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Micronutrients and their relationship with soil properties in Shirol Tehsil of Kolhapur District. (M.S.)

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Abstract

A study was conducted to assess micronutrient status of soils of Shirol Tehsil of Kolhapur District by GIS technique. 200 soil samples (0-22.5 cm) drawn during 2013 from 39 villages were analyzed for their fertility status and mapped by geographic information system (GIS) technique. The exact locations of soil samples were recorded with the help of GPS. The results indicated that all samples were slightly alkaline to moderately alkaline in soil reaction (7.0-9.0), non-saline (0.06-6.3dS m^{-1}), low to very high in organic carbon (0.30 – 1.29%) and Calcium Carbonates ranged from (1.1-15.1%). Regarding micronutrients, the DTPA extractable Zn and Fe were categorized as very low to medium which ranged from (0.21-4.35 mg Kg^{-1}) and (2.20-9.05 mg Kg^{-1}) respectively. The DTPA extractable Mn was ranged from (0.03-11.51 mg Kg^{-1}) which are categorized as medium to high. The DTPA extractable Cu was ranged from (0.62-27.96 mg Kg^{-1}) which are categorized as moderately high to very high.

Keywords: Micronutrient, geographic information system, global positioning system, fertility status

Introduction

Micronutrient plays a vital role in maintaining soil health and also productivity of crops. These are needed in very small amounts, the soil must supply micronutrients for desired growth of plants and synthesis of human food. Increased removal of micronutrients as a consequence of adoption of high yielding varieties and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil below normal at which productivity of crops cannot be sustained. However, exploitive nature of modern agriculture involving use of organic manures and less recycling of crop residues are important factors contributing towards accelerated exhaustion of micronutrients from the soil. The deficiencies of micronutrients have become a major constraints to productivity, stability and sustainability of soils. Soils with finer particles and with higher organic matter can generally provide a greater reserve of these elements whereas, coarse textured soils such as, sand have fewer reserves and tend to get depleted rather quickly. The life supporting systems of a country and socio-economic development of its people depends on the soil. More than ever before, a renewed attention is being given to soils due to rapidly declining land area for agriculture, declining in soil fertility and increasing soil degradation, wrong land use policies and irrational and imbalanced use of inputs (Kanwar, 2004) [4]. Soil testing provides the information about the nutrient availability of the soil. Soil fertility maps are meant for highlighting the nutrient needs, based on fertility status of soils to realize good crop yields. Obviously, a soil fetility map for a particular area can prove highly beneficial in guiding the farmers, manufacturers and palnners in ascertaining the requirement of various fertilizers in a season/ year and making projections for increased requirement based on cropping pattern and intensity.

The recent technologies like GIS and Global Positioning System (GPS) thus have much to offer for preparing soil fertility maps. Soil chemical and physical properties vary within a single field. Spatial tools like Global Positioning System (GPS) and Geographic Information System (GIS) for storing and analyzing spatial data can help us to make better decisions in agriculture particularly land development, environmental protection and restoration. The present study therefore, was taken up to evaluate and map micronutrient status of Shirol Tehsil soil using GIS technique for formulating site specific recommendation of nutrients.

Material and Methods

Study Area

Shirol is one of the tehsil of Kolhapur district of Maharashtra state, India. The geographical area of tehsil is 50300 ha. It belongs to Desh or Paschim Maharashtra region and located between 16^0 44’ 0’’ North latitude and 74^0 36’ 0’’ East longitude and elevation 550 m from mean sea level. (Fig. 1).

Soil characteristics

The soils of the district are developed over soft weathered and hard ruptured basalt and occur on nearly levelled to very gentle sloping upper and lower pediments. The soils which occur mostly on upper pediment, lack of horizonation except a plough layer are classified as order Entisol, whereas the soils which occur as lower pediment, nearly levelled to very gentle slope and have one or two diagnostic horizon e.g. cambic subsurface diagnostic horizon are classified as order Inceptisol. The very deep soil occurring on the levelled lower pediment and developed over soft weathered basalt very dark greyish brown clayey, strong coarse angular blocky peds with shiny pressure faces and well developed intersecting slickenside are classified under order Vertisol.

