| Profijt | 2.5 | 3.51 |
| Ambassadeur | 0.5 | 3.75 |
| Tedria | 0 | 4.91 |

Significant yield difference = 1.11 (P = 0.001). The varieties show markedly different performances in the experiment. The yields obtained are again quite low.

5.3. *Variety and spacing trial (St Coombs):*—The performance of seven different varieties at two spacings (12″ × 24″ and 10″ × 20″) was tested in a randomised trial replicated three times.

The results are presented in Table 10.

TABLE 10.—*Potato variety and spacing trial (St Coombs). Mean yield expressed as pounds of tubers per plot*

| Variety | Spacing a | Spacing b | Sig. diff. at 5% level=1.33 |
|---|---|---|---|
| | | | Mean |
| IVP 654 | 3.10 | 4.23 | 3.67 |
| Geld. Rode | 3.52 | 3.88 | 3.70 |
| Zeeburger | 4.40 | 3.73 | 4.07 |
| Gineke | 5.06 | 5.55 | 5.31 |
| Tedria | 6.65 | 6.96 | 6.81 |
| Hilla | 7.55 | 6.74 | 7.14 |
| Eigenheimer | 7.50 | 7.37 | 7.44 |
| Mean | 5.40 | 5.50 | 5.45 |

While varietal differences are again present, the two spacings have been without effect on yield.

## References

VISSER, T. (1962). Report of the Plant Physiologist for 1961. *Rep. Tea Res. Inst. Ceylon:* 100—123.

KEEGEL, E. L. (1963). Report of the Technologist for 1962. *Rep. Tea Res. Inst. Ceylon:*—

# REPORT ON THE SELECTION PROPAGATION AND TESTING OF CLONES FOR 1962

F. H. Kehl

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NOTE: This report incorporates information relating to a number of previous years, particularly of 1961 in respect of which no report was published. Normally this report would have been signed by the Vegetative Propagation Officer, Mr F. H. Kehl and Dr T. Visser, Plant Physiologist, but as the latter retired from the Tea Research Institute before the end of 1962, it appears under the name of Mr Kehl only.

I should like to express the thanks of the Tea Research Institute to Dr Visser who was associated with this work and gave Mr Kehl the benefit of his wide experience. (A. W. R. Joachim, 1.6. 1963).

## 1. General

1.1. *Staff.*—Mr W. Ekanayake was appointed as Field Attendant at Hantane from 2nd February, and Mr R. M. Chandrasekera as Field Attendant at St Coombs from 17th December.

1.2. *Correspondence and visits (including* 1961).—Letters received numbered 379 and those despatched 466. 160 visits to estates and the Sub-stations were made by members of the staff. As in previous years most of these visits were in connection with the selection of clones, and the collection and distribution of clonal cuttings to the different stations.

1.3. *Miscellaneous Information on the Clonal Stations.*—Apart from the work referred to under separate headings, the following is to be reported:—

(1) NEUCHATEL (about 100 ft).—The clonal areas were handed over to the estate early in January, 1961, and experimental work there ceased.

(2) HANTANE (about 2,500 ft).—The total rainfall was 75.89 inches and there were 199 wet days. A heavy infestation of Red Spider Mite was observed during August-September. It was controlled by the application of sulphur. Two staff bungalows were completed towards the end of the year.

(3) KOTTAWA (about 100 ft).—The rainfall recorded for the year was 111.99 inches. The number of wet days was 185. During very wet weather mild attacks of Rhizoctonia solani Kuhn were noticed; control was effected by spraying copper fungicides during periods when the tea was susceptible to the disease.

The building used as a temporary store was converted to a bungalow to house the Field Attendant. Two twin labour cottages were built during the year.

A sum of Rs. 2,000 was obtained from the sale of cuttings.

(4) PASSARA (about 3,500 ft).—Rainfall of 87.20 inches and 188 wet days were recorded. Symptoms of magnesium deficiency were not so marked as in previous years.

Sales of green leaf and of clonal cuttings realized Rs. 2,182.42 and Rs. 1,370/-, respectively.

## 2. Nursery Experiments

2.1. *Nursery testing of clones* (Kottawa, Hantane, Passara, St Coombs 1961).—The first set of tests was started in 1960 (Visser & Kehl, 1961) using clones which appeared to be promising as to yield and other characteristics as judged from observations made from (unreplicated) rows or small plots at St Coombs and on other estates. The purpose was to select for planting in the field those clones (out of about 70 clones) which showed the best rooting and growth in the nurseries of all four stations (elevations from 100 to 4,500 ft). Replicated nursery trials were carried out with the same clones twice each at St Coombs and Passara and once each at Hantane and Kottawa. The cuttings of each clone at each station were examined for rooting at 7, 9, 11, 13, and 16 weeks after planting; these examinations made it possible to determine the early rooter.

The 31 clones which were finally chosen for field trials (Table 1) were selected on the following bases: (*a*) rooting percentage after 16 weeks; (*b*) growth in the nursery assessed on growth of roots and shoots 16 weeks after planting; (*c*) general growth in baskets and polythene bags determined by visual observations shortly before planting was due; (*d*) whether good rooting and growth occurred in most or, in all of the 6 tests; (*e*) availability of plants at all 4 stations.

Table 1 gives the performance of 31 selected clones on nursery rooting tests. Classification in three categories. A (above average) B (about average) and C (below average) on the basis of tests at St Coombs, Passara, Hantane and Kottawa.

TABLE 1.—*Performance of 31 selected clones in Nursery rooting tests*

Classification into three categories. A (Above Average), B (About Average), and C (Below Average)

| Clone | Origin | Rooting | Root Growth |
|---|---|---|---|
| DG. 39 | Balangoda | A | B |
| MT. 18 | Balangoda | A | B |
| Mt/BG | Balangoda | A | B |
| CV4B1 | Cannavarella | A | C |
| CV5B1 | Cannavarella | A | B |
| CR. 4 | Craig | A | B |
| D N | Diyagama | A | B |
| DT 1 | Drayton | B | B |
| EN 31 | Endane | A | B |
| GMT 9 | Gonamotawa | A | B |
| KEN 15/7 | Kenilworth | A | B |
| KEN 16/3 | Kenilworth | A | B |
| K 150 | Kirkoswald | B | A |
| K 136 | Kirkoswald | B | B |
| NL 3/1 | Neluwa | A | B |
| NL 4/2 | Neluwa | A | A |
| PA 22 | Passara | A | B |
| PO 26 | Poronuwa | A | C |
| QT 1/5 | Queenstown | A | C |
| TK 48 | Talankande | B | B |
| CY 9 | Tangakelle | A | B |
| T 5/3 | Thotulagalla | A | B |
| T 5/35 | Thotulagalla | A | A |
| TRI 777 | St Coombs | B | C |
| TRI 2023 | St Coombs | A | A |
| TRI 2024 | St Coombs | A | B |
| TRI 2025 | St Coombs | A | B |
| TRI 2026 | St Coombs | A | A |
| TRI 2027 | St Coombs | A | B |
| TRI 2151 | St Coombs | A | B |
| UH 9/3 | Uva Highlands | A | B |

2.2. The nursery tests of the second series, consisting of 30 clones were completed. The cuttings of the various clones were put out in batches of 4 to 6 clones, TRI 2024 being included in every batch. The first set was planted on 25th September and the last on the 10th October. The design was similar to that described in 2.1.

Table 2 gives the performance of 18 selected clones on nursery tests.

TABLE 2.—*Performance of 18 selected clones in nursery rooting tests.*

Classification into three categories A (Above Average), B (About Average) and C (Below Average)

| Clone | Origin | Rooting | Root Growth |
|---|---|---|---|
| H 6 A1 | Hellbodde | C | C |
| H 13/4 | ,, | C | C |
| WY | Tangakelle | B | C |
| TRI 2024 | St Coombs | A | B |
| TRI 2016 | ,, | B | B |
| ,, 2020 | ,, | B | B |
| ,, 2022 | ,, | B | B |
| ,, 2024 | ,, | A | B |
| ,, 2039 | ,, | A | B |
| D | Diyagama | A | B |
| N 3 | Nayabedde | A | C |
| TRI 2024 | St Coombs | A | B |
| ,, 2043 | ,, | A | C |
| MG | Moray | B | C |
| TRI 2024 | St Coombs | A | B |
| MG 3/B1 | Cannavarella | B | B |
| NK 4/B29 | ,, | B | C |
| KP 204 | Palmgarden | B | C |
| TRI 2024 | St Coombs | B | B |
| CH 13 | Craighead | A | C |
| MPA 1 | Passara | B | B |
| TRI 2024 | St Coombs | A | B |
| NW2 | Norwood | No test<br>Insufficient material | |

Over-mature cuttings were responsible for the low rooting percentage of clones H 6A 1, H 13/4 and MG.

2.3. The third series of nursery tests on cuttings of 18 clones were started for 1963 clonal trials.

2.4. *New Clones.*—Cuttings of 9 new clones were put out in the nursery for preliminary tests. 8 clones were selected for vigorous growth and one for quality. Three other clones selected for quality were pruned; cuttings of these will be propagated early in 1963.

2.5. *Effect of shoot condition on rooting (St Coombs).*—An experiment was started in August to observe rooting and growth of cuttings from shoots which had (*a*) dormant terminal buds (banji); (*b*) terminal bud just starting to show signs of activity; and (*c*) fully active terminal buds. Cuttings of clones TRI 25 and TRI 2024 were used; the trial was replicated 4 times, with 30 cuttings/plot/clone.

TABLE 3.—*The effect of the condition of the terminal bud of the shoot in the performance of cuttings of TRI clones 25 and 2024 assessed 4 months after planting (means in brackets).*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Condition of shoot | Clone TRI | % rooting | Dry weight in g. | | |
| | | | roots | shoots | total plant |
| Dormant | 25 | 53 (75) | 0.143 (0.922) | 0.490 (0.581) | 0.633 (1.003) |
| | 2024 | 97 | 1.702 | 0.671 | 2.373 |
| Near-active | 25 | 59 (79) | 0.444 (0.945) | 0.523 (0.955) | 0.967 (1.899) |
| | 2024 | 98 | 1.445 | 1.386 | 1.831 |
| Active | 25 | 53 (75) | 0.164 (0.953) | 0.864 (1.014) | 1.028 (1.892) |
| | 2024 | 96 | 1.742 | 1.164 | 2.756 |
| Sign. diff. for means at P=0.05 | | N.S. | N.S. | 0.267 | |

The results of this experiment are given in Table 3 which shows that there is no significant difference between treatments as regards the rooting percentage (column 2) and the mean weight of roots (column 3). However, the shoot growth of cuttings taken from near-active or active shoots was significantly superior to that of cuttings made from shoots which had turned banji (column 4). The weights for total growth (column 5) show that the results improve with increased activity of the terminal bud. It can also be seen from Table 3 that the clones differ greatly in rooting and growth and behave somewhat differently according to the terminal bud activity of the shoot.

The experiment indicates clearly that the condition of the shoots can have a marked effect on the performance of cuttings in the nursery.

## 3. Growth Observation on Young Tea Plants

3.1. *The effect of pressing the soil in Polythene bags (St Coombs).*—A small-scale trial was done to observe the influence of (*a*) pressing the soil tightly round the roots of plants and (*b*) pressing the soil only moderately firmly. Each treatment was replicated thrice with 10 uniform 6 month old plants of clone TRI 2024. The plants were transferred from the nursery to polythene bags filled with a soil mixture consisting of 1 part sub-soil, 1 part peat and 1 part decomposed tea fluff.

TABLE 4.—*The effect of pressing the soil tightly (Tight) or moderately firmly (Mod) on the subsequent root and shoot weight (Dry weight in g) Assessed four months after transfer of plant beds to bags.*

| Plot No. | Root Weight | | Shoot Weight | |
|---|---|---|---|---|
| | Soil Pressed | | Soil Pressed | |
| | Tight | Mod. | Tight | Mod. |
| 1 | 5.37 | 15.25 | 5.79 | 41.16 |
| 2 | 6.36 | 11.08 | 4.24 | 28.32 |
| 3 | 6.77 | 12.87 | 10.84 | 38.12 |
| Mean S.E. | 6.17 ±0.41 | 13.40 ± 1.21 | 6.96 ± 1.99 | 35.87 ± 3.87 |

The results presented in Table 4 show a striking effect of the soil texture in the bags. The root weight of the plants in the loosely pressed soil was twice and shoot weight five times as high as those of the plants growing in the tightly pressed soil. In fact the plants in tightly pressed soil made hardly any new growth, the leaves gradually turning yellow after transplanting, while at the time of the assessment the finer roots were mostly dead or dying.

Presumably, pressing the soil firmly damaged the root system, on the one hand, while on the other the compactness of the soil must have impeded aeration and thus slowed down growth.

3.2. *The effect of removal of shoots and roots at transplanting* (*St Coombs, Passara, Hantane*).—These trials were carried out to assess the effect of partial removal of the shoot or roots at the time of transplanting on the survival and subsequent growth of the plants (see Report of the Plant Physiologist for 1961).

3.3. The effect of different treatments of polythene bags at the time of transplanting.

(1) KOTTAWA.—This experiment was designed to study the effect of (*a*) complete removal of the bag, (*b*) slitting the bag longitudinally at 4 places, (*c*) removal of basal discs, (*d*) bags intact.

The bags used were approximately 3.5 inches in diameter and about 9 inches long. The base was heat sealed and a number of perforations made to allow water to drain through. Plants approximately one year old were used, of clones Ken 16/3 and CV4B1. Assessments were carried out 8 months after the plants were put out in the field. The differences found are summarised in Table 5.

TABLE 5.—(*Kottawa*)—*The effects of* (*a*) *Removal of polythene bag* (*b*) *Slitting P. bags* (*c*) *P. bag intact* (*d*) *Removal of Basal disc at transplanting on clones KEN 16/3 and CV4B1. Mean dry weights of roots, leaves and stems per plant in g.*

| | Removed | Slit | Intact | Basal disc removed | Sign. diff. for means at P=.05 |
|---|---|---|---|---|---|
| Roots | 35.05 | 25.47 | 23.53 | 21.50 | 4.41 |
| Leaves | 49.41 | 35.04 | 27.95 | 27.11 | 5.10 |
| Stems | 52.60 | 39.96 | 31.49 | 30.45 | 5.43 |

These data show that the complete removal of bags gave better root leaf and stem growth than any of the other three treatments. Slitting of the bags resulted in more leaf and stem growth than the treatments, bags intact and basal discs removed, but no difference in root growth.

