Original Research Article

GIS based Soil Nutrient Assessment of Available Macro and Micronutrients in Tommaladahalli Microwatershed of Chikkamagaluru District, Karnataka, India

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A B S T R A C T

An investigation was undertaken in Tommaladahalli (566.13 ha) micro-watershed of Tarikere taluk, Chikkamagaluru district of Karnataka to assess available nutrient status in the surface soils. About 118 surface soil samples were collected grid wise by using cadastral map at 250 m grid interval and were analyzed for their fertility status using standard procedures. Soil fertility maps were prepared by means of interpolation method called Krigging. The results revealed that the pH, electrical conductivity, and organic carbon were ranged from 5.37 to 9.06, 0.065 to 0.466 dS m^{-1} and 0.33 to 1.62 per cent respectively. The available N, P_2O_5, K_2O were ranged from 175.6 to 545.6 kg ha^{-1}, 11.8 to 61.1 kg ha^{-1} and 122.7 to 491.4 kg ha^{-1}, respectively. The available nitrogen and phosphorus were low to medium, where as potassium content was medium to high in the entire study area. Micronutrients *viz*. zinc, iron and boron were sufficient and were ranged from 0.34 to 1.17 mg kg^{-1}, 2.03 to 21.86 mg kg^{-1} and 0.30 to 0.89 mg kg^{-1} respectively.

Introduction

Increasing population pressure and overexploitation of productive lands leads to serious problem of lowering the fertility status of soil. The deficiency of nutrients directly affects on the crop growth and response. The availability of nitrogen, phosphorus and potassium (NPK) in soils is among most of the nutrient studied for precision agriculture. Soil testing plays an important role in the use of fertilizers and other agricultural inputs. Soil

test summaries and soil fertility maps are of vital necessity as reference materials for scientific management of soil. This information will also help to adopt effective strategy on fertilizer use and cropping pattern. soil nutrient based fertilizer recommendations should be preferred to achieve precision in farming and to maximize crop production, maintain soil health and minimize fertilizer misapplication (Ramamurthy *et al.,* 2009). Hence it is necessary to assess the fertility status of soil with the consideration of available nutrients in soils and to recommend the specific nutrients for the proper management of soil. Information on soil fertility status in crop field is very important and useful for fertilizer requirement and also to the specific management of the crop and soil. With this back ground the present investigation was taken up to study nutrient status and mapping using GIS for the entire watershed.

Materials and Methods

Study area

The study area of Tommaladahalli micro watershed is located in Chikkamagaluru district of Karnataka state. The watershed area lies between 13° 46' 36" N latitude and 76° 0' 11" E longitude with a spatial extent of 566.13 ha. The study area comprises of five villages *viz.* Abbinaholalu, Muguli, Beguru, Asandi, Katiganere and Karihalli. Location map is given in Fig.1. The average temperature ranges from 16°C in winter months of December, January and February to 36°C during summer months of March, April and May. The mean annual rainfall for the last three decades in study area is 600 mm. The region receives rainfall mainly from South-West monsoon and partly from North East monsoon with an annual rainfall season spreading over a period of 4 to 5 months. The South-West monsoon occurs from June to September amounting to about 68 per cent and North East monsoon during October to November contributing about 32 per cent of the rainfall. Average relative humidity is about 65 per cent.

Sampling

Spatial locations of all sampling points of Tommaladahalli were acquired using portable GPS (Global Positioning System) equipment.

About, 118 surface soil samples were collected at a depth of 15 cm from different locations at a grid interval of 250 m during the same period. Collected soil samples were air-dried after removing stones and coarse plant roots or residues. Samples were thoroughly mixed and ground to pass through a 2.0 mm sieve, then stored in plastic bags prior to physical and chemical analysis.

Analysis

Sieved soil samples were determined for pH and electrical conductivity at 1:2.5 soil water suspensions (Jackson 1973). Organic carbon was measured by Chromic acid wet digestion method (Walkley and Black 1934). The available Zn, Cu, Mn, and Fe contents were assessed by extracting 10 g of each soil with 20 ml of diethylenetriamine penta-acetic acid extractant (0.005 M DTPA + 0.01 M CaCl2 + 0.1 M triethanolamine), adjusted to pH 7.30 (Lindasy and Norwell, 1978). Determinations were performed on the same extract with an Atomic Abosorption Spectrometer. Boron content in soil samples were extracted by hot water method and determined by the Azomethine-H reagent method (Keren 1996). The mapping of soil properties such as pH, EC, OC, and micronutrients were prepared by means of interpolation method of Kriging. Soil test values at unsampled locations were interpolated using geostatistical technique of kriging (Trangmar *et al.,* 1985).

