GIS-based soil fertility mapping in TIAC Farm, Radhapuram, Tirunelveli District, Tamil Nadu

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ABSTRACT

Soil fertility parameters viz., pH, electrical conductivity (EC), organic carbon and available macronutrients were determined in one hundred soil samples in The Indian Agriculture College farm, Radhapuram. Based on the data maps were prepared in ArcGIS 10.8. Soils are neutral to moderately alkaline (6.12 to 8.13) in reaction and non-saline. The organic carbon content was low to high (0.29 to 0.81 %). In the study area, the available nitrogen content was low to medium (216 to 465 kg ha^{-1}) while available phosphorus was low to high (11.7 to 18.1 kg P_2O_5 ha^{-1}) and the available potassium content was high (112 to 334 kg ha^{-1}). Based on the overall assessment, the nutrient status in these soils was optimum.

INTRODUCTION

Soil fertility mapping is the process of assessing soil fertility status in a given area and geo-encoding. The fertility status of the given area can be delineated on the maps to indicate the fertility level of the soil series easily. The soil fertility maps can be used for nutrient management strategies (FAO, 2006). It will provide a readymade source of information about soil fertility status and serve as the decision-making tool for the successful raising of crops. Inadequate fertilizer application limits crop yield, results in nutrient mining and causes soil fertility depletion. In the face of economic and environmental concerns, farmers face an increasing challenge of effective soil fertility management. One of the possible solutions to protecting such a position is the strategy of deciding what may be needed on site alone and managing the nutrient status accordingly. However, similarity interfacing is very effective given the fact that GIS can handle numerous datasets such as exo-climatic regions, land activities, soil preservation, etc., to give relevant information (Adornado and Yoshida, 2008). Also, GIS-based soil maps are likely to function as a support environment in allowing proper decision-making on the use of nutrients (Iftikar et al. 2010).

MATERIAL AND METHODS

One hundred surface (0-15 cm) soil samples were drawn at random from the Indian agriculture college farm, Radhapuram (Fig.1). The coordinates of the sampling locations were recorded using a hand-held GPS (Global Positioning System). Soil samples were first air-dried in the shade, then powdered gently with a wooden mallet sieved through a 2 mm sieve then stored in clean polyethylene containers for further analysis. The soil pH was measured in 1:2.5 soil water suspension using a pH meter and EC (dS m^{-1}) was measured in the supernatant solution of 1:2.5 soil water suspension using Conductivity Bridge (Jackson, 1973). Organic carbon was estimated by the Walkley and Black wet oxidation method. Available nitrogen was estimated by the modified alkaline $KMNO_4$ method Subbiah and Asija (1956). Available phosphorus was extracted with Olsen's reagent using a spectrophotometer at a wavelength of 660 nm Olsen et al. (1954). Available potassium in the soils was extracted by employing the neutral normal ammonium acetate method. The variability of data was assessed using the mean for each set of data. Soil fertility maps were prepared using ArcGIS 10.8 employing kriging as the interpolation method.

RESULTS AND DISCUSSION

Results of pH, EC, OC and available macronutrients (N, P & K) in surface soil samples of The Indian Agriculture College farm, Radhapuram are presented in Table 1.

Table1.Fertility parameters of soils

Parameter	pH	EC (dSm^{-1})	OC %	N	P	K
				(kg ha^{-1})		
Maximum	8.13	0.94	0.81	465	18.1	334
Minimum	6.12	0.41	0.29	216	11.7	112
Mean	7.12	0.69	0.54	327	15.1	224

Soil reaction

The soil reaction is neutral to moderately alkaline (6.12 to 8.13) in reaction. Higher soil reaction is mainly because of the calcareous nature and sodicity of soils. The major proportion was neutral (56.63%) followed by moderately alkaline (43.37%). The higher pH of soils could be attributed to the low intensity of leaching and accumulation of bases. The results are in agreement with Prabhavati et al. (2015).

Electrical Conductivity

The EC value of TIAC farm soil was in the range of 0.41 to 0.94 dSm^{-1}. The slightly higher level of soluble salts in the study area is due to semi-arid climatic conditions. The soluble salt content in the study area revealed that the area was non-saline.

Organic Carbon

The organic carbon content varied from 0.29 to 0.81 per cent. Mapping by GIS revealed that 47.65 per cent of the study area was low, 30.50 per cent was medium and 21.85 percent was in the high range. The low content may be attributed to the prevalence of semi-arid conditions, where the degradation of organic matter occurs at a faster rate coupled with little or no addition of organic manures and low vegetation cover on the fields, thereby leaving less chance of accumulation of organic carbon in the soils. Similar results were also reported by Prabhavati et al. (2015) for the soils of the northern dry zone of Karnataka.