It was observed that a better spreading type of root system had developed by the removal of bags, so that there was better soil exploitation. In the slit treatment some roots had grown through the slits but a fair proportion of the feeding roots appeared to be pot bound as in the other two treatments—bags intact and basal discs removed. It was also noticed that there were no signs of the polythene bags disintegrating at the time the assessments were carried out.

(2) PASSARA.—At Passara the polythene sleeves were not heat sealed but were left open. The treatments consisted of (*a*) complete removal (*b*) slitting, the bags longitudinally at 4 places (*c*) bags intact, *i.e.* with bottom open. The bags were approximately the same size as those used at Kottawa. 14 months old plants of clones UR 12 and DF were used. Assessments were carried out 8 months after planting. The results are shown in Table 6.

TABLE 6.—(*Passara*)—*The effect of* (*a*) *Removal of polythene bag* (*b*) *Slitting P. bag* (*c*) *P. bag intact at transplanting on clones UR 12 & DF. Mean dry weights of roots, leaves and stems per plant in g.*

| | Removed | Slit | Intact | Sign. diff. for means at P=.05 |
|---|---|---|---|---|
| Roots | 4.31 | 4.24 | 3.20 | N.S. |
| Leaves | 10.75 | 8.83 | 5.72 | 2.45 |
| Stems | 12.74 | 11.23 | 8.26 | 2.14 |

The results show that there is no significant difference between treatments as regards root formation. There is also no difference in leaf and stem weights between removal of bags and slitting but they are both superior to the other treatment, bags intact. It is obvious that the clones used in this trial did not make as much growth as those at Kottawa—Table 2. Growth at Kottawa is generally more vigorous than at Passara.

3.4. *Shade Experiment.*—An experiment was laid out by Mr V. S. Kulasegaram to investigate the influence of soil cover and shade on young tea plants following transplanting in the field. The treatments were:(*a*) control, *i.e.* no cover or shade; (*b*) plants shaded with fern; (*c*) Guatemala thatch; (*d*) fern and Guatemala thatch; (*e*) Crotalaria grown in alternate rows; (*f*) Crotalaria grown in alternate rows and Guatemala thatch. The Crotalarias were lopped periodically. The treatments were replicated four times, twice each at Hantane and at Kottawa. 10-months-old plants of clone TRI 2024 were used. Two assessments were carried out, one about 7 months after planting and the second about 5-6 months later. The results are presented in Table 7.

The first assessment showed no difference between the treatments in root growth. As regards stem growth the treatments, (*c*), (*a*), (*d*) and (*b*) are superior to the two Crotalaria treatments (*e*) and (*f*); in leaf growth the treatments (*a*) and (*c*) are better than the rest of the treatments.

At the second assessment treatment (*c*) was markedly superior to (*a*), (*b*), (*e*), and (*f*) but only slightly better than treatment (*d*) in root growth. There were no differences in top growth (stem and leaves).

In the early stages the Crotalaria treatments did not seem to favour top growth. In the later stages of growth thatching with Guatemala appeared to favour root development.

3.5. *Treatment of plants at transplanting.*—An experiment was initiated by Mr V. S. Kulasegaram to study the effect of removal of part of the shoots at the time of transplanting. The treatments (*a*) control, (*b*) 1/3 top removed and (*c*) ½ top removed, were replicated 8 times. The experiment was carried out at Passara using 9-month-old plants of the clone TRI 2024. Assessments were carried out 6-7 months after planting. The results are presented in Table 8.

TABLE 7.—*The effect of shade on young tea, Mean weight of roots; stems and leaves per plant of clone TRI 2024*

| | | TREATMENTS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean Wt. | (*a*) Control | (*b*) Fern | (*c*) Thatch | (*d*) Fern & thatch | (*e*) Crotalaria | (*f*) Crotalaria & thatch | Sign. diffi. for means at P=.05 |
| 1st asst. dry wt. in g/plant | Roots | 15.75 | 16.55 | 16.43 | 13.85 | 9.10 | 11.33 | not significant |
| | Stems | 98.48 | 86.65 | 102.43 | 91.85 | 49.18 | 61.65 | 20.72 |
| | Leaves | 97.25 | 78.48 | 95.10 | 75.63 | 56.50 | 63.73 | 14.05 |
| 2nd asst. fresh wt. in oz/plant | Roots | 11.42 | 11.33 | 18.50 | 13.34 | 10.07 | 9.30 | 5.73 |
| | Top growth (stems and leaves) | 31.28 | 33.80 | 39.42 | 31.58 | 22.69 | 29.19 | not significant |

TABLE 8.—*Effect of cutting back young plants at transplanting. Mean dry weight of roots, stems, and leaves, in g. per plant.*

| | Treatments | | | Sign. diff. for means at P=0.05 |
|---|---|---|---|---|
| | (*a*) Control | (*b*) 1/3 top removed | (*c*) 1/2 top removed | |
| Roots | 2.0 | 1.58 | 1.44 | 0.372 |
| Stems | 6.01 | 5.95 | 5.54 | Not significant |
| Leaves | 7.04 | 6.60 | 6.70 | do |

The results show that there are no differences between treatments in top growth but the removal of tops ($\frac{1}{2}$ and 1/3) did reduce root growth.

## 4. Clonal testing experiments (Kottawa, Hantane, Passara, St Coombs)

4.1. (1961 *Planting*).—Up to the present, the testing of clones has been done on the basis of a single row of bushes, which has proved to be convenient for demonstration, for observation on branching type and for preliminary records of yields, prior to weeding out of unsuitable types. It is evident that by resorting to single rows, the yield of a slow growing clone can be interfered with or depressed, if it happens to be flanked by two high yielding spreading clones. Also a vigorous grower, when placed between rows of slow growing clones, can often give yields higher than what would be normally obtained. Before a consistant behaviour in yield can be claimed a more accurate test is needed. In 1960 it was, accordingly, decided that the best clones selected on row tests at St Coombs and elsewhere should be properly tested in replicated experiments at different elevations.

The first 31 clones—selected after nursery testing (see 2.1 and Table 1)—were planted in 1961 in replicated plots at St Coombs, Passara, Hantane, and Kottawa. At each locality there are 4 blocks of which 2 are shaded and 2 are unshaded. The blocks, comprising 32 plots (31 clones and 1 seedling plot), are each divided into 4 sub-blocks of 56 feet square which contain 8 plots of 28 × 14 feet planted at 4 feet between rows and 2 feet in the row. The plots are separated by a guard row of the red flush clone, TRI 26, so that each plot contains 36 plants of the clone to be tested. Gliricidia or Dadaps were planted for shade at 14 × 14 feet on the shade blocks.

The experiments at St Coombs and Hantane were planted in tea land which had been reconditioned with Guatemala grass for about one year. The experimental area in Kottawa had formerly been scrub land and that in Passara had been patna. They were planted in Guatemala grass for one year and three years respectively before planting the clones.

The removal of the grass and planting operations were carried out in the following months:—

| | St Coombs | Passara | Hantane | Kottawa |
|---|---|---|---|---|
| Grass cut to ground level | end of March | early July | early August | end of September |
| Clones planted | 2nd half of June | November | 2nd half of October | Mid-October |

The planting was done in holes, except in Kottawa where it was done in trenches of 1 ft depth and of which the bottom was forked to a depth of about 9 inches. This was done to break up the hard gravel pan at about 1 ft; the trenches were filled with top soil.

Nearly all plants at the 4 stations were bent at least once. Some of the clones not selected for trial were planted in small plots for further observations.

The clones put out in 1961 were given a light cut-across in the following months:—

| | Hantane | Kottawa | Passara | St Coombs |
|---|---|---|---|---|
| Cut-across 18 to 20 inches | December | October | — | August |
| 1st Tipping | — | — | — | November |

It is hoped to give the first cut across at Passara early in 1963.

4.2. (*1962 Planting*).—16 clones, selected after nursery tests (see Table 2), were planted in replicated plots at Kottawa and Passara, 15 at Hantane and 18, at St Coombs. Clone H 13/4 had not made sufficient growth to be included at Hantane. Two extra clones put out at St Coombs are WY and N 2, plants of which were not available at the other stations. The design is similar to that described in 4.1.

Details of the various planting operations are given below:—

| | Hantane | Kottawa | St Coombs | Passara |
|---|---|---|---|---|
| Guatemala Planted | July 1960 | April 1960 | December 1959 | April 1958 |
| Guatemala cut at ground level | June 1962 | April 1962 | March 1962 | October 1962 |
| Clones Planted | July and November 1962 | May & June 1962 | May-June 1962 | November 1962 |

At Kottawa planting was done in trenches as described previously. Two of the blocks were planted without any soil rehabilitation. This was unavoidable as suitable land that was under Guatemala grass was used for other experiments.

5. **Clonal selection work 1937-1961.**—Detailed accounts of clones have appeared in the Annual Reports for 1945, 1946 and 1947 (Tubbs, 1946? 1947? 1948?), but since then only the yields of the better clones have been dealt with in the more recent Reports (Visser, 1960; Visser & Kehl, 1961). An attempt is now made to include in this report most of the information that has been obtained from the time clonal work started in 1937.

5.1. *St Coombs* (*elevation 4,500 feet*).—Some common factors in all the clonal test plots established between 1937 and 1956 are that the clones were planted in land that had previously been in tea, and the land was not rehabilitated. The system adopted for judging the prospective value of a clone has been to grow one row of 10-30 bushes for each clone: the spacing between rows is 4 ft, with 3 ft within rows. A few clones, of which a larger number of plants was available, were planted in duplicate rows. All blocks are without shade. Ex-nursery plants approximately one year old were used in most cases.

(1) The main block consists of clones planted in 1937-38, 1939, 1941 and 1941-42. The majority of these were from selections made from 2,762 bushes that had been chosen in fields on St Coombs for size and vigour of growth and of which the individual yields were recorded (Eden, 1941?). The few clones selected from Galatura Estate, Kiriella, were chosen after recording for 5 rounds the number of crop shoots plucked of each of 1,575 bushes (Tubbs, 1938?) the block also contains other estate clones selected by visual appraisal.

The primary selections on St Coombs were made in fields being pruned by pruners, who left 4 to 5 bushes unpruned each day, avoiding all roadside bushes, bushes adjoining vacancies and double bushes. After pruning of the field was completed all bushes left unpruned were carefully examined by an officer of the Physiology Division who selected only the best looking (size, density of plucking table, etc.). All bushes selected were given a light pruning and brought into plucking after 6 weeks. The leaf of the first two plucks was discarded and thereafter the bushes were plucked weekly. The procedure adopted in recording was to have numbered linen bags, one for each bush under test; bags with two tapes attached; one in the centre and the other on the top were used so that the plucked leaf was placed in the upper section and oven dried. Before the next pluck the dried leaf was shaken to the lower section of the bag. The accumulated leaf is weighed at the end of eight pluckings, after which the lowest yielders were discarded according to the following scheme (Kehl, 1960):—

| | Start | 8th pluck 1st discard | 16th pluck 2nd discard | 24th pluck 3rd discard | 32nd pluck 4th discard |
|---|---|---|---|---|---|
| Rejected ... | 0 | 50 | 25 | 8 | 6 |
| Retained ... | 100 | 50 | 25 | 17 | 11 |

Before the final selection was made the leaf of each bush was test-manufactured a few times. Bushes with undesirable qualities were discarded.

The bushes selected were given a clean prune and allowed to run up for cuttings. Cuttings of each selected bush were planted in the nursery and only those that were not difficult to root were put out in the field.

Most of these selections were from fields of hybrid types showing "China" influence. A few selections were made on other characteristics, such as clone 33 which has a pinkish flower with a sweet odour. It was thought that the flush would perhaps produce teas with an aroma, but tests have shown that the teas were below average. Clone 26 and 32 were selected as red leafed types.

The clones put out in 1941 in the main clonal area were not brought into plucking at the same times and are placed in two groups, (*a*) and (*b*). The latter came into plucking about 10 months after (*a*) the early prunings of clones in 1937-38, 1939, 1941 (*a*) and 1941 (*b*) were generally more severe than later prunings. The pruning dates and the types of pruning adopted are given in Table 9.

TABLE 9.—*St Coombs main clonal area* (1937-38—1943-44 *planting*)
*Record of main cultural operations*

Abbreviations: C.P.=Clean Prune
S.P.=Slope Prune
C.A.=Cut Across

| Pruning | | PLANTING | | | |
|---|---|---|---|---|---|
| | | 1937-38 | 1939 | 1941 (*a*) | 1941 (*b*) |
| 1st | Date | 9/41 | 8/42 | 6/43 | 6/44 |
| | Type | C.P. 6 to 8 in. | C.P. 6 to 8 in. | C.A. 10 to 12 in. | C.A. 10 to 12 in. |
| 2nd | Date | 8/44 | 8/45 | | |
| | Type | C.A. 10 to 12 in. | C.A. 10 to 12 in. | | |

In order to obtain information on the influence of time after pruning on quality it was planned to prune one-third of each row of all rows planted in 1937-38 to 1943-44. For that purpose, the block—the clonal rows which were planted up and down the hill—was divided into three sections or areas, so that each clone was represented by a similar number of bushes, bottom (1). middle (2), top (3) areas.

The pruning was planned to be carried out in May, but it was found that the new disease Blister Blight, caused serious damage to the primary shoot after recovery. Subsequent pruning was therefore done in November, so that recovery could take place during more favourable weather conditions. After Blister Blight had been brought under control, the pruning programme was altered to the original scheme from 1955 onwards. All clones were sprayed until the first plucking to prevent undue damage to the growth of primary shoots after recovery, no further spraying was done during the cycle in order to determine blister-blight resistance. The details on pruning and plucking cycles of the different blocks are given in Table 10.

