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Exploration through GIS for mapping Soil nutrient status of semi dry rice growing area of Ramnad District

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Abstract

A soil survey was carried out using global positioning system (GPS) and mapped in GIS environment and the soils were characterized. Spatial distribution of nitrogen, phosphorus, potassium, organic carbon and micro nutrients status were studied from 43 sites representing intensively direct seeding rice growing soils. . It could be understood that out of 2, 06,290 ha about 54.42% alone could be considered as normal soil, 29.28% as moderately acidic and 12.40% as moderately alkaline soil types. The soils were shallow to deep, dark yellowish brown to dark grayish brown, excessive to poorly drained, low in available nitrogen, low to medium in available phosphorus and medium to high in available potassium Micro nutrient status presented that shows that in general soil status is low in zinc, iron and boron. There is an immediate need to alleviate the problem in related with soil such as the low organic matter content, low in zinc and Fe content of the soil and seasonal defects low rainfall, early drought and late rainfall, water logging, sodic and alkaline soil & non-availability of suitable crop varieties to meet the local situations. On the basis of the major constraints, appropriate practices were suggested to Ramnad district farmers for their sustainable management.

Key words: Mapping, geographic information system, Semi-detailed, Nutrient content

I. Introduction

Ramnad is a dry district where non-system tank is the major source of irrigation. Hence, rainfall pattern is the most decisive factor. Yield variation among the non-drought and drought-prone districts also show that yield variability was found highest in Ramnad (44 to 60 %), despite the fact that the other districts also experienced higher variability during the drought period. Evidences show that fertilizer application in consonance with the onset of the monsoon and soil moisture availability results in a minimum of 50 percent increase in yield with benefit cost ratio of 3:1. Low, and most often, improper matching of soil moisture and fertilizer application in rain fed agriculture has reduced farmers' chances of achieving higher crop yields. In the recent years increasing emphasis has been on characterization of soils using GIS and developing rational and scientific criteria to ease the seasonal impacts land evaluation, and interpretation of soils for diverse land uses.

II. Materials and methods

Study area

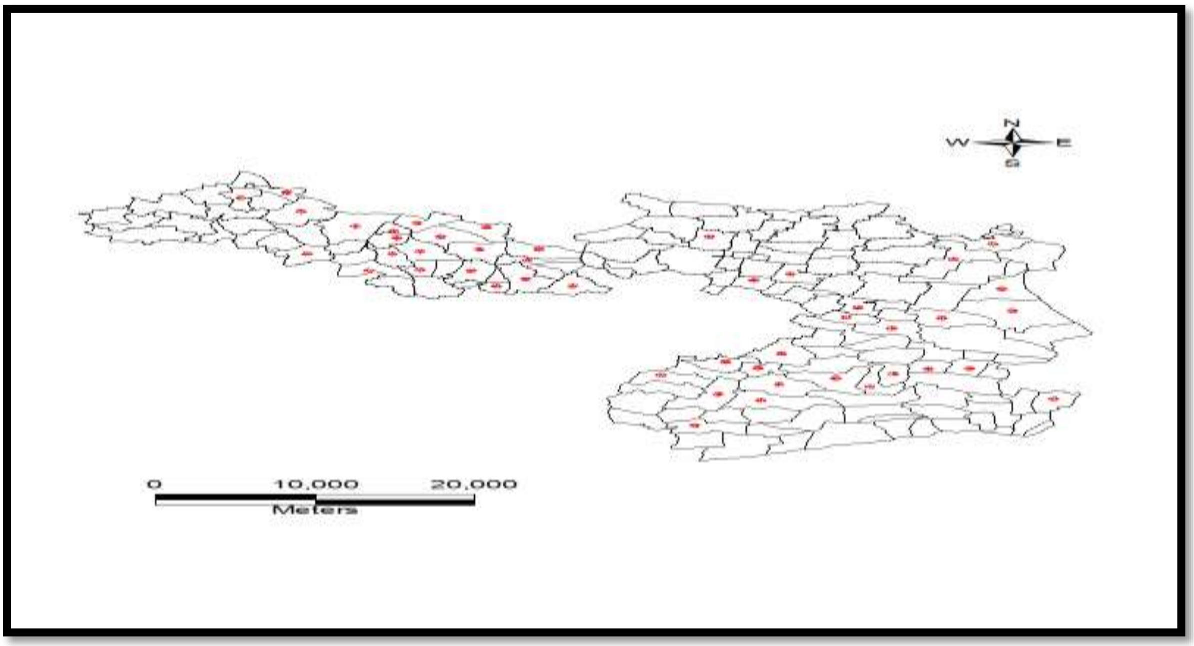
The study was conducted in Ramnad district. The District is located in the Southern part of Tamil Nadu State on the East Coast of India. The district has the East coast line as its eastern boundary parting the district from the Bay of Bengal. Hence the Palk Strait is guarding the district on the eastern side and Gulf of Mannar on the South. The district has a tropical climate and is hot and dry. The weather is pleasant during the period from December to January. Usually mornings are more humid than afternoon. The mean annual rainfall of the district is 823 mm with summer, south west monsoon, north east monsoon and winter contributing 14, 17, 60 and 9%of the total rainfall, respectively.

