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Zinc deficiency in Cocoa : diagnosis and correction

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A widespread occurrence of severe deficiency of zinc on cocoa plantings in India is reported. Foliar symptoms included chlorosis, crinkling of leaves with wavy margin, little leaf, sickle leaf and premature abscission of leaves. Twig symptoms included rosette and die back.

A mixture of zinc sulphate and lime when applied as a foliar spray corrected the deficiency in two-year-old cocoa plants under field conditions. Foliar spray of a mixture of zinc sulphate and lime at five different concentrations were tried. Though all the concentrations had beneficial effects, best results were achieved with 0.3% zinc sulphate and 0.15% (w/v) lime.

Severe incidence of a foliar abnormality leading to twig die back of cocoa (*Theobroma cacao* L.) has been observed during the last two years in many cocoa gardens in Kerala and Karnataka states of India. From the symptoms observed under natural conditions, this foliar abnormality is attributed to zinc deficiency.

Zinc deficiency in cocoa has been reported in Ghana (Ahenkorah, 1969; Greenwood & Hayfron, 1951) and New Guinea (Schroo, 1959). Sickle leaf symptoms were observed in cocoa plantings on inland sandy soils in West Malaysia (Ng, 1971). In India, its widespread occurrence has been observed during the last two years. Deficiency of zinc was observed on cocoa grown as a mixed crop either in arecanut or coconut gardens. In some of the cocoa gardens, all the cocoa plants were found to be showing the symptoms of zinc deficiency in a severe form. The present investigation was therefore undertaken to describe the symptoms of zinc deficiency as observed under natural conditions, and to test the efficacy of different concentrations of zinc sulphate as foliar spray in correcting the deficiency of zinc in cocoa under field conditions.

MATERIALS AND METHODS

Foliar symptoms as observed in nature were recorded from many cocoa gardens in Kerala and Karnataka States.

A field trial was laid out during August – September 1979 in cultivators' fields in South Kanara district of Karnataka State. The experiment was laid out in simple randomised block design with five replications in a two-year-old cocoa garden. Various concentrations of zinc sulphate from 0.05 – 0.3% (w/v) were tried. Lime was added to avoid leaf damage at half the concentration of zinc sulphate in each case. The following treatments were used to determine their effect on the foliar abnormality.

1. 0.5 g Zinc sulphate + 0.25 g lime/litre of water as foliar spray.

2. 1 g Zinc sulphate + 0.5 g lime/litre of water as foliar spray.

3. 2.g Zinc sulphate + 1.0 g lime/litre of water as foliar spray.

4. 3 g Zinc sulphate + 1.5 g lime/litre of water as foliar spray.

5. Control – distilled water alone.

Only one application of the chemical was given as foliar spray. The control plants were sprayed with distilled water alone.

Observations on the severity of deficiency were recorded just before the application of the chemicals and then one month after spraying. The foliar symptoms on each plant in each plot were recorded by using five grades of severity of the deficiency. A quantitative index of severity was calculated based on these ratings (McKinney, 1923).

RESULTS AND DISCUSSION

Deficiency symptoms

In most of the cases observed, chlorosis of leaves was the initial symptom of zinc deficiency in cocoa. Chlorosis appeared in patches and in advanced conditions the green portion was found only along the sides of the veins, giving a vein banding appearance to the leaves (*Figures 1* and *2*). Thus, the network of vein in each leaf was very distinct. Affected leaves showed mottling and crinkling with wavy margin and were thus often malformed (*Figure 2*). Most of the younger leaves were narrow, much reduced in size and sickle shaped, showing the characteristic little leaf symptom (*Figure 1*). The sickle leaf symptom was common too; but it did not appear on all plants. Affected plants rarely put forth new flushes and, when they did, the leaves showed acute symptoms of zinc deficiency.

Figure 1. Cocoa twig showing symptoms of zinc deficiency.

Twig symptoms included rosette and die back. Shortening of internodes caused a rosette type of growth. In severe cases, premature defoliation followed by die back of the branches was observed (*Figure 3*). Various combinations of these symptoms were also prevalent.

In a few instances, severe defoliation and die back caused gradual death of two- to three-year-old cocoa plants.

