EFFECT OF HEAVY METALS ON MICRONUTRIENT NUTRITION OF COCONUT

C. C. BIDDAPPA, H. H. KHAN, O. P. JOSHI and P. MANIKANDAN
Central Plantation Crops Research Institute, Kasaragod 670 124, India.

ABSTRACT

The influence of root feeding of Cd, Al, Cr, Ba, Bi and Pb on the micro-nutrient concentration in coconut crown was studied. Results indicate that the concentration of Fe, Mn, Zn and Cu had, in general, increased due to heavy metal treatments in all the leaf positions. Significantly higher concentration of Fe due to Cr treatment, Mn due to Bi, Zn due to Ba and Cu due to Pb was observed.

INTRODUCTION

THE toxic levels of non-essential trace metals in soil have been known to develop through natural soil properties and allied factors such as industrial pollution[1]. It has also been pointed out that the presence of excessive amounts of such non-essential trace metals would interfere with plant nutrition through competition for uptake, inactivation of enzyme, displacement of essential elements from functional sites and alteration of the structure of water[2]. Heavy metals interact with micro-nutrients either at the entry point between the solution phase and the root surface or at the translocation stage from the root to the leaf. Different metals would behave differently depending upon its ionic nature; some would exhibit a synergistic effect while others show antagonistic properties. The present investigation deals with the effect of root feeding of Al, Ba, Bi, Cd, Cr and Pb on micro-nutrient nutrition of coconut palm.

MATERIALS AND METHODS

Twenty eight palms of 15-year-old, growing on a red sandy loam soil (Arenic paleustults) at this Institute were selected for the study and were treated in four replications as given in table 1.

One-year-old roots, all around the coconut palm were exposed without injuring the roots. For each treatment, dilute heavy metal solutions prepared in water were uniformly fed in stages for different periods depending upon the intake of metals by the roots. Ba and Cr took less number of days while nearly 80 days were required to feed the specified quantity of Pb, Cd, Al and Bi.

The tissue samples representing fronds 1, 5, 9, 14, 16 and 21 were collected after the lapse of ten months. Leaf number 1 represents the youngest fully opened leaf, 14 represents the index leaf and number 21 represents the old leaf. The leaf samples were processed and the diacid extracts (HNO_3, $HClO_4$) were prepared. Fe, Mn, Zn and Cu in the digests were estimated using atomic absorption spectrophotometer (Varian Techtron model AA6).

RESULTS AND DISCUSSION

Iron

The data on the influence of different heavy metals on the iron concentration in different leaf positions (table 2) show that heavy metal treatments, in general, increased the iron concentration in all leaf positions as compared with the control. A higher Fe concentration induced by heavy metals might be due to the loss in the ability of the roots to exclude the toxic amounts of iron penetrating into the root owing to a depression of metabolic activity as suggested by Tsutsumi[3]. Cr treatments induced the highest iron concentration in the leaves followed by Bi and Cd. The iron concentration progressively increased with leaf maturity up to 11/14th leaf and decreased thereafter. The differences in effects observed among heavy metals might be due to the variation in their electronegativity[4].

Table 1 *Quantity of different elements fed*

Elements	Quantity mg/palm	No. of days fed
Pb	33.4	87
Cd	47.0	87
Al	1043.0	81
Bi	37.3	81
Cr	115.0	52
Ba	50.1	49
Control	00.0	-

Table 2 *Influence of heavy metals on the content of Fe (μg/g) in coconut leaves*

	Leaf numbers						
Heavy metal	1	5	9	14	16	21	Mean
Cd	224.57	255.63	393.60	236.52	271.47	255.63	281.20
Al	152.47	308.20	236.57	317.73	286.70	308.90	264.96
Cr	262.93	293.00	262.07	455.90	338.07	322.00	334.06
Ba	324.27	252.09	250.93	263.43	364.00	203.03	277.56
Bi	253.07	310.87	272.73	341.67	340.43	331.30	298.21
Pb	232.00	260.70	248.37	298.43	265.57	266.47	249.41
Control	110.13	187.37	191.23	197.50	174.73	179.77	174.43
Mean	222.78	266.84	266.44	301.56	291.57	266.73	

CD for treatment = 50.85.