Field survey and research

The soil investigation was carried out, examining 255 soil samples from 43 direct seeding rice growing villages were worked out with the help of global positioning system(GPS) used during collection and the soil samples (0-15cm) were dried, powdered and passed through 2 mm sieve. The soil pH was measured in 1:2.5 soil water analysis using glass electrode pH meter. Particle size analysis by bouyoucos hydrometer method, cation exchange capacity (CEC) was determined by using neutral sodium acetate and organic carbon by rapid titration method (walkley and Black, 1934). The available nitrogen was estimated by alkaline permanganate method of Subbiah and Asija (1956). The available phosphorus was extracted with 0.5M $NaHCO_3$ solution buffered at pH 8.5(Olsen *et al.*, 1954). Available potassium (K) was extracted by shaking the requisite amount of soil sample with 1N NH_4OAc (pH 7.0) solution.

The soil samples were collectred based on the major direct seeding rice growing villages in Ramnad district.

Fig.1. Location map of samplimg villages of Ramanathapuram district



The soil samples were taken using GPS to mark the location of samples. These point locations are fed into categories based on criteria given in Table A. The points having same category were grouped into class as a polygon and the maps for individual nutrients were generated in Arc GIS.

Table A:Criteria for assessment of organic carbon and macronutrients in soils (Tandon,1993)			
Parameter	**Low**	**Medium**	**High**
Organic carbon (%)	<0.5	0.5-0.75	>0.75
Available nitrogen(kg ha^{-1})	<280	280-5-450	>450
Available phosphorus(kg ha^{-1})	<11	11-22	>22
Available potassium(kg ha^{-1})	<118	118-280	>280

III. Results and discussion

The pH of soil ranges from 5.5 to 8.6. The pH values were generally higher in these soils than the normal soils which increased with the fineness of texture in these soils, confirming the report of Ramasharma *et al.* (1985). Generally, the soil pH was increasing with depth due to the solubility of salts moving with water as regulated by the clay distribution pattern and compaction in different sub horizons. The electrical conductivity(EC) varied between 0.12 and 4.71 dSm^{-1} with the mean of 1.82 dSm^{-1} The occurrence of poor quality ground water viz., marginally saline, were responsible for making surface soil slightly saline in soil EC due to its capillary rise during drought condition. Also, fairly high EC was due to its fine texture and aridity as reported by Chawla (1969).There was a significant and positive correlation between EC and free $CaCO_3$ (0.402**). The relatively higher CEC in soils might be due to high clay content and probably montmorillonitic type of clay minerals present in the series. The high exchangeable Ca and Mg were due to the basic igneous rock source of the alluvium from which these soils were derived and arid environment existing in this tract. Because of relatively the finest texture, slow movement of water through the horizons, capillary rice of Na^+ through water evaporation in summer, inadequacy of water to leach out the Na^+ and montmorillonitic type of clay minerals led to high exchangeable cations as in corroboration with the conclusions of Sandhu *et al.* (1981). The range of Organic carbon status varied from 0.03 to 1.35 per cent with a mean of 0.42 per cent. The arid climate, coarse texture of soils, low addition of organic manures, single rainfed rice crop which leaves low amount of crop residue were the reasons for low organic carbon status. Because of high pH and salt concentration the transformations and mineralization of nitrogen from soil organic matter were slower in salt affected soils (Batra and Abrol. 1986). In Ramnad district, the range of available N varied from 76 to 354 kg ha^{-1} with a mean of 198 kg ha^{-1} respectively. The available N status of these soils was grouped under low category, pointing out the need of judicious application of N fertilizer along with organic manures to get satisfactory returns. The range of available P varied from 5.0 to 16 kg ha^{-1} with a mean of 9.6 kg ha^{-1} respectively. The low organic matter status, calcareousness nature and low P fertilization rates of rainfed rice were the main reasons for low available P status.The range of available K status varied from 229 to 557 kg ha^{-1} with a mean of 338 kg ha^{-1} respectively. High BSP, high clay content and dominant clay minerals like illite or montmorillite were responsible for high available K status of soils. The increasing trend of available K^+ with depth in profile of salt affected soils indicated the translocation of K with clay in saline-alkaline environment (Kansal and Sehkon, 1976). The most important factors influencing micronutrient availability in salt affected soils are pH, soil texture, organic matter, calcareousness and salinity of soil. It was observed that each unit increase in pH reduces the solubility of divalent cations by 100 times and that of trivalent cations by 1000 times (Lindsay, 1972).

