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EFFECT OF LONG TERM FERTILISER APPLICATION AND CULTURAL PRACTICES ON SOIL CHEMICAL PROPERTIES AND YIELD OF COCONUT

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ABSTRACT

Management of coconut groves through cultural practices alone, like cultivation of interspaces twice a year and weed control using herbicides only produced poor yields ranging from 10.7 to 32.3 nuts/palm as compared to fertiliser treatments coupled with cultural practices which produced yields ranging from 83 - 107.9 nuts/palm/year, indicating that cultural practices alone could not sustain higher productivity. However, long term studies have indicated that cultural practices alone are superior to no cultivation and no manuring. For judging the nitrogen status of coconut groves plant analysis may be a reliable index than soil analysis. The plant N levels obtained are much lower even in palms which receive regular fertiliser application on a long term basis indicating that the critical levels established by IRHO may be lowered for Kerala conditions. The palms under cultural treatment have an imbalanced nutrition compared to palms which are regularly fertilized.

INTRODUCTION

Fertiliser application and manipulation of physical and chemical environment by cultural practices are known to affect the soil properties and yield of field crops. Better performance of coconut palms with regular cultural practices (Menon and Pandalai, 1970; Anon., 1989) and chemical fertilisation (Hameed Khan *et al.* 1986; Wahid *et al* 1988) have been reported. For a crop like coconut palm which is committed to the land on which it is planted for several decades, the soil physical and chemical environment plays a significant role in sustaining productivity. Several types of cultural practices are in vogue in the cultivation of coconut in the country with application of fertilisers or in its absence. The present investigation deals with the effect of long term fertiliser application and cultural practices on the soil properties, mineral nutrition and yield of coconut.

MATERIALS AND METHODS

The experiment to study the effect of manurial and cultural practices on the performance of coconut palms was initiated during 1919. The garden was under planted in 1967 and later the old palms were removed. Originally there were three treatments per plot. In 1972 each plot was sub-divided into two and the treatments were modified as detailed below. The plot size was maintained as 12 palms per plot with single replication. The trial was laid out adopting the methodology of permanent manurial experiments.

The experimental site was located (10m above MSL) in the Central Plantation Crops Research Institute, Kasaragod, Kerala. It receives an average annual rainfall

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The details of treatment history is as follows:

S. No.	Original treatments		Revised treatments since 1972
1.	Cultivation and manuring	T1	Cultivation (ploughing the inter spaces twice a year) + inorganics + organics
		T2	Cultivation + inorganics
2.	Cultivation but no manuring	T3	Inorganic fertilisers + forking the manuring circles (basin)
		T4	Cultivation alone
3.	No cultivatioin and	T5	Weed control witht herbicides only
	no manuring	T6	No cultivatiton and no manuring (neglect)

of 3500 mm. The soil is red sandy loam analysed 76 per cent sand, 22 per cent clay, 2 per cent silt and 0.37 per cent organic carbon. The pH varied between 4.58 and 4.63 and average cation exchange capacity of soil was 7.28 c mol(+)/kg. The soil was classified as Kandiustults.

The palms received inorganic fertilizers at the rate of 500 g N as urea, 320 g P_2O_5 as rock phosphate (Mussorie rock phosphate) 1200 g K_2O as muriate of potash per palm per year and the organic manure at the rate of 30 kg of green leaf.

Soil samples were collected during the month of May 1992 from the manuring circles of six palms from each treatment at a distance of 1.0 to 1.2 m around the bole and from three depths vix., 0-25, 25-50 and 50-100 cm. Leaf samples were collected from frond 14 (diagnostic leaf) (Prevot and Bachy, 1962) or n/2 or (n+1)/2 as the case my be. The soil and plant samples were systematically processed and analysed for major, secondary and micronutrients by conventional procedures (Jackson, 1967).