TABLE 10.—*St Coombs main clonal area. Record of main cultural operations subsequent to* 1945 *when all clones were brought into the same staggered schedules for pruning*

| Area | Pruning Date | Pruning Type | Cycle | Pruning Date | Pruning Type | Cycle | Pruning Date | Pruning Type | Cycle |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5/46 | C.P. 12 in. | 9/46 8/49 | 11/50 | S.P. 22 in. | 4/51 4/54 | 5/55 | S.P. 22 in. | 11/55 11/58 |
| 2 | 5/47 | C.P. 12 in. | 9/47 8/50 | 11/51 | S.P. 22 in. | 5/52 4/55 | 5/56 | S.P. 22 in. | 11/56 11/59 |
| 3 | 11/48 | C.P. 12 in. | 5/49 5/52 | 11/52 | S.P. 22 in. | 5/53 4/56 | 5/57 | S.P. 22 in. | 11/57 10/59 |

It will be noted from Table 10 that there is an interval of about one year between the last plucking and the next pruning date. This is due to the fact that the plucking cycle was actually 4 years, for quality studies (Keegel, 1955, 1959), but the yield of the 4th year was not recorded.

In December 1959 all areas were given a slope prune. Cuttings of some clones were taken for propagation in April 1960 after which clonal plants were given a light cut-across. They were skiffed in November 1960 and brought into plucking in January 1961, but no records were maintained.

Considering the limitations of single row tests, it was decided not to publish figures of clones as in the past, but to classify the clones on the basis of yield from areas 1, 2 and 3 into three groups. In Table 11 the categorisation is on the second cycle, unless stated otherwise.

The clones in the main area were examined for variations in resistance to Blister Blight by determining over 20 plucks the mean number of blisters; (*a*) per bush (*b*) per unit crop and (*c*) per crop shoot (Tubbs, 1948?). On the results obtained and observations made clones are placed in three groups (Table 11).

Table 11 also includes the rooting ability and yield intensity, *i.e.* the crop per unit (sq ft) bush area.

TABLE 11.—*St Coombs main Clonal area; Classification of Clones on the basis of yield; rooting tests; relative yield intensity; relative Blister-blight infection; relative quality,*

| Clones Planted | Origin | Rooting Nursery | No. of Bushes | Yield | Relative yield Int. | Blister blight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1937-38 | | | | | | | |
| M25* | Moray | B | 18 | B | — | C | A2 |
| M 23* | ,, | B | 16 | B | — | B | A2 |
| M21 | ,, | B | 26 | B | B | A | A2 |
| TRI 9* | St Coombs | B | 15 | B | — | A | C(1) |
| TRI 1* | ,, | B | 29 | B | A | A | B |
| G 18 | Galatura | B | 20 | C | — | A | C |
| M 222 | Moray | B | 30 | B | B | C | A2 |
| G 15* | Galatura | B | 20 | C | — | A | A2 |
| G 14* | ,, | B | 29 | C | C | C | A2 |
| G 16* | ,, | B | 19 | C | — | B | A2 |
| G 19 | ,, | B | 29 | C | B | C | B |
| G 13* | ,, | B | 21 | C | — | B | C |
| 1939 | | | | | | | |
| TRI 45* | St. Coombs | A | 19 | B | — | B | A2 |
| TRI 37 | ,, | B | 28 | B | B | C | A2 |
| ED 46 | Ederapolla | A | 28 | B | B | B | A2 |
| TRI 4 | St Coombs | B | 33 | B | B | A | A2 |
| MB 33* | Maliboda | C | 23 | C | — | A | B |
| D 32* | Diyagama | B | 18 | C | — | B | B |
| 1941 | | | | | | | |
| TRI 1114 | St Coombs | B | 28 | A | A | C | C |
| TRI 1526 | ,, | B | 28 | B | — | A | A1 |
| TRI 928 | ,, | A | 27 | B | A | A | A2 |
| TRI 777 | ,, | B | 33 | B | C | B | A1 |
| TRI 1076* | ,, | A | 23 | B | — | A | A2 |
| TRI 934* | ,, | B | 21 | B | — | B | B(3) |
| TRI 1530 | ,, | B | 55 | B | B | B | A2 |
| TRI 1082* | ,, | A | 21 | B | — | C | A2 |
| TRI 34 | ,, | B | 27 | B | A | B | B |
| TRI 343 | ,, | C | 30 | C | A | B | B |
| TRI 22 | ,, | B | 21 | B | — | C | C |
| TRI 483 | ,, | B | 29 | B | B | B | A2 |
| TRI 603 | ,, | A | 34 | B | B | B | B |
| TRI 407 | ,, | A | 31 | B | B | A | C(2) |
| TRI 216 | ,, | B | 55 | B | B | C | A2 |
| TRI 331 | ,, | A | 67 | B | B | C | A2 |
| TRI 128 | ,, | A | 31 | B | B | A | A2 |
| TRI 1294 | ,, | A | 59 | B | C | C | A1 |
| TRI 839 | ,, | A | 35 | C | C | B | B |
| TRI 43* | ,, | B | 41 | C | — | B | A2 |
| TRI 1005* | ,, | B | 19 | C | — | B | A2 |
| TRI 510* | ,, | A | 19 | C | — | B | C |
| Seedlings* | — | — | 43 | C | — | C | C |
| TRI 397* | St Coombs | B | 22 | C | — | B | B |
| TRI 20* | ,, | B | 7 | C | — | A | C |
| TRI 960* | ,, | B | 8 | C | — | C | C |

*Contd.*

| Clones Planted | Origin | Rooting Nursery | No. of Bushes | Yield | Relative yield Int. | Blister blight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1941-42 | | | | | | | |
| TRI 740 | St Coombs | A | 9 | B | — | A | C |
| TRI 142 | ,, | B | 28 | B | A | B | C |
| TRI 396 | ,, | B | 26 | B | C | B | C |
| TRI 105 | ,, | B | 20 | C | C | A | C |
| TRI 999* | ,, | B | 15 | — | — | C | B |
| TRI 293* | ,, | C | 18 | — | — | C | B |
| TRI 862* | ,, | B | 19 | — | — | C | B |
| TRI 687* | ,, | B | 10 | — | — | C | — |
| 1943-44 | | | | | | | |
| TRI 425 | St Coombs | B | 30 | B | — | A | A 1/2 |
| DT 1001 | Drayton | B | 13 | B | — | A | B |
| TRI 170 | St. Coombs | B | 30 | B | — | A | B |
| TRI 946 | ,, | B | 30 | B | — | B | C |
| TRI 896 | ,, | C | 30 | B | — | C | C |
| TRI 1446 | ,, | B | 20 | B | — | A | C |
| TRI 708 | ,, | C | 28 | B | — | A | B |
| TRI 1128 | ,, | C | 30 | B | — | A | C |
| TRI 1054 | ,, | C | 29 | C | — | A | C |
| TRI 235 | ,, | B | 30 | C | — | A | B |
| TRI 1456 | ,, | B | 30 | C | — | A | A2 |
| TRI 1118 | ,, | C | 27 | C | — | C | C |
| TRI 1002 | ,, | B | 17 | — | — | — | — |
| N 3 | Nayabedde | — | 38 | — | — | — | — |
| TRI 769 | St Coombs | B | 26 | — | — | — | — |
| TRI 789 | ,, | B | 26 | — | — | — | C |
| TRI 1544 | ,, | C | 40 | — | — | — | C |
| TRI 223 | ,, | C | 37 | — | — | — | C |
| TRI 132 | ,, | B | 40 | — | — | — | — |
| TRI 384* | ,, | C | 31 | — | — | B | C |
| TRI 124 | ,, | A | 36 | — | — | — | — |
| TRI 997* | ,, | B | 35 | — | — | A | C |
| N 1 | Nayabedde | — | 33 | — | — | — | — |
| S 255 | Sirikandura | — | 30 | — | — | — | — |
| TRI 742* | St Coombs | C | 36 | — | — | A | C |
| TRI 1387* | ,, | C | 19 | — | — | C | C |

Symbols classifying rooting, yield, rel. quality, blister resistance.

A = Above Average
B = About Average
C = Below Average

Symbols classifying Quality.

A1 = Outstanding
A2 = Good
B = Average
C = Poor

(1) Non-Fermenter
(2) Taint found on one occasion
(3) Taint found on two occasions

*Yields judged on First two years of first cycle

The plucking on TRI clones 23, 25, 740, 1526, 1076 and Galatura 18 was stopped after two years in the 1st cycle for the growth of propagation material.

Observations on the following clones were discontinued, (*a*) during the 1st cycle: D32, G13, G15, G16, MB33, TRI clones 9 (non-fermenter) 20, 22, 26, 43, 45, 293, 384, 397, 510, 687, 742, 862, 934, 960, 997, 999, 1005, 1016, 1082, 1387, (*b*) after the first cycle: S255, TRI clones 124, 132, 740. The following clones were rejected and uprooted: (*c*) after the first cycle: N1, S255, TRI clones 223, 769, 789, 1002, 1544; (*d*) after the second cycle: TRI 708, 896, 946, 1054, 1118, 1128, 1456 but clones N3, TRI 425 and TRI 1446 were uprooted but later replanted in other areas.

(2) The 1947-area comprises selections designed to extend the range of "Assam" type clones at St Coombs. The majority of the selections were made in a field raised from seed collected by Dr Tubbs from abroad. The selections were made after 8 rounds of test plucks in 1946. The popular TRI clones 2023, 2024, 2025, 2026 and other good clones such as 2021, 2022 and 2027 originated from seeds collected by Dr Tubbs from one particular open pollinated seed bearer. Clones were planted in May-June 1947; they were lightly cut across at 15 inches in December 1949 and brought into plucking in June 1950; plucking continued until May 1953. On account of the vigorous growth made by many clones it was decided to rest all clones for 3 months before the second prune (at 22-24 in. along the slope) which was carried out in August 1953. Upon the completion of 3 years plucking in January 1957 the bushes were rested again; as January was considered to be an unfavourable month for pruning, this was delayed until May 1957.

The area also includes 4 clones planted in June 1949-50 which were cut across pruned at 15-20 inches in November 1951. Though they were brought into plucking in March 1952 no records were maintained until after the second prune at 22 in. in August 1953. Clone TLK 13, which was planted in July 1954, was pruned at 22 in. along the slope in May 1957 and came into plucking in November 1957.

All clones were slope-pruned again at 22-24 in. in November 1960 and the bushes allowed to run up for cuttings.

Apart from yield the clones were observed for blister blight infection, tested for quality and yield intensity determined. The results and observations are given in Table 12.

TABLE 12.—*St Coombs* 1947 *Area: Classification of Clones on the basis of yield, rooting tests, relative yield intensity; relative blister-blight resistance; relative quality*

| Clones Planted | Origin | Rooting in nursery | No. of Bushes | Yield | Rel. yield Int. | Blister blight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1947 | | | | | | | |
| TRI 2024 | St Coombs | A | 31 | A | A | A | A2 |
| TRI 2026 | ,, | A | 28 | A | — | — | C |
| TRI 2025 | ,, | A | 34 | A | B | A | B |
| TRI 2046 | ,, | B | 26 | A | A | A | C |
| TRI 2016 | ,, | A | 33 | A | B | C | B |
| TRI 2043 | ,, | A | 32 | A | A | A | C |
| TRI 2023 | ,, | A | 63 | A | — | C | A2 |
| D 2050 | Diyagama | — | 6 | A | — | — | — |
| TRI 2022 | St Coombs | A | 33 | A | C | A | B |
| TRI 2042 | ,, | B | 33 | A | B | A | B |
| TRI 1076 | ,, | — | 25 | B | A | A | A2 |
| N 3 | Nayabedde | A | 26 | B | — | A | A2 |
| TRI 2021 | St Coombs | A | 9 | B | — | — | A2 |
| D 2049 | Diyagama | B | 52 | B | B | — | — |
| TRI 2044 | St Coombs | A | 34 | B | B | — | — |
| M 25 | Moray | — | 64 | B | A | C | A2 |
| TRI 2020 | St Coombs | A | 34 | B | B | — | A2 |
| TRI 2015 | ,, | B | 36 | B | B | — | — |
| M 23 | Moray | — | 25 | B | — | B | A2 |
| TRI 2014 | St Coombs | A | 34 | B | C | — | — |
| TRI 777 | ,, | — | 30 | B | A | — | A1 |
| TRI 2017 | ,, | B | 29 | B | C | — | — |
| TRI 2039 | ,, | A | 74 | B | C | — | — |
| TRI 2019 | ,, | A | 67 | B | B | — | — |
| TRI 2011 | ,, | A | 30 | C | C | — | — |
| TRI 2041 | ,, | A | 19 | C | — | — | A2 |
| TRI 2006 | ,, | A | 30 | C | C | — | — |
| 1949-50 | | | | | | | |
| MH | Moray | — | 11 | A | — | — | A2 |
| MG | ,, | — | 16 | A | C | — | — |
| F 8 | Fernlands | — | 20 | B | C | — | — |
| F 4 | ,, | — | 25 | B | B | — | — |
| 1954 | | | | | | | |
| TLK 13* | Talawakelle | — | 21 | C | — | — | — |

*First Cycle

(3) The clones in the blister-resistant block are selections made in 1947 from bushes appearing to be resistant to Blister Blight in Field No. 8 at St Coombs, which was badly affected after pruning. Originally 211 bushes were marked after careful examination of about 49,000 bushes. These were finally reduced to 21 bushes on which blisters were absent or extremely few (Tubbs, 1948?). No immune bushes were discovered in the process. Also included in the block are clones which were selected on the basis of apparent resistance to Blister Blight from outside estates.

Nearly all clones in this block were directly planted with 5 cuttings per hole in November-December 1947, but ultimately only one rooted cutting was left per hole. The cuttings received the same treatment as those in nurseries. This method was adopted in view of the urgency of estabishing clones showing resistance to Blister Blight. Clones that failed to establish were replaced between 1948 and 1954 with other clones represented by 3 or more rows in order to avoid too much competition on two sides by much older bushes.

