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# THE MINERAL STATUS AND PHYSICAL COMPOSITION OF SOME CULTIVATED AND UNCULTIVATED TEA SOILS OF SRI LANKA*

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The object of this investigation was to evaluate the effect of cultivation of tea on the physical and chemical properties of the soil. In the cultivated areas, the pH of the soil was lower than in the uncultivated jungle soils, because of the use of sulphate of ammonia as the source of nitrogen. The uncultivated soils had a higher organic carbon content. The carbon content decreased with increasing depth both in cultivated and uncultivated soils. Total P and K in all soils were approximately of the same magnitude and range, with the exception of the St Coombs soils, where P ranged from 0.02 - 0.05%. The exchangeable Ca and Mg contents were appreciably higher in the uncultivated soils. Total Cu and Zn, though not low, did not appear to fall into any known pattern, but Mn was higher in cultivated soils. Uncultivated soils, in most cases, had a high Ca/Na ratio.

## INTRODUCTION

In order to maximise land use, it is essential that a prior knowledge of the nutritional status of the land is known. Such information will greatly facilitate Agriculturists in predicting and formulating, within reasonable limits, fertilizer programmes. In the past many have concentrated in classyfying various soils and data on such classifications are plentiful. However, not much has been done to determine the mineral status of these soils and when such information is available the data are often unco-ordinated and as a result the information is of less value. Symptoms of either deficiency or toxicity have gone undetected, largely due to a lack of knowledge in recognizing such symptoms. Secondly, laboratories in the Agricultural Institutions in the country were ill-equipped to carry out the determinations of the nutritionally important elements, particularly, the minor elements. However, with the advent and commercial availability of atomic absorption spectrophotometers the determination of the minor elements hitherto considered as difficult and time consuming, can now be done with speed and accuracy.

## MATERIALS AND METHODS

Soils were sampled from St Coombs in Talawakele district; and three other sub-stations of the Institute, namely, Passara in Uva district, Hantane in Kandy district, St Joachim in Ratnapura district and Kottawa in the Galle district. In all places sampled, the selected experimental areas received zero potassium and phosphorus, but 84 Kg sulphate of ammonia per hectare per year as a source of nitrogen.

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Soils were sampled with a post-hole augur at depths of 15 cm intervals upto a depth of 0.62 m. At least 20 such samples were taken at each depth from each plot and soils of the same depth were bulked to form a composite sample. These were then labelled and sealed in polythene bags. Samplings were carried out with the minimum time lag and changes, if any, in weather conditions were recorded.

The soil samples were spread out uniformly on aluminium trays and allowed to air dry. When air dried, they were crushed lightly with a rubber tipped pestle in a porcelain mortar. The soil was then weighed and subsequently sieved using a 2 mm mesh. Particles remaining on the sieve were weighed and expressed as per cent gravel. Particle size distribution (mechanical analysis) was determined on the fine earth ($<$ 2mm) by the pipette method of Piper (1947) and the only modification was the use of sodium hexametaphosphate as a dispersing agent.

Exchangeable cations were determined by extracting one part by weight of soil with five volumes of 1 *N* Ammonium Acetate (pH 7.0) in a shaking machine overnight. The suspensions were filtered into clean dry receivers and the filtrates analysed for the cations. Cations exchange capacity (C.E.C.) was then determined by displacing the ammonia in the soil with acidified 1 *N* potassium chloride solution and distilling the displaced ammonia into 4% (w/v) boric acid, using calcined magnesium oxide powder. Potassium and phosphorus were extracted by refluxing the soil with 6 *N* HCI at 110°C for 4 hours, filtering the extracts and determining K by flame and P as the vanado-molybdate complex. K and P values so obtained were taken as total. Total nitrogen was determined as outlined by Piper (1947) and care was taken to include the nitrate-nitrogen fraction also.

For the determination of "trace elements" soils were digested with a mixture of conc. $HNO_3$ and 60% (w/w) Perchloric acid as described by Jackson (1958). K, Ca and Na were determined using and "EEL" flame photometer, Mg, Cu, Zn, Mn and iron were analysed using Atomic absorption spectrophotometry. Organic carbon was determined by the modified "cold finger" method of Tinsley (1950) and pH was determined in 1:2 soil water suspension using a glass electrode and a Radiometer.

