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Research Article

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Spatial variability of soil fertility in a coconut based agro ecological unit in the sandy plains of Kerala, India

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Summary

The sandy plain region of Kerala comprises a unique agro ecological unit designated as Onattukara sandy plain (AEU 3). The main cropping system prevailing in this region is coconut based cropping system in the upland. In the existing perennial plantations like coconut, soil fertility evaluation will help to identify the existing crop nutrition related constraints for formulating suitable nutrient management strategies. Therefore, this study was conducted with the objectives of identifying and mapping the spatial distribution of soil nutrient deficiencies for site specific nutrient management. Soil samples from 200 geo referenced sites were analyzed for available macro and micro nutrients. The nutrient deficiency maps developed can be used for macro and micronutrient management to address steady decline in the yield of coconut in the region through balanced nutrition. Yield gap of coconut in Onattukara region is 207.69 per cent. Thematic maps showed low organic carbon status in 74.2 per cent, P in 0.6 per cent and K in 82.6 per cent area. Ca and Mg deficiency were observed in 96.8 per cent area and S deficiency in 8.6 per cent area. Fe and Mn were observed to be sufficient. Zinc was found to be deficient in 90.3 per cent, Cu in 73.5 per cent and B in 93.1 per cent area of this sandy tract.

Key words : Coconut, Constraints, GIS, Mapping, Sandy tract, Soil nutrient status

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Introduction

Onattukara sandy tract is a fluvial and marine sand area of Alappuzha and Kollam districts of Kerala state in India. The region lies between 8°55'44" to 9°21'09"N latitude and 76°23'13"to 76°41'16" E longitude. The soils of the Onattukara region exhibit marked variance in their properties. The major soils occur as marine deposits extending to the interior upto the lateritic belt in the midland region. Onattukara soil is coarse textured with low nutrient and water retention capacity. The major cropping system prevailing in this region is coconut based cropping system. In older days this region was considered as a food bowl of Kerala, but now it has become an area of low productivity with many constraints limiting production (Premachandran, 1998). Soil problems resulting from either excess or shortage of certain nutrient elements are wide spread and significantly constrain crop produ now problems due to nutrient deficiencies have

been reported from many parts of this region. The supplementation of nutrients under such situation becomes more important to provide balanced nutrition to crops.

In order to maintain soil fertility, nutrients removed from the soil by the crops must be restored by the application of manures and fertilizers. The selection of the right kind of nutrient to be so replenished and the proper quantity to be applied is based on the nutrient requirement of crop and the nutrient supplying capacity of the soil. The assessment of nutrient supplying capacity of a soil is nothing but soil fertility evaluation. Hence, present study was undertaken at College of Agriculture, Vellayani, Kerala Agricultural University, Kerala with the objectives to assess and map the fertility status of coconut based cropping system in Onattukara based on soil nutrient status so as to tailor the nutrient management strategies to improve the productivity of coconut based cropping system of this region.

Resource and Research Methods

A total of 200 soil samples from coconut based cropping system were collected from 20 soil series of the Onattukara region of Kerala. The parameters analyzed included pH, EC, oxidisable organic carbon, available phosphorus, potassium, calcium, magnesium, sulphur, iron, copper, zinc, manganese and boron following standard analytical procedures (Jackson, 1973). The soils were classified in to six groups based on soil reaction as ultra acid, extremely acid, very strongly acid, strongly acid, moderately acid and slightly acid. Based on the soil test values for different nutrients, the soil samples were classified into three categories *viz.,* low, medium and high as per the ratings suggested by Dev (1997).

Data on available nutrient status of these soil samples were used for preparing the thematic maps for different parameters *viz.*, pH, Organic carbon, available P, K, Ca, Mg, S, Fe, Cu, Zn, Mn and B. Various GIS operations were conducted with the help of facilities available at the Geomatics Lab of Department of Soil Survey and Soil Conservation. The series map of the Onattukara region in the scale of 1: 50,000 was used as base map in this investigation.