Results and Discussion

The soil reaction in the study area was slightly acidic to alkaline (5.37 to 9.06).The high pH of the soils might be due to the presence of high degree of base saturation as reported by Meena *et al.,* (2006). Out of 566.13 ha, 188 ha was under moderately alkaline condition (33.16 %), 182 ha under strongly alkaline condition (32.15 %) and rest was in neutral to slightly alkaline range (Table 1). The extent of different classes of soil reaction is presented in *Fig*. 1.

The EC values in watershed area ranged from 0.06 to 0.47 dS m^{-1} indicating that the soils of selected micro watershed were non saline in nature. About 99.73 per cent area covered under normal (non saline) range.

This may be due to undulating nature of the terrain coupled with fairly good drainage conditions, which favored the removal of released bases by the percolating drainage water (Shivaprasad *et al.,* 1998). These soils did not show any specific relationship with depth. These results were in confirmation with the findings of Kumar (2011).Organic carbon content of these surface soil samples was found low to high and ranged from 0.33 to 1.62 per cent (Fig. 2).

About 120 ha area of the micro watershed was under medium category (21.29 %) and 428 ha area was under high category (75.58 %). According to Rao *et al.,* (2008) higher clay content in black soil was responsible for higher organic carbon content.

The available phosphorus content in the study area ranged from 11.8 to 61.1 kg per ha (Fig.3). The low values of available phosphorus which may be due to low CEC, clay content and soil reaction of < 6.5, Ravikumar *et al.,* (2019). The available

potassium content in major portion of the study area was under medium to high category (Fig. 4) and it was ranged from 122.7 to 491.4 kg ha^{-1}, the higher content of potassium might be due to the predominance of potash rich micaceous and feldspar minerals in parent rocks (Dasog and Patil, 2011).

About 416 ha and 148 ha area occupying 73.58 per cent and 26.14 per cent of study area were medium and high inavailable potassium respectively (Fig. 4).

The available iron content in micro-watershed ranged from 2.03 to 21.86 mg kg^{-1}. About 446 ha (78.84 %) of the study area were sufficient in range while 118 ha (20.88 %) had deficient in available iron status of study area (Fig.5). The available iron content was higher in the study area.

This may be due to the granite gneiss parent material which is known to possess higher iron content. The available manganese content in micro- watershed ranged from 1.82 to 18.43 mg kg^{-1} and was sufficient in range. The higher available manganese content in these soils attributed to its higher content in granite genesis parent material. (Rajkumar 1994).

The available zinc content of micro watershed area ranged from 0.34 to 1.17 mg kg^{-1}. About 316 ha (55.86 %) of the study area were sufficient in range while 248 ha (43.86 %) had deficient in available zinc status of study area (Fig. 6).

The overall higher copper content in the micro watershed area was due to the parent material (Rajkumar 1994). Major samples of the micro-watershed area fall under low to medium category for available Boron. About 446 ha of study area falls under medium category and 118 ha coming under high category of boron class.

Table.1 Extent of spatial variability in different classes of soil properties in the study area

Sl. No.	Soil properties	Classes	Range of	Area	Area (%)
1	pH	Slightly acidic to moderately	6.5-5.5	48	**8.6**
		Neutral	6.5 - 7.3	69	**12.24**
		Slightly alkaline to very	7.3 – >9.0	447	**78.89**
2	EC (dSm-1)	Non saline	< 02	564	**99.73**
3	Organic	Low	<0.5	16	**2.9**
	Carbon (%)	Medium	0.5-0.75	120	**21.3**
		High	>0.75	428	**75.6**
4	Phosphorus	Low	<23	371	**65.5**
	(Kg/ha)	Medium	23-56	193	**34**
5	Potassium	Medium	140-330	416	**73.6**
	(Kg/ha)	High	>330	148	**26.1**
6	Iron (ppm)	Sufficient	> 4.5	446	**78.8**
		Deficient	<4.5	118	**20.9**
5	Manganese	Sufficient	> 1.0	564	**99.7**
6	Zinc (ppm)	Deficient	< 0.6	248	**43.9**
		Sufficient	>0.6	316	**55.9**
7	Boron (ppm)	Medium	0.5-1.0	446	**78.9**
		Low	**<0.5**	**118**	**20.8**

