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THE INFLUENCE OF TYPES OF PHOSPHATIC FERTILIZERS ON THE GROWTH AND NUTRIENT UPTAKE OF TEA NURSERY PLANTS

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Four types of phosphatic fertilizers were tested on the growth of nursery plants in this study. Application of T65 mixture containing ammonium phosphate resulted in better shoot growth, while soil application of rock phosphate or superphosphate led to better root development of nursery plants. The T65 mixture was found to be most satisfactory for the growth of nursery plants.

INTRODUCTION

The importance of phosphorus for plant growth has been known for centuries. For several decades sterameal was used to supply the phosphorus requirements of nursery tea plants in Sri Lanka. Visser and Kehl (1961) compared the efficiency of partially insoluble inorganic mixtures containing superphosphate with that of a mainly organic mixture containing sterameal on nursery plants and found that the former was preferable as it was not only effective but was also easier to apply and was more economical.

Subsequently, Tolhurst and Visser (1961) found that the use of superphosphate was disadvantageous because it reacted with soluble ammonium sulphate and potassium sulphate in the mixture to form insoluble calcium sulphate. This led to several practical difficulties. The watering of the fertilizer solution on plants left a residue on the leaves. They substituted monoammonium phosphate for superphosphate and formulated a completely soluble nursery mixture T65 which contains 10.8 % P_2O_5. They found that this mixture was very satisfactory for nursery plants.

There have been periods when monoammonium phosphate was not available and triple superphosphate has been suggested as a substitute and the rest of the nutrients were given as T55 mixture (Tolhurst and Richards 1965). A similar situation was experienced in recent years and estates have been compelled to use T55 mixture along with superphosphate. The T55 mixture when applied at the recommended rate does not provide similar amounts of nitrogen, potassium and magnesium as the T65 mixture applied at the recommended rate. In order to compare the effect of different types of phosphatic fertilizers on the growth and uptake of nutrients by the nursery plants, we have, in the present study, formulated a mixture (T57) with the same components as in T55 mixture but containing similar amounts of nutrients, except for phosphate, as in T65 mixture.

This investigation was undertaken to compare monoammonium phosphate in the T65 mixture with the soil application of triple superphosphate, imported rock phosphate and apatite locally-mined at Eppawela.

MATERIALS AND METHODS

The composition and the nutrient content of the two mixtures used in this study are given in Table 1.

TABLE 1 — *The composition and the nutrient content of the T65 and T57 mixtures*

	T 65 mixture	T 57 mixture
Ammonium sulphate	15 parts	30 parts
Potassium sulphate	15 ,,	13 ,,
Epsom salt	15 ,,	14 ,,
Ammonium phosphate	20 ,,	—
	65 ,,	57 ,,
	% N 10.9 % P_2O_5 11.1 % K_2O 10.8 % MgO 4.0	% N 10.8 % K_2O 10.9 % MgO 3.9

The treatments tested were as follows:

1. Watering T65 mixture (containing ammonium phosphate) at the rate of 28 g in 4.5 l per 100 plants fortnightly.
2. Watering T57 mixture (containing no phosphate) at the rate of 28 g in 4.5 l per 100 plants fortnightly and soil application of 0.5 g P_2O_5 in the form of triple superphosphate per sleeve.
3. Similar to (2) but with soil application of rock phosphate instead of triple superphosphate.
4. Similar to (2) but with soil application of Eppawala apatite instead of triple superphosphate.

The experiment was of the randomized block design with six replicates. Ten cuttings of clone TRI 2025 were selected for each treatment. Polythene sleeves 18 cm long and 9 cm in diameter were filled with fumigated soil from Field No. 12, St Coombs and cuttings of clone TRI 2025 were planted. Some of the properties of the soil used in the study are given below:

pH	C %	N %	Olsen P ppm	Total P ppm	K me %
4.30	1.65	0.18	2.25	537.5	0.37

For treatments 2, 3 and 4, 0.5 g P_2O_5 of the respective phosphatic fertilizers were mixed with 1 Kg soil, three weeks prior to planting the cuttings. The number of applications of T65 mixture were adjusted to provide 0.5 g P_2O_5 per sleeve for treatment 1. The plants were raised under standard nursery conditions and watering of T65 and T57 mixtures commenced soon after rooting at fortnightly intervals. At the end of ten months the plants were harvested and the roots were washed with water to remove the soil completely. The leaves, stems and roots were separated and oven dried at 85° C and the dry weights were recorded.