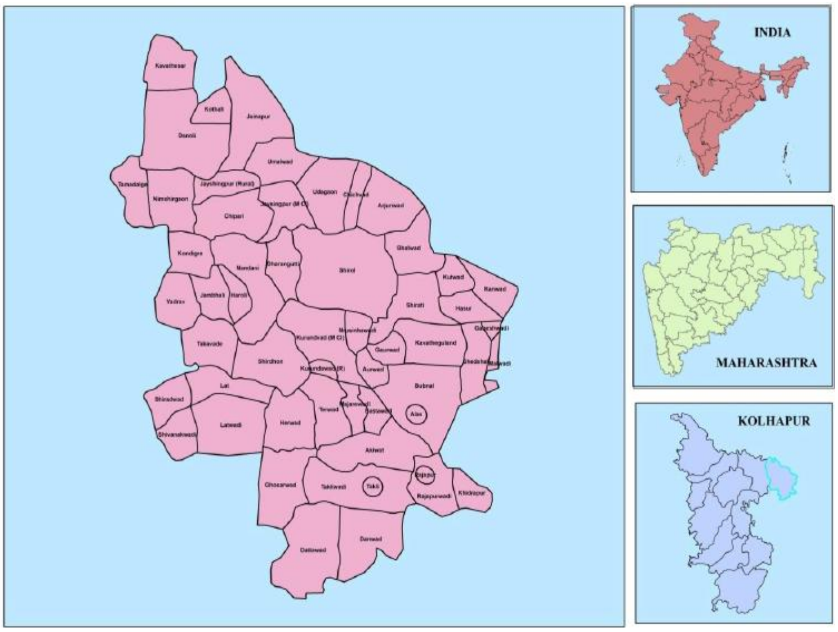

Fig 1: Location map of the study area

Climate

The climate of Shirol tehsil is very hot in summer. During summer highest day temperature is in between 33 ^{0}C to 41 ^{0}C. Average temperature is in between 25 ^{0}C to 29 ^{0}C. Annual average Rainfall is 750 mm.

Land use and natural vegetation

The major crops cultivated are sugarcane, banana, mango, sorghum and soybean, groundnut, chickpea and other vegetable crops. The forest trees like teakwood, neem and bamboo are also planted on bunds and uncropped land. Similarly, a few grasses of ecological importance such as *Heteropogon contrortus, Cynodon doctylon, Celosia argentea, Mimosa pudica* etc. are observed including Kardai.

Methodology

Soil sample collection and analysis

A systematic survey was carried out and a surface (0-22.5 cm depth) soil samples were collected from 200 sites of 39 villages. These soil samples of soil order shallow, medium and deep (Entisols, Inceptisols and Vertisols) from each village following the standard procedures of soil sample collection. The exact sample location was recorded using a GPS.

Soil samples were analyzed for chemical characteristics by following standard analytical techniques. Soil reaction was determined in 1:2.5 suspension using standard pH meter by Potentiometry (Jackson, 1973) [3]. The electrical conductivity was determined by 1:2.5 suspension using EC meter by Conductometry (Jackson, 1973) [3]. Soil organic carbon was estimated using the Wet oxidation method (Nelson and Sommer, 1982) [7] and $CaCO_3$ is determined by Rapid titration method by Piper (1966) [13]. DTPA-extractable micronutrients Fe, Mn, Zn and Cu were extracted from the soil samples by 0.005M DTPA at pH 7.3 according to Lindsay and Norvell (1978) [6] and the concentration of the micronutrients was estimated by atomic absorption spectrophotometer (AAS).

Generation of maps

The delineation of the area for different nutrient levels of soils and their extent of area were calculated and mapping was carried out by using Arc-GIS 9, version 9.3 software.

Statistical analysis

The soil chemical properties data were statistically analyzed by using standard statistical methods given by Panse and Sukhatme (1985) [10].

