Dithizone extractable zinc in rubber soils of Ceylon

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SUMMARY

Zinc is an essential micro-nutrient whose deficiency in Malayan rubber soils has been considered to predispose rubber seedlings to *Oidium hevea* attack. Results of preliminary investigation on dithizone extractable zinc in surface soils of the main rubber growng districts of Ceylon are reported. The extractable zinc content varies from 2 ppm to 56.4 ppm with an average value of 16 ppm. Soils of the Deniya series have the highest values (40 ppm) and those of the Ratnapura series the lowest (9.5 ppm). Results indicate that zinc deficiency is not likely to limit growth of rubber or be a predisposing factor in the incidence of *Oidium hevea* in acid soils with high dithizone extractable zinc contents. Low availability due to high soil pH is compensated by high amounts of extractable zinc. Excessive uptake of zinc is possible in acid, ill-drained Deniya soils.

INTRODUCTION

In addition to the macro-nutrients, a number of micro-nutrients are essential for optimum plant growth. Zinc is one such micro-nutrient.

Plant physiologists have often described the beneficial effects of zinc on plant growth as stimulation. Diseases such as " white bud " of corn (Viets, 1951) and rosetting of fruit trees have been shown to be due to zinc deficiency. Woody plants exhibit abnormalities in twigs and leaves due to deficiency of this element. Reduction of hormonal activity due to zinc deficiency results in failure of stem elongation. Zinc also functions as a catalyst in oxidation reactions in the plant.

The importance of zinc in cacao growing is well known (Greenwood & Hayfron, 1951). Zinc deficiency is the cause of sickle leaf disease. Investigations on sickle leaf disease of cacao in Ceylon by Vermaat (1956) revealed zinc contents of 6 ppm and 20 ppm in mature leaves obtained from affected and healthy trees respectively. In Ceylon, zinc deficiency has become increasingly common in tea nurseries and young plantations (Tolhurst, 1962) and remedial measures have been recommended. Malayan workers (Bolle-Jones and Hilton, 1956) have reported a striking relationship between zinc content of leaves and susceptibility of rubber seedlings to *Oidium hevea* attack. Zinc deficiency resulted in rosetting, malformation and death of young leaves in the 3rd month; in the 6th month, a severe infection of *Oidium hevea* was noted. Disease symptoms similar to those attributed to zinc deficiency were noticed in young hevea plants in two areas in Ceylon, namely Nakiadeniya estate in Galle district and Kumarawatte group in Moneragala. Zinc status of healthy and deficient leaf samples from these areas was reported by Jeevaratnam (1958).

In the present study, dithizone extractable zinc in representative surface soils from the rubber growing districts of Ceylon is reported. According to Viets & Boawn (1965) ammonium acetate-exchangeable and water-soluble zinc are usually regarded as being available for plants. However, the amounts of zinc so extracted are extremely low unless complexing agents like dithizone are also included in the extracting solutions. In soils with histories of deficiency or non-deficiency, Shaw & Dean (1952) showed that extractable zinc data could be interpreted better if soil pH was also considered.

MATERIALS AND METHODS

Surface soils of three profiles from each of the seven soil series recognised and described by Silva (1968) in the rubber growing regions of Ceylon, were analysed. The soils are briefly described in Table 1. Soil samples were collected in polythene bags, air dried in the laboratory, crushed with a wooden pestle and sieved through a 2mm sieve. Demineralised distilled water was used to prevent contamination. Glassware was washed with soap and rinsed with demineralised distilled water.

pH was determined on 1 : 4 soil : water suspensions using a Cambridge portable pH meter. Texture was determined with a soil colloid tester. Zinc was estimated by the method of Shaw & Dean (1952) using a Spekker absorptiometer.

RESULTS AND DISCUSSION

Soil analytical data are given in Table 2.

With the exception of the limestone-derived Kirigalpotta soil (pH 8.2), the other samples studied have pH values ranging from 4.1 to 5.7.

Zinc content varies widely, from 2.5 ppm in the biotite gneiss derived Parambe series soils of Dehiowita to 56.4 ppm in the low-lying, water-logged Deniya soils of Kalutara, with an average value of 16 ppm. On an average, Ratnapura series has the lowest (9.5 ppm) and Deniya series has the highest (40 ppm) dithizone extractable zinc contents.

Mitchell (1963) reported a range of 1-10 ppm of zinc as being extractable by an appropriate diagnostic agent from normal soils, excluding the seriously toxic or deficient ones. Jansen and Lamm (1963) indicated a value of 10 ppm as being high for most of the soils they studied. On these criteria, with the exception of three samples, the zinc contents of the soils investigated are generally high.

The high dithizone extractable zinc content (25.5-56.4 ppm) of Deniya soils may be explained in terms of drainage. Under ill-drained conditions, the minerals in which the micro-nutrients are bound up break down more readily and provide increased amounts of these elements (Mitchell 1963).

