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SOIL FERTILITY OF PADDY FIELDS IN KUTTANADU WETLAND AGROECOSYSTEM

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ABSTRACT Kuttanadu is a delta region formed through natural reclamation of flood deposits of four rivers - Pamba, Achancovil, Manimala and Meenachil. The landscape composition, structure, management and the regional setting of Kuttanadu are exclusive and praiseworthy. The agriculture of Kuttanadu wetlands is unique because in large areas rice cultivation is being done below the sea level. The present study is an attempt to evaluate the soil fertility status of paddy field soil in Kuttanadu wetland agroecosystem. The textural analysis showed that type of soil was either silt loam or sandy loam in the sampling locations. The pH of the soil samples ranged from 3.01 to 5.94. The organic carbon in the soil samples of Kuttanadu ranged from 1.45 to 5.93% while the available phosphorus content ranged between 33 to 148.5 kg/ha. The potassium content ranged from 259 to 578 kg/ha and the inorganic nitrogen content ranged from 363 to 759 kg/ha. The calcium content ranged between 521 to 893 kg/ha and magnesium content between 328 to 597 kg/ha. The geographic feature and complexity of the region and position of agricultural landscapes below mean sea level makes it environmentally exclusive.

KEYWORDS : SOIL FERTILITY; PADDY FIELDS; KUTTANADU WETLAND AGROECOSYSTEM; VEMBANADU

Introduction

Kuttanadu is a delta region of about 900 sq. km situated in the west coast of Kerala which was formed through natural reclamation of flood deposits of four rivers - Pamba, Achancovil, Manimala and Meenachil originating from the Western Ghats. The landscape composition, structure, management and the regional setting of Kuttanadu are exclusive and praiseworthy (MSSRF, 2007). The region is a larger mosaic of fragmented landscape patches and varied ecosystems like coastal backwaters, rivers, vast stretches of paddy fields, marshes, ponds, garden lands, edges, corridors and above are remarkably networked water ways (Murthy *et al.,* 2013). The agriculture of Kuttanadu wetlands is unique because in large areas rice cultivation is being done up to 2 m below the sea level.

Morphological and physicochemical properties of the soils of Kuttanadu show great degree of variation. They are low to medium in fertility, alluvial with silty clay texture. They are salty and are acidic, enriched by annual silt deposition during the monsoon floods. The acidity is due to the production of sulphuric acid by microbiological oxidation of sulfur compounds present in the soil. Soils are dark brown to black in colour, sticky, with deposits of lime shells and humus. Organic carbon and cation exchange capacity of the soil are higher compared to other parts of Kerala, but the base saturation is comparatively lower (Thampatti, 1997). The agricultural practices in Kuttanadu are quite unique as much of the land lies below the sea level. The paddy fields situated along the waterways need to be protected by strong and carefully designed bunds. Water is let in and drained out from time to time as per changing requirements of the paddy crop, using waterwheels or electric motors. Soon after the northeast monsoon ends in November, bunds are raised, seeds sown in November- December and the crops are harvested in February- March. The region is divided into six agronomic zones such as Upper Kuttanad, Purakkad, Lower Kuttanad, Kayal lands, Vaikom and North Kuttanad (Indo-Dutch Mission, 1989) (Fig. 1).The sampling locations of this investigation were selected such that it represented all agronomic zones of Kuttanad, and is proportional to the area of each agronomic zone. Thus twenty seven sampling locations were selected for the present study to evaluate the soil fertility status of paddy field soil in Kuttanadu wetland agroecosystem.

Materials and Methods

Soil samples were collected from all the sampling localities of from the top 15cm layer for physico-chemical analysis. Ten samples were collected randomly from different places at each location, and pooled together. Samples were placed in polythene bags and transported to the laboratory within two to three hours, were dried at 105^{0}C in oven, gently crushed in a glass mortar and sieved through 2mm steel mesh, and stored in polythene bags in a desiccators were used for all chemical analysis.

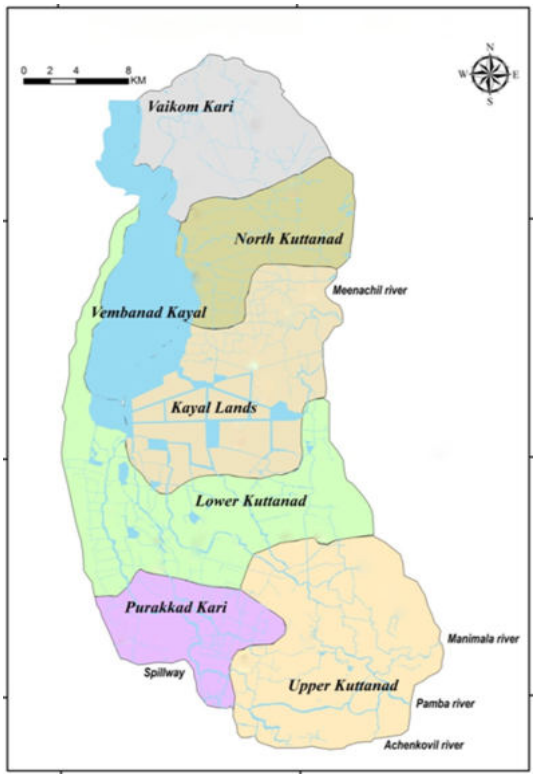

Fig 1. Agronomic zones of Kuttanadu wetland agroecosystem

The physico-chemical parameters analysed were texture, pH, electrical conductivity, organic carbon, available phosphorus, available potassium, total inorganic nitrogen, calcium and magnesium. The moisture content of the air dry samples was determined shortly before all the analysis and the moisture correction factor determined (van Reeuwijk, 2002 and Nathan *et al*., 2012).