Though the planting dates of clones differed, it was thought that a better comparison between clones could be made if the pruning operation was carried out when all the clones were ready for pruning. Clones put out in 1947 and between 1949 and 1950 were given a light cut-across prune at a height of about 15-18 in. in November 1951 and were plucked from May 1952 to April 1955. The second pruning was carried out in May 1955 and at the same time the 6 clones planted in 1952 and 1953 were given the first prune. Plucking on these 6 clones also commenced in January 1956 and ended in July 1959, when they were pruned and allowed to grow for cuttings. All clones, excluding the better clones from which cuttings were required, were given a skiff early in November 1960 and brought into plucking again towards the end of January 1961.

As for the other areas, Table 13 gives the classification of the clones.

TABLE 13.—*St Coombs blister-resistant area; classification of clones on the basis of yield; rooting tests; relative yield intensity; relative blister-blight resistance; relative quality*

| Clones Planted | Origin | Rooting Nursery | No. of bushes | Yield | Rel. Yield Int. | Blister bliight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1947 | | | | | | | |
| S 106 | Sirikandura | — | 6 | A | A | C | A1 |
| VK 9** | Ouvahkelle | B | 6 | A | A | C | A2 |
| KEN 16/3** | Kenilworth | B | 12 | A | A | C | B |
| KEN 15/7** | ,, | A | 13 | B | A | A | A2 |
| KEN 15/8** | ,, | B | 13 | B | A | B | B |
| S 123 | Sirikandura | — | 6 | B | B | C | A2 |
| KEN 15/2** | Kenilworth | A | 8 | B | B | — | C |
| TRI 1526** | St Coombs | — | 6 | B | B | A | B1 |
| TRI 2065** | ,, | A | 19 | B | B | A | C |
| KEW 4A/2* | Kew | B | 13 | B | B | C | B |
| TRI 2075 | St Coombs | A | 26 | C | C | A | — |
| TRI 2078** | ,, | B | 18 | C | C | A | — |
| TRI 2079** | ,, | A | 26 | C | C | — | — |
| VK 12 | Ouvahkelle | A | 12 | C | C | — | — |
| TRI 777 | St Coombs | — | 14 | — | | — | A1 |

*Contd.*

| Clones Planted | Origin | Rooting nursery | No. of bushes | Yield | Rel. yield Int. | Blister blight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1949 | | | | | | | |
| OK 2 | Ouvahkelle | — | 2 | B | — | A | B |
| VK 1 | ,, | A | 22 | B | A | A | B |
| UR 12 | Uda-Radella | — | 26 | B | B | A | A2 |
| OK 3 | Ouvahkelle | — | 13 | B | B | A | B |
| VK 11 | ,, | A | 13 | C | C | — | — |
| VK 4 | ,, | A | 13 | C | C | — | — |
| VK 2 | ,, | A | 13 | C | C | — | — |
| 1950 | | | | | | | |
| TK 48 | Talankande | A | 13 | A | A | — | A2 |
| KEW 14/1 | Kew | A | 13 | A | A | B | B |
| KEW 4A/4 | ,, | A | 13 | A | A | — | B |
| TRI 2091 | St Coombs | A | 13 | B | B | A | B |
| D | Diyagama | — | 12 | B | B | — | A2 |
| KEN 13/3 | Kenilworth | A | 13 | B | A | B | B |
| OK 4 | Ouvahkelle | — | 13 | B | A | A | A2 |
| TRI 2116 | St Coombs | A | 13 | B | B | C | A2 |
| OK 1 | Ouvahkelle | — | 13 | B | C | A | C |
| TRI 2104 | St Coombs | A | 13 | B | B | A | C |
| KEN 15/13 | Kenilworth | A | 13 | B | A | C | B |
| TRI 2115 | St Coombs | A | 13 | B | B | C | C |
| TRI 2086 | ,, | A | 13 | B | B | — | B |
| AO 4 | Agra Ouvah | — | 12 | B | B | B | — |
| TRI 2114 | St Coombs | B | 13 | B | B | C | B |
| KEN 15/15 | Kenilworth | B | 11 | B | B | — | — |
| TRI 2093 | St Coombs | A | 13 | B | B | A | — |
| KEN 22/1 | Kenilworth | A | 6 | B | — | B | B |
| TRI 2088 | St Coombs | A | 24 | B | C | A | — |
| TRI 2103 | ,, | A | 13 | B | C | A | — |
| B 11/69 | Bogawana | — | 8 | B | C | — | — |
| KEN 15/12 | Kenilworth | A | 13 | B | B | — | — |
| TRI 2096 | St Coombs | B | 9 | C | C | — | — |
| TRI 2112 | ,, | B | 13 | C | C | B | — |
| TRI 2092 | ,, | B | 10 | C | C | A | — |
| TRI 2074 | ,, | B | 13 | C | C | — | — |
| B 8* | Bogawana | — | 5 | B | — | — | — |
| MT/BG* | Balangoda | — | 30 | B | — | — | — |
| 1953-53 | | | | | | | |
| K 145* | Kirkoswald | — | 11 | A | A | B | B |
| K 150* | ,, | — | 8 | B | B | B | A2 |
| C 56* | Chapelton | — | 12 | B | B | B | — |
| C 58* | ,, | — | 5 | B | C | — | — |
| C 7* | ,, | — | 7 | B | B | — | — |
| C 40* | ,, | — | 11 | B | C | — | — |

*Classified on yield of first cycle.
**Cuttings planted direct in field.

(4) The windbelt area consists of a collection of clones the majority of which were selected by estates; it also includes 10 clones selected at Diyanilakele Estate for resistance to Meadow Eelworm (Portsmouth, 1954). No yield records were taken but all bushes chosen were vigorous growers even though they grew in highly infested soil. Also some of the other clones in this area came from estates which are known to be infested by Meadow Eelworm.

Most of the clones were planted in July 1953 and 10 clones in July 1954; the former were pruned in May 1955 and brought into plucking in January 1956, the latter pruned in April 1957 and plucking commenced in November 1957. The pruning given was a cut across at 15-18 in. All clones were pruned again along the slope at about 22 in. in August 1959 and allowed to grow up for propagation material. After shoots of the better clones were removed for propagation, the clones were pruned lightly in April 1960, and allowed to grow up again for cuttings. All clones, except the better ones from which cuttings were needed, were given a skiff early in November 1960 and brought into plucking at the end of January 1961.

TABLE 14.—*St Coombs Wind belt area Classification of clones on the basis of yield (1st cycle) rooting tests, relative yield intensity relative blister-blight infection; relative quality*

| Clones Planted | Origin | Rooting nursery | No. of bushes | Yield | Rel. yield Int. | Blister blight resist. | Relative quality |
|---|---|---|---|---|---|---|---|
| 1953 | | | | | | | |
| TRI 2151 | St Coombs | A | 13 | A | A | C | A2 |
| B 95 | Bogawana | A | 14 | B | B | C | B |
| DK 11 | Diyanilakelle | A | 17 | B | — | B | C |
| TRI 2025 | St Coombs | — | 16 | B | A | A | B |
| DK 19 | Diyanilakelle | A | 12 | B | B | C | A1 |
| W 3 | Wooton | B | 13 | B | A | B | A1 |
| B 77 | Bogawana | A | 18 | B | A | B | — |
| RA | Rutland | A | 6 | B | A | A | — |
| DN | Diyagama | A | 18 | B | B | C | B |
| TK 42 | Talankande | A | 16 | B | B | A | B |
| 3012 | Haputale Jungle | A | 15 | B | B | — | — |
| CH 13 | Craighead | A | 19 | B | B | — | B |
| W 14 | Wooton | A | 11 | B | A | B | A1 |
| DK 1 | Diyanilakelle | A | 14 | B | B | C | B |
| TRI 2142 | St Coombs | A | 13 | B | B | B | A2 |
| RE | Rutland | A | 14 | B | B | C | A2 |
| DK 8 | Diyanilakelle | A | 17 | B | B | A | A2 |
| DK 9 | ,, | A | 16 | B | A | A | — |
| C 171 | Chapelton | A | 15 | B | B | A | A2 |
| C 12 | ,, | A | 13 | B | B | A | — |
| TK 69 | Talankande | A | 16 | B | B | A | — |
| GN 10/1 | Glenamore | C | 11 | B | C | B | — |
| RB | Rutland | A | 9 | B | B | C | — |
| DK 24 | Diyanilakelle | A | 12 | B | B | B | — |
| TRI 2137 | St Coombs | A | 13 | B | C | A | — |
| TRI 2138 | ,, | A | 13 | B | C | B | — |
| TK 45 | Talankande | A | 9 | B | C | A | — |
| DK 2 | Diyanilakelle | A | 17 | B | C | B | — |
| 3B2 | Albion | A | 17 | C | B | — | — |
| TK 53 | Talankande | A | 13 | C | B | A | — |
| R 80 | Rutland | A | 26 | C | B | C | — |
| 3B5 | Albion | A | 20 | C | C | — | — |
| TRI 2077 | St Coombs | A | 36 | C | B | — | — |
| C 41 | Chapelton | A | 18 | C | B | A | — |
| TRI 3011 | St Coombs | A | 26 | C | C | A | — |
| RD | Rutland | A | 14 | C | B | C | — |
| DK 3 | Diyanilakelle | A | 16 | C | C | B | — |
| DK 13 | ,, | A | 19 | C | C | C | — |
| DK 17 | ,, | A | 10 | C | C | A | — |
| LP 5/3 | Sheen | — | 12 | C | C | A | — |
| 1954 | | | | | | | |
| C 103 | Chapelton | — | 5 | B | — | A | — |
| K 145 | Kirkoswald | A | 9 | B | — | A | — |
| MK 2 | Mattakele | A | 7 | B | — | A | — |
| K 136 | Kirkoswald | A | 12 | B | — | A | — |
| MK 5 | Mattakele | A | 10 | B | — | B | — |
| W 30F3 | Waltrim | A | 5 | B | — | C | — |
| HV | Hauteville | B | 8 | B | — | B | — |
| W 24F2 | Waltrim | A | 12 | B | — | B | — |
| W 34F3 | ,, | A | 6 | C | — | B | — |
| W 23F2 | ,, | A | 8 | C | — | A | — |

(5) (1955-56 plots). This block consists of 48 clones from outside estates, 4 from St Coombs and 1 from outside Ceylon. The clones had been planted in single rows for preliminary tests in July 1956 and July 1957. The area was previously under tea which was uprooted prior to the planting operations. The growth of the clones put out in 1956 suffered a setback on account of the adverse weather conditions that prevailed soon after planting. As a result, the first prune had to be carried out along with the clones put out in 1957. All clones were given a cut across at 22 inches in June-July 1958. The second prune was done at 20 inches in November. Table 15 gives the categorization into 3 groups for rooting, yield and relative quality.

TABLE 15.—1955-56 *Areas:—Classification of clones on the basis of yield; rooting tests relating quality*

| Clones Planted | Origin | Rooting nursery | No. of bushes | Yield | Relative Quality |
|---|---|---|---|---|---|
| 7/56. | | | | | |
| CW 21 | Coombewood | A | 36 | A | B |
| TRI 2142 | St Coombs | A | 20 | B | A1/2 |
| CAR 7/10A | Carolina | A | 27 | B | A2 |
| CAR 2/18 | ,, | B | 28 | B | A2 |
| QT 1/5 | Queenstown | A | 15 | B | B |
| E 7/27 | Somerset | A | 27 | B | B |
| DUN | Dunsinane | A | 24 | B | A1/2 |
| UH 9/3 | Uva Highlands | A | 22 | B | B |
| TRI 1446 | St Coombs | B | 25 | B | A2 |
| NL 3/1 | Neluwa | A | 33 | B | A2 |
| DT 1 | Drayton | A | 21 | B | A1 |
| BW. CB3B3 | Brunswick | A | 26 | B | B |
| SJ 2/30 | St James | A | 28 | B | B |
| K. EEUD 163 | Kirkoswald | A | 37 | B | B |
| CAR 7/10B | Carolina | A | 23 | B | B |
| LLF 14/2 | Luckyland | A | 20 | B | B |
| NL 4/2 | Neluwa | A | 27 | B | A1 |
| TRI 2120 | St Coombs | A | 34 | B | B |
| NL 8/3 | Neluwa | A | 34 | B | A2 |
| SJ 2/28 | St James | A | 30 | B | B |
| DON 3N1 | Marigold | A | 23 | B | B |
| UH 3/7 | Uva Highlands | A | 32 | B | B |
| AL 10/24 | Aislaby | A | 28 | B | B |
| KEEUD 20 | Kirkoswald | A | 28 | B | B |
| BW CB 2A1 | Brunswick | A | 26 | B | B |
| CAR 7/3 | Carolina | B | 34 | B | B |
| TRI 2118 | St Coombs | A | 36 | B | B |
| C 38 | Chapelton | A | 26 | B | A2 |
| DT 95 | Drayton | A | 21 | B | B |
| GF 7/6 | Gordon | A | 27 | B | A2 |
| BW DT1-47 | Brunswick | A | 28 | C | B |
| C 33A | Chapelton | B | 27 | C | B |
| TRI 425 | St Coombs | B | 27 | C | A1/2 |
| AL 3/4 | Aislaby | A | 29 | C | B |
| H 5/1 | Harrow | A | 26 | C | A2 |
| BW 1B2 | Brunswick | A | 29 | C | B |
| QT 4/4 | Queenstown | A | 27 | C | B |
| K EEUD 65 | Kirkoswald | A | 28 | C | A2 |
| BW DT1-56 | Brunswick | A | 15 | C | B |
| UH 3/4 | Uva Highlands | A | 28 | C | B |
| 7/57. | | | | | |
| MT 18 | Balangoda | B | 19 | B | B |
| TC 9 | Tillicoultry | A | 17 | B | A1 |
| QT 3/3 | Queenstown | A | 22 | B | B |
| INTRI 5/9 | Introduction | — | 6 | B | — |
| QT 1/3 | Queenstown | A | 20 | B | C |
| PA 22 | Passara | A | 22 | B | C |
| GW 19 | Great Western | A | 19 | B | A2 |
| CAR 7/4 | Carolina | B | 28 | C | B |
| TC 10 | Tillicoultry | A | 23 | C | B |
| GLEA 6 | Graigie Lea | B | 18 | C | A1/2 |
| GLEN 6/3 | Glentilt | A | 23 | C | B |
| VO 33/3 | Vellai Oya | A | 26 | C | B |

5.2. *Neuchatel (elevation 100 ft).*—The land used for clonal tests at this station was previously under rubber which was cleared just before test rows were planted.

