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Short Note

Distribution of Available Macro and Micronutrients in Cashew Growing Soils of Dakshina Kannada District of Coastal Karnataka

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Available macro and micronutrient status of soils of cashew growing regions of Coastal Karnataka was carried out in Dakshina Kannada district to help in determining the potential of the soils to supply nutrients for crop growth. Six pedons *viz.,* Pala hillock, NRCC-Shanthigodu, Muchipadavu, Mulia, ARS Ullal and Palikudel were studied throughout the major cashew growing areas of Dakshina Kannada district representing the major climatic zones. The macro and micronutrients status of collected soil samples were analyzed by using standard analytical procedures. Results indicated that the available nitrogen status was found to be varying from low to medium in all the pedons. Further, the soils were low in available phosphorus, low to medium in available potassium and low to medium in available sulphur. Among the DTPA extractable micronutrients, iron and manganese were sufficient in most soils, available copper was sufficient and available zinc was deficient. The available macronutrient and micronutrient status was found to decrease with increasing depth of the soils. Phosphorus and zinc were highly deficient in all the pedons.

Key words: Macronutrients, Micronutrients, Cashew and Coastal soils

Soil fertility, compactability and erodibility are the elements of soil quality. Among these elements, the problem of decline in soil fertility endangers the maximum the growth in productivity (Katyal, 2003). Warren and Agnew (1988) described that of all the threats to sustainability, the threat due to soil fertility depletion is the most serious. Depending upon the cropping pattern, leaching, erosion etc., soil looses a considerable amount of nutrients every year. If cropping is continued over a period of time without nutrients being restored to the soil, its fertility will be reduced and crop yields will decline. Poor soil fertility conceives sparse plant cover, which promote erosion vulnerability. This happens because 90% of plant available N and S, 50-60% K, 25-30% P and almost 70% of micronutrients reside in organic matter (Stevenson, 1982). Soil fertility is meant for highlighting the nutrient needs, based on fertility status of soils (and adverse soil conditions which need improvement) to realise good crop yields. In India, cashew is mostly grown on laterite and red soils and coastal sands in the states of Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu, Orissa and West Bengal. The fertility status of these soils varies widely. The most fertile soils occurring on which cashews are grown is the forest soils on the Western slopes of the Western Ghats in Kerala and Dakshina Kannada district of Coastal Karnataka. The coastal sands of part of Dakshina Kannada district on which cashew are often grown are very poor in fertility and the yields are low in these soils unless the trees are fertilized regularly. The laterite soils of Dakshina Kannada district vary considerably in depth, texture and other physical and chemical properties. Available macro and micronutrient status in soil profile help in determining the soils potential to supply nutrients for crop growth. Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximising the crop yields. In order to provide a base line data and information on available nutrients status, the present study was undertaken in major cashew growing soils of Dakhsina Kannada district of Coastal Karnataka.

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Materials and Methods

The study was undertaken in six pedons from four taluks of Dakshina Kannada district of Coastal Karnataka during 2009 -11. The area receives a mean annual rainfall ranged from 3592 to 3842 mm. The mean annual temperature is 27.6 °C and mean maximum and minimum temperature are 36 °C and 20 °C respectively. The area has *ustic* moisture regime and isohyperthermic temperature regime. The soil samples collected were analysed for macro and micro nutrient contents following standard procedure.

Results and Discussion

Available Macronutrients

The data on available macronutrients of the soils is presented in Table 1. The available nitrogen status in all the pedons was rated as low to medium and the range of available nitrogen varied from 31.6 to 429.6 kg ha^{-1} throughout the depth. However, available N status was found to be maximum in surface horizons and decreased regularly with soil depth, which might possibly be due to the accumulation of plant residues, debris and rhizosphere. Level of available nitrogen is less than 280 kg ha^{-1} as rated low, 280 to 560 kg ha^{-1} as medium and more than 560 kg ha^{-1} as high (Srinivasamurthy *et al*., 1999).

