



## PREPARATION OF SOIL NUTRIENT STATUS THEMATIC MAPS OF NANDYAL MANDAL OF KURNOOL DISTRICT BY GEOGRAPHIC INFORMATION SYSTEM

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### ABSTRACT

The present study is an attempt to assess the spatial variability by generating thematic maps of available soil fertility status of Nandyal mandal in Kurnool District by GIS technique. Two hundred and forty three geo-referenced soil samples were collected from sixteen villages at random and analysed for soil fertility adopting standard procedures and mapped by Geographic information system. The pH of the soil samples was neutral to highly alkaline in reaction. Available nitrogen was generally low to medium whereas Phosphorous and potassium are available in all the three ranges i.e. low, medium and high. The available micronutrient viz., Iron, copper, zinc and manganese were deficit in 13.54 per cent, 18.76 per cent, 31.22 per cent and 16.83 per cent area respectively in these soils. The spatial variability of the various soil parameters helps the farmers to take up sustained crop management practices.

**KEYWORDS:** Soil fertility, Spatial variability, Nutrient mapping, Geographic information system.

### INTRODUCTION

The general recommendation/management practices for crop production are based on the assumption that fields are homogeneous areas. Soil fertility management is one such practice where the fertilizer requirements are recommended on whole field basis. Bouma and Finke (1993) reported that spatial variability can occur on a variety of scales, between regions, between fields or within fields. Variation in soil components can sometimes be discerned on a sub millimeter scale. However since 70 years it has been reported that the fields are not homogeneous and several sampling techniques have been recommended to cover the field variability. GIS is a powerful tool for collecting, storing, retrieving, transforming and displaying spatial data (Burrough, 1993). GIS can be used in producing soil fertility map of an area which helps to understand the status of soil fertility spatially and temporally. Such maps help in formulating balanced fertilizer recommendation, precision farming, crop suitability analysis and other sustainable crop management decisions. Therefore an appropriate understanding of the spatial variability of soil fertility at field level is essential. It is possible through generation of nutrient status thematic maps through spatial interpolation of point based measurements of soil properties. Therefore the present investigation was taken up for the assessment and mapping of soil fertility status

of Nandyal mandal in Kurnool district of Andhra Pradesh. The major cropping pattern of this area is rice followed by rice and fallow followed by bengalgram.

### MATERIALS AND METHODS

The study area comprising of Nandyal mandal in Kurnool district lies between 15°37'01.9" to 15°58'11.4"N latitude and 78°25'54.8" to 78°63'48.3"E longitude (Fig. 1). It falls under scarce rainfall zone of agricultural zone of Andhra Pradesh. The area receives mean annual rainfall of 670 mm received mainly during June to September.

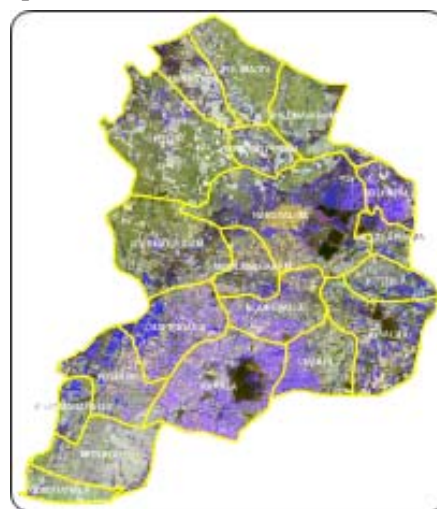


Fig. 1. Location map of study area

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## Preparation of soil nutrient status thematic maps

Geo-referenced surface soil samples were collected at an average of fifteen samples per village from the study area representing different soil units and cropping systems as per the soil map prepared by NBSS & LUP were collected randomly at 0-15 cm depth by adopting the standard procedures of soil sample collections. A total of 233 samples were collected from all 15 villages of the mandal. The total geographical area of the study area is 23458.12 ha.

