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ABSTRACT

The micronutrient status of soil and leaf was studied in three coconut genotypes, West Coast Tall, Tall × Dwarf, and Dwarf × Tall, receiving three levels of NPK fertiliser combinations. The lowering of pH by NPK treatments enhanced the availability of Mn, Fe, and Al in soil. However, only Mn was taken up by the palm in larger amounts. Water soluble Mn in soil was highly correlated with plant uptake. The micronutrient requirements of the three genotypes were similar. Zn and Cu requirements of the palm were increased by increased NPK application. The implication of enhanced micronutrient availability in soil following NPK fertilization is discussed.

INTRODUCTION

MUCH emphasis is now being given on the trace element nutrition of crops as our present knowledge stresses the importance of these elements for the maintenance and good performance of plants. The evolution of high yielding genotypes with high feeding potential and the increasing use of NPK fertilisers are known to aggravate the micronutrient problems of plants. Information regarding the trace element nutrition of annual crops is more voluminous than that of perennial crops. Only some isolated reports are available on trace element deficiencies in coconut (Joshi, 1959 ; Anonymous, 1969). The present work reports the effect of NPK fertilization on the trace element nutrition of three coconut genotypes, West Coast Tall, Tall × Dwarf, and Dwarf × Tall, as evidenced by their foliar and soil status.

MATERIALS AND METHODS

The materials collected from an existing NPK trial (started in July 1965), using three coconut genotypes, West Coast Tall, Tall × Dwarf (a hybrid between West Coast Tall and Chowghat Dwarf Orange), and Dwarf × Tall (hybrid of the reciprocal cross between the same parents), and laid out in a randomised block design with three replications were utilized for this study. There were nine treatments comprising of three genotypes, each receiving three levels of NPK fertiliser combinations, *viz.*, (*a*) F_0 : no fertilisers ; (*b*) F_1 : 0·5 kg N, 0·5 kg P_2O_5, and 1·0 kg K_2O/palm/year ; and (*c*) F_2 : 1·0 kg N, 1·0 kg P_2O_5 and 2·0 kg K_2O/palm/year. The fertilisers were applied in two splits, 1/3rd in May–June and 2/3rd in August–September in the form of ammonium sulphate (21% N), superphosphate (16% P_2O_5), and muriate of potash (60% K_2O). The number of palms/treatment/replication was five and the palms were 8 years old. The soil was of red sandy loam type with pH 5·1 and CEC 5·5 me/100 g.

Soil samples (one sample/palm) were taken before the first split application of fertilisers in May, 1973 from basins of each palm under the same treatment for each replication at 1 m from the hole and depth of 0–50 cm, and composited. The air-dried soil samples were analysed for dithizone extractable Zn, EDTA extractable Cu, water soluble, exchangeable and easily reducible Mn, NH_4OAC extractable Fe ($Fe^{++} + Fe^{+++}$), ammonium oxalate extractable Mo, and pH (1 : 2·5 soil : water ratio) by the methods suggested by Jackson (1967). KCl extractable Al was determined by the method of Chapman and Pratt (1961).

Leaf numbered 9th or 14th starting from the first fully opened one (Chapman, 1964) was taken from each palm and composited as for soil samples. Total Fe, Al, Mn, Zn, Mo, and Cu were determined, after diacid digestion, by the same methods as above.

RESULTS

The data pertaining to pH and micronutrient status of soil are given in Table I and that of leaf in Table II. Soil pH was considerably lower in the fertilized plots than in control. Significant increases were

TABLE I

Trace element status of soil (ppm) as influenced by NPK fertilisation

Treatments	pH	Zn	Cu	Mn (WS)*	Mn (Ex)**	Mn (ER)***	Mn (Active)	Fe	Al	Mo
F_0	5·10	2·97	0·99	0·36	7·84	143·78	151·59	1·43	34·44	0·02
F_1	4·30	3·13	0·68	8·93	14·04	108·71	132·80	1·63	46·94	0·02
F_2	4·30	2·81	0·79	14·44	13·76	96·78	125·28	2·23	56·56	0·02
CD (P = 0·05)	0·10	NS	NS	4·00	2·82	10·30	12·35	0·52	3·25	NS

NS = Not significant
* = Water soluble
** Exchangeable
*** = Easily reducible.

noticed for water soluble and exchangeable Mn, and exchangeable Fe ($Fe^{++} + Fe^{+++}$), and Al, while easily reducible and active Mn showed the reverse trend. However, Zn, Cu, and Mo contents were found to be unaffected by fertiliser application.