The soil type of this district is widely varying with soils containing more of clay to sandy soils with a sandy layer to a depth of 30 to 50 cm over a hard clay pan. The depth of sandy layer recedes from sea coast to inland.sub soil clay layer is lateritic in nature with lateritic parent material of clay which helps in impounding rain water for rice cultivation. It also causes water logging (over 10 – 25 cm) for a prolonged period and this situation reduces tillering and resistance to lodging. Saline and alkaline condition is also found all over the district.

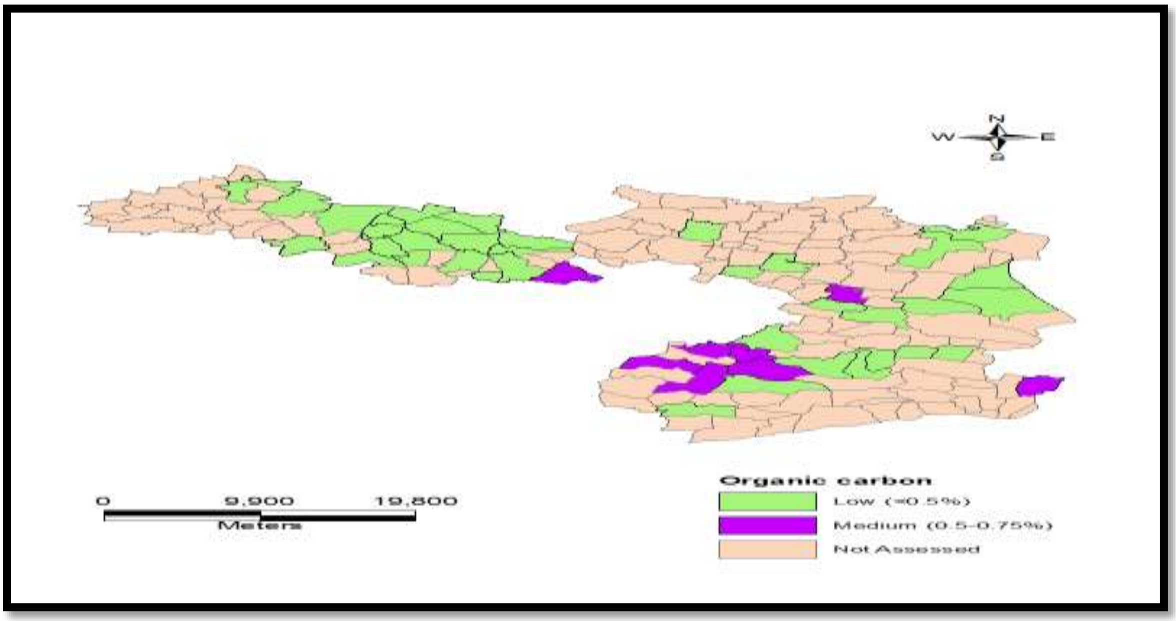


Fig 1: Spatial distribution of soil organic carbon status of direct seeding rice grown soils of Ramanathapuram district