Results and Discussion

Chemical characteristics of soil

The pH of the soils in Shirol tehsil ranged from 7.0 to 9.0. Among the soil samples tested, most of the soils were moderately alkaline (77.5 per cent) followed by slightly alkaline (22.0 per cent) and neutral (0.5 per cent). The similar results were recorded by Patil and Sonar (1994) [11] in swell-shrink soils of Maharashtra and Pharande *et al.* (1996) [12] in important vertisol series of western Maharashtra. The EC of various soil sample of Shirol tehsil ranged from 0.06 to 6.30 dS m^{-1}. The EC noticed in Shirol tehsil indicated that most of the soils were non saline in nature (91.5 per cent) and suitable for crop. The higher EC values might be due to basin topography of characterized area where the water table was high and also due to seepage of water along with soluble salts and carbonates of calcium and magnesium might have increased the EC. The similar results were reported by Padole and Mahajan (2003) [9] in swell-shrink soils of Vidharbha region. The EC more than 4 dS m^{-1} indicated the hazards of soluble salts prescribed by Jackson (1967) [2]. The organic carbon of various soil samples of Shirol tehsil were ranges from 0.30 to 1.29 per cent with the mean of 0.89 per cent. The data indicated that 39.5 per cent samples were very high, 23.0 per cent samples are found to be moderately high, 21.5 per cent samples were found to be high, 13.5 per cent samples are found to be moderate and 2.5 per cent low in organic carbon. The $CaCO_3$ in soils of shirol tehsil ranges from 1.10 to 15.10 per cent with the mean of 4.82 per cent. The data revealed that 56.0 per cent soils are moderately calcareous, 27.5 per cent soils were calcareous, 10.0 per cent soils were slightly calcareous, 6.5 per cent soils were highly calcareous. (Table 1).

Table 1: Soil pH, EC, Organic Carbon and $CaCO_3$ status of Shirol Tehsil

Particulars	pH	EC (dSm^{-1})	Organic Carbon (%)	$CaCO_3$ (%)
Mean	8.2	0.48	0.89	4.82
Range	7.0-9.0	0.06-6.3	0.30-1.29	1.1-15.1
SE±	0.02	0.04	0.01	0.20