In the case of limestone-derived soils of the Matale series, the high extractable zinc content may be suggestive of a high total zinc content as well. Kalpagé and Silva (1968) observed high total manganese values in these limestone-derived soils and suggested that the noncalcareous material associated with the limestone is rich in manganese. It would, therefore, be interesting to ascertain whether the noncalcareous material is rich in the other micronutrients as well.

There is wide variation within soils of the Parambe series (22.1 ppm 7.4 ppm, 2.5 ppm). Kalpagé and Silva (1968) observed a similar variation in the total manganese content of soils in this series and attributed this to the wide variability in the composition of the parent material.

Soil pH is one of the main factors influencing deficiency and toxicity levels. Massey (1957) obtained a negative correlation between zinc uptake and soil pH. As reported by Shaw and Dean (1952), zinc deficiency symptoms are least likely to occur in the pH range 5 to 6.5 and under these pH conditions dithizone extractable soil zinc values of as low as 0.5 ppm will not produce deficiency symptoms. On the other hand, at pH values above 6.5 deficiency symptoms may occur unless dithizone extractable zinc contents are above 2.5 ppm. The availability of zinc to plants is greatly reduced under strongly acidic and highly alkaline conditions.

CONCLUSION

Zinc deficiency is not likely to limit growth or be a predisposing factor for *Oidium hevea* attack in acid soils with high dithizone extractable zinc contents. However, in soils such as the Kirigalpotta soils of the Matale series, although the soil pH is high (8.2) since extractable zinc amounts to as much as 20.1 ppm, zinc deficiencies may not arise.

These preliminary studies indicate that zinc deficiency is unlikely to occur in most rubber growing districts of Ceylon. Excessive uptake, however, is possible under acid conditions where extractable zinc contents are also high. This can occur in the ill-drained soils of the Deniya series.

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TABLE I.—Some soil relationships (from Kalpagé and Silva, 1968)

	Soil Series	*Parent Material (or distingusihing features)*	*Great Soil Group*
1.	Matale	Limestone derived	Reddish brown latosolic and immature brown loam
2.	Parambe	Biotite gneiss derived	Reddish brown latosolic and immature brown loams
3.	Ratnapura	Garnetiferous granulite derived	Red-yellow podzolic
4.	Homagama	Quartzite derived	Red-yellow podzolic
5.	Agalawatta	Granite derived	Red-yellow podzolic
6.	Boralu	Laterization evident	Red-yellow podzolic
7.	Deniya	Low-lying, waterlogged	Low-humic gley

TABLE II.—Soil analytical data

Soil Series	Location	Depth (in)	Texture	pH	Dithizone extractable zinc (ppm)	Average zinc value for each series (ppm)
1. Matale	(a) Wariyapola Group, Matale	0—4	Sand	5·70	18·9	16·8
	(b) Viharagama Estate, Matale	0—4	Sand	5·30	11·5	
	(c) Kirigalpotta, Matale	0—4	Loamy sand	8·20	20·1	
2. Parambe	(a) Parambe Group, Undugoda	0—6	Light loam	4·35	22·1	10·7
	(b) Golinda Group, Kegalle	0—17	Sand	4·48	7·4	
	(c) Ernan Division, Dehiowita	0—10	Sand	4·92	2·5	
3. Ratnapura	(a) Carney Estate, Ratnapura	0—3	Sandy grit	4·90	7·6	9·5
	(b) Ratnapura Town	0—17	Sandy grit	5·10	10·2	
	(c) Near Rest House, Ratnapura	0—7	Loamy sand	4·90	10·8	
4. Homagama	(a) Ambadeniya Group, Aranayake	0—9	Sandy loam	4·40	5·4	10·1
	(b) Narangala Group, Aranayake	0—9	Loamy sand	4·30	11·8	
	(c) Dalkeith Group, Lathpandura	0—18	Loamy sand	4·50	13·8	
5. Agalawatta	(a) Mirihankande, Badureliya	0—11	Sand	4·10	10·9	11·6
	(b) Hedigalla Division Badureliya	0—8	Sand	4·50	12·9	
	(c) Dartonfield, Agalawatta	0—10	Loamy sand	4·30	11·1	
6. Boralu	(a) Culloden Group, Neboda	0—14	Loamy sand	4·10	36·5	18·8
	(b) Tudugalla Estate, Tudugalla	0—14	Sandy grit	4·50	11·4	
	(c) Nellunuyana Estate, Bentota	0—8	Sandy loam	5·00	8·7	
7. Deniya	(a) Rajamalwagura, Agalawatta	0—10	Sandy grit	4·90	25·5	40·0
	(b) Attiville, Kalutara	0—10	Sand	4·40	56·4	
	(c) Durampitiya Estate, Avissawella	0—8	Sand	4·90	38·2	