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Soil Fertility Mapping using GIS in Agricultural College Farm, Mahanandi in Kurnool District, Andhra Pradesh

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ABSTRACT
Soil fertility parameters viz., pH, electrical conductivity (EC), available macronutrients and micronutrients were determined in one hundred and fifty seven soil samples in Agricultural college farm, Mahanandi. Based on the data maps were prepared in GIS environment using ArcGIS 9.3.1. Soils are neutral to moderately alkaline (7.00 to 8.10) in reaction, and non-saline. The organic carbon content was low to high (0.02 to 0.77 %). In the study area the available nitrogen content was low to medium (50.18 to 388.86 kg ha^{-1}) while available phosphorus was low to high (2.23 to 62.37 kg P_2O_5 ha^{-1}) and the available potassium content was high (361.20 to 1117.54 kg ha^{-1}). The availability of sulphur and the micronutrients Zn, Cu and Fe are in deficient to sufficient range while manganese is in sufficient range. Based on the overall assessment, the nutrient status in these soils was optimum.
Key words: *Soil fertility, nutrients mapping, geographic information system*

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INTRODUCTION

Soil fertility mapping is the process of assessing soil fertility status in the given area and geo-encoding. The fertility status of the given area can be delineated on the maps so as to indicate the fertility level of the soil series easily. The soil fertility maps can be used for the nutrient management strategies [4]. It will provide the readymade source of information about soil fertility status and serve as the decision making tool for 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. An approach towards justifying such concerns is site specific nutrient management which takes into account spatial variations in nutrients status, thus cutting down the possibility of over or under use of fertilizer. Geographic information system (GIS) is a powerful tool which helps to integrate many types of spatial information such as agro-climatic zone, land use, soil management, etc. to derive useful information [1]. Furthermore, GIS generated soil fertility maps may serve as a decision support tool for nutrient management [5]. A number of studies on soil fertility mapping have been documented [13] but no study was made in Agricultural college farm, Mahanandi. In this background, a study was initiated with the objective to map the spatial distribution of soil fertility parameters in Agricultural college farm, Mahanandi in Kurnool district, Andhra Pradesh.

MATERIAL AND METHODS

One hundred and fifty seven surface (0-15 cm) soil samples were drawn at random from the agricultural college farm, Mahanandi (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 shade, then powdered gently with a wooden mallet and sieved through 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 pH meter and EC (dS m^{-1}) was measured in the supernatant solution of 1:2.5 soil water suspension using conductivity bridge [6]. Organic carbon was estimated by Walkely and Black wet oxidation method. Available nitrogen was estimated by modified alkaline $KMNO_4$ method Subbiah and Asija [17]. Available phosphorus was extracted with Olsen's reagent using spectrophotometer at wavelength of 660 nm Olsen *et al.* [8]. Available potassium in the soils was extracted by employing neutral normal ammonium acetate method. Available sulphur was estimated by turbidimetric method [3]. Micronutrients (Fe, Zn, Cu and Mn) were extracted by DTPA reagent using the procedure outlined by Lindsay and Norvell [7]. Variability of data was assessed using mean and standard deviation for each set of data. Soil fertility maps were prepared using *ArcGIS* 9.3.1 employing kriging as the interpolation method.

RESULTS AND DISCUSSION

Results of pH, EC, OC, available macronutrients (N, P, K, and S) and micronutrients (Zn, Fe, Cu and Mn) in surface soil samples of Agricultural college farm, Mahanandi are presented in table 1 and their maps are depicted in Fig. 2 to Fig. 9.

Soil reaction

The soil reaction is neutral to moderately alkaline (7.00 to 8.10) in reaction. Higher soil reaction is mainly because of calcareous nature and sodicity of soils. Major proportion was slightly alkaline (70.70%) followed by neutral (19.11%) and moderately alkaline (10.19%).The higher pH of soils could be attributed to low intensity of leaching and accumulation of bases. The results are in agreement with Prabhavati *et al.* [11].

Electrical Conductivity

The EC of soils in Agricultural college farm was in the range of 0.01 to 0.90 dSm^{-1}. Slightly higher level of soluble salts in the study area is due to semi-arid climatic condition. Soluble salt content in study area revealed that, the area was non-saline.

Organic Carbon

The organic carbon content varied from 0.02 to 0.77 per cent. Mapping by GIS revealed that 47.77 per cent of the study area was low, 30.57 per cent was medium and 21.66 percent was in high range (Fig. 3). The low content may be attributed to the prevalence of semi-arid condition, 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, there by leaving less chances of accumulation of organic carbon in the soils. Similar results were also reported by Prabhavati *et al.* [11] for the soils of northern dry zone of Karnataka.