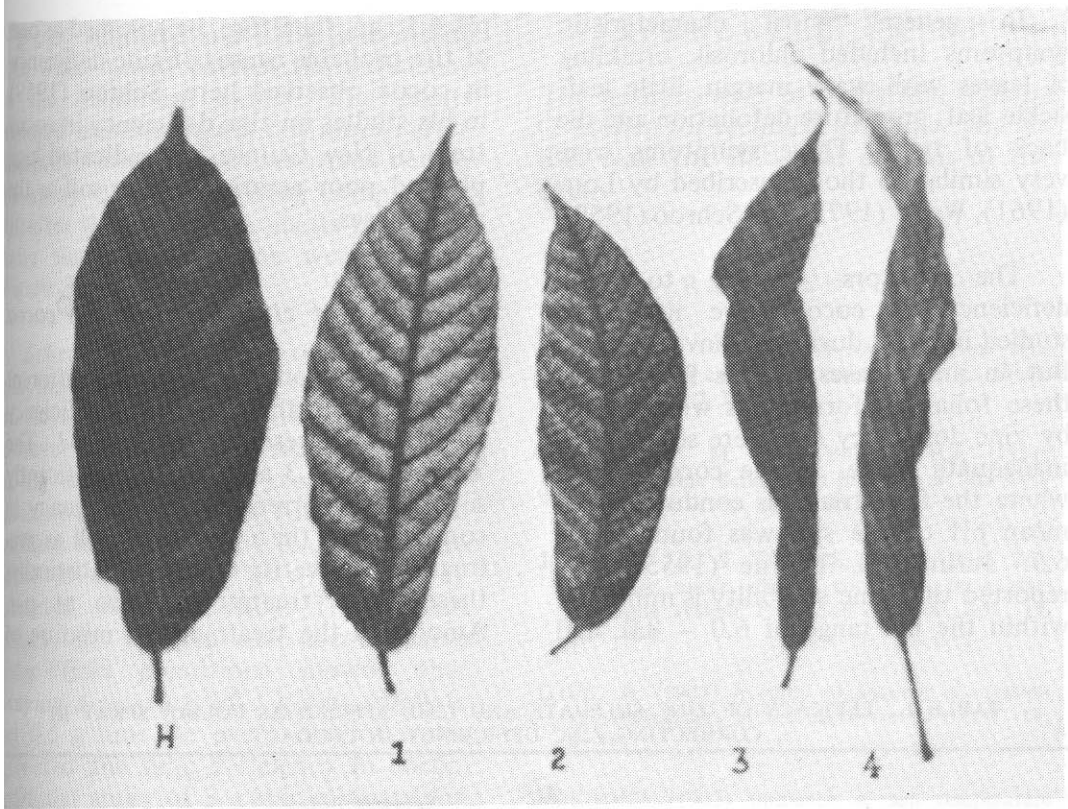

Figure 2. Foliar symptoms of zinc deficiency – H – healthy ;1–4 different stages of zinc deficiency.