## RESULTS AND DISCUSSION

**pH:** Values of the jungle soils are higher than those of the cultivated soils (Table 1-5). The effect of depth on pH was variable. As reported earlier, plots in the experimental areas have been receiving an application of 84 kg N as sulphate of ammonia per hectare per year and it is evident that the lower pH values in these areas are due to such applications of ammonium sulphate.

**Carbon:** The organic carbon content decreased with an increase in depth of soil, in all the areas sampled. The carbon content in the uncultivated soils was higher than in the cultivated soils for all areas sampled, except in the St Joachim soils. It would therefore be seen that the cultivation of tea depleted the organic carbon content. Weight for weight organic matter contributes towards the exchange capacities of a soil and from the data presented, it would be seen that lower carbon values were associated with the lower exchange capacities, other factors being constant.

TABLE 1—*The physical and chemical composition of cultivated and uncultivated soils — St Coombs (Tea Research Institute)*

| *Type of Cultivation* | *Depth in cm%* | *pH* | *C %* | *Clay %* | *CEC me%* | *Total N %* | *C/N Ratio* | *P %* | *K %* | *Exchangeable cations me%* K | *Exchangeable cations me%* Ca | *Exchangeable cations me%* Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent tea cultivated area | 0-15 | 4.40 | 4.70 | 46 | 13.3 | 0.31 | 15.4 | 0.06 | .095 | 0.41 | 0.56 | 0.10 |
| | 15-30 | 4.30 | 3.50 | 44 | 11.3 | 0.22 | 15.9 | 0.03 | .100 | 0.38 | 0.19 | 0.10 |
| | 30-45 | 4.30 | 2.38 | 46 | 8.6 | 0.14 | 16.5 | 0.03 | .110 | 0.36 | 0.28 | 0.12 |
| | 45-60 | 4.30 | 2.28 | 46 | 8.5 | 0.13 | 17.1 | 0.02 | .105 | 0.35 | 0.25 | 0.11 |
| Old tea cultivated area | 0-15 | 4.50 | 2.64 | 40 | 10.1 | 0.22 | 12.1 | 0.05 | .013 | 0.46 | 0.10 | 0.10 |
| | 15-30 | 4.50 | 2.16 | 48 | 9.2 | 0.17 | 12.6 | 0.04 | .100 | 0.41 | 0.10 | 0.10 |
| | 30-45 | 4.50 | 1.99 | 45 | 7.7 | 0.13 | 15.2 | 0.04 | .090 | 0.35 | 0.15 | 0.11 |
| | 45-60 | 4.45 | 1.78 | 44 | 7.4 | 0.12 | 13.6 | 0.03 | .080 | 0.19 | 0.19 | 0.12 |
| Jungle area | 0-15 | 4.90 | 4.75 | 48 | 12.9 | 0.35 | 13.5 | 0.03 | .090 | 0.26 | 4.56 | 0.83 |
| | 15-30 | 4.90 | 3.00 | 48 | 10.6 | 0.18 | 16.7 | 0.02 | .110 | 0.18 | 1.69 | 0.25 |
| | 30-45 | 4.95 | 2.23 | 59 | 9.2 | 0.15 | 14.8 | 0.02 | .115 | 0.13 | 0.75 | 0.10 |
| | 45-60 | 5.00 | 2.16 | 58 | 7.6 | 0.14 | 16.0 | 0.02 | .108 | 0.10 | 0.56 | 0.09 |

TABLE 2—*The physical and chemical composition of cultivated and uncultivated soils — Hantane — Kandy District*