The 1956-area was planted in May-June 1956 with clonal material consisting of well-grown plants of clones transported from the nursery at Vogan, Matugama (Walter, 1957). Rogues have been detected in about half of the clonal rows in this area, probably partly because a number of clones got mixed in the process of transporting from Vogan.

These clones, as well as those put out later, were planted at 3 feet in the row and 4 feet between rows and as shade Gliricidia was grown at 12 × 16 feet. The clones came into plucking in May 1958, completing their first cycle in May 1960. The yield classification of the clones is given in Table 16.

TABLE 16.—*Neuchatel 1956 area: Classification of clones on the basis of yield; rooting tests*

| Clones | Origin | No. of bushes | Yield |
|---|---|---|---|
| 18 | Doubtful | 80 | A |
| TRI 2026 | St Coombs | 117 | B |
| MT 18 | Balangoda | 13 | B |
| TRI 2022 | St Coombs | 15 | B |
| ED 31 | Ederapolla | 58 | B |
| ED 397 | ,, | 133 (3) | B |
| KEW 4A/4 | Kew | 87 | B |
| OP 117 | Opatha | 56 (1) | B |
| ED 177 | Ederapolla | 19 (1) | B |
| A 19 | Alupolla | 209 (2) | C |
| ED 180 | Ederapolla | 88 (3) | C |
| ED 129 | ,, | 225 (3) | C |
| TRI 2024 | St Coombs | 28 | C |
| ED 128 | Ederapolla | 11 | C |
| ED 379 | ,, | 374 | C |
| ED 60 | ,, | 19 (1) | C |
| S 220 | Sirikandura | 54 | C |
| PW 58 | Panawatte | 13 | C |
| ED 56 | Ederapolla | 19 (1) | C |
| ED 199 | Alupolla | 370 (3) | C |
| A 17 | Ederapolla | 99 | C |
| ED 97 | ,, | 164 (3) | C |
| ED 350 | ,, | 444 (3) | C |
| ED 116 | ,, | 18 (1) | C |
| ED 22 | ,, | 104 (3) | C |
| KEN 16/3 | Kenilworth | 62 | C |
| OP 110 | Opata | 122 (2) | C |
| R 5 | Rayigam | 45 | C |
| TRI 1526 | St Coombs | 18 | C |
| K 150 | Kirkoswald | 13 | C |
| TRI 1114 | St Coombs | 28 | C |
| PW 44 | Panawatta | 40 | C |
| ED 117 | Ederapolla | 19 | C |
| ED 95 | ,, | 223 (3) | C |
| A 13 | Alupolla | 144 (3) | C |
| E 31 | Endane | 22 (3) | C |
| PW 46 | Panawatte | 28 | C |
| PW 40 | ,, | 52 | C |
| ED 184 | Ederapolla | 122 (3) | C |
| ED 24 | ,, | 203 (3) | C |
| ED 73 | ,, | 22 (1) | C |
| HWSDL | Hunuwella | 21 | C |
| OP 66 | Opata | 82 (3) | C |
| R 12 | Rayigam | 26 | C |
| D | Diyagama | 43 | C |
| A 15 | Alupolla | 54 (3) | C |
| ED 134 | Ederapolla | 33 (1) | C |
| P 13 | Panawatte | 14 | C |
| HW 167 | Hunuwella | 29 (3) | C |
| ED 188 | Ederapolla | 122 (3) | C |
| ED 53 | ,, | 20 | C |
| ED 151 | ,, | 11 (1) | C |
| HW 154 | Hunuwella | 13 | C |
| ED 145 | Ederapolla | 20 | C |

The clones in the 1957 area were planted in May-June 1957 and came into plucking in April 1959 and completed 20 months plucking before the station closed down early in January 1961. Table 17 classifies the clones into 3 categories for rooting and yield.

TABLE 17.—*Neuchatel 1957 area; Classification of clones on the basis of yield; rooting tests*

| Clone | Origin | Rooting | No. of bushes | Yield |
|---|---|---|---|---|
| TRI 2023 | St Coombs | A | 57 | A |
| TRI 2025 | ,, | A | 54 | B |
| TRI 2026 | ,, | A | 56 | B |
| TRI 2021 | ,, | A | 52 | B |
| TRI 2022 | ,, | A | 57 | B |
| TRI 2024 | ,, | A | 58 | B |
| TRI 1076 | ,, | A | 57 | B |
| MT/BG | Balangoda | A | 57 | C |
| OP 177 | Opata | A | 45 | C |
| TRI 1294 | St Coombs | B | 58 | C |
| M 25 | Moray | B | 43 | C |
| TRI 2016 | St Coombs | A | 55 | C |
| ADK 29 | Alupolla | A | 40 | C |
| ADK 20 | ,, | A | 35 | C |
| KEW 14/1 | Kew | A | 56 | C |
| ED 45 | Ederapolla | A | 34 | C |
| ED 43 | ,, | B | 52 | C |
| ED 46 | ,, | B | 52 | C |
| 61/14A 21 | Alupolla | B | 48 | C |
| ED 40 | Ederapolla | B | 52 | C |
| KEW 4A/2 | Kew | A | 58 | C |
| ED 95 | Ederapolla | A | 40 | C |
| ADK 2 | Alupolla | A | 47 | C |
| ED 54 | Ederapolla | A | 56 | C |
| TRI 740 | St Coombs | B | 51 | C |
| ED 31 | Ederapolla | A | 49 | C |
| HAL 9 | Halwatura | A | 45 | C |
| WEL 1B7 | Wellandura | B | 38 | C |
| HWROW | Hunuwella | A | 57 | C |
| GIKI 3 | Gikiyanakande | B | 54 | C |
| WEL 34 | Wellandura | A | 46 | C |
| HAL 8 | Halwatura | A | 51 | C |

5.2. PASSARA (elevation about 3,500 ft.).—The land used for the clonal blocks was originally in mana grass and was then put under Guatemala grass for nearly two years (December 1955 to July 1957) before the clonal tests rows were established. Gliricidia was planted in July 1957 at a spacing of 12 ft × 20 ft on a modified triangular system so that each clonal row had approximately the same number of shade trees. Basket plants were put out in November 1957 at a spacing of 4 feet by 3 feet Crotalaria species were grown in alternate rows from November 1957 for about 12 months. The Crotalaria was lopped periodically. The rows between the tea were thatched in May 1958 with loppings of Guatemala grass at the rate of about 15 tons per acre. The first prune, which was a light cut-across at about 18 in. was given at different times (May 1959, October 1959 and January 1960) owing to the marked variations in growth of the different clones. The clones pruned in May and October were brought into plucking between December 1959 and January 1960 and plucking on those pruned in January 1960 started in April 1960. Table 18 gives the yield and rooting performance of the clones in three categories.

TABLE 18.—*Passara: Classification of clones on the basis of yield; Rooting tests*

| Clones Planted | Origin | Rooting Nursery | No. of bushes | Yield |
|---|---|---|---|---|
| 1957 | | | | |
| TRI 2023 | St Coombs | A | 176 | A |
| TRI 2026 | ,, | A | 60 | A |
| TRI 2024 | ,, | A | 115 | A |
| TRI 2025 | ,, | A | 59 | A |
| PUH 5 | Poonagalla | B | 59 | B |
| MT/BG | Balangoda | A | 60 | B |
| PCG 2 | Poonagalla | B | 59 | B |
| KEN 16/3 | Kenilworth | A | 60 | B |
| GT 4/4 | Queenstown | B | 57 | B |
| T 5/35 | Thotulagalla | A | 57 | B |
| PULG 1 | Poonagalla | B | 59 | B |
| NL 8/3 | Neluwa | B | 59 | B |
| NL 4/2 | ,, | A | 47 | B |
| SS/P | Passara Sub-Station | A | 57 | B |
| Y 2/3 | Yapame | A | 60 | B |
| TRI 1294 | St Coombs | A | 53 | B |
| T 5/3 | Thotulagalla | A | 60 | B |
| NL 3/1 | Neluwa | A | 49 | B |
| K 150 | Kirkoswald | B | 59 | B |
| TRI 2016 | St Coombs | A | 59 | B |
| TRI 25 | ,, | A | 60 | B |
| QT 1/3 | Queenstown | A | 37 | C |
| GMT 9 | Gonamotawa | A | 58 | C |
| TRI 740 | St Coombs | B | 60 | C |
| CV 4B1 | Cannavarella | A | 60 | C |
| AMAH 3/12 | Ampitiakande | A | 59 | C |
| K 145 | Kirkoswald | B | 59 | C |
| AMDCA 9/6 | Ampitiakande | A | 53 | C |
| TK 48 | Talankande | A | 59 | C |
| D | Diyagama | B | 60 | C |
| KEW 14/1 | Kew | B | 37 | C |
| T 5/2 | Thotulagalla | A | 52 | C |
| AMDCA 12/2 | Ampitiakande | A | 59 | C |
| QT 3/4 | Queenstown | B | 38 | C |
| NK 3/B1 | Cannavarella | A | 60 | C |
| TRI 2020 | St Coombs | A | 58 | C |
| TRI 1526 | ,, | B | 57 | C |
| BS 35 | Brookside | A | 58 | C |
| KEN 15/2 | Kenilworth | A | 55 | C |
| OK 4 | Ouvahkellie | A | 58 | C |
| 1958 | | | | |
| TRI 2027 | St Coombs | A | 60 | A |
| TRI 1076 | ,, | C | 60 | A |
| DT 3 | Balangoda | B | 60 | B |
| MT 35 | ,, | A | 59 | B |
| DW 26 | Downside | A | 59 | B |
| MT 20 | Balangoda | B | 60 | B |
| CY 9 | Tangakelle | A | 60 | B |
| DG 7 | Balangoda | B | 60 | B |
| MT 18 | ,, | A | 59 | B |
| DG 39 | ,, | A | 60 | B |
| CH 13 | Craighead | A | 60 | B |
| TRI 2012 | St Coombs | A | 58 | C |
| TK 42 | Talankande | B | 57 | C |
| DW 19 | Downside | C | 45 | C |
| DW 1 | ,, | A | 59 | C |
| DW 32 | ,, | A | 56 | C |
| TRI 23 | St Coombs | A | 60 | C |
| MT 13 | Balangoda | A | 54 | C |
| BW CB 2A1 | Brunswick | A | 59 | C |
| UR 12 | Uda Radella | B | 57 | C |
| DG 66 | Balangoda | B | 54 | C |
| DW 5 | Downside | B | 58 | C |
| G 18 | Galatura | A | 60 | C |
| KEN 15/7 | Kenilworth | B | 59 | C |
| TRI 2086 | St Coombs | A | 49 | C |
| KEN 15/8 | Kenilworth | B | 59 | C |

| Clones Planted | Origin | Rooting Nursery | No. of bushes | Yield |
|---|---|---|---|---|
| 1960 | | | | |
| UH 9/3 | Uva Highlands | A | 57 | B |
| PLLG 2 | Poonagalla | B | 60 | B |
| DW 29 | Downside | A | 59 | B |
| DW 12 | ,, | A | 55 | C |
| QT 115 | Queenstown | A | 54 | C |
| DW 16 | Downside | A | 59 | C |
| PA 29 | Passara | A | 35 | C |
| QT 7/1 | Queenstown | A | 52 | C |
| PUH 1 | Poonagalla | B | 60 | C |
| UH 3/4 | Uva Highlands | B | 37 | C |
| DW 3 | Downside | B | 46 | C |
| GOW 15/25 | Gowerakelle | A | 53 | C |
| GOW 15/30 | ,, | A | 49 | C |
| PA 2 | Passara | A | 42 | C |
| GOW 20/1 | Gowerakelle | A | 56 | C |
| TRI 2043 | St Coombs | A | 40 | C |
| PA 3 | Passara | A | 44 | C |
| AMA 5/60 | Ampitiakande | A | 58 | C |
| MG 3/31 | Cannawarella | A | 19 | C |
| KEW 4A/4 | Kew | B | 45 | C |
| PA 5 | Passara | A | 46 | C |
| PD 14 | Gonakelle | A | 32 | C |
| T 2/2 | Thotulagalla | A | 52 | C |

The clones planted in 1957 and 1958 were given a rim-lung prune early in November.

## 6. **Estate Clonal Areas**

Some data have been obtained on yields of clonal blocks planted on estates.

6.1. *Balangoda Group.*—Two one-acre blocks were planted in November 1954, one with seedlings and the other with clones DG2, DG3, DG4, DG6, DG7, DG8, DG9, DG10, MT3, MT10, MT12, MT13, MT15 (approximately 3,700 plants per acre). Plucking commenced in November 1957. The yields of the two blocks for 3 years are given in Table 19.

TABLE 19.—*Balangoda: Yield of seedlings and clonal blocks in lb per acre per year*

| | V.P. | Seedlings |
|---|---|---|
| 1st year ... ... | 149 | 11 |
| 2nd year ... ... | 562 | 41 |
| 3rd year ... ... | 910 | 138 |
| Total ... | 1,621 (853%) | 190 (100%) |

Table 19 shows that the clones came into bearing very much more quickly than the seedlings, the latter had scarcely yielded anything while the clones produced 1,600 lb crop over the first cycle.

One of the clones, DG4, was found to be susceptible to drought, while only the 3 clones DG3, DG7 and MT13, are considered to be above average with regard to yield. Had the whole block been planted with these clones the yield of the clonal block would have been much higher.

6.2. *Palmgarden Estate.*—Two 5-acre blocks of clones 2023 and 2026 were planted in April-May 1957, at a spacing of 4 by 2 feet, the first prune was carried out in May 1959, after which the clones were brought into plucking in June 1959. The blocks were pruned for the second time in August 1961. The data are given in Table 16, which shows that the yields compare favourably with those obtained in test rows at St Coombs and in the sub-stations.