Soil samples collected were air dried under shade, ground with mortar and pestle, passed through a 2 mm sieve and then were used for laboratory analysis after proper labeling. These soil samples were analysed for estimating physical, physio-chemical and chemical properties of the soil using the standard methods. The pH of the soil in 1:2.5 soil water suspension was determined by glass electrode pH meter (Jackson, 1967). The available nitrogen was determined by alkaline permanganate method outlined by Subbaih and Asija (1956) and the results are expressed in  $\text{kg ha}^{-1}$ . The available phosphorus content was determined by extracting the soil with 0.5 M  $\text{NaHCO}_3$  (Olsen *et al.*, 1954) and estimated by developing blue colour using ascorbic acid as reductant on calorimeter (Olsen and Watanabe, 1965). Available potassium in the soils was extracted by neutral normal ammonium acetate and determined by the flame photometer (Jackson, 1973). The available micronutrients *viz.*, Fe, Cu, Zn and Mn were determined in the DTPA extract of soil (pH 7.3) using Atomic Absorption Spectrophotometer as outlined by Lindsay and Norwell (1978). Fertility status of N,P,K are interpreted as low, medium and high and that of sulphur, iron, copper, zinc and manganese are interpreted as deficit and sufficient.

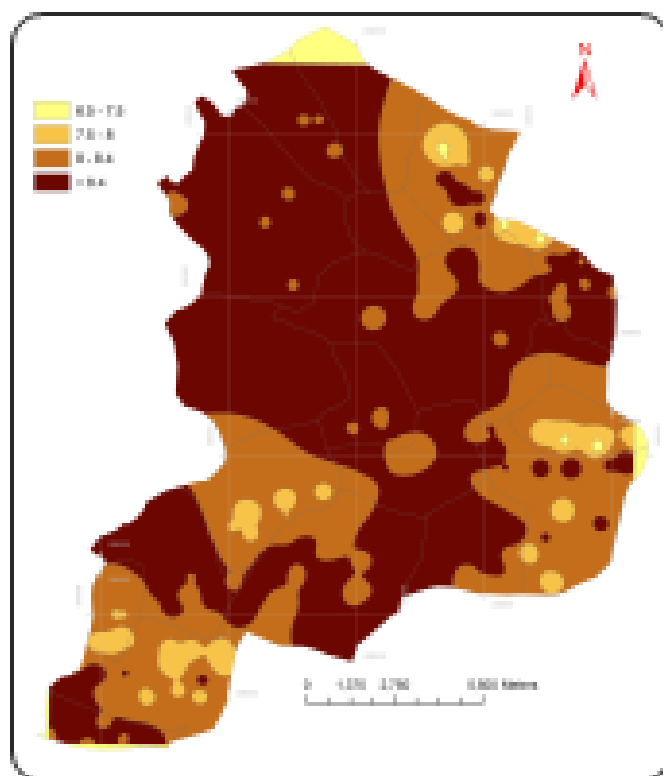
Arc Map 10.0 with spatial analyst function of Arc GIS software was used to prepare soil fertility maps. Interpolation method employed was kriging. Then map was reclassified according to the ratings of respective nutrients and estimated the area under different standard ratings.

## RESULTS AND DISCUSSION

The data pertaining to fertility status of Nandyal mandal are presented in Table 1 for the soil Ph, major and micronutrients.

The soil pH plays an important role in crop productivity. It is the pattern of the soil reaction which decides the corresponding solubility and availability of

the nutrients causing the soil suitable for a particular cropping pattern. In the study area the soils were neutral to highly alkaline reaction (6.48 to 9.32) with low soluble salts. The major portion of the area is occupied by pH range of more than 8.4 with highly alkaline reaction in an area of 13906 ha (59 %) and the zone represented by pH range of 6.5 to 7.5 (1.58 %) occupies minimum area 371 ha (Fig. 2). The highly alkaline reaction of the soils may be due to efficient recycling of basic cations and also due to presence of sodium as dominant cation on exchangeable complex (Thangaswamy *et al.*, 2005).