| *Type of cultivation* | *Depth in cm* | *pH* | *C %* | *Clay %* | *CEC me%* | *Total N %* | *C/N Ratio* | *P %* | *K %* | *K* | *Exchangeable cations me% Ca* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent tea cultivated area | 0-15 | 4.45 | 1.44 | 38 | 7.2 | 0.17 | 8.6 | 0.07 | 0.04 | 0.22 | 0.38 | 0.05 |
| | 15-30 | 4.35 | 1.07 | 35 | 5.4 | 0.14 | 7.7 | 0.04 | 0.04 | 0.18 | 0.19 | 0.13 |
| | 30-45 | 4.35 | 0.73 | 36 | 4.1 | 0.10 | 7.1 | 0.06 | 0.04 | 0.18 | 0.13 | 0.11 |
| | 45-60 | 4.45 | 0.67 | 36 | 5.8 | 0.11 | 6.2 | 0.06 | 0.03 | 0.19 | 0.25 | 0.15 |
| Old tea cultivated area | 0-15 | 4.45 | 1.44 | 31 | 5.0 | 0.13 | 11.3 | 0.05 | 0.04 | 0.37 | 0.38 | 0.10 |
| | 15-30 | 4.40 | 1.34 | 34 | 5.0 | 0.11 | 12.4 | 0.04 | 0.03 | 0.23 | 0.25 | 0.10 |
| | 30-45 | 4.40 | 0.96 | 32 | 4.7 | 0.11 | 9.0 | 0.04 | 0.03 | 0.18 | 0.23 | 0.11 |
| | 45-60 | 4.50 | 0.47 | 35 | 3.8 | 0.09 | 5.5 | 0.03 | 0.02 | 0.13 | 0.13 | 0.12 |
| Jungle area | 0-15 | 5.75 | 0.29 | 38 | 9.9 | 0.21 | 9.8 | 0.05 | 0.08 | 0.69 | 4.50 | 1.96 |
| | 15-30 | 5.95 | 1.62 | 40 | 8.6 | 0.18 | 9.2 | 0.05 | 0.07 | 0.64 | 3.06 | 1.43 |
| | 30-45 | 5.40 | 1.31 | 43 | 7.4 | 0.14 | 7.1 | 0.05 | 0.07 | 0.51 | 1.75 | 0.71 |
| | 45-60 | 5.55 | 0.70 | 44 | 6.7 | 0.06 | 7.5 | 0.04 | 0.06 | 0.23 | 1.31 | 0.67 |

TABLE 3— *The physical and chemical composition of cultivated and uncultivated soils - Passara - Uva District*

| *Type of Cultivation* | *Depth in cm* | *pH* | *C %* | *Clay %* | *CEC me%* | *Total N %* | *C/N Ratio* | *P %* | *K %* | *Exchangeable cations me%* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | *K* | *Ca* | *Mg* |
| Recent tea cultivated area | 0-15 | 4.00 | 2.30 | 35 | 1.08 | 0.16 | 14.7 | 0.05 | 0.02 | 0.22 | 0.10 | 0.10 |
| | 15-30 | 4.01 | 2.02 | 33 | 0.90 | 0.10 | 19.4 | 0.03 | 0.02 | 0.17 | 0.10 | 0.10 |
| | 30-45 | 4.16 | 2.02 | 36 | 0.54 | 0.13 | 15.9 | 0.05 | 0.02 | 0.23 | 0.10 | 0.10 |
| | 45-60 | 4.20 | 1.92 | 36 | 0.36 | 0.09 | 19.7 | 0.06 | 0.01 | 0.15 | 0.09 | 0.05 |
| Old tea cultivated area | 0-15 | 3.90 | 3.14 | 29 | 1.98 | 0.20 | 15.1 | 0.04 | 0.03 | 0.27 | 0.10 | 0.10 |
| | 15-30 | 3.95 | 2.11 | 34 | 1.08 | 0.14 | 15.4 | 0.03 | 0.03 | 0.24 | 0.10 | 0.10 |
| | 30-45 | 4.10 | 2.33 | 31 | 0.90 | 0.17 | 14.0 | 0.03 | 0.03 | 0.22 | 0.09 | 0.07 |
| | 45-90 | 4.25 | 2.30 | 32 | 0.90 | 0.19 | 12.2 | 0.05 | 0.02 | 0.28 | 0.38 | 0.04 |
| Jungle area | 0-15 | 5.20 | 3.36 | 26 | 0.63 | 0.25 | 13.4 | 0.02 | 0.04 | 0.54 | 0.50 | 0.46 |
| | 15-30 | 4.95 | 2.54 | 30 | 1.44 | 0.18 | 14.4 | 0.03 | 0.03 | 0.29 | 0.19 | 0.21 |
| | 30-45 | 4.80 | 1.51 | 36 | 2.16 | 0.11 | 13.9 | 0.02 | 0.02 | 0.18 | 0.10 | 0.10 |
| | 45-60 | 4.80 | 1.61 | 38 | 1.80 | 0.11 | 15.0 | 0.02 | 0.02 | 0.13 | 0.01 | 0.08 |