Macronutrients

The available nitrogen in the surface soils of the TIAC farm varied from 216 to 465 kg ha^{-1}. GIS Mapping revealed that 33.97 per cent area in the study area is low, 55.20 per cent of the area is in the medium and 10.83 percent is in the high range. Basavaraju et al. (2005) reported that the reason may be due to low organic matter content in these areas due to low rainfall and high temperature which facilitate faster degradation and removal of organic matter leading to N deficiency. The available phosphorus has ranged from 11.7 to 18.1 kg P_2O_5 ha^{-1}. Mapping of available P by GIS revealed that it was low in 7.65 per cent of the study area and 50.04 per cent was medium while high in 42.31 per cent of the study area. Low P availability is related to their high pH, calcareousness and low organic matter content. Corresponding findings were in line with those of Shivaprasad et al. (1998). The available potassium content was high and ranged from 112 to 334 kg ha^{-1} which might be due to the predominance of K-rich micaceous and feldspars in parent material. Rao et al. (2008) also reported similar types of results in their studies.

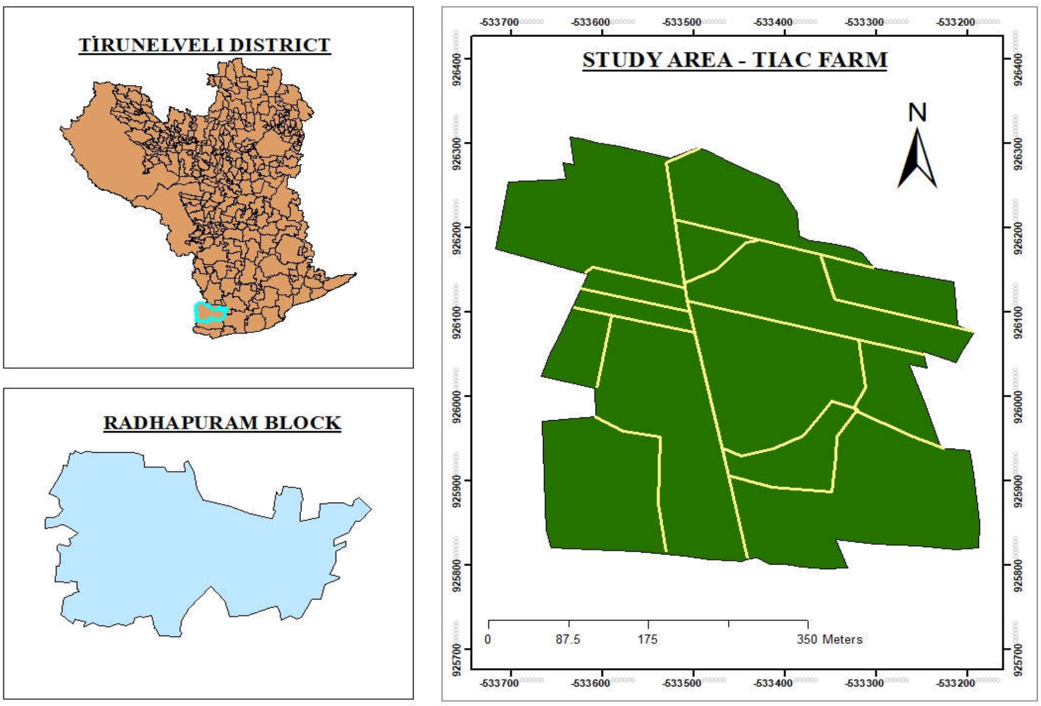

Fig 1. Location map of the study area

CONCLUSION

The pH of the soils was neutral to moderately alkaline. Alkaline soils with solid $CaCO_3$ can be reclaimed with grass cultures, organic compost, organic garbage, waste paper, rejected lemons/oranges, etc. ensuring the incorporation of much acidifying material into the soil, and enhancing dissolved Ca in the field water by releasing CO_2 gas. The soils are non-saline, and organic carbon content is low to high. Macronutrients like available nitrogen are low to medium while phosphorus content is low to high and potassium is in the high range. Sulphur and micronutrient content are deficient to sufficient except for manganese which is insufficient range. Based on the overall assessment, the nutrient status in these soils is optimum. The information generated in this study could be used for the temporal study of soil fertility to compare fertility status in the future. As some of the nutrients like K are in the high range, moderation in its application is advisable.

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