Fig.1 Soil reaction map of Tommaladahalli
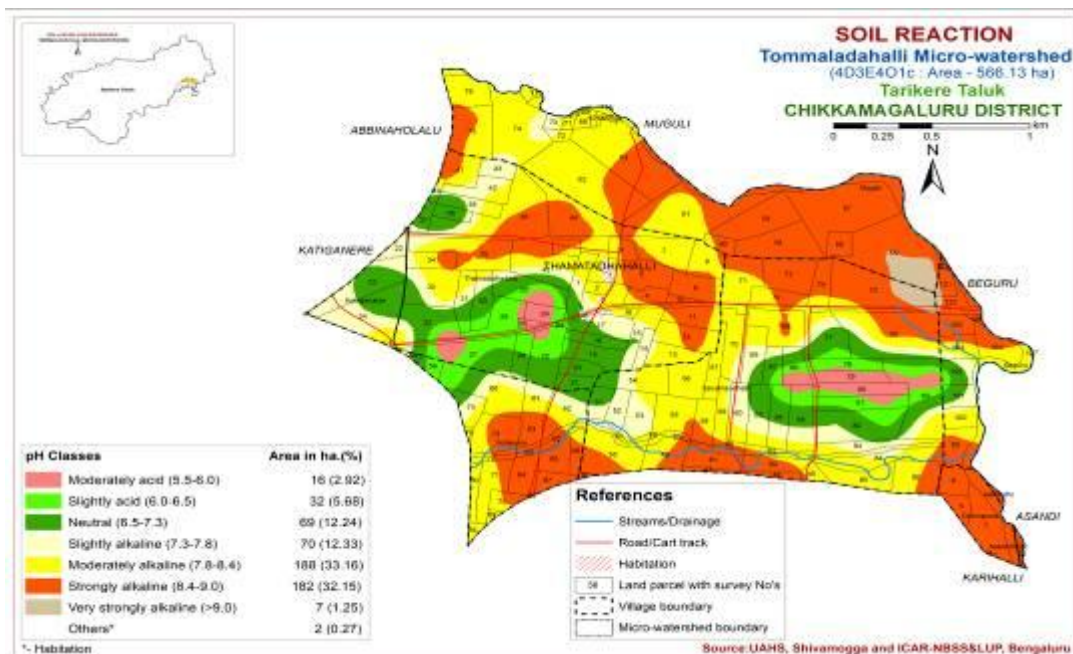
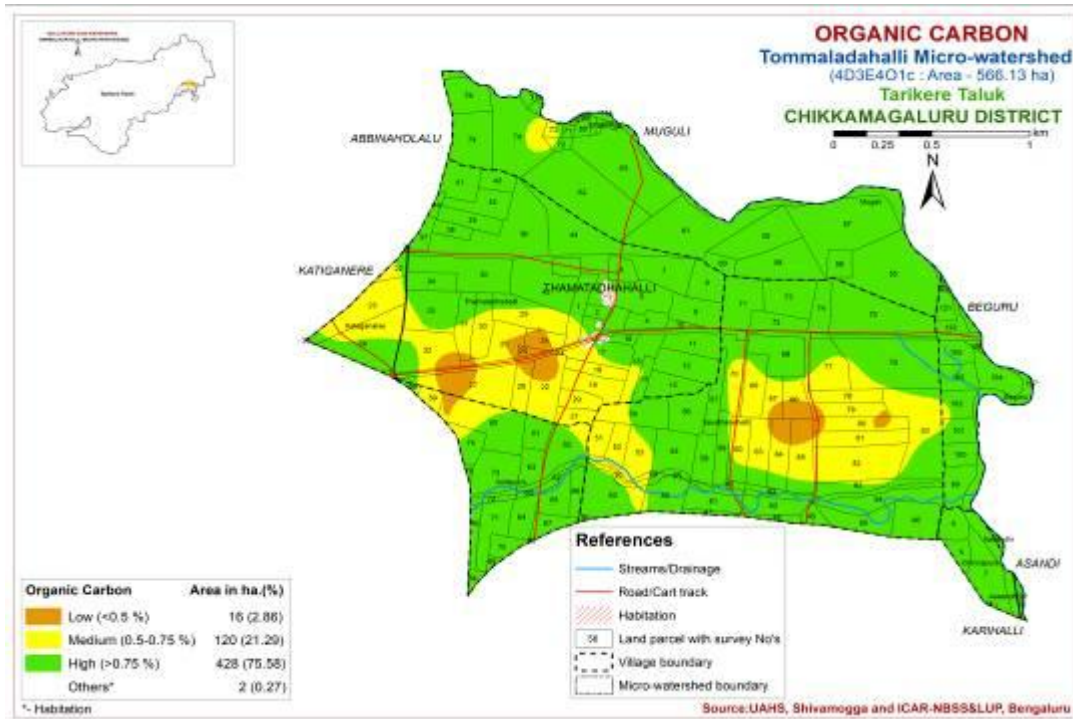**Fig.2** Organic carbon map of Tommaladahalli