**Fig. 2. Spatial distribution of soil pH**

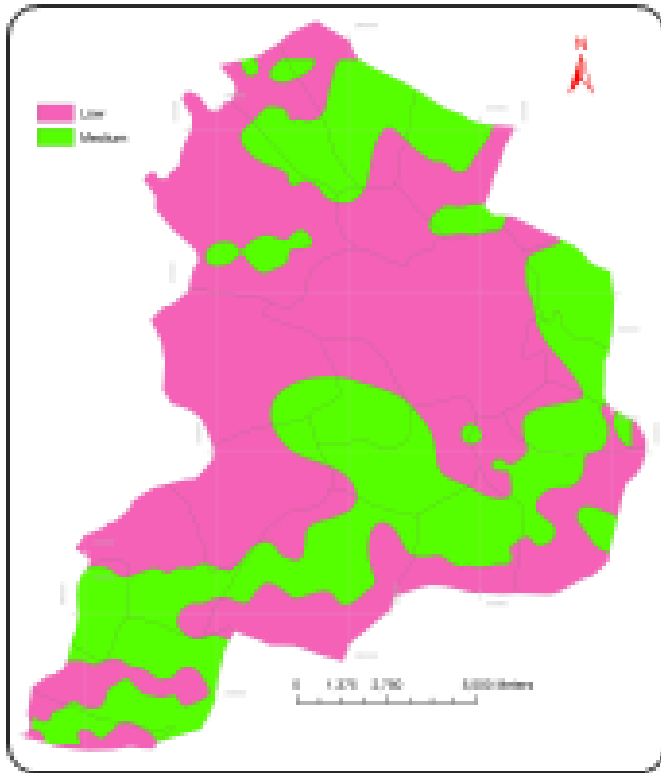
The available nitrogen content of villages of study area ranged from 60 to 626  $\text{kg ha}^{-1}$  with a mean value of 230.38 and standard deviation of 15.25. out of the total study area, the largest area of 14640.5 ha (62.48 % of the area of the mandal) falls under low available nitrogen range while the medium nitrogen content of range occupies an area of 8793.4 ha (37.52 % of the area of the mandal) (Fig. 3). The major portion of the nitrogen content in soils is contributed by organic matter. The total nitrogen content in the soils is dependent on temperature, rainfall and altitude. Nitrogen variation may be related to soil management, application of FYM and fertilizer to previous crop (Ashok Kumar, 2000). The low organic

