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Boron Deficiency In Young Coconut (*Cocos nucifera* L.) In Sri Lanka

SYMPTOMS AND CORRECTIVE MEASURES

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ABSTRACT

Apart from N, P, K, and Mg deficiencies in coconut so far observed in Sri Lanka, boron (B) deficiency was observed in 12 young coconut palms of age 1-3 y at Poojapitiya in Kandy district. The symptoms were : Unsplit, crinkled nature of leaflets; stunted and withered apical leaves; lack of leaflets in some fronds. The third leaf of the affected palms had 3.4—7.5 ppm B as compared to 7.6—10.0 ppm B for healthy palms in the same vicinity. Soil application of sodium tetraborate (Na_2BO_4. $5H_2O$) at the rate of 28 and 56 g/palm to the affected palms at incipient stages improved the condition of palms within six months and complete recovery was achieved at the end of eight months. However, the symptoms in the untreated affected palms gradually became acute and the palms died after 6-8 months. Results suggest that the critical nutrient concentration range for B in the third leaf is 8-10 ppm and the deficiency could be corrected only at the incipient stages by soil application of sodium tetraborate.

INTRODUCTION

Coconut is one of the three major plantation crops in Sri Lanka and is cultivated in about 0.5 million hectares. As most of the coconut-growing soils in the island are deficient in N, P, K, and Mg, the Coconut Research Institute of Sri Lanka recommends fertilizer mixtures containing N, P, and K, and also recommends the regular application of Mg, fertilizers. In Sri Lanka nutritional deficiencies normally observed in coconut are due to N, P, K, and Mg. However, in October 1979, 12 young coconut palms of age 1-3y, on a hilly land at Poojapitiya, Kandy district were reported to have crinkled, withered, and stunted apical leaves (Loganathan, 1981; Jayasekara *et al.*, 1981) which are characteristics of the boron deficiency symptoms in coconut reported in India (Chakrabathy *et. al.*, 1973), Indonesia (Shorrocks, 1974), Ivory Coast (Brunin and Cooman, 1973), and the Philippines (Azucena, 1972). This paper describes the B deficiency symptoms observed in young coconut palms in Sri Lanka and the rate of recovery of the palms after soil application of B-fertilizer.

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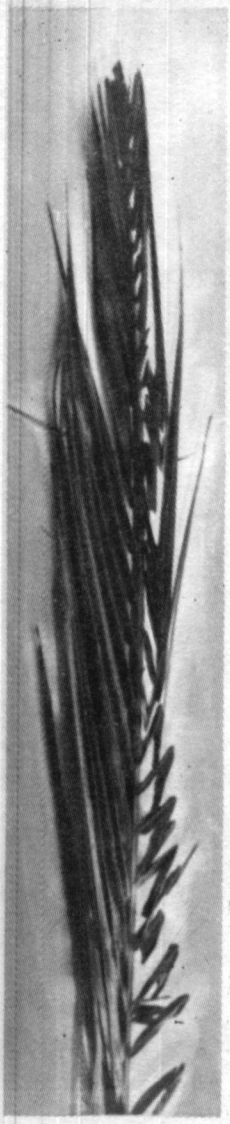

Fig. 1. Hooked and fused leaflets showing B-deficiency symptoms in coconut.

Fig. 2. Crinkled and stunted leaf of a B-deficient coconut seedling.

Fig. 3. Coconut seedling showing advanced stage of B-deficiency showing the dead apical leaf.

MATERIALS AND METHODS

Twelve young (1-3 y) coconut palms showing symptoms of dried, crinkled, and withered apical leaf and/or young leaves, located in a hilly land (altitude 548 m; mean annual rainfall 1800 mm) at Poojapitiya, Kandy were used in this study. The land was intensively intercropped with tea and pepper but all crops had been regularly fertilized with N, P, K, and Mg, fertilizer mixtures, without any micronutrients. Soils of the area were clay loam at the surface (0-50 cm) with PH of 5.0 (1:2 soil/water ratio) and are classified as Reddish Brown Latasolie Soils or Tropudults (De Silva and Panabokke, 1972-73). Careful and detail inspection of the affected palms showed that the symptoms were definitely not associated with any insect, fungus or "leaf scorch". They were very similar to the symptoms of B-deficiency previously reported from other countries by Brunin and Cooman (1973) and Manciot *et al.*, (1980). The condition was thought to be due to B-deficiency. No symptoms were observed in mature coconut palms, tea, pepper or any other plants in the land. In the vicinity of the affected coconut palms, there were six healthy young palms (1-3 y) without any symptoms. Enquiries revealed the past occurrence of similar symptoms in at least five young coconut palms in the past in the neighbouring lands and the subsequent death of these palms.

Out of the 12 affected palms only 10 palms were in a suitable condition for a nutritional study and hence these 10 palms were categorised into two groups depending on the severity of symptoms as follows:

1. Incipient stage of symptoms (IN)—7 palms: Palms had slightly withered and stunted apical leaf, crinkled leaves (Fig. 1), and hooked and fusion of leaflets (Fig. 2).