The soil from the polythene sleeves was air dried and passed through a 2 mm sieve. The total nitrogen was determined by the standard Kjeldahl method. Phosphorus in the soil was estimated by extracting with 1:1 HCl and with malic acid and determined by the molybdophosphoric blue colour method (Fogg and Wilkinson 1958). Exchangeable cations were extracted with N NH_4 Cl. Calcium and potassium were determined by flame photometry using an Eel flame photometer. Magnesium was determined by the titan yellow method (Chenery 1964), and aluminium by the modified aluminon method (Jayman and Sivasubramaniam 1974).

The leaves, stems and roots were ground to pass through a 40 mesh sieve using a Wiley grinding mill and were analysed separately for nitrogen by the Kjeldahl method and for phosphorus by the vanado-molybdate yellow method (Jackson 1958). Potassium, calcium, magnesium and aluminium were determined by the methods described for soil samples.

RESULTS AND DISCUSSION

The effects of the four treatments on the nutrient status of the soil are given in Table 2.

TABLE 2 — *Effect of different phosphatic fertilizer treatments on the nutrient status of the soil*

Treatment	N %	Malic acid P ppm	Total P ppm	K me %
1 — T 65	0.232	9.31	624.3	0.50
2 — T 57+triple superphosphate ...	0.250	26.77	741.3	0.75
3 — T 57+rock phosphate	0.250	30.84	742.1	0.75
4 — T 57+Eppawala apatite ...	0.242	44.34	700.4	0.77
L.S.D.(P=0.05)	0.010	5.32	39.6	0.07
(P=0.01)	0.013	7.36	54.9	0.10

The total nitrogen, malic acid extractable P, total P and exchangeable K in the soil of those plants which received T57 as the fertilizer were higher than in the plants which received T65.

The plants which received T65 mixture showed marked differences in shoot growth (Fig.1) whereas in the other three treatments the growth was almost the same. This is further confirmed by the dry matter content of the plants as presented in Table 3.

TABLE 3 — *Dry matter content of nursery plants given different fertilizer treatments*

Treatment	Dry matter content (g)			
	Leaf	Stem	Root	Total /plant
1 — T 65	15.0	5.8	8.7	29.5
2 — T 57+triple superphosphate ...	12.1	4.4	9.8	26.3
3 — T 57+Rock phosphate ...	12.1	4.2	10.2	26.5
4 — T 57+Eppawela apatite ...	11.4	4.4	8.4	24.2
L.S.D. (P=0.05)	2.0	0.6	1.1	3.3

The leaf, stem and total dry matter content of those plants which received T65 treatments were significantly higher than those which received T57 treatments in combination with soil application of phosphatic fertilizer. But the plants which received soil application of superphosphate and rock phosphate had higher dry matter content of the roots than those given the other two treatments. This confirms that the T65 mixture is superior to the T57 mixture for shoot development of nursery plants. The soil application of rock phosphate and superphosphate seems to have a favourable effect on root development of nursery plants.

The total amounts of phosphorus taken up by the three components of the plant and by the whole plant showed trends comparable to their growth performance. Although no significant difference was observed in the phosphorus uptake by the leaf, the stem and plant as a whole, significant differences were observed in the phosphorus uptake by the root which is given in Table 4.

TABLE 4 — *Phosphorus removed by roots of nursery plants*

Treatments	Phosphorus removed (mg) Root
1. T 65	5.9
2. T 57+triple superphosphate	6.9
3. T 57+rock phosphate	8.2
4. T 57+Eppawela apatite	5.8

The uptake of phosphate by roots of plants which received only rock phosphate showed a significant difference from the other three treatments. Although Tolhurst and Richards (1965) recommended triple superphosphate to be incorporated along with T55 mixture as an alternative to T65, the results in this investigation indicate that rock phosphate is a better substitute than triple superphosphate.

The effect of the type of phosphatic fertilizer on nitrogen and potassium uptake by nursery plants are given in Table 5.