RESULTS AND DISCUSSION

Soil analysis did not reveal the effect of long term fertilizer application and cultural practices on the available nitrogen status of soil. However, the surface soil of the treatment-cultivation alone analysed 89.4 ppm available N compared to other treatments where it ranged from 104.1 to 117.9 ppm, the highest value among treattments being recorded in the plots receiving both organic and inorganic fertilisers (Table 1).

Table 1. ***Effect of long term fertiliser application on soil available nutrient status.***

Treatment/	Available nitrogen (ppm)			Available phosphorus (Barly-I) (ppm)			Available potash (ppm)		
depth (cm)	0-25	25-50	50-100	0-25	25-50	50-100	0-25	25-50	50-100
T1 Cultivation + organics + inorganic fertilisers	117.9	88.9	84.7	118.2	36.4	12.3	312.7	129.2	89.1
T2 Cultivation + inorganics alone	107.8	86.9	71.2	108.5	43.5	9.6	255.3	117.5	73.3
T3 Fertiliser application+ forking basins	107.9	99.2	83.8	51.0	22.8	5.8	348.3	173.3	97.9
T4 Cultivation only (no manures)	89.4	98.4	78.4	15.5	7.28	7.7	49.4	31.3	24.2
T5 Weed control with herbicides	107.4	108.7	90.3	9.01	6.21	6.19	43.8	31.7	23.3
T6 No cultivation and no manuring (neglect)	104.1	96.1	84.9	5.8	3.5	5.2	31.7	21.3	16.7

(Mean of six values)

In this context it has been observed earlier (Hameed Khan *et al.* 1986) that the available nitrogen status of plots receiving inorganic fertilisers for 18 years was on par with control plots indicating that in the humid tropics it is difficult to create N gradients by simple inorganic fertiliser application. This is also indicative of the fact that for perennial crops like coconut soil available N status may not be suitable for judging the nutrient status for diagnostic purpose.

The soil available phosphorus status is much influenced by the fertiliser treatments. The fertiliser treatments recorded higher P content at the surface (0-25 cm) which gradually decreased with depth (Table I). Surprisingly inorganic fertilizer application and forking the basin (T3) treatment had 50 per cent less available phoshporus than the treatment cultivation plus inorganics and organics (T1) and cultivation plus inorganics (T2) treatment where it ranged from 108-118 ppm. The comparatively low available phosphorus in the treatment fertiliser application and forking alone is due to the fact that till 1972 this plot was under cultivation alone, and subsequently the treatments were revised. In the cultural treatment (T4, T5 and T6), the available P varied from 5.8 to 15.5 ppm at the surface, the lowest being in T6 - no cultivation and no manuring. When the cultural treatments (T4, T5, T6) and feertiliser treatments (T1, T2, T3) were compared to a depth of 100 cm the fertiliser treatments had 45-3 ppm available P where as it was only 7.3 ppm in the cultural treatments. (Table 2). This indicates that feertiliser application is essential to build up the soil available phosphorus.

Table 2. ***Mean values of available P and K at 0-100 cm depth in fertilizer and cultural treatments***

Treatments	Available nutrients (ppm)	
	Phosphorus	Potash
Fertilizer treatments (T_1, T_2, T_3)	45.3	177.4
Cultural treatments (T_4, T_5, T_6)	7.3	30.3

The available K values very high in the fertiliser treatments which varied from 255.3 - 348.3 ppm in the surface soil (0-25 cm) compared to 31.7 to 49.4 ppm in the cultural treatments. When the 0-100 cm depth profile is considered it was 177.4 ppm in the fertilizer treatments compared to 30.3 ppm in the cultural treatments (Table 2). Biddappa *et al.* (1993) indicated the critical level for soil available K to be 59-78 ppm for red sandy loam soils which suggested that palms growing under cultural treatments alone would suffer from K deficiency in this oil type.