Table 1. Soil characteristics of Nandyal mandal

| S. No. | Mandal        | No. of Samples | pH                  | N                   | P                | K                    | S                | Iron              | Copper             | Zinc               | Manganese     |
|--------|---------------|----------------|---------------------|---------------------|------------------|----------------------|------------------|-------------------|--------------------|--------------------|---------------|
| 1      | Ayyalur       | 20             | 7.15-8.97<br>(8.19) | 204-268<br>(231.5)  | 5-30<br>(15.1)   | 235-475<br>(388.25)  | 8-18<br>(13.4)   | 7-12<br>(8.53)    | 0.3-0.5<br>(0.35)  | 0.3-1.0<br>(0.77)  | 3-4<br>(3.25) |
| 2      | Bheemavaram   | 14             | 8.1-8.92<br>(8.5)   | 204-274<br>(236.3)  | 4-19<br>(13.9)   | 225-500<br>(367.15)  | 8-15<br>(12.1)   | 4.5-9.0<br>(6.30) | 0.3-0.5<br>(0.40)  | 0.4-1.0<br>(0.83)  | 3-4<br>(3.2)  |
| 3      | Brahmanapalle | 10             | 7.03-8.1<br>(7.78)  | 198-274<br>(211.8)  | 8-24<br>(17.6)   | 165-370<br>(240.5)   | 11-17<br>(12.5)  | 7-10<br>(7.6)     | 0.3-0.4<br>(0.38)  | 0.4-0.8<br>(0.6)   | 3-3<br>(3)    |
| 4      | Chabolu       | 14             | 7.49-8.27<br>(7.74) | 198-276<br>(247.15) | 11-34<br>(17.43) | 135-500<br>(387.5)   | 7-14<br>(11.43)  | 4-9<br>(6.21)     | 0.3-0.6<br>(0.4)   | 0.5-0.9<br>(0.76)  | 3-3<br>(3)    |
| 5      | Chapirevula   | 9              | 7.1-8.6<br>(7.9)    | 204-212<br>(207.78) | 8-30<br>(17.44)  | 225-495<br>(358.3)   | 7-19<br>(15.44)  | 8-10<br>(9.33)    | 0.4-0.5<br>(0.41)  | 0.7-0.8<br>(0.73)  | 3-4<br>(3.11) |
| 6      | Gunthanala    | 19             | 7.14-8.95<br>(7.88) | 204-626<br>(262.32) | 5-31<br>(16.2)   | 125-490<br>(230.52)  | 6-18<br>(13)     | 4-10<br>(6.26)    | 0.3-0.5<br>(0.39)  | 0.3-1.0<br>(0.76)  | 3-4<br>(3.05) |
| 7      | Kanala        | 15             | 7.08-9.32<br>(8.13) | 60-272<br>(241.47)  | 5-31<br>(16.2)   | 100-400<br>(235.67)  | 7-16<br>(11.47)  | 8-12<br>(8.5)     | 0.3-0.5<br>(0.39)  | 0.4-0.9<br>(0.75)  | 3-3<br>(3)    |
| 8      | Kothapalli    | 20             | 6.8-9.24<br>(8.15)  | 200-278<br>(234.1)  | 4-17<br>(9.1)    | 110-380<br>(246.75)  | 6-17<br>(12.05)  | 6-12<br>(8.6)     | 0.4-0.5<br>(0.425) | 0.5-1<br>(0.81)    | 3-4<br>(3.05) |
| 9      | Kottala       | 4              | 7.15-7.8<br>(7.45)  | 198-278<br>(234)    | 8-20<br>(14)     | 115-1250<br>(163.75) | 18-20<br>(19.25) | 6-8<br>(7)        | 0.3-0.5<br>(0.4)   | 0.7-0.9<br>(0.85)  | 3-4<br>(3.5)  |
| 10     | Mitnala       | 19             | 6.48-8.93<br>(8.04) | 178-270<br>(232.7)  | 6-31<br>(12.73)  | 85-475<br>(268.68)   | 7-19<br>(13.31)  | 6-12<br>(9.05)    | 0.3-0.6<br>(0.47)  | 0.3-1.0<br>(0.75)  | 3-4<br>(3.1)  |
| 11     | Moolasagaram  | 10             | 8.1-9.01<br>(8.65)  | 228-274<br>(244.8)  | 5-13<br>(8.7)    | 220-500<br>(325.5)   | 6-18<br>(13)     | 3-7<br>(4.45)     | 0.3-0.5<br>(0.44)  | 0.7-0.9<br>(0.79)  | 3-3<br>(3)    |
| 12     | Munagala      | 19             | 8-8.95<br>(8.59)    | 184-274<br>(222)    | 4-22<br>(9.4)    | 230-650<br>(424.74)  | 9-20<br>(14.58)  | 4-9<br>(7.89)     | 0.4-0.6<br>(0.44)  | 0.4-0.9<br>(0.71)  | 3-4<br>(3.26) |
| 13     | Nandyal(M)    | 20             | 7.9-8.96<br>(8.39)  | 188-274<br>(2227.2) | 4-23<br>(10.85)  | 215-500<br>(348.5)   | 7-21<br>(15.55)  | 7-9<br>(8)        | 0.1-0.4<br>(0.32)  | 0.4-0.9<br>(0.705) | 3-4<br>(3.75) |
| 14     | Polur         | 20             | 7.85-8.26<br>(8.06) | 166-262<br>(213.5)  | 7-38<br>(19.3)   | 150-495<br>(299)     | 6-15<br>(10.95)  | 6-12<br>(9.1)     | 0.1-0.6<br>(0.41)  | 0.4-1.0<br>(0.63)  | 3-4<br>(3.1)  |
| 15     | Pusulur       | 20             | 8-9.25<br>(8.49)    | 130-278<br>(213.5)  | 2-30<br>(11.65)  | 140-500<br>(327.88)  | 8-19<br>(14.9)   | 4-12<br>(8.65)    | 0.2-0.6<br>(0.47)  | 0.4-0.9<br>(0.72)  | 3-4<br>(3.05) |
|        | Mean          |                | 8.13                | 230.38              | 13.97            | 307.51               | 13.53            | 7.7               | 0.41               | 0.74               | 3.14          |
|        | Range         |                | 6.48-9.32           | 60-626              | 2-38             | 85-650               | 6-21             | 3-12              | 0.1-0.6            | 0.3-1              | 3-4           |
|        | SD            |                | 0.35                | 15.25               | 3.44             | 74.03                | 2.15             | 1.38              | 0.04               | 0.07               | 0.21          |
|        | CV            |                | 4.27                | 6.62                | 24.63            | 24.07                | 15.89            | 18.01             | 9.91               | 9.05               | 6.72          |