Leaf analysis (Table II) revealed that, among the treatments, Zn, Cu, and Mn levels were greatly increased by fertiliser application while no difference was seen in respect of foliar Fe, Mo, and Al. Neither soil nor leaf analysis showed any significant difference between genotypes for any of the micronutrients studied. For this reason, the data are not presented here.

DISCUSSION

The fall in soil pH in the fertilized plots may be attributed to the effect of ammonium sulphate. Reactions leading to the nitrification of NH_4^+ ions would result in the acidification of soil, and, therefore, long term application of this fertiliser would have been mainly responsible for bringing about such a change in soil pH. Concomitant with decrease in pH, the availability of the micronutrients Mn, Fe, and Al, was also improved in the soil (Table I). The supply of micronutrients to soil as fertiliser impurities may not be of much significance for two reasons, the low micronutrient contents of the fertiliser materials and the reduction in the active Mn of the soil with increasing fertiliser dose. The lowering of pH, consequent on the application of ammonium sulphate, may have caused the conversion of easily reducible Mn to water soluble and exchangeable forms, whereby depletion in the reverse Mn of soil took place. The enhanced induced uptake of Mn could be possibly due to this availability (Table II). Leaf Mn values

TABLE II

Trace element status of leaf (ppm) as influenced by NPK fertilisation

Treatments	Zn	Cu	Mn	Fe	Al	Mo
F_0	13·2	11·5	426	276	4·56	0·75
F_1	29·0	20·3	765	277	4·11	0·67
F_2	32·5	22·8	842	297	5·28	0·87
CD (P = 0·05)	5·75	9·25	100·20	NS	NS	NS

NS = Not significant

exceeding 1,000 ppm may lead to toxicity in crop plants (Mitchell, 1965). In this context the present observation assumes importance and it is stressed that the fall in pH values must be taken care of under such conditions to alleviate probable toxic effects. Of the three estimates of soil Mn, *viz.*, water soluble, exchangeable, and available (water soluble + exchangeable), water soluble fraction was found to correlate best with leaf values ($r = 0·59$**) accounting for a variation of 35% (r^2). Contrary to this, the absorption of Fe and Al was not found to be enhanced by increase in availability of these elements in the soil. In the case of Al, it is probable that the Al absorbed might have got locked up in the roots, hindering upward translocation (Black, 1968). As regards the uptake of Zn and Cu, the palm tended to absorb more with increasing fertiliser doses indicating that the requirements of these nutrients may also be increased with higher rates of NPK application. As the foliar levels of micronutrients were not different between genotypes, their requirements may be similar in all cases.

Another implication of the result is on the statistical interpretation of the experimental results especially of yield responses. It is quite likely that whatever effects obtained will be attributed solely to the NPK nutrients rather than to the NPK fertiliser sources. The results of the present study show that such conclusion would be biased as the interaction of fertiliser with soil and consequent alteration in the availability of the nutrients (Mn in this case) could not be distinguished by statistical analysis. Davis and Pillai (1966) reported that Mn could increase the yield of nuts in coconut. According to Pomier (1967), the application of K is effective only when the needs of Fe, Mn, and N are satisfied. From these observations, it seems probable that one of the reasons for getting differential responses to NPK fertilisers in different soils may be the side reactions of fertilisers with soil resulting in an altered availability of trace elements. Hence, effects of such probable side reactions may also be taken into consideration for more valid interpretations of the results of fertiliser experiments.

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