TABLE 20.—*Palmgarden: Yields lb per acre per year*

| Clone | | | 1959-60 | 1960-61 |
|---|---|---|---|---|
| 2023 | ... | ... | 2,538 | 3,305 |
| 2026 | ... | ... | 2,382 | 3,321 |

6.3. *Berubeula Estate.*—The clonal block, of TRI 2026 which is nearly one acre in extent gave a yield of 2,858 lb of made tea per acre in the pruning year 1960 (Jayawickrema, 1960). The recorded yield in 1961 was 4,385 lb per acre.

Another area, approximately 6 acres of mixed clones planted in 1958 at a spacing of 4 by 2 feet, gave 3,500 lb per acre in 1961. The clones in the block are TRI clones 25, 2022, 2023, 2024 and 2026. Clone TRI 2026 covers about 4½ acres and TRI 2023 about one acre. The manufactured tea from the mixed clones gave more O.P. from the big bulk than that from the seedling areas.

**Acknowledgements.**—We once again record our thanks and appreciation to Superintendents of estates who have offered clonal material for our trials. The assistance received from the Superintendents and Assistants of Enselwatte, Gonakelle, Hantane and St Coombs is acknowledged with thanks. Thanks are also due to the Officers-in-charge of the sub-stations for their good work.

## References

EDEN, T. (1941?). Report of the Plant Physiologist for 1940. *Bull. Tea Res. Inst. Ceylon*, no. **22**: 63-72.

JAYAWICKREMA, D. A. (1960). Some results of vegetative propagation with TRI 2026. *Tea Quart.* **31**: 81-82.

KEEGEL, E. L. (1955). Report of the Technologist for 1954. *Bull. Tea Res. Inst. Ceylon*, no. **36**: 33-37.

KEEGEL, E. L. (1959). Report of the Technologist. *Rep. Tea Res. Inst. Ceylon.* 51-55.

KEEGEL, E. L. (1959). Tea made from clones. *Tea Quart.* **30**: 134-142.

PORTSMOUTH, G. B. (1951). Report of the Plant Physiologist for 1949. *Bull. Tea Res. Inst. Ceylon*, no. **31**: 32-37.

PORTSMOUTH, G. B. (1954). Report of the Plant Physiologist for 1952. *Bull. Tea Res. Inst. Ceylon*, no. **34**: 31-39.

TUBBS, F. R. (1938?). Report of the Plant Physiologist for 1937. *Bull. Tea Res. Inst. Ceylon*, no. **18**: 44-62.

TUBBS, F. R. (1946?). Report of the Plant Physiologist for 1945. *Bull. Tea Res. Inst. Ceylon*, no. **27**: 37-42.

TUBBS, F. R. (1947?). Report of the Plant Physiologist for 1946. *Bull. Tea Res. Inst. Ceylon*, no. **38**: 40-49.

TUBBS, F. R. (1948?). Report of the Plant Physiologist for 1947. *Bull. Tea Res. Inst. Ceylon*, no. **29**: 33-44.

VISSER, T. (1960). Report of the Plant Physiologist for 1959. *Rep. Tea Res. Inst. Ceylon*, 73-90.

VISSER, T., KEHL, F. H. (1961). Report on the selection, propagation, and testing of clones for 1960. *Rep. Tea Res. Inst. Ceylon*, 90-93.

WALTER, T. E. (1957). Report of the Low-country Scientific Officer for the period January-August, 1956. *Bull. Tea Res. Inst. Ceylon*, no. **38**: 58-60.

# REPORT OF THE STATISTICIAN FOR 1962

P. Kanapathipillai, B.Sc., F.S.S.

**Staff.**—Mr K. Seevaratnam, Technical Assistant, assumed duties on 8th December, 1962.

**Dr Pearce's Visit.**—Dr S. C. Pearce of East Malling Research Station, Kent worked with the Statistics Division from 6th January 1962 to 15th February 1962. He developed a technique for the analyses of the data of yield and fertilizer applications on estates. Briefly, the technique is as follows. The estates are first categorised into groups as homogeneous as possible in regard to elevation, rainfall *etc.* The present yields of each group of these estates are then analysed in relation to the nitrogen* applications of the present year ($N_1$), the previous year ($N_2$), the previous two years ($N_3$), and the previous four-years ($N_4$). Working on the residuals, the variance-covariance matrix or the "dispersion-matrix" is obtained. From this "dispersion-matrix" is derived the correlation matrix. The constants in the correlation-matrix gave the best estimates of the relative contributions of the factors under study towards yield.

## Analysis of Experiments

1. *Fungicide Trials*—The trials on Fields Nos. 6, 9, and 10, laid out in 1960 and 1961, and the S.W. and N.E. Monsoon trials of 1962 were analysed. Attempts to fit a dosage-mortality curve were not quite successful owing to the low incidence of Blister Blight in recent years at St Coombs.

2. *Manurial Trials*—In order to make allowance for differential plant populations, analysis of covariance was used on the data of the 3rd cycle of the 3 × 3 × 3 manurial trial at Endane. The puzzling features of this experiment, namely, no significant difference in yield in any level of any treatment, still remained.

A preliminary analysis of the 3 × 3 × 3 fertilizer trial 1962 laid out at St Coombs with clone TRI 2024, showed no significant difference in heights of plants due to the treatments.

3. *Other Trials*

The following data were also analysed:—

I. Contingency table of estates classified:
   (*a*) by elevation and injury to roots;
   (*b*) by elevation and number of nematodes per 100 gram of soil;
   (*c*) by monsoons and distribution of numbers of nematodes.
II. Sampling variations in nematode counts.
III. Nematode-susceptibility of different clones in different types of soil.
IV. The efficacy of marigold and Nemagon in increasing yields. (This experiment was conducted on Derryclare Estate).

**General**—Individual estate data of yield and fertilizer applications over the past 10 years of about 100 estates have so far been analysed. Suggestions for future fertilizer applications have been based on the above analysis together with personal discussions between the Director, the Chief Advisory Officer, the Superintendent of the estate, and myself. This scheme follows the abandonment of ratio-manuring. This interim procedure has been adopted until results from new fertilizer experiments covering the levels of fertilizer now in use, become available.

The Division continued to give assistance on problems of design, analyses and sampling.

*Nitrogen here refers to the Nitrogen in the fertilizer mixture.

# REPORT OF THE TECHNOLOGIST FOR 1962

E. L. Keegel

1. **Staff.**—Mr A. H. R. Balthazaar resigned in September; his place was filled by Mr C. Kandappah on 15th October.

Within the last four years 4 Junior Officers have resigned from the division and although they have been replaced at the first opportunity, these changes have interrupted the continuity of work. However, it is pleasing to record that in every instance the new recruits have picked up the work in a remarkably short time.

One Research Assistant and one Technical Assistant have yet to be appointed; attempts to fill these posts were not successful.

2. **Advisory.**—81 visits were made to factories, and nearly 1000 samples examined. Advisory work continued to be heavy.

3. **General.**—A series of one-day courses for tea-makers was held in various districts and proved to be a complete success. Judging from the numerous questions asked (over 300) and the interest shown in the discussions, there is no doubt that these courses have served a very useful purpose and that worthwhile results have been achieved. Over 700 tea-makers and assistant teamakers attended, including teamakers from estates not affiliated to the Planters' Association.

Details of the 13 meetings held are as follows:—

| | Date | Districts | Attendance | No. of questions asked |
|---|---|---|---|---|
| 1. | 22-1-62 | Dimbula | 100 | 19 |
| 2. | 26-2-62 | Morawake Korale | 21 | 13 |
| 3. | 2-4-62 | Sabaragamuwa | 42 | 26 |
| 4. | 11-6-62 | Pussellawa | 61 | 41 |
| 5. | 25-6-62 | Dickoya | 113 | 25 |
| 6. | 2-7-62 | Passara | 39 | 32 |
| 7. | 9-7-62 | Hewaheta | 25 | 25 |
| 8. | 16-7-62 | Nuwara Eliya | 62 | 33 |
| 9. | 23-7-62 | Badulla | 51 | 8 |
| 10. | 30-7-62 | Haputale | 58 | 41 |
| 11. | 6-8-62 | Southern Province | 47 | 25 |
| 12. | 20-8-62 | Kandy, Kurunegala and part of Kegalle | 68 | 16 |
| 13. | 27-8-62 | Kalutara, K. V., and part Kegalle | 46 | 15 |
| | | Total | 733 | 319 |

The following lectures were given:—

1. Theory of manufacture ... E. L. Keegel
2. Practice of manufacture ... A. H. R. Balthazaar
3. Thermometry and hygrometry ... W. C. A. de Silva
4. Factory Organization ... E. L. Keegel
5. Common manufacturing faults ... L. S. Weragoda

Texts of these papers and the discussions which followed will be made available in the form of a booklet to all teamakers.

The Technologist addressed the Dimbula District Planters' Association on "Future developments in tea manufacture". The address was repeated at a meeting of the Kandy District Planters' Association.

## 4. Clonal

4.1. *Examination of techniques.*—From past experience and wide knowledge of quality testing of clones, it became evident that if small-scale methods of manufacture were to be sufficiently reliable for the assessment of potential quality, the product should bear some resemblance to a tea turned out by conventional methods on a commercial scale. Otherwise wrong conclusions could be drawn.

In the mincing-machine technique, it is not of course possible to obtain a tea of standard appearance. This is nothing to worry about but one unrealistic result is the extra colour and strength. The difference in these characteristics between the mincing-machine technique and ordinary rolling can be very appreciable. That is not all; the improvement in liquoring properties is associated with some loss of inherent quality. In addition, the liquors are inclined to be harsh. If all these shortcomings are to be corrected by a very mild treatment, such as mincing the leaf once or using a mild cutter, the liquor then becomes too light and thin by normal standards. Hitherto, leaf was thoroughly crushed, even a miniature Clivemeare roller being used for the initial rupturing of the leaf. Such a technique produced strong, coloury liquors and gave misleading results. The technique has since been modified and, by the use of suitable cutters and suitable sieves, some of the previous weaknesses of such teas have been eliminated.

One feature which can be expected in a tea produced on a very small-scale is harshness. Some tasters may refer to it as brassy or metallic. Investigations revealed that, more often than not, over-withering or 'under-rolling' accentuated it. It does not, however, detract from quality unless it is pronounced. The high metal to leaf ratio was also suspected but experiments carried out on two sets of miniature rollers—one with wooden tables and the other with metallic tables—revealed that the metal was not the cause. Longer fermentations were also tried but there were no indications that the short period of fermentation adopted with a view to conserving quality was the contributory factor. A higher temperature of fermentation gave no conclusive results. So it was concluded that harshness of a liquor, unless caused by over-withering or 'under-rolling' (brought about by insufficient rupturing), was more probably due to an inherent character of the leaf than a direct result of using a mincing machine.

The employment of miniature rollers, however, results in teas more true to type. Yet here again a wide range of characteristics was possible merely by the alteration of the method of roll-breaking and period of fermentation. It appeared that a wider latitude than in the case of commercial manufacture was permissible in the estimation of quality, probably because of the much lower temperatures experienced. Nevertheless, a technique was finally arrived at which, to all intents and purposes, gave a tea not far short of a commercial product in both appearance and liquor.

One aspect of all this work was the method of firing. Because of the small quantities involved single tray drying has to be employed. Two points had to be established.

(i) *Over-all period of fermentation.*—In a normal batch process dhools are fired at different times, the difference in period between the first and last dhools that are fed into a drier being usually as much as one hour. In a miniature drier all this leaf has to be fired together at the same time. The period of fermentation had therefore to be so carefully selected that the results would not have been very dissimilar from those obtained had the teas been fired over a period of one hour or so. It was possible to get a period without loss of quality and with only an insignificant change in the other characteristics.

(ii) *Temperature of firing.*—Leaf in a 6-tray drier is subject to a progressively higher temperature as it travels from one tray to the next. It is not feasible to reproduce these conditions in a single-tray drier but we were able to simulate these conditions by subjecting the leaf initially to a low temperature and then to a higher temperature in the last stages of firing. By suitable adjustments in load, period, and temperature, we obtained results which were almost identical with those from a normal firing process.

Thus it will be seen that, in the assessment of quality or for that matter any other liquoring characteristic by micro methods of manufacture, we have developed techniques that give as true a result as can be expected on a commercial scale. In the case of the infusion, however, some differences in brightness are inevitable, mainly because of temperature differences. The colour of the infusion can also be altered in the mincing-machine technique by varying the degree of rupturing—the less the rupturing, the greener the infusion. Nevertheless, by standardising small-scale techniques, it is possible to get a result that bears some relation to what would be obtained from normal commercial scale manufacture.

4.2. *Testing of individual bushes.*—Besides the observations on the 400 bushes referred to in our last annual report, a further 500 bushes were selected in 1962 and studied for their teamaking properties particularly with a view to seeing whether a relationship existed between leaf characteristics and any particular features in the manufactured product. The characters under observation in the former case were:—

(*a*) size of leaf,
(*b*) colour of leaf,
(*c*) pubescence,
(*d*) length of internodes,
and (*e*) shape of leaf.

No conclusions could be drawn from the results, and it may safely be said that there is no possibility of selecting a bush for quality by visual observation. The only indication we had of some sort of relationship was that lighter coloured flush appeared to produce better quality teas than the darker green varieties, but here again because of some exceptions we would not place too much reliance on such an observation.

4.3. *Testing of clones:*

More clones from the V.P. plots of the Plant Physiology Division have been tested for their potential quality, and the results are given in Table 1. The symbols within brackets denote previous rank, and those marked with an asterisk possess useful colour and strength (see also Table 2). The following lists are subject to revision.

Table 1.—*Classification of clones into groups according to quality.*

Group A1.—*Clones of good quality.*

TRI 2142 (A2).

Group A1/2.—*Clones of potentially good quality*
TRI 407*(C); TRI 1001* (B); TRI 2077; B 95 (B); C 103*; DK 11 (C); DK 17*; HV; RL 80; RLB*; TK 45*.