## Preparation of soil nutrient status thematic maps

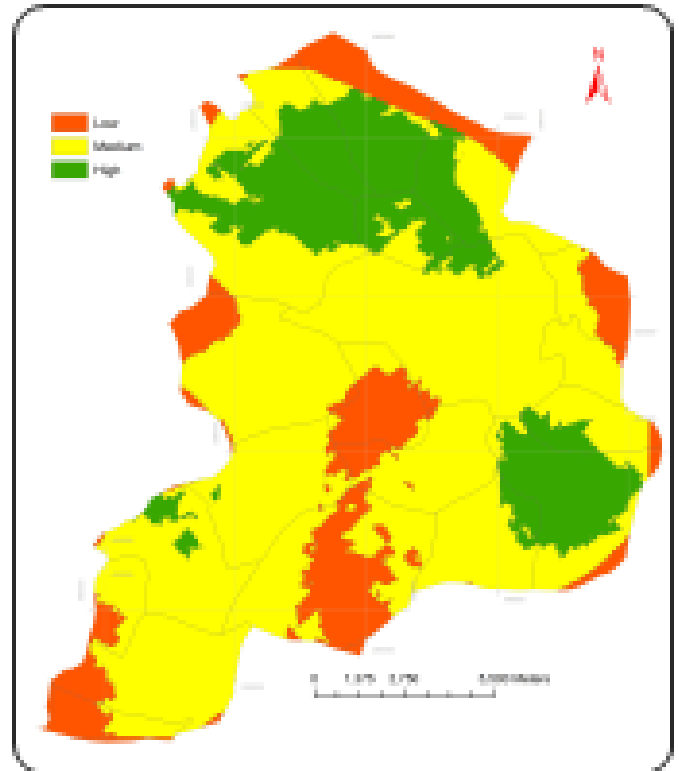
matter content in the soils due to low rainfall and low vegetation results in faster degradation and removal of organic matter leading to low nitrogen content in the soils may be one of the reason. The observations are in accordance with Patil *et al.* (2011).



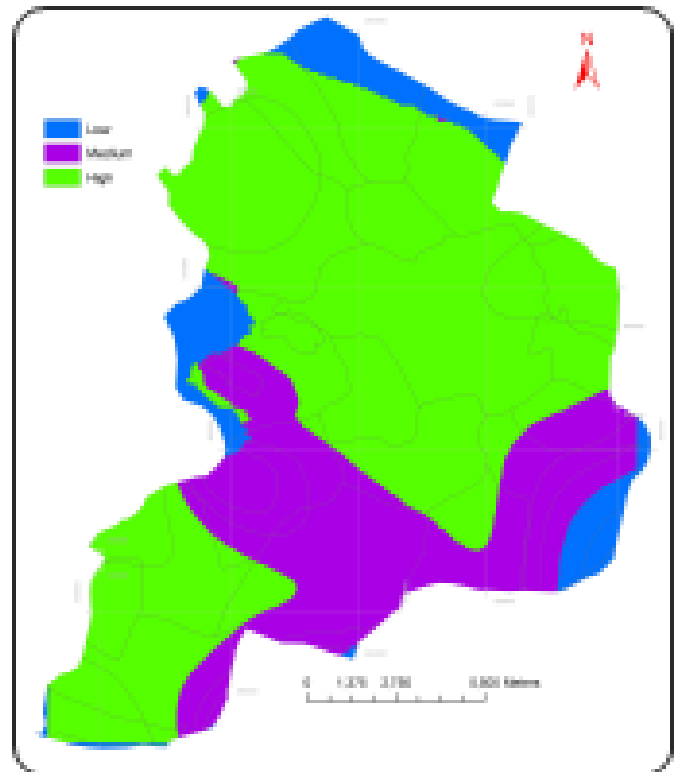
**Fig. 3. Spatial distribution of Nitrogen**

The available phosphorous status of soils of in the study area ranged from 2.0 to 38kg ha<sup>-1</sup> with a mean value of 13.97 kg ha<sup>-1</sup>. The map (Fig. 4) shows that 16% (3751.5 ha) and 64.6% (15129.7 ha) of the soils in the mandal is characterized by low and medium phosphorous content respectively and whereas 19.4 % area (4552.7 ha) by high range. The low content of phosphorous may be due to low CEC and clay content. The results are in conformity with the findings of Bopathi and Sharma (2006) and Madan Mohan (2008).