Table 1. Depth wise distribution of available macronutrients in major cashew growing soils of Dakshina Kannada District, Coastal Karnataka

Depth (cm)	Available macronutrients							
	Horizon	OC (%)	N	P	K	Ca	Mg	S ($mgkg^{-1}$)
			< ——— Kg ha^{-1}		——— >	($cmol_{(p^+)}$ kg^{-1})		
Pedon-1 (Pala hillock)								
0-21	A1	3.07	430	6.8	158	1.90	1.60	9.37
21-41	Bw/BA	1.53	232	5.8	48	0.57	0.27	8.75
41-68	Bt 1	0.38	188	6.8	34	0.82	0.64	8.75
68-95	Bt 2	0.32	144	8.7	33	0.50	0.50	6.25
95-123	BC	0.13	125	7.8	32	0.49	0.60	3.75
Pedon-2 (NRCC-Shanthigodu)								
0-19	Ap	1.68	285	8.7	176	0.82	0.89	12.50
19-42	B w	0.97	201	7.8	49	0.36	0.81	8.12
42-71	CB	0.70	182	4.8	43	0.57	0.80	11.87
71-90	Cr 1	0.14	119	3.9	33	0.65	1.05	11.25
Pedon-3 (Muchipadavu)								
0-25	Ap	0.97	216	4.8	59	1.37	0.52	6.87
25-50	Bt 1	0.82	207	5.8	48	2.11	0.39	6.25
50-84	Bt 2	0.50	169	9.7	51	0.82	0.39	10.0
84-128	Bt 3	0.40	154	10.7	34	0.32	0.84	11.87
128-160	Bt 4	0.26	232	7.8	25	0.63	0.60	20.0
160-206	Bt 5	0.12	182	6.8	17	0.65	0.71	14.37
206-210	BC	0.14	204	8.7	9.0	0.45	0.62	32.5
Pedon-4 (Mulia)								
0-17	A	2.80	367	8.7	88	1.24	0.60	15.62
17-41	AB/BA	2.04	364	8.7	69	1.38	0.61	9.37
41-60	Bt 1	1.42	326	6.8	75	1.46	0.82	9.37
60-90	Bt 2	0.65	279	5.8	82	1.54	1.12	8.12
90-215	BC	0.43	197	6.8	32	1.09	0.73	8.12
Pedon-5 (ARS-Ullal)								
0-20	Ap	1.56	370	17.5	135	0.43	0.36	14.37
20-40	BA	0.83	263	6.8	68	0.13	0.19	9.37
40-70	Bt 1	0.13	254	1.9	82	0.73	0.62	8.75
70-99	Bt 2	0.45	273	1.9	136	1.75	1.05	8.75
99-127	Bt 3	0.36	257	2.9	70	1.59	1.13	9.37
127-165	Bt 4	0.27	245	3.9	55	1.09	0.93	10.0
165-191	Bt 5	0.03	191	5.8	63	0.92	0.95	15.0
191-210	BC	0.03	50	7.8	71	0.80	0.62	17.50
210-220	Cc	0.22	31	9.7	51	0.67	0.50	9.37
Pedon-6 (Palikudel)								
0-28	A	1.79	304	13.6	119	1.58	0.67	11.87
28-55	B w	1.30	188	9.7	29	0.74	0.49	10.0
55-90	Bt 1	0.73	138	4.8	24	0.58	0.60	8.75
90-130	Bt 2	0.36	122	3.9	17	0.76	0.78	6.25
130-180	Bt 3	0.28	113	4.8	22	0.84	0.56	12.50
180-210	BC	0.23	75	3.9	19	0.07	0.80	15.0
210-235	C 1	0.07	69	2.9	24	0.81	0.73	7.50

The available phosphorus status in the pedons varied from 2.9 to 17.5 kg ha^{-1} and rated as low. However, the highest available P was observed in the surface horizons and decreased regularly with depth. Higher P in the surface horizon might be due to the confinement of crop cultivation to this layer and supplementation of the depleted phosphorus through external sources *i.e.* fertilizers. Low available phosphorus of soils was due to the prevalence of heavy rainfall which leached all the base cations leaving mostly Fe and Al oxides, which fixes available phosphorus.