TABLE 4 — *The physical and chemical composition of cultivated and uncultivated soils — St Joachim Estate, Ratnapura District*

| *Type of Cultivation* | *Depth in cm* | *pH* | *C %* | *Clay %* | *CEC me%* | *Total N %* | *C/N Ratio* | *P %* | *K %* | *Exchangeable cations me%* *K* | *Ca* | *Mg* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recent tea cultivated area | 0-15 | 4.80 | 1.62 | 29 | 1.34 | 0.10 | 16.7 | 0.04 | 0.03 | 0.41 | 0.15 | 0.14 |
| | 15-30 | 4.62 | 1.32 | 30 | 1.29 | 0.09 | 15.5 | 0.03 | 0.02 | 0.28 | 0.10 | 0.10 |
| | 33-45 | 4.65 | 1.14 | 28 | 0.85 | 0.06 | 19.3 | p.03 | 0.02 | 0.36 | 0.10 | 0.10 |
| | 45-50 | 4.60 | 0.96 | 30 | 0.71 | 0.05 | 19.2 | 0.02 | 0.01 | 0.19 | 0.09 | 0.08 |
| Old tea cultivated area | 0-15 | 4.75 | 1.74 | 27 | 2.59 | 0.13 | 13.6 | 0.07 | 0.06 | 0.79 | 0.55 | 0.19 |
| | 15-30 | 4.50 | 1.41 | 28 | 1.95 | 0.10 | 13.9 | 0.05 | 0.09 | 0.59 | 0.18 | 0.10 |
| | 30-45 | 4.45 | 1.32 | 22 | 1.53 | 0.09 | 14.2 | 0.04 | 0.05 | 0.53 | 0.11 | 0.09 |
| | 45-60 | 4.62 | 1.26 | 30 | 1.25 | 0.08 | 14.7 | 0.04 | 0.06 | 0.36 | 0.10 | 0.08 |
| Jungle area | 0-15 | 5.02 | 1.56 | 26 | 1.58 | 0.13 | 12.5 | 0.01 | 0.03 | 0.62 | 0.29 | 0.15 |
| | 13-30 | 5.10 | 1.53 | 28 | 1.34 | 0.10 | 15.9 | 0.01 | 0.02 | 0.43 | 0.10 | 0.10 |
| | 30-45 | 5.30 | 1.02 | 27 | 0.94 | 0.07 | 14.4 | 0.01 | 0.02 | 0.32 | 0.10 | 0.09 |
| | 45-60 | 5.35 | 0.84 | 28 | 0.85 | 0.06 | 12.9 | 0.01 | 0.02 | 0.27 | 0.08 | 0.08 |

TABLE 5 — *The — physical and chemical composition of cultivated and uncultivated soils — Kottawa — Galle District*

| *Type of Cultivation* | *Depth in cm* | *pH* | *C %* | *Clay %* | *CEC me%* | *Total N %* | *C/N Ratio* | *P %* | *K %* | *K* | *Exhangeable cations me%* Ca | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Recent tea cultivated area** | 0-15 | 4.70 | 1.92 | 29 | 3.42 | 0.11 | 16.7 | 0.001 | 0.02 | 0.13 | 0.13 | 0.10 |
| | 15-30 | 4.80 | 1.20 | 30 | 2.43 | 0.08 | 15.5 | 0.009 | 0.02 | 0.13 | 0.13 | 0.10 |
| | 30-45 | 5.00 | 0.70 | 36 | 1.57 | 0.06 | 19.3 | 0.008 | 0.02 | 0.12 | 0.10 | 0.10 |
| | 45-60 | 5.05 | 0.59 | 34 | 2.29 | 0.05 | 19.2 | 0.008 | 0.02 | 0.09 | 0.10 | 0.08 |
| **Old tea cultivated area** | 0-15 | 5.20 | 1.62 | 25 | 3.86 | 0.13 | 13.6 | 0.008 | 0.03 | 0.09 | 0.44 | 0.33 |
| | 15-30 | 5.25 | 1.26 | 29 | 2.71 | 0.10 | 13.9 | 0.006 | 0.03 | 0.08 | 0.19 | 0.21 |
| | 30-45 | 5.30 | 0.71 | 29 | 3.00 | 0.07 | 14.2 | 0.007 | 0.03 | 0.05 | 0.10 | 0.18 |
| | 45-60 | 5.30 | 0.68 | 34 | 3.29 | 0.06 | 14.7 | 0.006 | 0.03 | 0.05 | 0.10 | 0.11 |
| **Jungle area** | 0-15 | 5.05 | 2.05 | 30 | 4.71 | 0.15 | 12.5 | 0.008 | 0.02 | 0.08 | 0.22 | 0.39 |
| | 15-30 | 4.95 | 1.49 | 33 | 3.15 | 0.11 | 15.9 | 0.008 | 0.02 | 0.06 | 0.10 | 0.92 |
| | 30-45 | 5.45 | 1.08 | 35 | 2.71 | 0.08 | 14.4 | 0.008 | 0.01 | 0.05 | 0.10 | 0.23 |
| | 45-60 | 5.50 | 0.86 | 36 | 2.00 | 0.06 | 12.9 | 0.008 | 0.02 | 0.05 | 0.10 | 0.15 |