Research Findings and Discussion

The data sets generated from the analysis of soil samples were used for assessing soil nutrient status of coconut based cropping system in the study area. The content of soluble salts in the soil was very low and normal for all crops and no deficiency of micronutrients iron and manganese was recorded in any of the analyzed samples.

In general, soils were acidic with pH ranging from 4.0 to 6.5 and most of the samples were very strongly acidic (4.5-5.0) followed by strongly acidic (5.1-5.5). Around, 71.47 per cent (28836.62 ha) area were very strongly acidic while 13.19 per cent (5320.49ha) were strongly acidic.

Primary and secondary nutrient status of soils of Onattukara region:

In the study area, organic carbon content of the samples ranged from 0.04 to 1.11 per cent and available P ranged from 9.5 to 62 kg ha^{-1}. Majority of the study area belonged to the high class of available P whereas in the case of K availability, majority of the area showed low status. It ranged from 13 .0 to 337.7 kg ha^{-1}. Majority of the area of Onattukara region recorded low available

Table 1: Primary and secondary nutrient status of soils of Onattukara region

Nutrient	Min.	Max.	Mean	Per cent samples		
				Low	Medium	High
Org.C (%)	0.04	1.11	0.52	53	17	30
Ava.P (kg ha^{-1})	9.5	62	27.75	2	36	62
Ava.K (kg ha^{-1})	13	337.7	128.79	62	28	10
				Deficient		Sufficient
Ava.Ca	24.33	390.95	135.64	88		12
Ava.Mg	5.79	138.45	43.26	89		11
Ava.S	1.7	18.17	6.85	18		82

calcium status. Samples ranged in their Ca availability status from 24.33 to 390.95 mg kg^{-1}. Magnesium deficiency was seen all over the area except in some pockets. It ranged from 5.79 to 138.45 mg kg^{-1} only 11 per cent samples showed sufficient available Mg content. Among the samples, only 18 per cent samples were deficient in available sulphur (Table 1). The results are in agreement with that of Nair *et al.* (2013).

Micronutrient status of soils of Onattukara region:

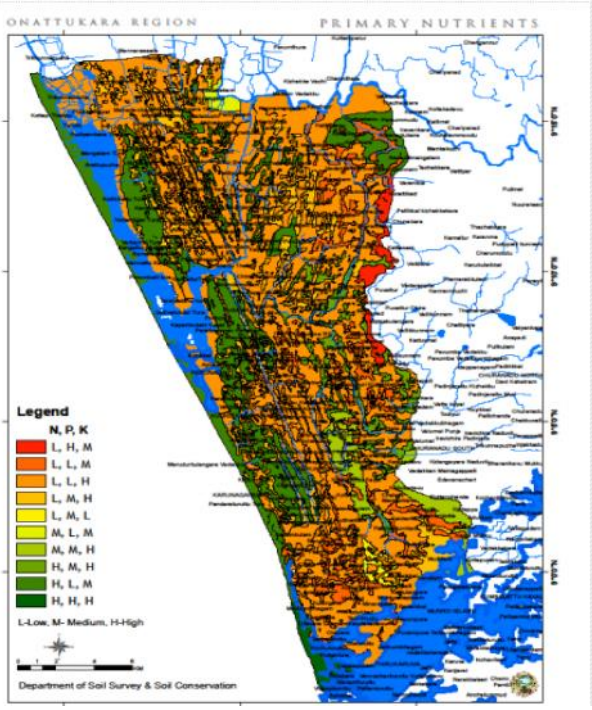
Deficiencies of Zn, Cu and B were prevailing in the coconut based cropping system (Table 2). The study area showed 100 per cent sufficiency of available Fe and Mn. Only 34 per cent samples showed sufficiency of available Zn and 66 per cent samples showed deficiency in Zn availability. Soil samples from the study area ranged from 0.21 to 1.94 mg kg^{-1} in available copper content. Fifty three per cent samples showed deficiency. The hot water extractable boron was found to vary from 0.14 to 0.73 mg kg^{-1} with an average of 0.33 mg kg^{-1} and among the samples 77 per cent samples were deficient in available B (Table 2).