Available potassium status of the soils ranged from 8.7 to 176.1 kg ha^{-1}, generally low to medium status but most of the study area soils were of low level of potassium. The highest available K status was noticed in the surface horizons and showed decreasing trend with depth. This could be attributed to more intensive weathering, release of labile K from organic residues, application of K fertilizers and upward translocation of K from lower depths along with capillary rise of ground water. The fertility status of some typical soils of coastal Karnataka reported that the available potassium varied from 30 to 220 kg ha^{-1}. Coarse textured and gravelly soils with deeper solum are particularly low in available potassium, possibly due to faster and deeper leaching and physico- chemical properties (Badrinath *et al*., 1986). Ratings for available potassium indicated that less than 168 kg ha^{-1} as low 168 to 337 kg ha^{-1} as medium and more than 337 kg ha^{-1} as high (Srinivasamurthy *et al*., 1999). It is well known that the chemical characteristics of a soil can vary with depth down the soil profile. The vertical variation of nitrogen, phosphorus and potassium is the result of the profile distribution of the parent materials from which they derive or soil aggregations or concretions. Changes in soil management may also alter the vertical distribution of nutrients. The depth of accumulation and the amount of nutrient that accumulates also depends on rainfall and leaching.

The available sulphur in the soils varied from 6.25 to 20 mg kg^{-1} and most of the soils were very low in ratings. Muchipadavu and Palikudel soils had higher amount of available sulphur compared to other locations. Due to higher amount of organic matter in surface layers than in deeper layers, the available sulphur is more in surface horizons than the sub-surface horizons.

Exchangeable Calcium and Magnesium

Exchangeable calcium and magnesium in all the six profiles were low and ranged from 0.49 to 1.90 c mol (p+) kg^{-1} and 0.36 to 1.60 c mol (p+) kg^{-1} respectively, this is due to the prevalence of excess and frequent rainfall in the study areas which leached most of the basic cations like calcium, magnesium, potassium and sodium from the surface soil to lower horizons. The clay complex was dominated by exchangeable Ca in surface and subsurface horizons of most soils followed by Mg. Exchangeable Ca and Mg showed irregular trend with depth of soils.

Available Micronutrients

The examination of the data on available micronutrients of the soils presented in Table 2

Table 2. Depth wise distribution of available micronutrients in major cashew growing soils of Dakshina Kannada District, Coastal Karnataka

Depth (cm)	Horizon	Available micronutrients			
		Fe	Mn	Zn	Cu
		< ———— mg kg^{-1} ———— >			
Pedon-1 (Pala hillock)					
0-21	A1	48.40	6.60	0.96	0.56
21-41	Bw/BA	17.80	1.72	0.38	0.28
41-68	Bt 1	10.60	4.20	0.40	0.30
68-95	Bt 2	7.00	4.00	0.40	0.28
95-123	BC	6.60	3.56	0.20	0.28
Pedon-2 (NRCC-Shanthigodu)					
0-19	Ap	21.74	12.60	0.60	0.76
19-42	Bw	13.08	7.74	0.22	0.74
42-71	CB	12.00	9.36	0.28	0.78
71-90	Cr 1	8.50	8.38	0.30	0.76
Pedon-3 (Muchipadavu)					
0-25	Ap	11.0	4.36	0.26	1.08
25-50	Bt 1	7.0	2.86	0.24	0.88
50-84	Bt 2	2.46	1.60	0.16	0.64
84-128	Bt 3	3.48	1.84	0.10	0.68
128-160	Bt 4	2.26	1.60	0.04	0.62
160-206	Bt 5	2.30	1.48	0.04	0.56
206-210	BC	2.20	0.92	0.04	0.60
Pedon-4 (Mulia)					
0-17	A	24.2	5.78	0.48	1.02
17-41	AB/BA	21.6	7.76	0.16	0.90
41-60	Bt 1	14.8	10.12	0.46	0.86
60-90	Bt 2	8.76	9.25	0.22	0.66
90-215	BC	3.6	8.04	0.34	0.66
Pedon-5 (ARS-Ullal)					
0-20	Ap	37.40	4.80	0.30	1.34
20-40	BA	23.60	3.98	0.28	0.84
40-70	Bt 1	13.06	6.72	0.40	0.82
70-99	Bt 2	11.08	5.04	0.38	0.80
99-127	Bt 3	7.64	2.30	0.42	0.76
127-165	Bt 4	7.92	2.02	0.42	0.80
165-191	Bt 5	6.40	2.36	0.36	0.78
191-210	BC	6.40	2.20	0.24	0.76
210-220	Cc	6.78	2.16	0.12	0.74
Pedon-6 (Palikudel)					
0-28	A	50.00	13.3	0.54	1.52
28-55	Bw	26.80	8.80	0.44	1.26
55-90	Bt 1	16.00	7.00	0.42	1.04
90-130	Bt 2	10.20	4.00	0.30	0.88
130-180	Bt 3	7.40	3.36	0.24	0.80
180-210	BC	7.30	3.02	0.16	0.86
210-235	C 1	7.14	3.20	0.14	0.82