Macronutrients

The available nitrogen in surface soils of the Agricultural college farm varied from 50.18 to 388.86 kg ha^{-1}. GIS Mapping revealed that 89.17 per cent area in the study area is low and 10.83 per cent area is in medium range (Fig. 4). Basavaraju *et al.* [2] 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 2.23 to 62.37 kg P_2O_5 ha^{-1}. Mapping of available P by GIS revealed that, it was low in 7.64 per cent of the study area and 49.04 per cent was medium while high in 43.32 per cent of the study area (Fig. 5). 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.* [15].

The available potassium content was high and ranged from 361.20 to 1117.54 kg ha^{-1} which might be due to the predominance of K-rich micaceous and feldspars in parent material. Rao *et al*. [12] also reported similar types of results in their studies.

Sulphur

Mapping of available sulphur by GIS revealed that 83.44 per cent in the study area was sufficient and 16.56 per cent was deficient in available sulphur ranging from 0.67 to 132.14 mg kg^{-1} (Fig.6).

DTPA extractable Micronutrients

The available zinc varied from 0.01 to 5.80 mg kg^{-1}. About 62.42 per cent is deficient and sufficient in 37.58 per cent of the study area (Fig. 7). The content of Zn increased with decrease in pH and increase in organic carbon content. Related findings were reported by Satyavathi and Reddy [14].

The available copper ranged from 0.01 to 4.10 mg kg^{-1}. Mapping of available copper by GIS revealed that 25.48 per cent in the study area was deficient in available copper and 74.52 per cent was sufficient in available copper (Fig. 8). Patil *et al.* [10] also observed sufficient status of available copper in soils of north Karnataka.

The available iron content varied from 0.72 to 51.46 mg kg^{-1} .About 21.02 per cent of the study area was deficient and sufficient in 78.98 per cent of the study area (Fig. 9). Patil *et al.* [10] observed that the low iron content may be due to precipitation of iron by CaCO3, which increased its availability.

The available manganese ranged from 1.11 to 44.40 mg kg^{-1}. Manganese was sufficient in 98.73 per cent and deficient in 0.27 per cent of the study area. Similar results were also reported by Sireesha and Naidu [16] who reported that available Mn was sufficient in the soils of Banaganapalle mandal of Kurnool district in Andhra Pradesh.

Table1.Fertility parameters of soils

Parameter	pH	EC (dSm-1)	OC %	N	P	K	S	Zn	Cu	Fe	Mn
				(kg ha-1)			(mg kg-1)				
Maximum	8.10	0.90	0.77	388.86	62.37	1117.54	132.14	5.80	4.10	51.46	44.40
Minimum	7.00	0.00	0.02	50.18	2.23	361.20	0.67	0.01	0.01	0.72	1.11
Mean	7.57	0.19	0.51	197.19	24.02	951.84	25.96	0.81	0.89	11.15	16.44
SD	0.23	0.21	0.22	63.96	10.31	151.68	16.44	0.98	9.73	11.61	9.73
CV	3.04	109.48	43.5	32.44	42.93	15.94	63.31	120.12	1095.20	104.16	59.20