Spatial variability of soil nutrient status:

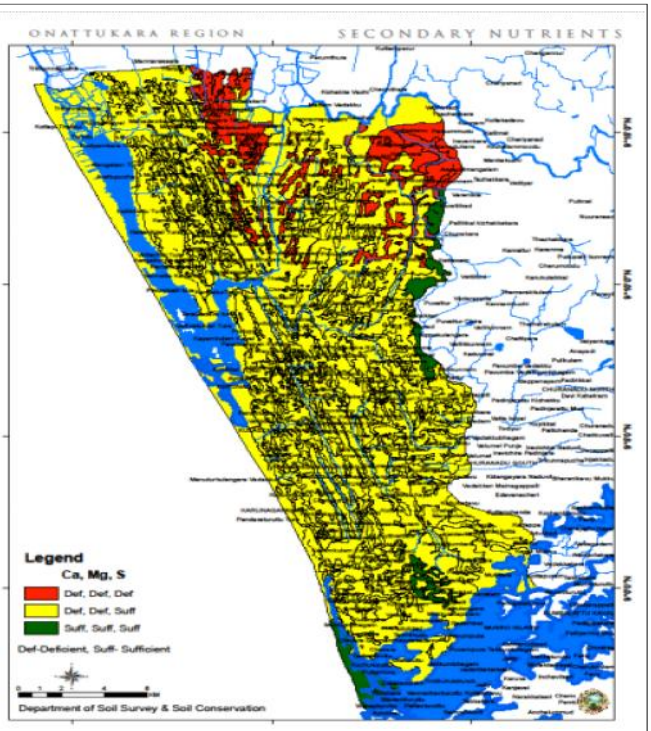
Thematic maps of available soil nutrient status of onattukara sandy tract were prepared using the attribute data of soil nutrient status and soil map of the study area (Table 3). Overlaid fertility maps for primary nutrients, secondary nutrients and micronutrients are given in Fig.1. Thematic map for primary nutrients showed low status of organic carbon in 74.2 per cent, P in 0.6 per cent and K in 82.6 per cent area. Similar results were reported by Nair *et al.* (2013). As the organic carbon status of soil is an index of available nitrogen, the deficiency of N as well as low microbial activity could be expected in these soils. In soils where available P content is high, there are much chances of Zn deficiency and it is extremely important to follow soil test based recommendations on use of P fertilizers. Lack of 2:1 type clay and coarse texture of soils result in low retention of K and even the applied potassic fertilizer would be lost by leaching unless need based split application is followed. Ca and Mg deficiency were observed in 96.8 per cent area and S deficiency in 8.6 per cent area. The very low calcium content may be due to high rainfall which leaches calcium from sandy soils and high acidity is also well correlated with low calcium status. Mg availability was less than the critical level of 120 mg kg^{-1} in 89 per cent of samples. Tropical climate itself leads to leaching losses of Mg as in the case of Ca. Further imbalanced fertilizer application and non-inclusion of magnesium fertilizers in crop culture might have lead to such a situation. Results on low status of Ca and Mg warrants mandatory application of these two elements as amendments in the planning for any fertility management in this region. Comparatively low sulphur deficiency in the region might be an integral effect of wide spread use of Factamfos, a complex NP fertilizer. With respect to the micronutrient status of this region, Fe and Mn were observed to be sufficient. It may be attributed to strong acidity of the soil (Santhosh, 2013). Zinc was found to be deficient in 90.3 per cent, Cu in 73.5 per cent and B in 93.1 per cent area of this sandy tract. Unscientific use of high analysis fertilizers, leaching and excess P may be the reasons for this wide spread deficiency of available Zn. Copper is tightly held by the exchange complex of the soil but is prone to leaching in light textured soils. Another reason for low copper status in these soils may be the antagonism between copper and phosphorus and formation of insoluble copper phosphate in soil. Wide spread deficiency of B was found in Onattukara region. It was even prominent than Zn deficiency. Crop removal of this nutrient without any supply, decline in organic matter content etc. should be