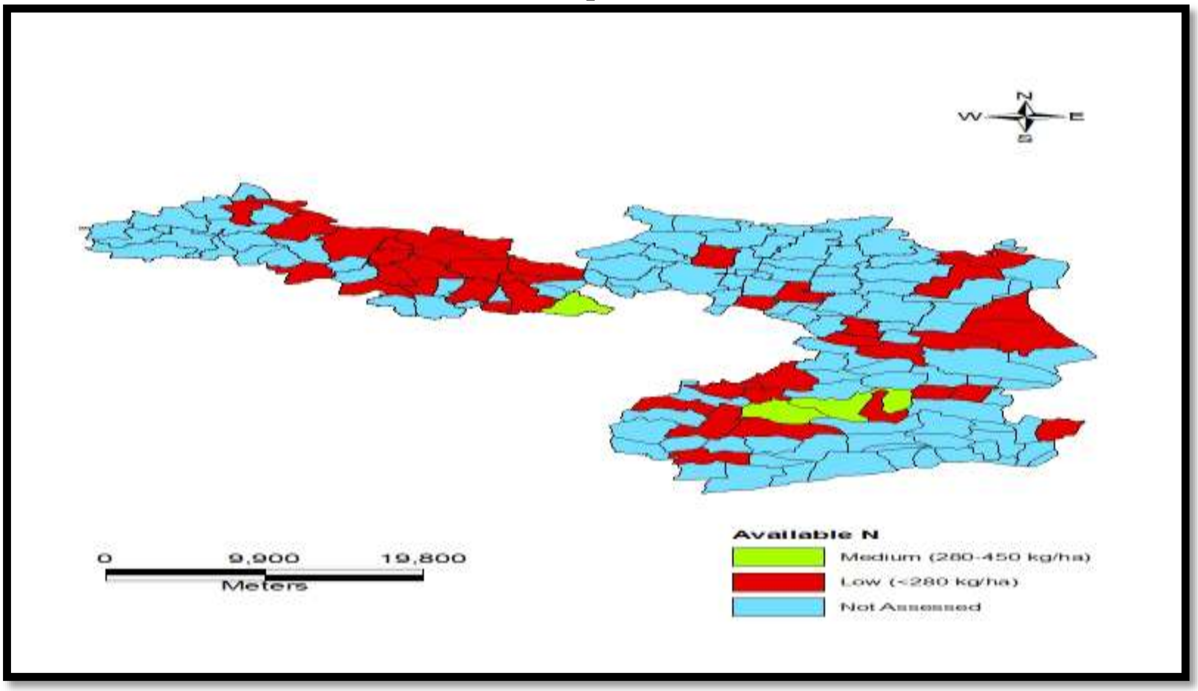


Fig 2: Spatial distribution of soil available N status of direct seeding rice grown soils of Ramanathapuram district