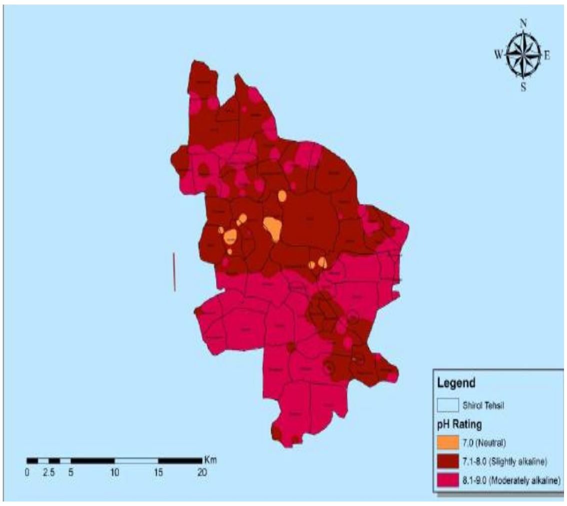

Fig 2: pH of Shirol Tehsil

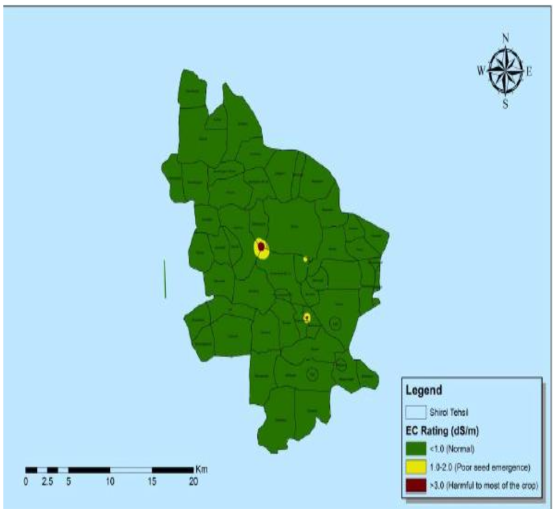

Fig 3: EC of Shirol Tehsil

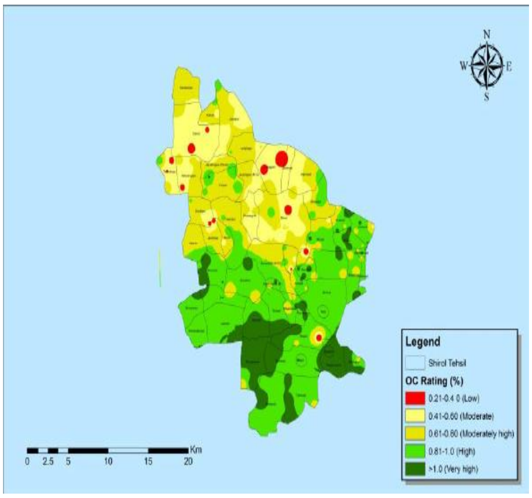

Fig 4: Organic carbon of Shirol Tehsil

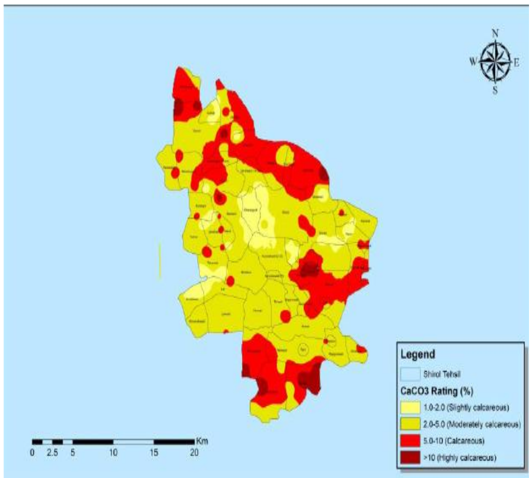

Fig 5: $CaCO_3$ of Shirol Tehsil

Available micronutrients status and influence of soil chemical characteristics

DTPA extractable Zinc

The DTPA extractable zinc in soils of Shirol tehsil ranged from 0.2 to 4.3 mg Kg^{-1} with a mean of 1.4 mg Kg^{-1} (Table 2). Out of all the soil samples collected 40.0 per cent samples were medium, 29.0 per cent samples were moderately high, 16.5 per cent samples were high, 10.5 per cent samples were very high, 3.5 per cent samples were low and 0.5 per cent samples were very low in DTPA extractable zinc in certain pockets of Kutwad, Dattawad, Danwad, Tamadalge and Chipari (Fig. 6). The deficiency in DTPA extractable zinc might be due to low organic matter content in soil, which acts as natural chelating agent, wash out of the upper soil surface and excess of available phosphorus in soil. Pharande *et al.* (1996) [12] recorded the similar trends of DTPA extractable zinc in important Vertisol and Alfisol soil series of western Maharashtra.

DTPA extractable Iron

The DTPA extractable iron in soils of Shirol tehsil was ranged from 2.9 to 16.0 mg Kg^{-1} with a mean of 6.5 mg Kg^{-1} (Table 7). Out of all the soil samples collected 69.0 per cent were medium, 17.5 per cent were low and 13.5 per cent were moderately high in DTPA extractable iron (Fig. 3). The high availability of DTPA extractable iron might be due to high organic matter content. The similar trend of iron was noted by Patil and Sonar (1994) [11] in soils of Nagpur district. The similar trend was also recorded by Singh and Rathore (2013) [14] in Aravalli mountain ranges of Pratapgarh, Rajasthan.