The soils in the study area were found to be low to high in available potassium status ranging from 85 to 650 kg ha<sup>-1</sup> with a mean value of 307.51 kg ha<sup>-1</sup>. The spatial variability map of study area (Fig. 5) shows that the maximum area of 15356.72 ha (65.53 %) is occupied by the high range of available potassium, 6059.95 ha (25.86%) with medium range of available potassium whereas 8.61 per cent (2017.26 ha) of the mandal is occupied by low potassium range. Binita *et al.* (2009)



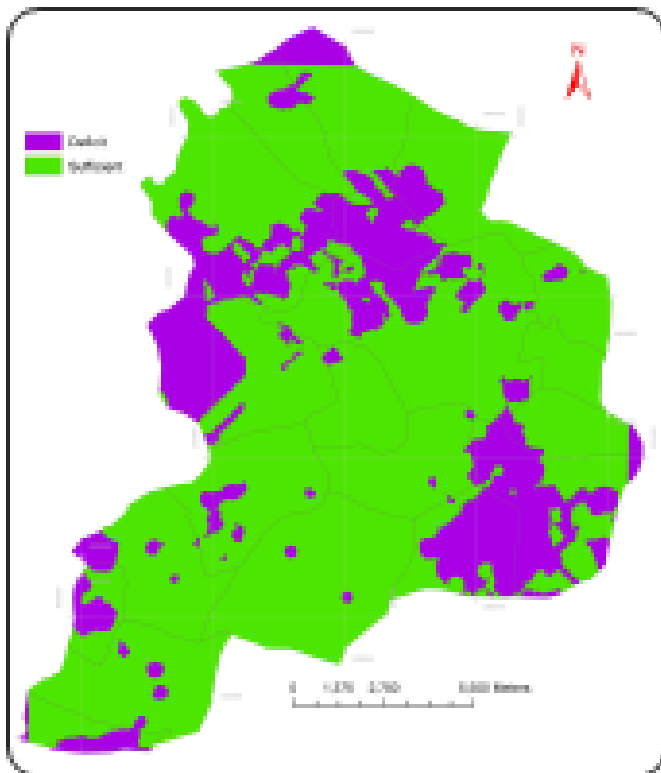
**Fig. 4: Spatial distribution of Phosphorus**



**Fig. 5. Spatial distribution of Potassium**

reported high K in study area with black soils. Soils of the study area may be predominantly rich in K containing micaceous and feldspars minerals in parent material leading to major portion of study area with high K availability (Ravi Kumar, 2006).

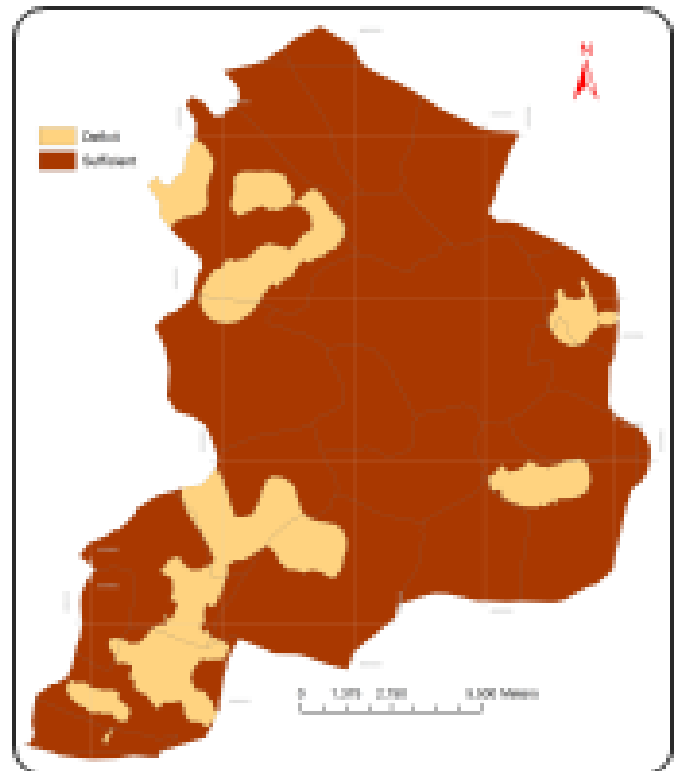
The availability of sulphur in study area ranged from 6 to 21 kg ha<sup>-1</sup>, with a mean value of 13.53 kg ha<sup>-1</sup>. About 76.23 per cent (17864.57 ha) of the area is characterized by sufficient sulphur content range (Fig.6). Similar results were reported by Deveraj (1994) where he observed that fine texture soils are generally well supplied with sulphur.