It has been suggested that organic matter, an indication of which is given by the carbon content, has a profound indirect effect on the soil reaction, by reason of the microbiological activity which it supports. Probably, the most important part played by the organic matter in regulating the soil reaction (pH) is through the formation of carbon dioxide from it by biological activity. This results in an increase in the Hydrogen Ion concentration, and hence an acidic soil reaction. It should therefore follow that a soil well supplied with organic matter will yield carbon dioxide to the soil solution more rapidly than a soil poor in organic matter. However, even though the uncultivated soils sampled contained a higher carbon content, yet their Hydrogen ion concentrations were much lower than in the cultivated soils. Comparisons cannot be made on the effect of organic matter on the pH in the uncultivated and cultivated soils, because the latter have been fertilized with sulphate of ammonia.

**Nitrogen:** As with carbon, the N content decreased with an increase in depth, irrespective of whether the soil was cultivated or otherwise. A close correlation existed between C and N. It will be seen, however, that without exceptions, the uncultivated soils contained a higher nitrogen content than the cultivated soils. In undisturbed soils, there is a natural equilibrium between the formation of organic matter by vegetation and its decomposition by micro-organisms, the balance between these two being determined primarily, by climatic conditions. Cultivation however, disturbs that natural equilibrium and decreases the nitrogen content of the soil, because less organic matter is returned to the soil, while the decomposition process is hastened and a loss of N results. The build up of N is possible by the addition of organic matter to the soil in areas where the temperature is low, as this would favour its preservation. In areas where the temperature is high this would be difficult, if not impossible, because the high temperature would militate against N accumulation by favouring decomposition. Although cultivated areas have been receiving N fertilizers, yet their C and N contents were lower than in the uncultivated areas. It could therefore be possible that the demand for N by growing tea plants exceeded N supply and this fact coupled with N losses resulting from carbon depletion has caused cultivated areas, although receiving N fertilizers to contain less N than uncultivated soils. Further, nitrification by microbiologically active organisms is markedly inhibited by acidity. That being the case, in the cultivated areas, where the acidity is much higher than in the jungle soils, nitrification of the ammonium sulphate will be markedly inhibited. This will result in little or no nitrate-nitrogen formation and its subsequent loss by leaching. Nitrogen fixation has therefore, to take place as an exchange process and the quantum of fixation will be determined by the exchange capacity of the soil concerned. From the data in Tables 1-5, it is clearly seen that where C.E.C. is high, total nitrogen is also high and prolonged cultivation, especially in the St Coombs and Hantane soils has resulted in the lowering of the exchange capacities of these soils.

**Total Phosphorus:** With the exception of the Kottawa soils, P status in all other soils was generally about the same. (Table 1-5). Apparently cultivation of tea has had no effect on the P status of these soils. The P content in the Kottawa soils is comparatively much lower and perhaps this might, in part, explain the reason for the tea plants responding to phosphate applications in Kottawa only.

**Total Potassium:** To total K status of soils, with the exception of St Coombs, was generally low. These ranged from about 0.02-0.05% whereas, the St Coombs soil contained about 0.10% K. Between cultivated and uncultivated soils there was no difference, except in the Hantane soils where uncultivated soils contained almost double the amount of K than cultivated soils.

**Exchangeable K, Ca and Mg:** With the exceptions of St Joachim and Kottawa soils, in all others, the uncultivated areas had very high exchangeable Ca and Mg contents compared to those of the cultivated areas. It will also be seen that, especially, Ca decreased with an increase in soil depth. The use of ammonium sulphate increased the soil acidity and also caused the leaching of most divalent cations. Exchangeable K also decreased with increase in depth. One striking fact that emerged from the data was that the total K content of the soils did not necessarily indicate the level of exchangeable K. The St Coombs soil, for instance, with a total K content of about 0.10% had only 0.40 me% exchangeable K, whereas the St Joachim soils with a total K content of about 0.3% had an exchangeable K content of 0.62 me%. It is well recognized that the various forms of K in the soil are in the state of dynamic equilibrium and the direction of shift of one form of K to another can occur under the influence of several factors.