Results and Discussion

Soil texture represents the relative proportion of mineral particles of different sizes (sand, silt and clay). The textural analysis done in this investigation showed that type of soil was either silt loam or sandy loam in the sampling locations (Table 1).

Table 1: Soil texture in the sampling locations of Kuttanadu

S.I. No	Agronomic zone	Sand %	Silt %	Clay %	Textural class
1	Upper Kuttanadu	32	57	9	Silt loam
2	Purakkad	55	35	9	Sandy loam
3	Lower Kuttanadu	42	50	7	Silt loam
4	Kayal lands	85	11	3	Sandy loam
5	Vaikom	31	65	2	Silt loam
6	North Kuttanadu	71	26	2	Sandy loam

Soil pH is the measure of hydrogen ion concentration in the soil. It indicates the acidic and alkaline nature of soil. In Kuttanadu the pH of the soil samples ranged from 3.01 to 5.94. The mean pH was lower in Upper Kuttanadu compared to the other agronomic zones. 73% of the soil samples collected from Kuttanadu were extremely acidic, 25% of the samples were strongly acidic and 2% of the sample were moderately acidic. Electrical Conductivity gives a clear idea of the soluble salts present in the soil and physical properties of the particles which make up the soil. In Kuttanadu the conductivity of the soil samples ranged from 0.07 mS/cm to 0.97 mS/cm.

The organic carbon in the soil defines the fertility status of the soil. The organic carbon in the soil samples of Kuttanadu ranged from 1.45 to 5.93%. The mean organic carbon was lowest in Purakkad and highest in Kayal lands. Depending upon the organic carbon content, the soil nutrient status was graded as low, medium and high and all the samples were in high category. The fertility rating was high in all the sampling locations of Kuttanadu. Phosphorus is an essential macronutrient, which regulates protein synthesis. In Kuttanadu, the available phosphorus content ranged between 33 to 148.5 kg/ha. The mean value of available phosphorus was comparatively higher in Kayal lands. Out of the eighty one samples analysed 96% were in the very high fertility level and 4% in high fertility level as per the soil quality rating of Dorahy *et al.* (2004). All the sampling locations were in very high fertility rating.

Potassium is an essential nutrient for plant growth, associated with movement of water, nutrients, and carbohydrates in plant tissue. Depending upon the concentration of potassium in the soil, the quality of soil may be graded as low, medium and high. In Kuttanadu, the available potassium content ranged from 259 to 578 kg/ha. The mean value of potassium was lowest in Purakkad and highest in Kayal lands. The fertility level was medium in 10% of samples and high in 90%. Nitrogen is a major plant nutrient, absorbing as either nitrate or ammonium ions through the roots. Most of the nitrogen is used by plants to produce protein and nucleic acids. In Kuttanadu, the inorganic nitrogen content in the soil ranged between 363 to 759 kg/ha. Calcium plays a very important role in plant growth and nutrition, as well as in cell wall deposition. In Kuttanadu, the calcium content in the soil ranged between 521 to 893 kg/ha. The mean value of calcium was lower in lower Kuttanadu and highest in Purakkad. The highest range of calcium values were observed in one site each of North Kuttanad, Purakkad and Upper Kuttanadu. Magnesium plays an important role in the formation of chlorophyll and in photosynthesis. In Kuttanadu, the magnesium content in the soil ranged between 328 to 597 kg/ha. The mean value of magnesium was lowest in lower Kuttanadu and highest in Purakkad.

The soils of Kuttanadu were classified based on the fertility status as computed through nutrient index (Table 2). According to this the paddy fields are grouped into high category based on organic carbon, available phosphorus and available potassium.

Table 2: Nutrient index value for the soil samples of Kuttanadu

Characteristics	Nutrient index value	Remarks
Organic carbon	3.0	High
Available Phosphorus	3.0	High
Available Potassium	2.9	High

The obtained results are in tune with available reports. Vijayan and Ray (2015) adumbrated soil pH, Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg) of three distinct soil regions (Upper-Kuttanadu, Lower-Kuttanadu and Kayal-lands) in two different crop-seasons (the Puncha and Viruppu) at the two different growth-stages (the seedling and panicle stage) of paddy. In another investigation, Vijayan and Ray (2016) found out the relation between diatom species richness and diversity index to soil parameters such as pH, N, P, K, Ca and Mg of different regions of Kuttanadu at different crop-growth-stages and crop-seasons. Mixed agro-ecosystems such as backwaters, rivers, vast stretches of paddy fields, marshes, ponds, garden lands, edges, corridors and water ways are the characteristic feature of Kuttanadu Wetland agro-ecosystem landscape which also has profound impact on the physicochemical attributes of the ecosystem.

The geographic feature and complexity of the region and position of agricultural landscapes below mean sea level makes it environmentally exclusive. Apart from agriculture and inland fisheries other ecosystem services like water supply, health and sanitation, transportation, recreation and conservation of biodiversity are also crucial in determining the physicochemical attributes.

Conclusion

Kuttanadu wetland agroecosystem is unique in a plethora of attributes with profound impact on adjoining communities. The soil fertility characteristics of the region are of paramount importance as it has direct impact on various agricultural practices and yields. The present study highlights the need of more studies in this regard.

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