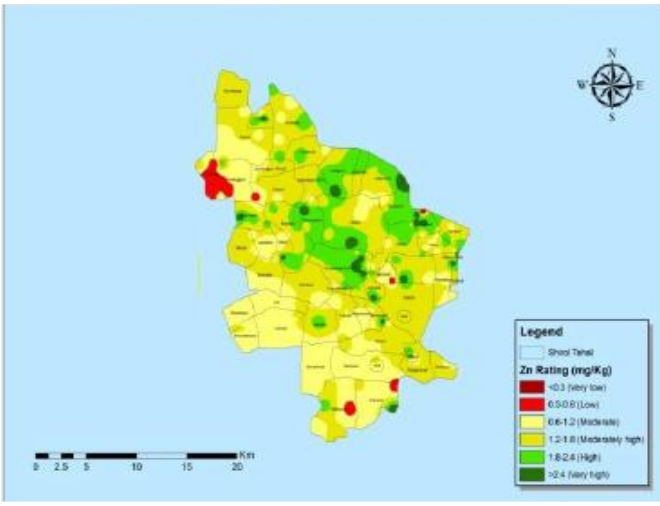

Fig 6: Soil available Zinc of Shirol Tehsil

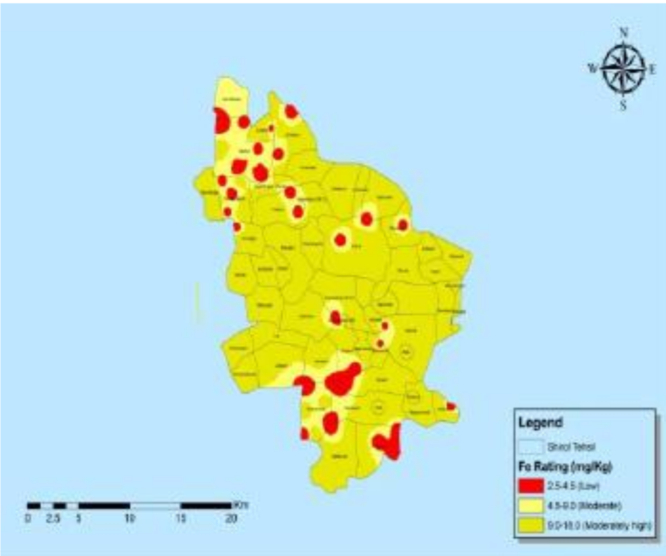

Fig 7: Soil available Iron Shirol Tehsil

DTPA extractable Manganese

The DTPA extractable manganese in soils of Shirol tehsil was ranged from 0.03 to 11.51 mg Kg^{-1} with a mean of 6.18 mg Kg^{-1} (Table 2). Out of all the soil samples 57.5 per cent samples are moderately high, 23.5 per cent samples are high and 19.0 per cent are medium in DTPA extractable manganese (Fig. 8). The sufficiency of DTPA extractable manganese might be due to high organic matter content and optimum soil moisture content. The similar observation have been reported by Patil and Sonar (1994) [11] in Swell-Shrink Soils of Maharashtra. Pharande *et al.* (1996) [12] reported the similar findings in important Vertisol and Alfisol soil series of Western Maharashtra.

DTPA extractable Copper

The DTPA extractable copper in soils of Shirol tehsil was ranged from 0.6 to 27.9 mg Kg^{-1} with a mean of 3.0 mg Kg^{-1} (Table 2). All the soil samples collected from Shirol tehsil were very high in DTPA extractable manganese (Fig. 9). The high amount of DTPA extractable copper might be due to the high organic matter content and optimum soil moisture in soil. Similar results were recorded by Kumar and Babel (2011) [5] in Jhunjhunu tehsil of Jhunjhunu district in Rajasthan. Patil and Sonar (1994) [11] also reported the similar trend of DTPA extractable copper in swell-shrink soils of Maharashtra.