**The Minor element status:** Table 6 shows the total copper, zinc, manganese, iron, and the Ca/Na ratio of the soils sampled from the various locations and the mean values for the first 15 cm depth only are presented as the variation in the minor element status with increase in depth was minimal. The Cu values did not appear to fall into any pattern and only the jungle soils from Hatane contained a very high proportion of Cu compared to that of any other soils. Zinc too showed a similar trend as Cu, but only St Coombs soil contained more Zn than the other soils sampled. Apparently there does not appear to have been any effect of cultivation on either Zn or Cu. The jungle soils of St Coombs, Hantane, Passara and Kottawa contained more Mn than their respective cultivated areas. It is known that higher acidity dissolves more Mn and other elements, and it is probable that with the low pH values prevailing in cultivated areas, more Mn was released which the tea plant is known to absorb although the part played by Mn within the tea plant is as yet obscure. Total iron content varied from 0.74% in Passara to 6.84% in St. Coombs. With the exception of Kottawa, the jungle soils contained less iron than the cultivated areas sampled. Barring, Ratnapura and Kottawa soils, the jungle soils in all other areas, had a high Ca/Na ratio than in the cultivated areas sampled. It has been suggested that a high Ca/Na ratio promotes aggregation and permeability of soils. Unfortunately in our work, aggregate analysis was not carried out. Lutz (1938) suggested that a high iron content is usually associated with a low cation exchange capacity. However, from our data it was found that St Coombs

TABLE 6 — *Minor elements status of cultivated soils sampled at different locations. Only mean values for the first 15cm depth are presented.*

| *Location* | *Type of areas sampled* | *Total Cu ppm* | *Total Zu ppm* | *Total Mn ppm* | *Total Fe %* | *Ca/Na Ratio* |
|---|---|---|---|---|---|---|
| St Coombs T.R.I. | Recent tea cultivated area | 65 | 55 | 140 | 5.48 | 2.2:1 |
| | Old tea cultivated area | 53 | 75 | 140 | 6.84 | 0.1:1 |
| | Jungle area | 35 | 74 | 340 | 5.31 | 15.2:1 |
| Hantane Sub-Station | Recent tea cultivated area | 100 | 23 | 220 | 3.92 | 9.9:1 |
| | Old tea cultivated area | 135 | 22 | 200 | 4.28 | 1.6:1 |
| | Jungle area | 290 | 38 | 640 | 3.64 | 16.1 |
| Passara Sub-Station | Recent tea cultivated area | 63 | 22 | 210 | 1.00 | 1.1:1 |
| | Old tea cultivated area | 80 | 13 | 170 | 1.00 | 1.3:1 |
| | Jungle area | 75 | 20 | 210 | 0.74 | 5.6:1 |
| St Joachim Sub-Station | Recent tea cultivated area | 100 | 53 | 164 | 1.52 | 0.9:1 |
| | Old tea cultivated area | 30 | 39 | 80 | 2.26 | 2.6:1 |
| | Jungle area | 40 | 28 | 40 | 0.84 | 1.4:1 |
| Kottawa Sub-Station | Recent tea cultivated area | 130 | 28 | 54 | 2.66 | 0.5:1 |
| | Old tea cultivated area | 80 | 48 | 24 | 1.76 | 2.6:1 |
| | Jungle area | 48 | 53 | 32 | 2.14 | 1.3:1 |

soils with nearly 6.84% iron had a C.E.C. of 13 me% whereas, Passara with 0.74% iron had a C.E.C. of 1.5 me%; clearly therefore, there are other factors involved than merely an Fe, C.E.C. relationship as postulated by Lutz (1938). It will also be noted that no effort was made to determine the "available" trace elements. It is known that the total analysis of an element does not necessarily indicate its availability to the plant, and the argument reverts back to that controversial topic of availability. What is "availability", and how available is available trace elements? Generally speaking, the exchangeable nutrients are considered to be immediately available to the plant. However, data being published elsewhere on the work done here do not immediately support that contention. On the other hand, especially, with regard to trace elements when these occur in the region of inadequacy a total analysis provides a more meaningful picture than an exchangeable analysis of these elements.

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