Group A2.—*Clones with very fair quality*
TRI 16 (A2); TRI 23 (A2); TRI 45 (A2); TRI 170* (B); TRI 1016* (A2); TRI 2115 (C); TRI 2138*; TRI 3011; AB 3B2; B 3B5*; C12; C N41; DK 2*; DK 3; DK 9; DK 13; K 136* (A2); K 145 (B); KEN 15/8* (B); KEN 15/13* (B); KEN 16/3* (B); MK 2*; MK 5; OK 3* (B); RL D; RL E* (A2); TK 42 (B); TK 53*; TK 69; WT 23/F2; WT 24/F2*; WT 30F/3; WT 34/F3*.

Group B.—*Clones with fair quality*
TRI 2065 (C); TRI 2137; TRI 3012; B 77; C 171 (A2); DK 24; GN 10/1; RL A.

*Useful colour and strength, and would suit mid-country requirements.

*Abbreviations*

| | | |
|---|---|---|
| TRI | ... | Tea Research Institute |
| B | ... | Bogawana |
| AB | ... | Albion |
| C | ... | Chapelton |
| DK | ... | Diyanilakele |
| GN | ... | Glenanore |
| HV | ... | Hauteville |
| K | ... | Kirkoswald |
| KEN | ... | Kenilworth |
| MK | ... | Mattakelle |
| OK | ... | Ouvahkellie |
| RL | ... | Rutland |
| TK | ... | Talankande |
| WT | ... | Waltrim |

4.4. *Mid-country requirements.*—Up to now presentation of results of the clonal work carried out at the TRI has primarily been concerned with high-grown quality. Recently, on account of some useful work carried out by the Superintendent of Pelmadulla Group, it has also been possible to make some recommendations on the suitability or otherwise of certain clones for the low-country (Keegel 1963). With regard to the mid-country, however, no attempt has so far been made to indicate which of the clones examined for high-grown quality would be the most appropriate. In view of the enquiries we are receiving in this respect and a possible delay in establishing a manufacturing unit at the Hantane clonal-proving station, we have now selected a few clones, the manufacturing properties of which we consider would be the most suitable for mid-country conditions.

In making this choice two important points were considered. One was quality and the other, colour and strength. Although a premium is paid to teas with good colour and strength, we would not dare to recommend a clone, however coloury it may be, unless it possesses reasonably good quality. Dullish, coloury liquors are of no use to anybody, and since the brightness of the colour of a liquor is linked with quality, the selection must obviously be confined to those clones with promising quality (Groups A1 and A2).

Since the mincing-machine technique tends to give extra colour and strength, some allowance has naturally to be made when assessing a clone for these characteristics. The list given in Table 2 has been compiled after due consideration of this discrepancy, and represents clones which could be expected to produce good all-round liquors by conventional methods of manufacture.

It has not been possible to classify these clones into groups in the manner adopted for quality and tip. The clones are not arranged according to merit, and the list is subject to revision.

TABLE 2.—*Clones with useful liquoring properties*

| | | |
|---|---|---|
| T.R.I. | ... | 128, 331, 483, 777, 1082, 1294, 1530, 2021, 2023, 2024, 2041 and 2151. |
| Beaumont | ... | 12/3, 11/4 and 4B/19. |
| Brunswick | ... | BW-EM 9 |
| Cannavarella | ... | CV 4/B1 |
| Carolina | ... | CAR 2/18 |
| Chapelton | ... | C 38 |
| Craigie Lea | ... | GLEA 6 |
| Diyanilakele | ... | DK 19 |
| Dunsinane | ... | DUN 7 |
| Hellbodde | ... | H 6A/1 |
| Kirkoswald | ... | K 150 and K EEUD 65 |
| Melfort | ... | S/4/10 |
| Mooloya | ... | MO 110, MO 114, MO 208, MO 209 and MO 241 |
| Ouvahkellie | ... | OK 4 |
| Rayigam | ... | RGM/12 |
| Sirikandura | ... | S. 106 |
| Talankande | ... | TK 70 |
| Uda Radella | ... | UR 12 |
| Waltrim | ... | WT 26 and WT 36 |
| Wootton | ... | W 3 and W 14 |

5. **Age from Pruning.**—This investigation which commenced in 1959 (Keegel 1960) was terminated in July, and covered a period of about 3½ years. Interim reports on the results have been published in consecutive annual reports.

The field selected for these experiments was situated in Pedro Estate, Nuwara Eliya, at an elevation of about 6,000 ft. At this altitude, recovery from pruning is slow and takes 8-9 months. By normal up-country standards, reference only to the age from pruning might therefore be somewhat misleading. Accordingly the age of the bushes from the first pluck should also be noted when examining the results.

Previous findings (Keegel 1955, 1959) indicated that once a bush attains normal growth the tea produced from it is not markedly different from an older bush. The experiments at Pedro Estate were specially designed to test the effect of extending a pruning cycle and also to confirm previous results.

Putting together the results from a long period conveys little or no information on the effect of age on the made tea. A clearer picture is obtained if the pruning cycle is divided into smaller periods. To present the results of the three following groups in a simple way, it has been decided to split Group I into 2 periods, and Group II into 4 periods. In the case of Group III this scheme has not been adopted although this particular experiment covered a period of 9 months, because from an examination of the data there did not appear to be any inconsistent variations between the two ages from month to month.

The statistical interpretation of all results has been based on a level of significance of $P=0.05$. The following comparisons were made on an experimental scale (roller capacity 30 lb withered leaf).

GROUP I.—*Bushes 30 months from pruning compared with bushes recovering from pruning*

(Difference in age—22 months)

Period of experiment ... September 1961 to June 1962 (10 months)
Number of manufactures 23

| | Age from pruning | Age from 1st plucking |
|---|---|---|
| Older leaf ... | 30–40 months | 22–32 months |
| Younger leaf ... | 8–18 ,, | 0–10 ,, |
| Difference in age ... | 22 ,, | 22 ,, |

(NOTE:—All ages given in the following and subsequent tables refer to age from first plucking).

TABLE 3.—*Average marks obtained for the first 6 months*

(September to February)

| Characteristic | Older leaf (22-28 months) | Younger leaf (0-6 months) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | 5.31 | 4.42 | +0.89 | Significant |
| Colour ... | 5.14 | 5.47 | −0.33 | Not significant |
| Strength ... | 5.08 | 4.88 | +0.20 | ,, ,, |
| Quality ... | 5.04 | 4.26 | +0.78 | Significant |
| Valuation ... | Rs. 2.35 | Rs. 2.20 | +15 cts. | ,, |

TABLE 4.—*Average marks obtained for the next 4 months*

(March to June)

| Characteristic | Older leaf (28-32 months) | Younger leaf (6-10 months) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | 5.32 | 5.18 | +0.14 | Not significant |
| Colour ... | 5.27 | 5.27 | 0 | ,, ,, |
| Strength ... | 5.08 | 5.03 | + 0.05 | ,, ,, |
| Quality ... | 4.84 | 4.60 | + 0.24 | ,, ,, |
| Valuation ... | Rs. 2.27 | Rs. 2.20 | + 7 cts. | Significant |

*Colour and Strength.*—Results on the whole showed no significant difference in these characteristics between the two ages. Even in the early stages of the experiment there was not much variation in colour between the older and younger leaf. The only time at which colour of the younger leaf showed a tendency to be better than the other was during the dry-weather period.

Strength did not follow such a trend. The younger leaf was inferior to the older leaf in this respect for the first few plucks only, after which there was practically no difference.

*Quality.*—As expected, the younger leaf gave less quality than the older leaf for the first 6 months after plucking. The difference in quality for the next 4 months was however statistically insignificant.

*Infusion.*—This followed the same trend as quality. The infusion of the younger leaf was not only less bright but greener as well than the other for the first few plucks. In the last 4 months of the experiment the infusions were not different from one another.

*Valuation.*—The difference in the mean valuation was statistically significant for both periods, although no significant difference was observed in the liquoring characteristics for the last 4 months of the experiment.

The slightly better flavour in the older leaf when this characteristic was present evidently influenced the valuations to some extent.

GROUP II.—*Bushes 44 months from pruning compared with bushes recovering from pruning*

(Difference in age—44 months)

Period of experiment .... December 1959 to November 1961 (24 months)
Number of manufactures ... 53

| | Age from pruning | Age from 1st plucking |
|---|---|---|
| Older leaf ... | 53–77 months | 44–68 months |
| Younger leaf ... | 9–33 ,, | 0–24 ,, |
| Difference in age ... | 44 ,, | 44 ,, |

TABLE 5.—*Average marks obtained for the first 6 months*

(December to May)

| Characteristic | Older leaf (44-50 months) | Younger leaf (0-6 months) (not marked) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | | | | |
| Colour ... | 5.00 | 5.07 | −0.07 | Not significant |
| Strength ... | 5.07 | 4.95 | +0.12 | ,, ,, |
| Quality ... | 5.01 | 4.72 | +0.29 | Significant |
| Valuation ... | Rs. 2.42 | Rs. 2.29 | +13 cts. | ,, |

TABLE 6.—*Average marks obtained for the nezt 6 months*

(June to November)

| Characteristic | Older leaf (50-56 months) | Younger leaf (6-12 months) (not marked) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | | | | |
| Colour ... | 4.96 | 5.09 | −0.13 | Not significant |
| Strength ... | 5.04 | 4.97 | +0.07 | ,, ,, |
| Quality ... | 5.04 | 4.97 | +0.07 | ,, ,, |
| Valuation ... | Rs. 2.40 | Rs. 2.40 | 0 | ,, ,, |

TABLE 7.—*Average marks obtained for the period January to June* (6 months)

| Characteristic | Older leaf (57-63 months) | Younger leaf (13-19 months) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | 5.41 | 5.03 | +0.38 | Significant |
| Colour ... | 5.30 | 5.86 | −0.56 | ,, |
| Strength ... | 5.19 | 5.30 | −0.11 | Not significant |
| Quality ... | 4.97 | 4.59 | +0.38 | Significant |
| Valuation ... | Rs. 2.38 | Rs. 2.37 | +1 ct. | Not significant |

TABLE 8.—*Average marks obtained for the last 5 months*

(July to November)

| Characteristic | Older leaf (63-68 months) | Younger leaf (19-24 months) | Difference | Result |
|---|---|---|---|---|
| Infusion ... | 5.82 | 5.48 | +0.34 | Significant |
| Colour ... | 5.16 | 5.32 | −0.16 | Not significant |
| Strength ... | 4.95 | 5.34 | −0.39 | Significant |
| Quality ... | 5.29 | 5.19 | +0.10 | Not significant |
| Valuation ... | Rs. 2.33 | Rs. 2.35 | −2 cts. | ,, ,, |

The results follow the same trend as in Group I despite a very much bigger difference in the ages. After 6 months from the first plucking the teas are almost identical, the main notable difference having occurred in colour during the dry weather period in favour of the younger leaf (Table 7). In this same period preference was given to the older leaf in infusion and quality but the differences, though statistically significant, did not affect the mean valuations of the teas. A decline in strength of the older leaf in the last 5 months of the experiment should be noted, which was compensated for by the improvement in the brightness of the infusion. Otherwise the two teas were practically the same.

*Colour of infusion.*—As in Group I the infusion of the younger leaf was slightly greener than the other in the early stages.

*Flavour.*—The early months of 1960 did not produce much flavour, so it was not possible to establish anything with regard to this feature. In 1961, however, by which time the younger leaf was just over a year old from the first plucking, there was evidence of flavour in some of the manufactures carried out. There was little to choose between the younger and older leaf in this respect.

GROUP III.—*Bushes 62 months from pruning compared with bushes 44 months from pruning*

(Difference in age—18 months)

Period of experiment ... March 1959 to November 1959 (9 months)
Number of manufactures ... 19

| | Age from pruning | Age from 1st plucking |
|---|---|---|
| Older leaf ... | 62–71 months | 53–62 months |
| Younger leaf ... | 44–53 ,, | 35–44 ,, |
| Difference in age ... | 18 ,, | 18 ,, |

TABLE 9—*Average marks obtained for the whole period March to November*

| Characteristic | Older leaf (53-62 months) | Younger leaf (35-44 months) | Difference | Result |
|---|---|---|---|---|
| Infuson ... | 6.52 | 6.71 | −0.19 | Not significant |
| Colour ... | 5.23 | 5.92 | −0.69 | Significant |
| Strength ... | 5.14 | 5.73 | −0.59 | ,, |
| Quality ... | 5.32 | 5.48 | −0.16 | Not significant |
| Valuation ... | Rs. 2.54 | Rs. 2.60 | −6 cts. | ,, ,, |

*Colour and strength.*—With the exception of a few isolated instances, the younger leaf consistently gave more colour and strength, the difference being significant.

*Infusion and quality.*—No significant difference was observed between the two ages in these characteristics.

*Valuation.*—A higher mean valuation of 6 cts. was obtained for the younger leaf because of the better colour and strength but this difference was not statistically significant.

*Flavour.*—This when present was not affected.

*General conclusions.*—It is not a simple matter to translate all these results into practical terms, which would have a very wide application, because of the conditions under which these experiments were conducted. For one thing the material was derived from an estate in Nuwara Eliya district, and for another the leaf was manufactured at St Coombs. The time of pruning and method of pruning are also important since the period at which a bush comes into plucking and the time taken for it to recover from pruning could alter the characteristics of the made tea somewhat appreciably.

However, it is possible to draw some broad conclusions, and one such conclusion is that undue extension of a pruning cycle does not improve quality (Table 9).

A second conclusion is that only during periods favourable to the development of inherent quality does older leaf produce more quality than very much younger leaf. For example in Group I it was observed that in the later stages of the experiment, when the weather was wet, the younger leaf showed no difference in quality from older leaf. This must be regarded more as a result of the change in climatic conditions than because of the leaf getting older. The point is best illustrated in Tables 6, 7 and 8, where no significant difference was observed between 6-12 months and 50-56 months, but the latter was significantly better in the next 6 months; in the period following this, however, quality was again similar to each other.

A third and interesting result is that colour also reacts in a marked way to a change in climatic conditions. If the weather is not conducive to the development of quality, 28 months gives the same results as 50 months when compared with leaf only 6 months from plucking. In a quality period, younger leaf gives better colour than older leaf (Table 7). The reason for 35-44 months giving better colour than 53-62 months (Group III) is however obscure, since in the light of the results from Groups I and II one would have expected no difference. Anyway there is some justification for concluding from the general trend of the results that the younger the leaf the better the colour.