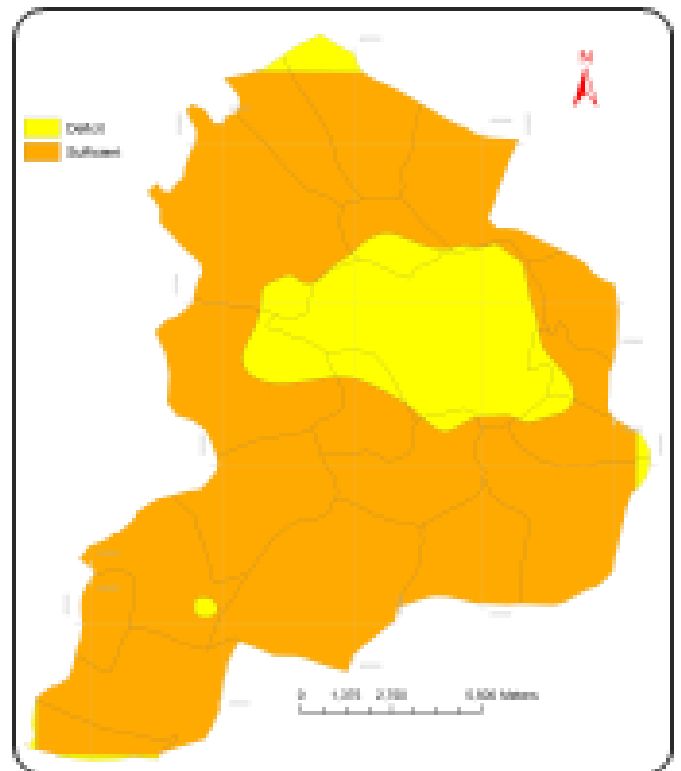
**Fig. 6. Spatial distribution of Sulphur**

The iron content ranged from 3 to 12 mg kg<sup>-1</sup> with mean value of 7.7 mg kg<sup>-1</sup>. The area of 13.54 % (3171.95 ha) of the mandal comes under deficit iron content whereas 86.46 per cent (20261.98 ha) area by sufficient iron content (Fig. 7). The deficit iron content in certain portions of the area may be due to precipitation of iron by caco3 and resulting in decrease of its availability (Thampatti and Jose, 2006).

The major portion of the study area had sufficient quantity of copper available in an area of 81.24 per cent (19036.90 ha) of the mandal whereas in an area of 18.76 per cent (4397.03 ha) deficit content is recorded (Fig. 8).



**Fig.7. Spatial distribution of Iron**



**Fig. 8. Spatial distribution of Copper**

### Preparation of soil nutrient status thematic maps

On the whole the Cu content ranged from 0.10 to 0.60 mg kg<sup>-1</sup> with mean value of 0.41 mg kg<sup>-1</sup>.

Available zinc status in the mandal ranged from 0.30 to 1 mg kg<sup>-1</sup> and an area of 68.78 per cent (16118.3 ha) is characterized by sufficient zinc content range and 31.22 per cent (7315.63) with deficit zinc status in the study area (Fig. 9). In alkaline pH range zinc forms negatively charged zincate ions and alter stability of soluble and insoluble organic complexes of zinc (Singh and Singh, 1996).

In the study area sufficient quantity of manganese content is available in an area of 83.17 per cent (19490 ha) of the mandal whereas 16.83 per cent (3943 ha) area by deficit manganese content (Fig. 10) due to neutral to low pH and nature of the parent material as reported by Prasad and Sahi (1989), while Arora and Shekon (1981) observed that high pH decreases the availability by converting in to unavailable for (Mn<sup>+++</sup>). Vijayshekhar et al (2000) reported that sufficient quantity of Mn is due to high organic matter.

The coefficients of variation (Table 1) of soil fertility status shows that it ranged from 4.27 to 24.63, the large values of CV shows that soil fertility in the study area is not homogeneous in distribution. This may be due to several natural factors such as geology, topography and manmade factors as land use and land management practices.