2. Advanced stage of symptoms (AD) -3 palms: Palms had severely withered, stunted and dying apical leaf (Fig. 3) crinkled leaves, hooked and fusion of leaflets, and some fronds without leaflets.

Three healthy palms (HE) were also selected for the study.

As the third leaf (youngest fully opened leaf as number one) has been shown to be the best diagnostic one to reveal micronutrient status of young palms (de Silva, 1974; Magat, 1978), 5-8 leaflets from this leaf were sampled from each of the palms in the three categories, dried in an oven at 70°C, ground and analysed for N, P, K, B, Zn, Fe, Mn, and Cu using the methods described by De Silva (1974). The first three youngest leaves of tea plants in the land were also sampled and analysed for B. Soil samples were collected to a depth of 30 cm within 1 m radius around the base of the palms and analysed-for total and hot water extractable B (Wear, 1965). The 10 affected palms were divided into three groups and were treated with sodium tetraborate (Na_2BO_4. $5H_2O$) at the rate of O, 28 and 56 g/palm after dissolving the chemical in 8 l of water and adding to the soil at the base of the palm within 1 m radius. Condition of the palms was noted and photographic records were taken at 0, 4 1/2, 7, and 8 months after treatment. Leaflets from the third leaf of palms were again sampled at eight months and analysed for B content.

RESULTS AND DISCUSSION

Leaf nutrient concentration

Leaf nutrient concentration of the young coconut palms at different stages (healthy—HE, incipient—IN, and advanced—AD) of suspected B—deficiency symptoms is reported in Table 1.

Table 1. *Leaf* (3rd) *nutrient concentrations of young* (1-3 *y*) *coconut palms prior to B treatment*

Condition of palms*	...	Mean nutrient concentrations							
		N	P	K	B**	Zn	Fe	Mn	Cu
		%	%	%	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*
Healthy (HE) (3)	...	2.14	0.12	0.71	8.5 (7.6-10.0)	13.0	53	236	1.6
Incipient Stage (IN) (7)	...	1.78	0.10	1.13	6.6 (5.9-7.5)	14.2	69	289	4.1
Advanced Stage (AD) (3)	...	1.79	0.13	0.72	4.9 (3.4-5.6)	13.6	66	382	2.1

* Number of palms in each category shown within parenthesis

** Concentration range shown within parenthesis.

Results show that B content is low in both IN and AD palms compared to the HE palms in the same vicinity, supporting the hypothesised B—deficiency. However, in all coconut palms (including HE), B concentrations were lower than the critical B level of 10 ppm (Manciot *et al.*, 1980) and 13-14 ppm (Cecil and Pillai, 1978) reported for young coconut. This indicates the possibility of B—deficiency even in HE palms with time. Deficiency symptoms in HE palms did appear seven months after the first visit to the site confirming the above prediction. The N, P, and K concentrations were also slightly lower than the levels reported by Fremond (1965). However, no N, P, K, and Mg deficiency symptoms were observed in any of the palms in the land, probably becauuse all plants had been annually fertilized with the recommended NPK—Mg fertilizers.

Response of palms to B-fertilizer application

The condition of the affected palms at different intervals of time after the application of B-fertilizer is summarised in Table 2. Palms which received the two rates (28 and 56 g/palm) of sodium tetraborate recovered completely within eight months and their leaf B concentration also increased, confirming that the deficiency symptoms were due to B. All palms of advanced state of deficiency (AD) died in spite of the application of high B levels, suggesting that after a critical stage of severity of B-deficiency, the young palms

cannot recover through soil application of B-fertilizer. Observations indicated that the critical stage at which palms would not respond to treatment was when the leaves are withered with severely stunted apical leaf, crinkled leaves, and when some fronds lack leaflets. However, the increased rates of B application increased the leaf B concentration in the dying AD palms suggesting passive absorption and transport of B from the soil-root interface to the leaf canopy along with the main transpiration stream as has been reported by Epstein (1972).

Table 2. *Effect of B treatments on the rate of recovery of the B deficient palms*

Initial condition of palms	*Number of palms*	*Boron rate $Na_2BO_4.5H_2O$ g/palm*	*Time after* 4 *months*	*Soil B* 7 *months*	*Application* 8 *months*	*Leaf B ppm at* 8 *months*
Incipient Stage (IN)	2	0 (Control)	advanced	advanced	almost dead	5.6, 5.6
	1*	0 (Control)	incipient	1-2 new healthy leaves	normal	7.6
	2	28 (Low)	incipient	2-3 new healthy leaves	normal healthy	10.0, 17.0
	2	56 (High)	incipient	2-3 new healthy leaves	normal	17.3, 27.6
Advanced stage (AD)	1	0 (Control)	advanced	almost dead	almost dead	4.8
	1	28 (Low)	advanced	almost dead	almost dead	19.0
	1	56 (High)	advanced	almost dead	almost dead	23.0

All, except one (IN—control*: Table 2), of the affected palms which received no fertilizer have died with time. The recovery of this palm (control*) may be due to its enhanced ability to extract soil B with time, as indicated by the increase in its leaf B con-

centration to 7.6 ppm, while leaf B concentration of all other palms which did not receive B-fertilizer decreased with time. During the eighth month visit, three of the healthy palms started to show the same B-deficiency symptoms and sodium tetraborate at the rate of 28 g/palm was applied to these palms. The B-deficiency symptoms disappeared 10 months after B application.