revealed that the DTPA extractable iron, manganese zinc and copper content varied from deficiency to toxicity level in all the pedons. The depth wise distribution of available micronutrients is clearly shown in fig.1. The DTPA extractable Zn ranged from 0.26 to 0.96 mg kg^{-1} in surface and 0.04 to 0.44 mg kg^{-1} in subsurface horizons. Vertical distribution of Zn exhibited little variation with depth. Considering 0.60 mg kg^{-1} as critical level for zinc deficiency (Lindsay and Norvell, 1978), these soils could be classified as deficient in Zn content except surface soils of pedon 1 and 2. The relatively high content of available zinc in surface horizons may be attributed to variable intensity of the pedogenic processes and more complexing with organic matter which resulted in chelation of Zn.

All the pedons were found to be sufficient in available copper (0.28 to 1.52 mg kg^{-1}) as all the values were well above the critical limit of 0.20 mg kg^{-1} proposed by Lindsay and Norvell (1978). A

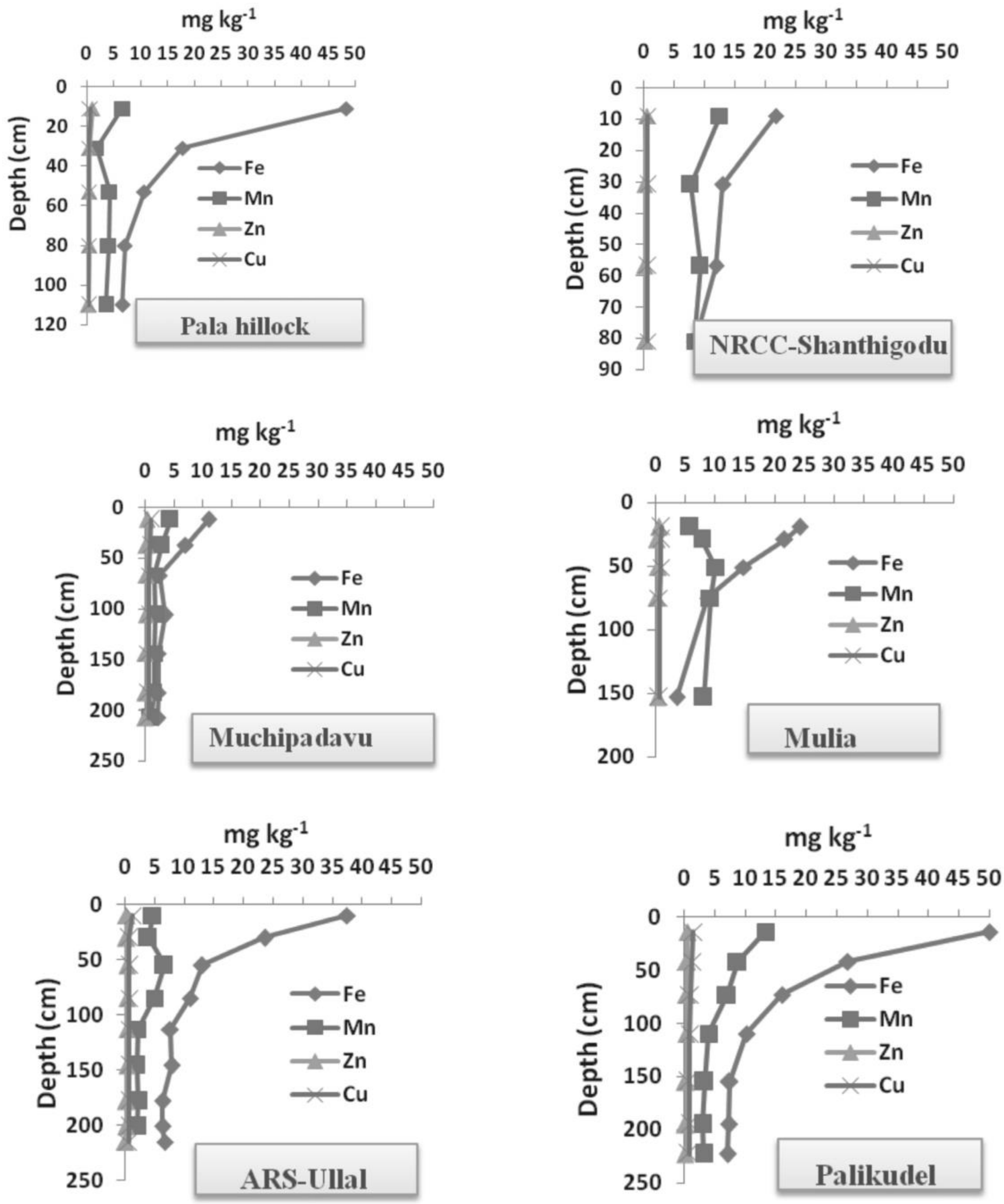

Fig.1. Depth-wise distribution of available micronutrients in study areas

decreasing trend with depth was noticed in all the pedons except in 2 and 3 which showed a irregular trend with depth. The available Cu content was more in surface layers and decreased with depth, which might be due to association with organic carbon.

The DTPA extractable Fe content varied from 2.20 to 50 mg kg^{-1} soil. According to the critical limit of 4.5 mg kg^{-1} of Lindsay and Norvell (1978), the soils were rich in available iron except Bt2, Bt3, Bt4, Bt5 and BC horizons of pedon 3. The higher concentration of DTPA-Fe in subsurface horizons of Pedons 1, 2, 4, 5 and 6 might be due to the accumulation of iron brought down as a result of illuviation of clay from the upper horizons. However, the higher DTPA-Fe in surface horizons of all the pedons might be due to accumulation of organic carbon in the surface horizons. The organic carbon due to its affinity to influence the suitability and availability of iron by chelating action might have protected the iron from oxida-tion and precipitation, which consequently increased the availability of iron in the surface horizons (Prasad and Sakal, 1991).