Table 2: Micronutrient status of soils of Onattukara region

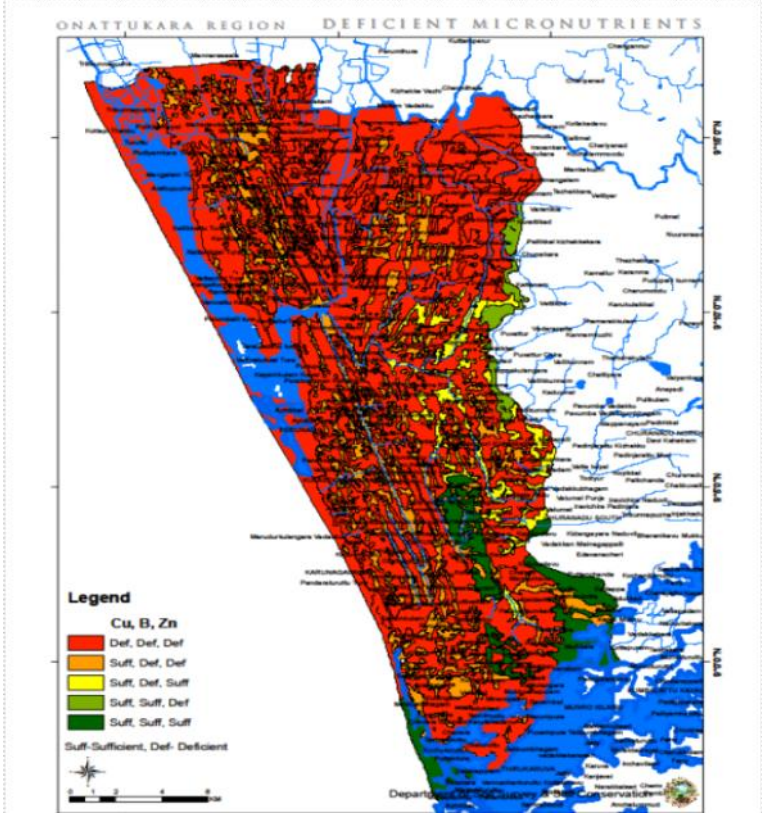
Nutrient (mg kg^{-1})	Minimum	Maximum	Mean	Per cent sample	
				Deficient	Sufficient
Fe	6.05	45.66	14.68	0	100
Mn	1.05	19	8.92	0	100
Zn	0.20	1.93	0.85	66	34
Cu	0.21	1.94	0.81	53	47
B	0.14	0.73	0.33	77	23



Spatial distibution of primary nutrients



Spatial distibution of secondary nutrients



Spatial distibution of micronutrients

Fig.1: Spatial distribution of available nutrients in the Onattukara region

considered as major reasons. Boron deficiency is common in sandy, light textured acid and low organic matter soils (Gupta, 1993).

Conclusion:

Extensive soil acidity, low soil organic matter, very high level of phosphorus and wide spread deficiencies of calcium, magnesium, boron, zinc and copper are the major limitations to crop production in the region. Amelioration of soil acidity and external inputs of secondary and micronutrients along with the major nutrients are essential for enhancing the productivity of the coconut based cropping system in this region. The productivity of coconut over the past few decades has been almost stagnant with only slight improvement in the current decade. The spatial information generated may be useful in formulating site specific nutrient use strategies to improve the productivity of this sandy tract. There is a need to use plant nutrients in an integrated way so as to achieve sustainable crop production through management of soil fertility.

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