Exchangeable Ca and Mg of the soil were low irrespective of fertiliser/cultural treatments. However, fertiliser treatments recorded higher exchangeable Ca in the surface soil (0.55 to 0.60 m.e/100 g) (Table 3). The comparatively higher exchange Ca might have resulted due to addition of phosphatic fertilisers containing lime. No difference was observed in the fertilised and cultural treatments for exchangable Mg.

In all the treatments, soil available micronutrients viz., Fe, Mn, Zn and Cu were above the criticala level. (Table 4). However, in fertilized plots, soil available Fe was more. The pH of the soil was marginally lower in fertiiized plots (4.27) compared to plots receiving cultural treatments (4.52).

Nitrogen and phosphorus levels of plants were found to be below the critical levels considering the values established by IRHO (Manciot *et al.* 1979 a, b) (Table 5). The mean of N contents of the diagnostic leaf was 1.56% (as against 1.8 - 2.0% critical level) in the fertilizer treatments palms which received no cultivation and no manure (T_6) recorded lowest values of 1.28% N. Hameed Khan *et. al.* (1986) opined that fertilizer treatments resulted in minimal increase in soil available N levels, whereas improved N nutrition was apparent judging foliar N levels.

Table 3. *Effect of long term fertiliser application and cultural practices on the soil exchangeable nutrients (m.e./100g) and pH*

S. No. Treatment/ depth (cm)	Ca			Mg			pH		
	0-25	25-50	50-100	0-25	25-50	50-100	0-25	25-50	50-100
T1 Cultivation + organic + inorganic fertiliser	0.55	0.20	0.10	2.22	0.75	0.46	4.31	4.10	4.24
T2 Cultivation + inorganics alone	0.48	0.16	0.03	2.18	0.72	0.47	4.35	4.25	4.25
T3 Fertiliser application Forking basins	0.60	0.19	0.14	2.53	0.88	0.68	4.32	4.21	4.47
T4 Cultivation only (No manures)	0.17	0.10	0.05	2.09	1.03	0.92	4.58	4.40	4.58
T5 Weed control with herbicides	0.24	0.09	0.10	2.32	1.00	1.62	4.62	4.35	4.35
T6 No cultivation and no manuring (neglect	0.28	0.19	0.15	2.86	1.82	1.79	4.63	4.50	4.58

(Mean of six values)

Table 4. *Effect of long term fertiliser application and cultural practices on the soil available micronutrient status (ppm)*

S.No. Treatment/ depth (cm)	Fe			Mn			Zn			Cu		
	0-25	25-50	50-100	0-25	25-50	50-100	0-25	25-50	50-100	0-25	25-50	50-100
T1 Cultivation + organic + inorganic fertiliser	21.3	18.7	15.4	12.2	11.9	11.5	0.60	023	0.16	0.81	0.63	0.32
T2 Cultivation + inorganics alone	20.4	18.9	19.7	12.0	11.3	11.3	0.61	0.23	0.19	0.91	0.65	0.51
T3 Fertilizer application + forking basins	19.7	17.2	17.1	12.2	12.1	12.6	9.75	0.29	0.21	0.75	0.46	0.36
T4 Cultivation only (No manures)	15.5	16.9	18.4	11.8	11.7	12.0	0.28	0.17	0.15	0.57	0.49	0.34
T5 Weeds control with herbicides	16.1	15.6	16.6	12.0	12.0	12.0	0.57	0.19	0.15	0.81	0.43	0.35
T6 No cultivation and no manuring (neglect)	14.3	14.9	17.4	11.9	11.7	11.7	0.65	0.31	0.29	0.67	0.47	0.46

(Mean of six values)

However, the plant N levels did not reach sufficiency levels established elsewhere and under Kerala conditions the critical level of N for realising higher yields is some what lower than those reported by Manicot *et al.*, (1979 a,b). The plant P levels were also below the critical levels and were not reflecting the soil available P status suggesting that for recommending P fertilisation to coconut, soil nutritional status rather than plant contents would serve as better diagnostic tool.