### CONCLUSIONS

The soils of Nandyal mandal in Kurnool district show considerable spatial variability in respect to the soil fertility status. The generation of such soil fertility maps helps in identifying the areas which require much attention of a farmer. In this study, some nutrients are high in availability and others moderate. Some areas may need immediate attention for sustained crop production. Wherever micronutrients are deficit, they may be replenished in order to avoid the crops suffering from their deficiency and also to obtain optimum utilization of other nutrients. These maps forms the basis to control the under usage and overusage of the fertilizers and also helps in deciding the cropping pattern based on the soil fertility status.

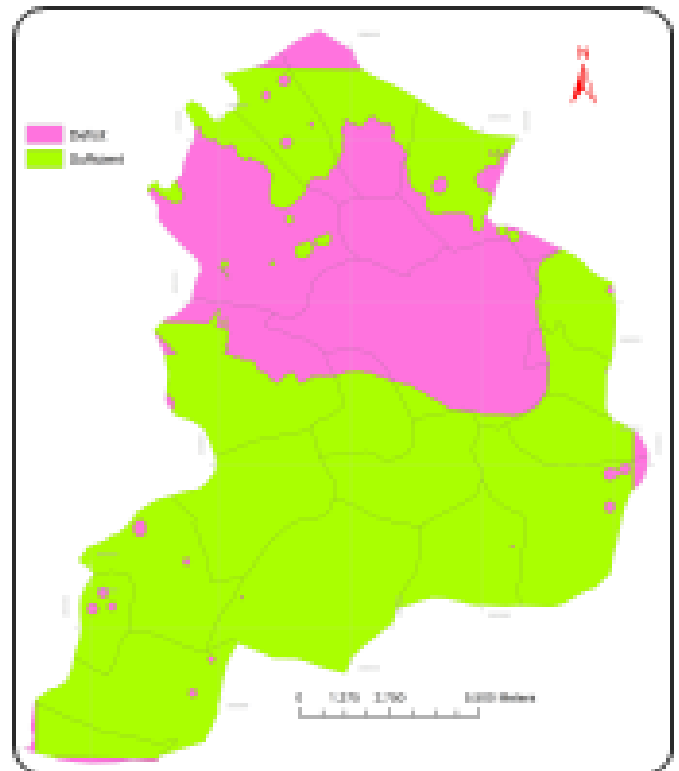


Fig.9: Spatial distribution of Zinc

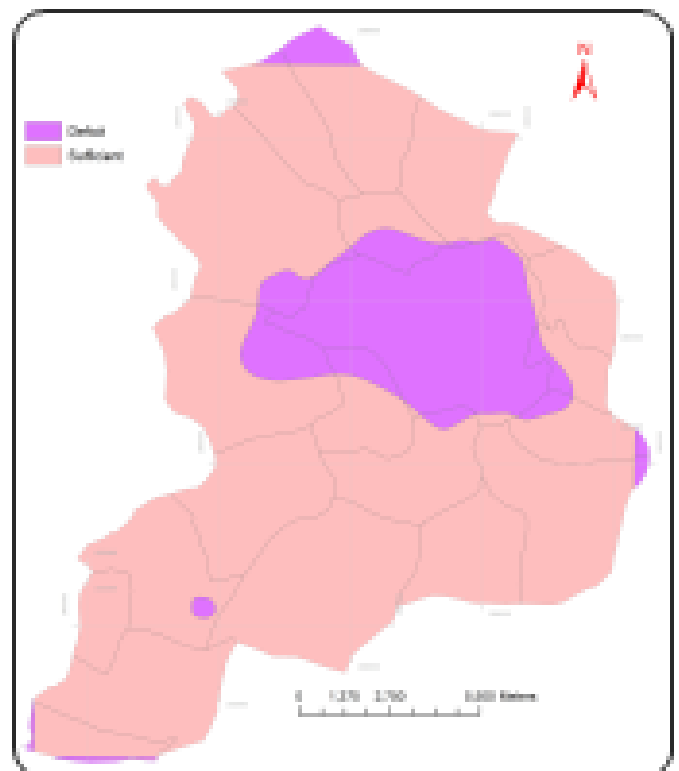


Fig. 10. Spatial distribution of Manganese

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