Critical leaf B concentration

Leaf B concentration of affected palms was less than 7.5 ppm and that of the healthy palms at the initial stage of the study was 7.6-10.0 ppm (Table 1). After eight months even the healthy palms started to show B-deficiency symptoms. This suggests that leaf B concentration of 7.6-10.0 ppm may not be sufficient for young coconut. Table 2 shows that the palms which were recovered as a result of soil application of B-fertilizer had leaf B concentration of 7.6-27.6 ppm. Based on these observations, leaf (third) B concentration of 8-10 ppm is suggested as the critical leaf nutrient concentration range for young coconut palms, below which B-deficiency is likely to occur. These values are slightly lower than those reported by Cecil and Pillai (1978) and Manciot *et al.* (1980).

Soil boron

Total and hot water-soluble B in the soils around the affected palms were 8.63 and 0.42 ppm, respectively. These values are considered to be low in comparison with the concentrations required for the optimum growth of most crops (Reisenauer *et al.*, 1973). The availability of B to coconut is further reduced by the competition of tea and pepper which were intensively intercropped with coconut in the land. The leaf B concentration in the tea plants (17 ppm B) was slightly higher than the critical leaf B concentration of 6-14 ppm reported for tea (Pethiyagoda and Krishnapillai, 1971) and this may perhaps be due to the acidic root exudation of tea plants making them more efficient in extracting and utilizing soil B. compared to coconut.

REFERENCES

Azucena, B. A. (1972). Nutrition deficiency symptoms. In: *Coconut Production.* Ed. R. G. Emata. Bur. Soils, Manila, Philippines. 39-42.

Brunin, C. and Cooman, P. 1(973). Boron deficiency in young coconut palms in the Ivory Coast. *Oleagineux.* 28(5): 229-234.

Cecil, S. R. and Pillai, N. G. (1978). Role of boron in coconut nutrition. *Indian Coconut J.* 9: 1-13.

Chakrabathy, B. K., Nath, B. K. and Goswami, R. N. (1973). Boron brings brighter fortune to coconut palms. *Coconut Bulletin* (India). 6(2): 10-12.

de Silva, K. A. and Panabokke, C. R. (1972-73). Handbook of the soils of Sri Lanka. *J. Soil Sci. Soc. Ceylon.* 2: 1-97.

de Silva, M. A. T. (1974). Micronutrients in the nutrition of coconut. I. Methods and preliminary investigations . *Ceylon Cocon.* Q. 25: 116-127.

Epstein, E. (1972). *Mineral nutrition of plant: Principles and Perspectives.* John Wiley and Sons Inc. New York.

Fremond, Y. (1965). Mineral nutrition of coconut. *Oleagineux*. 20: 89-95

Jayasekara, K. S., Anthonipillai, G. M., and Loganathan, P. (1981). Boron deficiency in young coconuts (*Cocos nucifera L.*) in Sri Lanka: Symptoms and corrective measures. Proc. Sri Lanka Assoc. Adv. Sci. 37th Ann. Sess. Part II p. 42.

Loganathan, P. (1981). Report of the Soil Science Division—1980. *Ceylon Coconut* Q. 32: 43-56.

Magat, S. S. (1978). A review of fertilizer studies on coconut. *Philippine J. Cocon. Stud.* 3 (2): 57-72.

Manciot, R. Ollagnier, M., and Ochs, R. (1980). Mineral nutrition and fertilization of the coconut around world. *Oleagineux*. 35(1): 23-27.

Pethiyagoda, U. and Krishnapillai, S. (1971). Studies on the mineral nutrition of Tea. 3. Experimentally induced minor nutrient deficiency symptoms. *Tea Quart. (Ceylon)*. 42(1-2): 19-29.

Reisenauer, H. M. Walsh, L. M., and Hoeft, R. G. (1973). Testing for sulphur, boron molybdenum and chlorine. *Soil Testing and Plant Analysis*. Ed. L. M. Walsh and J. D. Beaton. In: Soil Science Society of America, Madison, Wisconsin. 173-200.

Shorrocks, V. W. (1974). Boron deficiency—Its prevention and cure. Publ. Tech. Ser Dept. Borax consolidated Ltd. UK. pp. 55.

Wear, J. I. (1965). Chemical and Microbiological Properties. In: *Methods of Soil Analysis part* 2. Ed. C. A. Black, D. D. Evans, L. E. Ensminger, J. L. White and F. E. Clark. American Society of Agronomy, Madison, Wisconsin. 1059-1063.