As regards strength the pattern is somewhat clearer. This characteristic quickly regains a normal level after the first few plucks and declines when the bush gets too old.

It is not possible of course from these results to specify the exact age at which any characteristic is at its optimum during a pruning cycle, because quite evidently there are a number of conditions to consider, chief of which appears to be climate. This would appear to be a more influencing factor than age from pruning on the made tea, and tends to confuse the issue. However, these results in conjunction with earlier work carried out (Keegel, 1955, 1959) indicate that with respect to quality, the older the leaf the better the quality when this characteristic is intrinsically present to a high degree due

either to climatic conditions or some inherent property in the leaf. Otherwise leaf as young as 6 months from the first plucking produces just as good quality as much older leaf. In the case of colour the general conclusion is that the older the leaf the less the colour. Strength is quite definitely below par in the early stages of a pruning cycle, probably reaches a peak, and then tends to decline. Flavour appears to follow the same trend as quality and so does the brightness of the infusion.

The general conclusion is that for colour and strength the short er the pruning cycle the better but for quality and flavour long pruning cycles are preferable.

In addition to this work two blocks of clone TRI 2024, grown at St Coombs and planted at different times, were examined during the dry weather period (January to March). Particulars of these blocks are as follows:—

| | Date of planting | Date of pruning | Age from pruning | Age from 1st plucking |
|---|---|---|---|---|
| Block 41 | October 1953 | Mid 1959 | 2½ years (approx.) | 2 years (approx.) |
| „ 46 | June 1955 | — | — | 4 „ ( „ ) |

There was no significant difference between the two teas, except in colour, Block 41 (2 years from plucking) having been preferred—a result consistent with previous observations.

6. **Relationship between various characteristics.**—The vast amount of data collected from the foregoing pruning experiments was utilized for a statistical investigation of any relationship which existed between some of the characteristics reported on. Quality in relation to infusion and colour was examined, and the results from 100 samples are given in Tables 10 and 11. Each sample was evaluated by 8 tasters, and the average marks for each characteristic were obtained after a rejection test had been carried out statistically for each sample.

**Notation etc:**

r = coefficient of correlation
i = infusion (brightness of, not colour of)
q = quality
c = colour
s = strength

*e.g.*

$r_{iq}$ = total correlation between i and q

$r_{iq.c}$ = partial correlation between i and q when c is kept constant.

$r_{iq.sc}$ = partial correlation between i and q when both s and c are kept constant.

TABLE 10.—*Relationship between infusion and quality*

| | Correlation coefficient (r) | Level of significance | degrees of freedom | Value of r after transformation to z |
|---|---|---|---|---|
| $r_{iq.}$ | 0.6130 | P<0.001 | 98 | 0.7131 |
| $r_{iq.c}$ | 0.6084 | P<0.001 | 97 | 0.7066 |
| $r_{iq.s}$ | 0.6854 | P<0.001 | 97 | 0.8400 |
| $r_{iq.sc}$ | 0.5507 | P<0.001 | 96 | 0.6200 |

Standard error between any two values of

$$z = .1455$$

The correlation coefficients are not significantly different. Therefore the relationship between infusion (i) and quality (q) appeared to be independent of strength (s) or colour (c).

TABLE 11.—*Relationship between colour and quality*

| | Correlation coefficient (r) | level of significance | degrees of freedom | value of r after transformation to z |
|---|---|---|---|---|
| $r_{cq.}$ | 0.1145 | Not significant even at P=.1 | 98 | 0.11516 |
| $r_{cq.i}$ | 0.06466 | ,, | 97 | 0.06464 |
| $r_{cq.s}$ | −0.3058 | P<0.001 | 97 | 0.31593 |
| $r_{cq.is}$ | −0.4328 | P<0.001 | 96 | 0.46330 |

$$\frac{z_{cq.is} - z_{cq.}}{S.E.} = 2.393$$ which is significant at 2%.

$r_{cq.}$ is significantly different from $r_{cq.is.}$

Accordingly the relationship between c and q appeared to be influenced by either infusion (i) or strength (s) or both.

$$\frac{z_{cq.is} - z_{cq.s}}{S.E.} = \frac{.14737}{.1455}$$ which is not at all significant.

$r_{cq.is}$ is not significantly different from $r_{cq.s.}$ Therefore the relationship between colour (c) and quality (q) appeared to be unaffected by infusion (i).

$$\frac{z_{cq.s} - z_{cq.i}}{S.E.} = \frac{0.25129}{0.1455} = 1.7271$$ which is not significant at 5% level, but is significant at 10%.

Since $r_{cq.is}$ and $r_{cq}$ are significantly different, it seems reasonable to attribute this difference only to the influence of s. Hence the relationship between colour ($c$) and quality ($q$) appeared to be affected only by strength ($s$) and not by infusion ($i$).

*Conclusion.*—The results indicate that a significant correlation exists between the brightness of an infusion and quality, which does not appear to be influenced by the degree of colour or strength.

There is a tendency for colour to improve with a decrease in quality, but this relationship seems to be affected by the strength of a liquor. Under what conditions strength contributes to this relationship remains to be determined.

7. **Shade.**—With the co-operation of the Plant Physiology Division, the effect of shade was investigated on an area planted up with clone TRI 2025, which was pruned in June 1959 and had been in regular plucking since May 1960. At the time manufacture tests commenced the bushes had been in regular plucking for about 15 months. Tests covered a period of approximately one year, during which 25 manufactures were carried out.

Three levels of shade were examined, namely:—

| | | |
|---|---|---|
| No shade | .... | 100% light |
| Medium | ... | 60% ,, (approximately) |
| Heavy | ... | 40% ,, ,, |

The results are given in Table 12.

TABLE 12.—*Average marks and valuations obtained for three levels of shade*

| Characteristic | Means | | | Conclusion |
|---|---|---|---|---|
| | No. shade | Medium shade | Heavy shade | |
| Infusion | 5.88 | 4.39 | 3.63 | No shade better than medium shade, which is better than heavy shade.* |
| Colour | 4.74 | 5.71 | 5.81 | No shade worse than both medium and heavy shade, which are not significantly different.* |
| Strength | 5.29 | 5.65 | 5.72 | No shade worse than both medium and heavy shade, which are not significantly different.** |
| Quality | 5.39 | 4.37 | 4.05 | No shade better than both medium and heavy shade, which are not significantly different.* |
| Valuation | Rs. 2.41 | Rs. 2.26 | Rs. 2.20 | No shade better than both medium and heavy shade, which are not significantly different.* |

* Level of significance < 0.1%

** ,, ,, ,, < 2%

The results are quite conclusive. Shade improves colour and strength but has an adverse effect on quality, and also flavour, when the latter is present. In the height of the flavoury season, the differences in flavour and quality were so pronounced that on one occasion no shade was valued 70 cts higher than heavy shade. The colour of the infusion also appears to be influenced by shade, the heavier the shade the greener the infusion. The effect of shade on the various characteristics and valuations is best seen from the graphs in Figures 1 to 5.

8. **Manuring.**—The Annual Report for 1958 (Keegel, 1959) refers to some experiments on the effects of nitrogen, potash and phosphate on the made tea. The conclusions were based on a general trend of marks given by tasters for the various samples. In view of the importance of the subject, the results have now been more closely analysed on a statistical basis and are given in Tables 13, 14 and 15.

TABLE 13.—*Effect of nitrogen* (40 *N vs* 80 *N*)

| | | |
|---|---|---|
| Colour | ... | Difference significant in favour of 40 N at 5% level |
| Strength | ... | ,, ,, ,, ,, 2% ,, |
| Quality | ... | ,, ,, ,, ,, <1% ,, |
| Valuation | ... | ,, ,, ,, ,, <1% ,, |

TABLE 14.—*Effect of potash* (20 *K vs* 40 *K*)

| | | |
|---|---|---|
| Colour | ... | Difference significant in favour 40 K at 2% level |
| Strength | ... | ,, not ,, even at 10% level |
| Quality | ... | ,, ,, ,, ,, ,, |
| Valuation | ... | ,, ,, ,, ,, ,, |

TABLE 15.—*Effect of phosphate* (30 *P vs* 60 *P*)

| | | |
|---|---|---|
| Colour | ... | Difference not significant even at 10% level |
| Strength | ... | ,, ,, ,, ,, |
| Quality | ... | ,, significant in favour of 60 P at <5% level |
| Valuation | ... | ,, not significant even at 10% level |

The statistical data indicate that under the experimental and sampling conditions, the examination of samples of tea manufactured with miniature scale equipment on a limited number of occasions tend to show that colour and quality are adversely affected by the higher nitrogen dosage applied. Colour tends to be improved by the higher level of potash and quality by the higher level of phosphoric acid used. Further investigations on this subject are contemplated.

Further experiments were done in 1962, leaf from the shade experiments being used for comparing two levels of nitrogen. The following combinations were examined:—

| | | |
|---|---|---|
| N1K1 | ... | 100 lb N and 50 lb K (A) |
| N1K2 | ... | 100 ,, ,, ,, 100 ,, ,, (B) |
| N2K1 | ... | 200 ,, ,, ,, 50 ,, ,, (C) |
| N2K2 | ... | 200 ,, ,, ,, 100 ,, ,, (D) |

Seventeen manufactures were carried out spread over 6 months. There was no significant difference between all 4 treatments, on the basis of tasters' reports.

From the data as regards 40 N and 80 N, there is every reason to believe that beyond a certain level of fertiliser application the influence of dosage on the made tea is insignificant. This explains the failure of treatments A and B to produce a better tea than C or D. These conclusions should however be regarded as tentative till more evidence is available.

9. **Withering materials.** Further to the work carried out on nylon net and plastic materials, reported in the Annual Report for 1961 (Keegel, 1962), observations on the following materials have been begun:—

| *Manufacturers* | *Agents* | *Type of Material* |
|---|---|---|
| I.C.I. | — | "Terylene" |
| Fukui Fishing Net Co. (Japan) | Bristol Agency | Knotless 'Mycle' net |
| Nippon Seimo Co. (Japan) | P.P.P. Jinadasa | Knotless "Kuralon" net |
| Courtauld & Co. (U.K.) | — | Polythene Courlene x 3 |
| Reeves (U.S.A.) | — | Polyethylene yarn |
| Chicopee Mills (U.S.A.) | — | Lumite woven Polypropylene fabric. |

It is far too early yet to offer any opinion on the suitability or durability of these materials, or to make any specific recommendation as to which is the best material available at present. However, the choice of a material should take the following points into consideration:—

1. Mesh size of 4 meshes to the inch
2. Mesh size remains constant
3. Light in weight and has good tensile strength properties
4. Does not require much stretching, and
5. Free from knots.

A matter that is somewhat confusing to the purchasers of nylon material—the diamond type that has to be stretched—is the specification given for mesh size and length. Mesh size refers to the diagonal distance and not to the actual size of the mesh in a linear direction. For example, "½ inch stretched mesh" corresponds to 4 meshes to the linear inch after the material is stretched for a withering tat. Likewise, a specified stretched measurement is not the same as that of a material after it has been stretched in all directions when installed as a tat. A stretched measurement of say 50′ would be equivalent to only the length of a standard tat (34′). The word 'stretched' in the suppliers' specifications refers to the material as supplied and *not* to any measurements after the material has to be stretched further.

10. **Miscellaneous:**

10.1. *Roll-Breaking.*—The improvement of the colour and strength by double roll-breaking of the dhool is well known up country and because of this it is quite a common practice to double roll-break a dhool in quite a number of up-country factories. What is perhaps not recognized is that although the coarser fraction of a dhool is inferior to the finer portions in these characteristics it does not necessarily follow that a similar difference in quality exists. From the results of a series of trials carried out to study this question it would appear that with respect to quality it may in fact be a disadvantage to take too even a dhool. Re-rolling that fraction of the dhool which is considered too large in size may result in an appreciable decline in quality. Double roll-breaking of a dhool should therefore not be indiscriminately carried out just because it happens to be a popular practice. The decision to do so should be guided by the actual size and quantity of the coarser fraction of a dhool, and also whether more emphasis is placed on colour and strength than on quality.

10.2. *Taint trials.*—In collaboration with the Entomologist taint trials were conducted on Dipterex, Sevin, Malathion and Aldrex. The results and the manner in which they should be used are reported on by the Entomologist.

A fungicide for protection against Blister Blight, called Brestan, was also tested. This compound did not taint tea under the conditions it was used.

11. **Publications:**

KEEGEL, E. L. Relation of temperature and humidity to made tea. *Tea Quart* **33:** 60-68.

KEEGEL, E. L. Future developments in tea manufacture. *Tea Quart* **33:** 177-182.

KEEGEL, E. L. Tea made from clones—Part 2. *Tea Quart* **33:** 183-188.

12. **Acknowledgments.**—The fullest co-operation was received from Mr N. M. Sanders of Pedro Estate and the Plant Physiologist in the pruning, shade and manurial trials, and our grateful thanks are due to them. Thanks are also due to the Statistician for the assistance he has given us in the statistical analysis of the results.

As usual we have received considerable assistance from the Tea tasters in Colombo, and to all those gentlemen who have spared so much of their time to taste our experimental teas we express our grateful thanks.

**References:**

KEEGEL, E. L. (1955). Report of the Technologist for 1954. *Bull. Tea Res. Inst. Ceylon*, No. 36: 33-37.

KEEGEL, E. L. (1959). Report of the Technologist for 1958. *Rep. Tea Res. Inst. Ceylon:* 51-55.

KEEGEL, E. L. (1960). Report of the Technologist for 1959. *Rep. Tea Res. Inst. Ceylon:* 91-97.

KEEGEL, E. L. (1962). Report of the Technologist for 1961. *Rep. Tea Res. Inst. Ceylon:* 125-133.

KEEGEL, E. L. (1963). Tea made from Clones. Part 2—*Tea Quart.* **33:** 183-188.

*Printed by* Wilfred Samarasinghe of No. 5, 3rd Lane, Pita Kotte, Kotte, at M/s H. W. Cave & Co., Ltd., Gaffoor Building, Main Street, Colombo 1, for the Tea Research Institute of Ceylon, St Coombs, Talawakele.

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