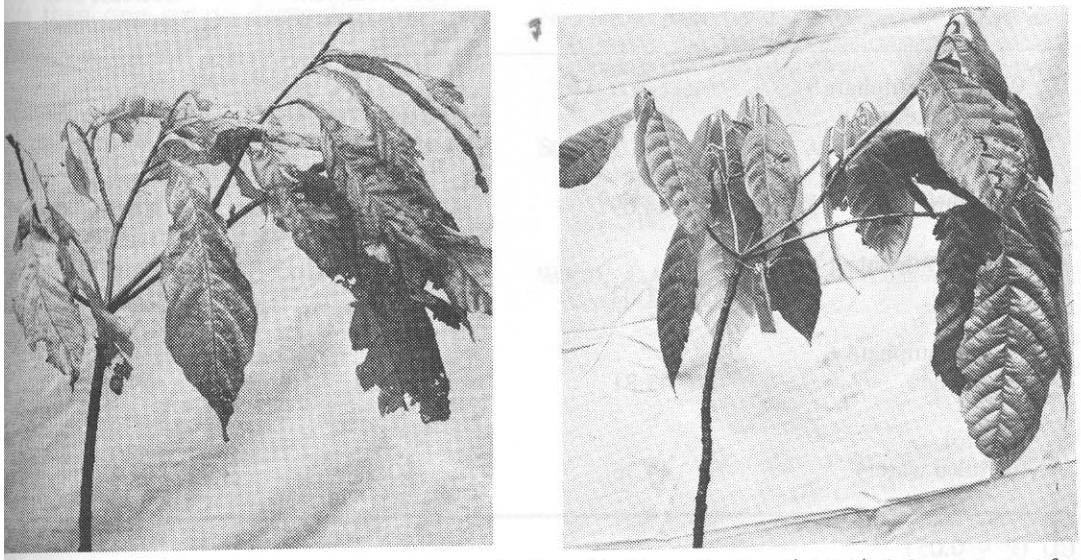

Figure 3. Two-year-old cocoa plant – before (left) and after (right) foliar spray of a mixture of zinc sulphate and lime (Treatment 4).

In general, most characteristic symptoms included chlorosis, crinkling of leaves with wavy margin, little leaf, sickle leaf, premature defoliation and die back of twigs. These symptoms were very similar to those described by Loue (1961), Wood (1975) and Schroo (1959).

The factors leading to zinc deficiency in cocoa have not been studied in detail during this investigation. But in many cases, it was found that these foliar malformations were caused by zinc deficiency and were severe with inadequate shade. In the cocoa garden where the field trial was conducted, the mean pH of the soil was found to be 6.5. Jurinak & Thorne (1955) have reported that zinc solubility is minimum within the pH range of 6.0 – 8.0, and pH 6.5 can, therefore, be assumed as one of the probable causes of zinc deficiency in cocoa observed here. Schroo (1959) in his studies on zinc deficiency in cocoa trees of New Guinea had indicated high pH and poor aeration of the soil as the main causes.

Correction of zinc deficiency in cocoa

The data on the effect of different treatments on the severity of deficiency of zinc are presented in *Table 1*. The Treatments 2, 3 and 4 were significantly superior in correcting the deficiency as compared to the control as well as pre-treatment severity index. Statistically, these three treatments were at par. Among all the treatments a mixture of

TABLE 1. EFFICACY OF ZINC SULPHATE AND LIME APPLIED AS FOLIAR SPRAY IN CORRECTING ZINC DEFICIENCY IN COCOA

Treatment	*Severity index*		
	*Pre-treatment**	*Post-treatment**	*% increase or decrease over pre-treatment*
1. 0.5 g zinc sulphate + 0.25 g lime	47.13	22.89	51.40 (–)
2. 1 g zinc sulphate + 0.5 g lime	44.09	6.63	84.90 (–)
3. 2 g zinc sulphate + 1 g lime	31.02	5.05	83.70 (–)
4. 3 g zinc sulphate + 1.5 g lime	45.81	2.03	95.60 (–)
5. Control (distilled water)	44.36	50.59	14.04 (+)

CD (P = 0.05)
* Mean of five replications
(–) decrease ; (+) increase

3 g zinc sulphate and 1.5 g lime in one litre water could correct the deficiency to the maximum extent. The plants resumed normal growth one month after the spray. Leaves that malformed before the spray did not improve completely, but after the spray, the plants produced many new leaves which were normal (*Figure 3*).

Schroo (1959) has reported that spraying with 2.5 g zinc sulphate every ten days corrected zinc deficiency within seven months. Ahenkorah (1969) in his studies on 2½-year-old potted Amazon cocoa seedlings, found that zinc sulphate at the rate of 2.0 kg/ha applied either to the soil or as a foliar spray corrected the deficiency. The present studies on two-year-old cocoa plants under field conditions showed that spraying a mixture of 1 g zinc sulphate and 0.5 g lime for every litre of water corrected the zinc deficiency in cocoa. But foliar spray of 3 g zinc sulphate and 1.5 g lime (Treatment 4) could correct the deficiency to the maximum extent. Larger plants may, sometimes, require more than one spray, depending on the severity.

Loue (1961) also reported spraying of a mixture of zinc sulphate and lime as the chief remedial measure. Foliar spray of a mixture of zinc sulphate and lime has been thus found to be an effective and quick method of correcting zinc deficiency in cocoa.

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