TABLE 5 — *Effect of the type of phosphatic fertilizer on nitrogen and potassium uptake by nursery plants*

Treatments	Leaf		Stem		Root		Total/plant	
	N	K	N	K	N	K	N	K
1. T 65	571.7	165.1	130.1	44.8	267.5	165.8	969.3	375.7
2. T 57+superphosphate	445.2	127.0	116.1	33.6	330.7	194.1	892.0	354.7
3. T 57+rock phosphate	446.4	127.1	108.5	36.4	308.4	187.7	863.3	3.512
4. T 57+Eppawela apatite	457.4	129.9	112.1	34.5	252.6	153.1	822.1	317.5
L.S.D (P=0.05)	96.9	21.9	15.4	8.1	49.0	28.7	147.9	34.0

From Table 5 it is evident that as in the case of dry matter content (Table 3) and phosphorus uptake (Table 4) the nitrogen and potassium content in the leaf, stem and in the whole plant which received T65 mixture were significantly greater than for the other treatments. In the root those plants which received soil application of superphosphate and rock phosphate, however, showed significantly higher uptake of nitrogen and potassium by the roots.

Statistical analysis of the calcium, magnesium and aluminium uptake by the plants did not show significant differences between the four treatments tested.

Although T55 mixture has been recommended as a substitute for T65 mixture, it did not provide similar amounts of nitrogen, potassium and magnesium. Lower rates of T55 were recommended due to the presence of a higher nitrogen content in the mixture which would otherwise scorch the plants. In this experiment although a new mixture T57 was formulated, containing similar amounts of nutrients as in the T65 mixture, the performance of the plants was still relatively poor. The total dry matter content of the plants which received T65 mixture was significantly greater than with the other three treatments, providing evidence that the application of T65 mixture containing ammonium phosphate is superior to soil application of any of the other phosphatic fertilizers. It appears therefore that the T65 mixture still proves to be the most suitable fertilizer for nursery plants. Superphosphate and rock phosphate applications to the soil appear to encourage root development but without much shoot growth. This observation needs further investigation as better root development may prove useful in establishing plants under dry field conditions.

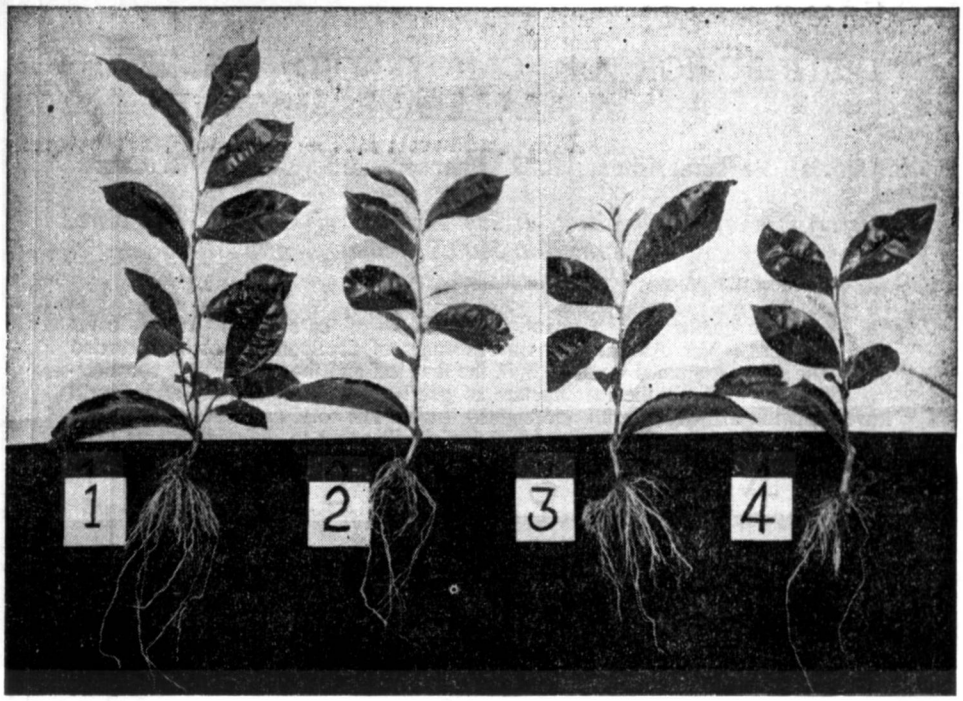

FIG. 1 *The effect of* (1) T 65 (2) *T* 57—*triple superphosphate* (3) *T* 57—*rock phosphate and* (4) *T* 57+ *Eppawela apatite on the growth of tea nursery plants*

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