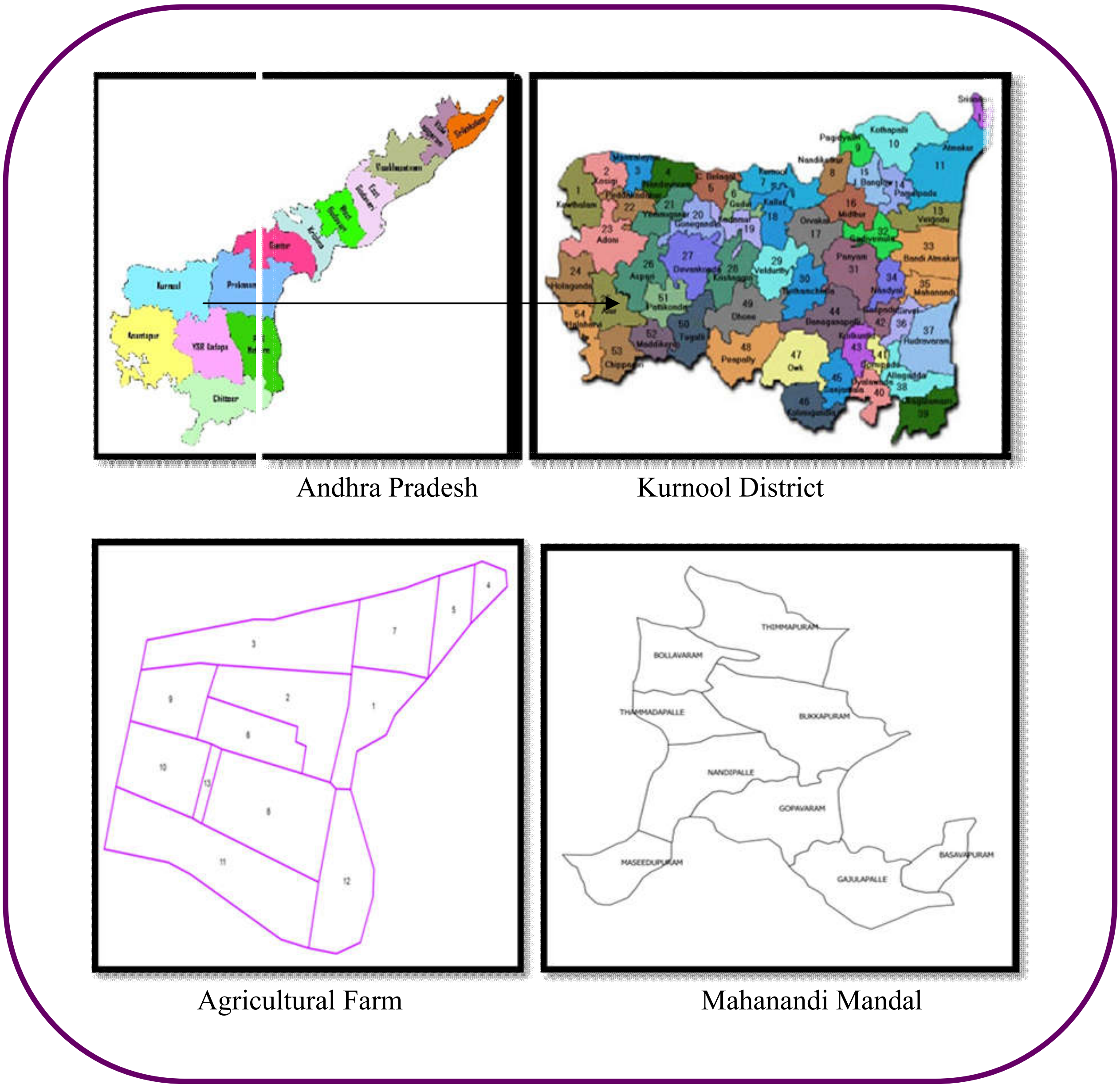

Fig 1. Location map of the study area

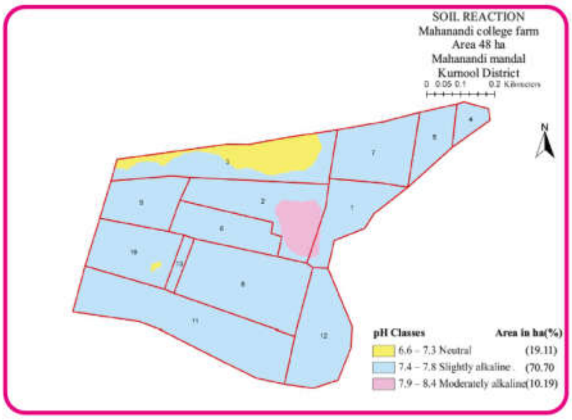

Fig 2. Soil reaction status

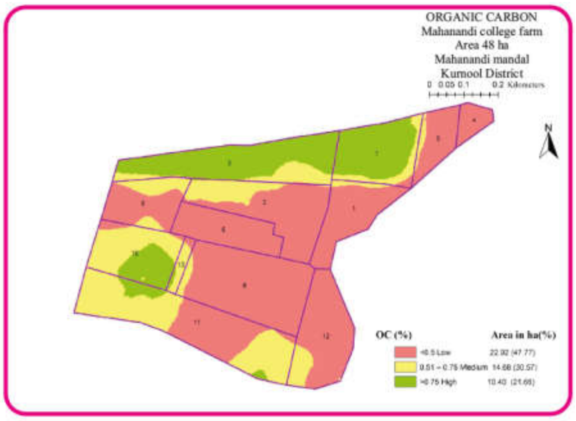

Fig 3. Organic carbon status

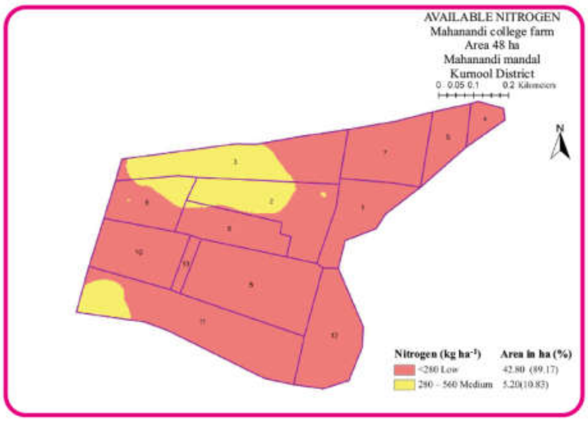

Fig 4. Available nitrogen status

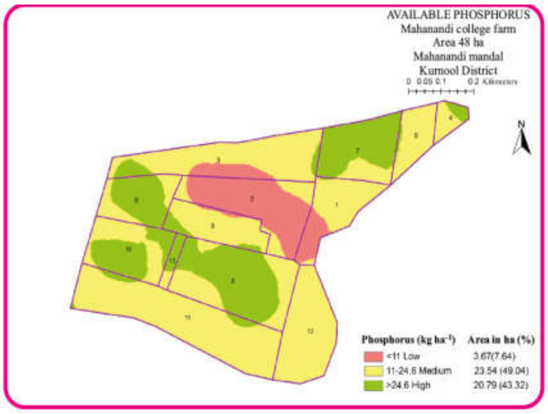

Fig 5. Available phosphorus status

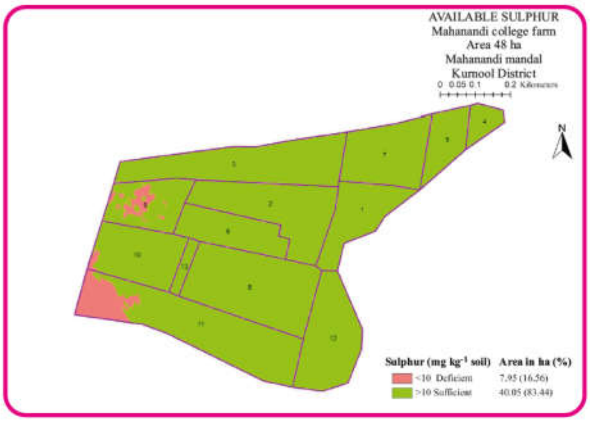

Fig 6. Available sulphur status

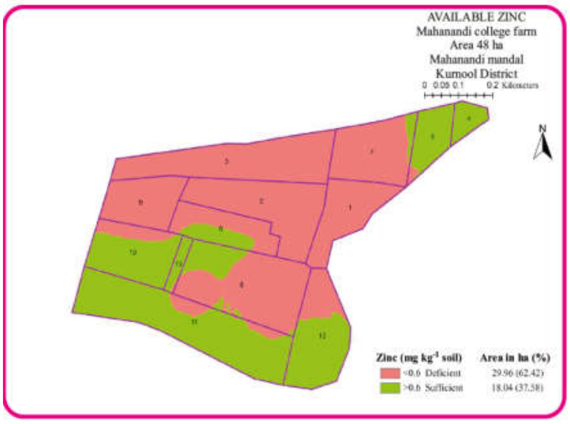

Fig 7. Available zinc status

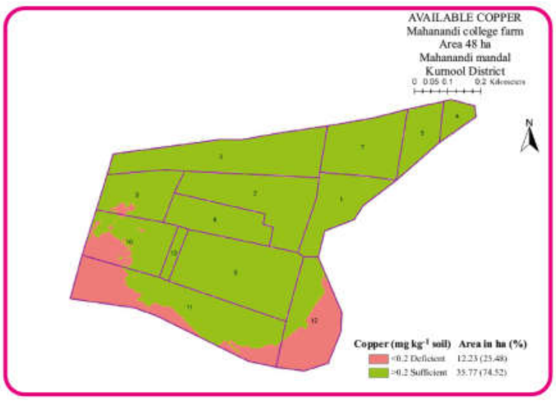

Fig 8. Available copper status

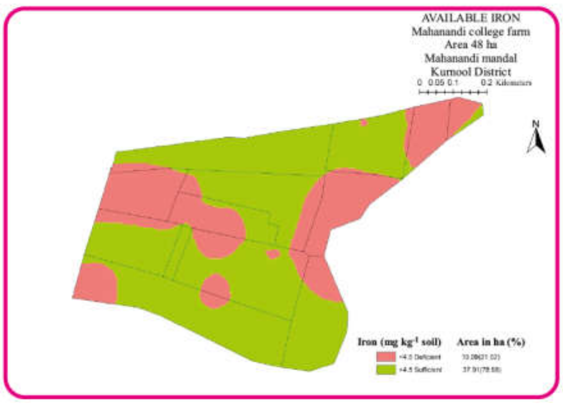

Fig 9. Available iron status

CONCLUSION

The pH of the soils were 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 in nature, 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 high range. Sulphur and micronutrients content are deficient to sufficient except manganese which is in sufficient range. Based on the overall assessment, the nutrient status in these soils is optimum. The information generated in this study could be used for temporal study of soil fertility to compare the fertility status in future. As some of the nutrients like K is in high range, moderation in its application is advisable.

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