

Micronutrients in coconut nutrition

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Before approaching the study devoted to coconut, it should be noted that the I.R.H.O. was led to undertake research in this field following the creation of the Rangiroa Station in Polynesia in 1959 on coral limestone. In effect, from 1957 on, leaf analysis showed that the chlorotic appearance of most of the coconut groves was due to iron and manganese deficiencies.

This article follows one which appeared on the oil palm in the June 1980 issue (n° 6) of this Review. After recalling generally known facts about each micronutrient, a geographical inventory will be made of the levels observed in soils or following leaf analysis (Table XI) and the results of the trials effected in pot culture or in the field will be described.

I. — ALUMINIUM

1. — General.

Although research undertaken on mineral nutrition of plant tissues has shown the positive effect of aluminium on growth, the useful role of this metalloid in the plant is not very well known. It is known that its accumulation in the root system provokes toxicity, and that this accumulation depends on soil pH. In the leaves, this toxicity has often been associated with phosphorus deficiency and with high iron and manganese values, the calcium and magnesium contents remaining low.

2. — I.R.H.O. results.

a) Soil analysis.

On quaternary sands in West Africa, the quantities of exchangeable aluminium observed in some soil analysis vary from 0.01 to 0.90 meq/100 g. In Madagascar, on coastal sands, the levels also vary considerably (0.05 to 0.76 ppm) but in all cases, these differences do not disturb plant growth.

b) Leaf analysis.

Leaf aluminium levels are relatively constant, notably in Benin, the Ivory coast and Madagascar (76 ppm on the average for 40 analyses), but lower values are noted in Sri Lanka (24 ppm) and Vanuatu (formerly New Hebrides) on clayey plateau soil (13 ppm), and high values in Sumatra (127 ppm) without apparent consequences. Nonetheless, at Port Bouet in the Ivory Coast it has been shown that the levels present a leaf « gradient » and increase regularly with ageing of the leaf from 9 ppm on leaf 1 to 48 ppm on leaf 29.

c) Experimental results — hydroponics (table I).

A first approach to the study of aluminium toxicity was made by the I.R.H.O. in 1980 in heated glasshouses at Montpellier (France) with year old plants raised in hydroponics. Among other elements, the nutrient solution contained 0.6 eq/l of K, 0.8 eq/l of Ca, 0.3 eq/l of Na and 0.4 eq/l of Mg i.e. 0.21 eq/l in all. The quantities of aluminium added represent respectively, 0, 12, 25, 50, 100 and 200 p. 100 of this amount. At the end of the 2-month trial, no sign of toxicity was observed on the plants. Aluminium analysis carried out on the various organs of young coconuts showed marked accumulation of the metal in the roots whereas the levels in the other organs are scarcely modified, indicating that the element has not migrated inside the plant.

Under experimental conditions, root levels increased up to an aluminium concentration representing 50 p. 100 of the sum of the other 4 cations.

It seems that the coconut can stand high concentrations of aluminium in the soil solution without visual symptoms of toxicity appearing.

II. — BORON

1. — General.

Boron is indispensable to plant development. A lack of it often provokes marked malformation of the leaf structure and appearance of necroses. It greatly disturbs growth and favours the appearance of secondary effects (rot). In the final stage, the plant dries.

The young tissues are always the ones to suffer the malformations as boron effects sugar translocation phenomena. In an experiment conducted by Heller [8] the influence of boron on the development of plant tissues was clearly shown. It plays a major role in cell differentiation, which is inhibited wherever this metalloid is deficient.

Boron also intervenes in the synthesis of nucleic acids, promoting their metabolism.

In a deficient situation, the nitrates « stored » in the roots, leaves and stem probably inhibit the formation of amino-acids and protein synthesis. The accumulation of auxins would promote the appearance of necroses.

2. — Geographical inventory.

In the Ivory Coast, on soil formed over quaternary sands of marine origin, leaf 14 levels are generally between 8 and 15 ppm.

In Madagascar and the Philippines, leaf levels are similar to those in the Ivory Coast : 9 to 16 ppm.

On coral soils in the Pacific atolls the levels are higher : 18 to 33 ppm [3], as they are in Papua-New Guinea [6], but they depend essentially on soil quality. Thus, in Vanuatu, where there is a distinction between the sandy coral soils of the seaboard with their alkaline pH (mean 7.6 to 8/0) and the plateau clay soils of more acid pH (5.1 to 6.6), boron levels in the top-soil are 0.6 to 1.0 ppm in the former, 1.2 to 1.4 ppm in the latter. On the other hand, in the plant the boron levels are reversed, particularly in the Malayan Red Dwarf variety where in rank 9 leaves they are 22 ppm on coral soils and only 17 ppm on plateau soils. In Tall varieties the values vary from 8 to 12 ppm, whatever the type of soil and without the trees showing signs of malformation.

These levels are often below the 20-100 ppm considered normal for the plant. A value over 200 ppm is considered toxic.

3. — Experimental results.

In hydroponics.

As in the case of oil palm, boron lack affects leaf elongation. In other respects, the collar is a characteristic onion shape, and at 12 months, dry weight is only 23 p. 100 of the control, well supplied with B. Leaf 4 presents spots, and the start of necrosis ; elongation stops by leaf 7. It has been observed, however, that levels in leaf 4 are never below 4.5 ppm and it has been impossible to determine the level above which the coconut no longer shows deficiency symptoms.

In the field.

In the Ivory Coast, young coconuts planted on land having borne several cycles of food crops and coffee bushes, developed growth anomalies comparable to those observed on boron-deficient oil palms : fused terminal leaflets, bayonette leaf, lower part of the rachis without leaflets, shortening of the spear. Boron applications were unable to correct these symptoms in spite of an increase in the leaf levels [1]. The malformations did regress and disappear after a year however, independently of treatments. The particular and characteristics symptoms of « white spots » observed in pot culture do not appear clearly in the field.

The history of research on the effects of boron reviewed in a recent paper [7] describes the results obtained to date, notably that a preventive application of 15 g/tree of Boracine at the time of planting, then 15 g/tree at 6 months, prevents any growth

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