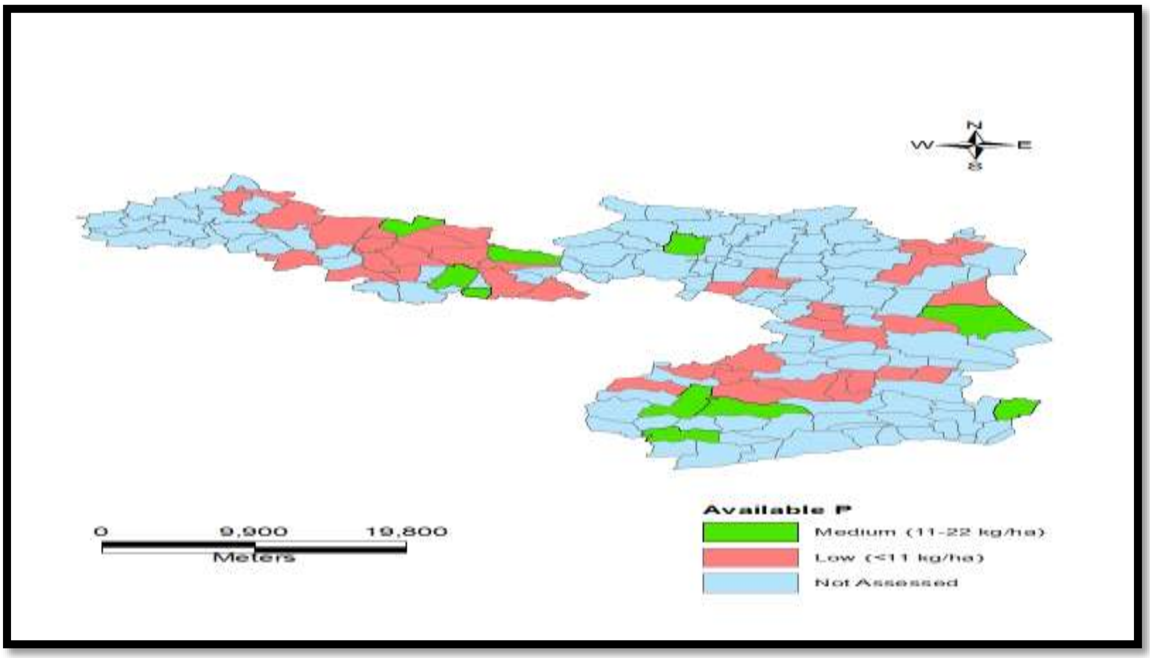


Fig 3: Spatial distribution of soil available P status of direct seeding rice grown soils of Ramanathapuram district

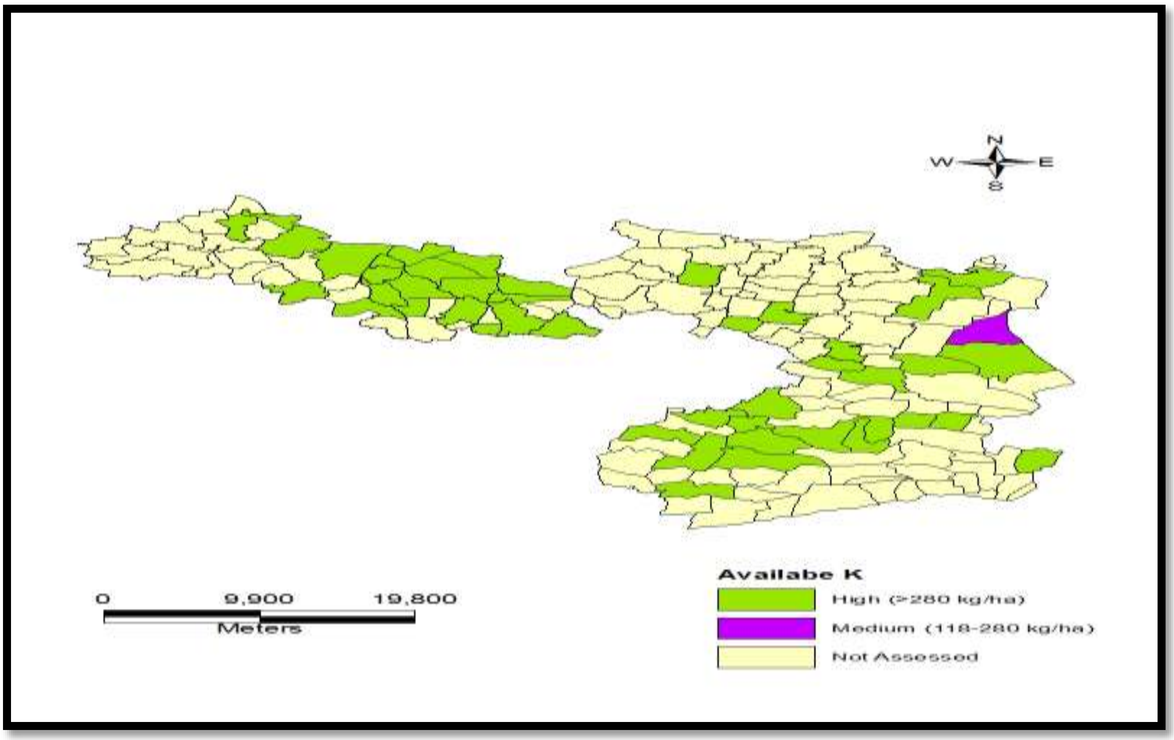


Fig 4: Spatial distribution of soil available K status of direct seeding rice grown soils of Ramanathapuram district

IV. Conclusion

The generation of soil properties maps by GIS technique depicts their spatial variability and gives a strong base knowledge about the soil wide/infield variation for site-specific nutrient management to optimize crop production and input use efficiency in direct seeding rice. The results of the study are of potential practical use in determining site specific nutrient management practices, that would help in improving fertilizer use efficiency, reducing cost of cultivation and preventing environmental pollution. The deficient nutrients have to be restored through organic/inorganic inputs to maintain soil and environment health.

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