Manganese

The results (table 3) show that heavy metal treatments invariably increased Mn concentration in the leaf barring Cd and Cr. Mn concentration is enhanced in the younger leaves, i.e. up to 11th leaf due to Cd and Cr feeding. However, beyond this Cd and Cr treatments resulted in a much lower Mn concentration in the leaf. Maximum concentration was recorded in palms treated with Bi followed by Al and Pb. Al toxicity is frequently accompanied by higher levels of Fe and Mn in the plant tissues[5]. In younger leaves the treatment by Pb favoured the accumulation. In general, Mn concentration progressively increased with leaf maturity.

Zinc

The data (table 4) reveal that Bi and Ba treatments enhance Zn concentration in the leaf as compared to the control. On the other hand, Al did not show any significant variations except in the leaf positions 1 and 5. In general heavy metal treatments favoured a higher Zn concentration in all the leaf positions barring Pb. The Zn concentration is slightly decreased with leaf maturity. In the index leaf (14th) the Cr treatment recorded the highest concentration (66.6 ppm) followed by Ba (59 ppm) whereas other heavy metals did not show significant variation as compared with the control.

Copper

The results (table 5) show that Pb treatment recorded the maximum Cu concentration in comparison with the control, particularly in the younger leaves followed by Cd. Synergistic interaction between Cd and Cu was earlier reported[6] probably due to secondary effects. The palms receiving Cr and Ba recorded low Cu concentration probably due to the antagonism for its translocation from root to top. Pendias and Pendias[6] indicated that the Cu–Cr antagonistic reactions are related to the variable valency of Cr. It is interesting to note that among the leaf position, leaf number 9 recorded

Table 3 *Influence of heavy metals on the content of Mn (μg/g) in coconut leaves*

	Leaf numbers						
Heavy metal	1	5	9	14	16	21	Mean
Cd	167.13	280.93	332.37	297.07	346.13	296.00	286.49
Al	206.80	291.27	313.60	464.36	480.77	534.73	364.30
Cr	142.70	264.57	278.70	322.50	350.43	391.60	288.43
Ba	224.70	323.37	347.20	365.87	420.97	490.17	338.13
Bi	182.97	370.70	411.50	512.23	561.37	615.93	414.79
Pb	341.00	449.43	288.63	328.90	336.23	431.27	346.31
Control	112.40	295.20	291.47	368.07	403.87	457.00	302.20
Mean	196.81	325.00	323.35	379.85	414.25	459.53	

CD for treatments = 47.19; CD for leaf numbers = 53.51.

Table 4 *Influence of heavy metals on the content of Zn (μg/g) in coconut leaves*

	Leaf numbers						
Heavy metal	1	5	9	14	16	21	Mean
Cd	52.00	56.60	53.70	40.83	47.97	43.00	54.00
Al	34.24	49.50	38.20	41.30	46.10	57.50	43.74
Cr	68.17	62.70	34.27	66.63	66.37	40.47	56.35
Ba	79.10	51.67	75.73	58.97	59.83	52.63	68.03
Bi	59.63	62.20	67.70	46.90	62.75	84.07	65.86
Pb	101.23	80.53	60.20	42.43	36.30	31.43	58.56
Control	52.70	45.20	39.67	40.83	39.07	42.03	42.66
Mean	63.87	58.34	52.78	48.99	51.20	51.30	

CD for treatments = 17.45.

Table 5 *Influence of heavy metals on the content of Cu (μg/g) in coconut leaves*

	Leaf numbers						
Heavy metal	1	5	9	14	16	21	Mean
Cd	14.01	17.91	15.62	22.14	13.02	20.83	17.38
Al	18.26	16.92	15.58	15.50	14.24	8.85	15.78
Cr	13.29	15.37	8.96	13.17	15.37	15.37	12.93
Ba	15.82	15.34	19.18	10.87	13.90	9.62	13.51
Bi	16.86	18.68	13.45	12.93	10.57	15.93	14.93
Pb	33.04	39.95	15.25	21.55	13.81	14.53	23.44
Control	14.98	14.92	16.58	14.92	14.44	14.89	15.37
Mean	18.03	18.71	14.38	15.87	13.69	14.29	

CD for treatments = 4.93.

lower Cu concentration in all heavy metal-treated palms as compared with the control. In the index leaf, a high Cu concentration was recorded in Cd-treated palms followed by Pb, while Ba showed very low Cu content in the index leaf.

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