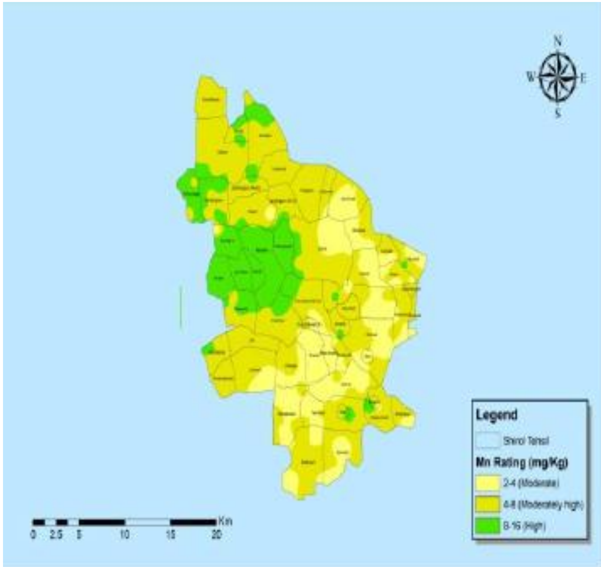

Fig 8: Soil available Manganese Shirol Tehsil

Fig 9: Soil available Copper Shirol Tehsil

Table 2: Soil available micronutrients status of Shirol Tehsil

Particular	DTPA extractable micronutrient (mg Kg^{-1})			
	Zn	Fe	Mn	Cu
Mean	1.44	6.58	6.18	3.04
Range	0.20-4.30	2.90-16.00	0.03-11.50	0.60-27.90
S.E ±	0.05	0.15	0.16	0.13
Very low	1 (0.5%)	-	-	-
Low	7 (3.5%)	35 (17.5%)	-	-
Moderate	80 (40%)	138 (69%)	38 (19%)	-

Moderately High	58 (29%)	27 (13.5%)	115 (57.5%)	1 (0.5%)
High	33 (16.5%)	-	47 (23.5%)	-
Very high	21 (10.5%)	-	-	199 (99.5%)

Total no. of soil samples-200, figures in parenthesis indicates percentage.

Table 3: Correlation of soil properties with available nutrients

Chemical properties / Available Nutrients	pH	EC	OC	$CaCO_3$
Fe	-0.364**	0.074	-0.022	-0.374**
Mn	-0.431**	0.106	-0.265**	-0.104
Zn	-0.199**	0.080	-0.093	-0.103
Cu	-0.138	0.085	0.0001	-0.087

Total no. of sample: 200 * Significant at 5% level: 0.142,
****** Significant at 1% level: 0.186

Correlation Study

Data (Table 3) showed negative and significant relation of iron with pH (r=-0.364**) and $CaCO_3$ (r=-0.374**) and poor negative correlation with OC. While Manganese showed negative and significant relation with pH (r=-0.431**) and OC (r=-0.265**) and non-significant negative correlation with $CaCO_3$. Zinc showed negative and significant relation with pH (r=-0.199**) and non-significantly negative correlation with OC and $CaCO_3$. Copper showed non-significant negative correlation with pH and $CaCO_3$ while, The EC of Shirol tehsil showed no significant correlation with available DTPA extractable zinc, iron, manganese, copper. The similar results was observed by Chaudhari *et al.* (2013) [1] in soils of north Maharashtra region. The present correlation pattern was also observed by Nipunge *et al.* (1996) [8].

Conclusion

The soils of Shirol Tehsil of Kolhapur District were slightly alkaline to moderately alkaline in reaction, normal in salt content, moderately high to very high in organic carbon and moderately calcareous to calcareous in nature. DTPA extractable zinc, manganese, copper and iron were sufficient in most of the area except few pockets of villages Kutwad, Dattawad, Tamadalge, Chipari, Danoli, Ghalwad, Kurundawad and Danwad. Holistic survey and precise use of analytical techniques in this investigation have enabled the investigator to come out with soil fertility maps of the Shirol Tehsil of Kolhapur District. These soil fertility maps will be of great utility for monitoring the fertilization schedule on sound scientific footing for improving the crop yields of Shirol Tehsil. Moreover, the timely monitoring of soil health deterioration can also be maintained by following appropriate soil reclamation techniques.

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