Available Mn varied from 0.92 to 13.3 mg kg^{-1} soil and almost decreased with depth which might be due to higher biological activity and organic carbon in the surface horizons. The higher content of available Mn in surface soils was attributed to its chelation by organic compounds released during the decomposition of organic matter left after harvesting of the crop. These observations are in accordance with the findings of Verma *et al*. (2005). The micronutrient analysis of cashew growing soils of Dakshina Kannada District of Coastal Karnataka indicated that the surface soils and subsurface soils are sufficient in DTPA extractable Fe and Mn except the subsurface soils of Pedon 3. Available copper content in surface and subsurface soils of all the pedons are sufficient for crop growth. Surface and subsurface soils of all the pedons were deficient in available zinc content except A1 and Ap horizons of pedon 1 and pedon 2, respectively.

Conclusion

Available macro and micronutrients status of cashew growing soils of Dakshina Kannada district of Coastal Karnataka as discussed above indicated that soils are low to medium in available N and K and low in available P in surface and subsurface horizons. Available sulphur remained low to medium in most soils. Among the exchangeable bases, exchangeable calcium was found to be high in most soils, followed by magnesium. With respect to micronutrients, iron and manganese contents were sufficient, available copper was sufficient and available zinc was deficient in surface and subsurface soils of all the pedons. The deficient nutrients have to be restored through chemical fertilizers and/or organic manures to maintain soil health for efficient and sustainable cashew production in these soils.

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