The plant K content of palms receiving fertiliser was 1.07% whereas for the palms receiving cultural treatment only the mean K value was 0.49% indicating severe K deficiency. When the plant K value was 1.07% in the fertiliser treated plots, the combined values of Na + Ca + Mg was 0.71% compared to cultural treatments where it was 0.49% for K and 1.12% for Na + Ca + Mg suggesting that the absence of proper nutrition createes imbalance in the nutritional status of palms. While plant Ca values were

Table 5. ***Effect of long-term fertiliser application and cultural practices on plant nutrient status of coconut palms.***

Treatment	(Frond 14*) % nutrient content ppm									
	N	P	K	Na	Ca	Mg	Fe	Mn	Zn	Cu
T1 Cultivation + organics + inorganic fertil.	1.59	0.107	1.04	0.17	0.30	0.26	210	575	28	5.3
T2 Cultivation + inorganics alone	1.61	0.096	1.13	0.19	0.31	0.26	220	733	26	6.0
T3 Fertiliser application + forking basins	1.49	0.079	1.04	0.15	0.24	0.27	2.6	584	29	5.0
T4 Cultivation alone	1.43	0.090	0.48	0.32	0.27	0.49	207	558	34	5.9
T5 Weed control with herbicides	1.41	0.081	0.44	0.33	0.27	0.49	207	558	34	5.9
T6 No cultivation & no manuring (neglect)	1.28	0.076	0.23	0.39	0.34	0.52	293	632	37	8.2

* Frond n/2 or n + 1 2 (Mean of six values)

Table 6. ***Effect of management practices on yield of coconut palms***

Treatments	yield (nuts/palm/year) 1991-92	1987-88 to 1990-91
T1 Cultivation + organic + inorganic fertilisers	88.3	107.9
T2 Cultivation + inorganic fertilizers	78.1	91.2
T3 Inorganic fertiliser & forking basins	70.1	83.0
T4 Cultivation alone	36.4	32.3
T5 Weed control with herbicides	20.5	10.7
T6 No cultivation and no manuring (neglect)	2.7	0.4

not much influenced by K levels, Mg and Na were found to be depressed indicating an antagonistic relationship (Wahid *et al.* 1974; Hameed Khan *et al.* 1986). An interesting relationship among mono and divalent cations and root CEC and yield in coconut has been given explaining the role of ionic ratios in the nutrition of palms (Wahid *et al.* 1974). Interestingly when plant K levels were low in palms in cultural treatments, the Na levels were higher indicating that a partial substitution by Na for the role of K is possible in coconut. Substitution of Na for K has also been documented in the nutrition of rice (Yoshida and Castaneda, 1969) and sugarbeet (Marschner, *et al.*, 1981). A good account of Na substituting for K for osmoregulation and enzyme activation besides classification of plants according to differences in growth response to Na has been outlined by Marschner (1986).

The micronutrient contents suggested that irrespective of the treatments, the palms had adequate levels of micronutrients in the system.

Soil and leaf analysis of palms under different cultural and fertiliser treatments strongly suggest that for satisfactory growth and productivity of palms in the red sandy loam soil mere cultural treatments alone cannot improve the nutritional status of palms and supplementing the nutrition with inorganic fertilizers and organic manures is necessary to sustain productivity. From the data of Joshi *et al.*, (1986) it was observed that in general available water capacity and maximum water holding capacity was higher in fertiliser treatments compared to treatments receiving cultural practices alone. Hence the established contention that cultivation + fertiliser application improved the physical and chemical properties of soil holds good for soils grown to coconut palms as well.

The yield data reflects the poor inherent fertility status of soil which could support only low yields of palms (Table 6). Since coconut palms derive their major nutrition from a limited volume of soil around its bole, and considering the nutrient export for production of fronds, nuts and other above ground parts (Pillai and Davis, 1963) it is necessary that the palms be fertilized regularly for obtaining higher returns and restoring the productivity of the soil.

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