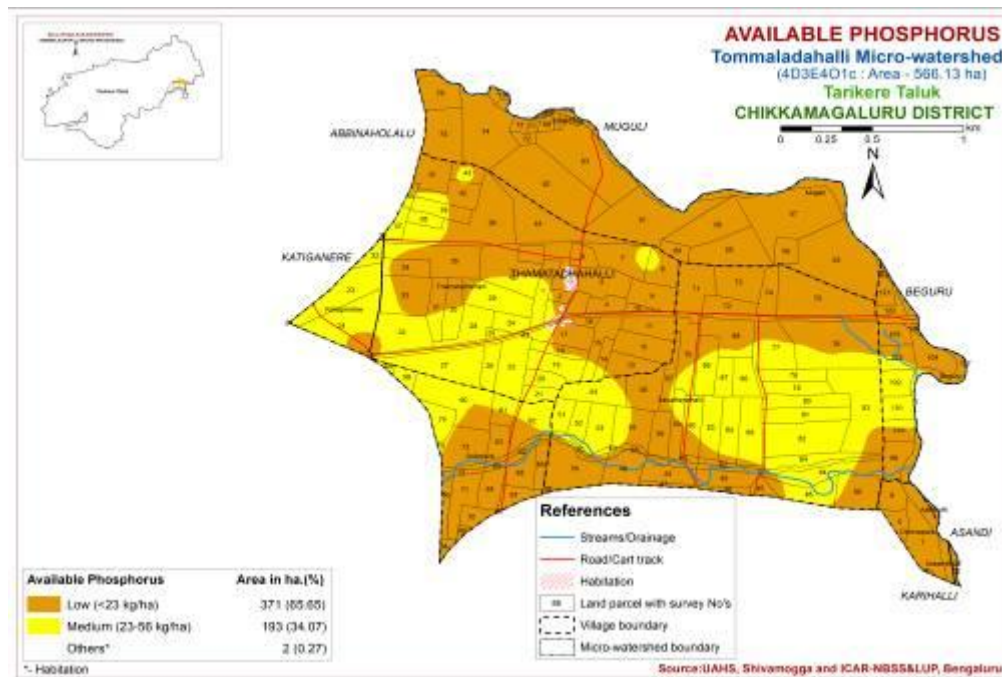**Fig.3** Available phosphorus map of Tommaladahalli

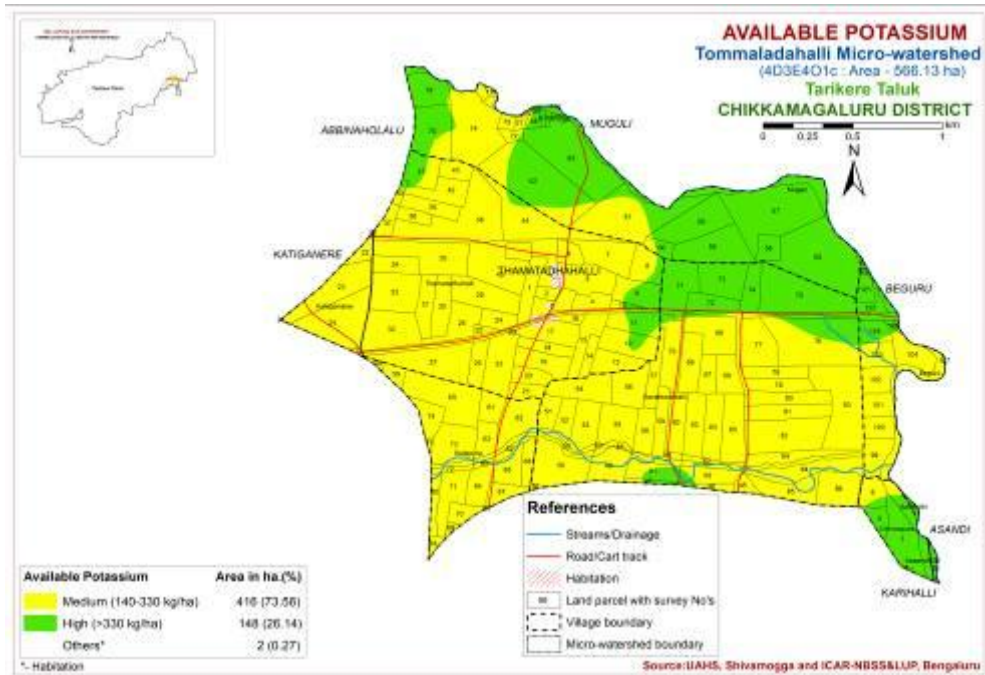**Fig.4** Available potassium map of Tommaladahalli

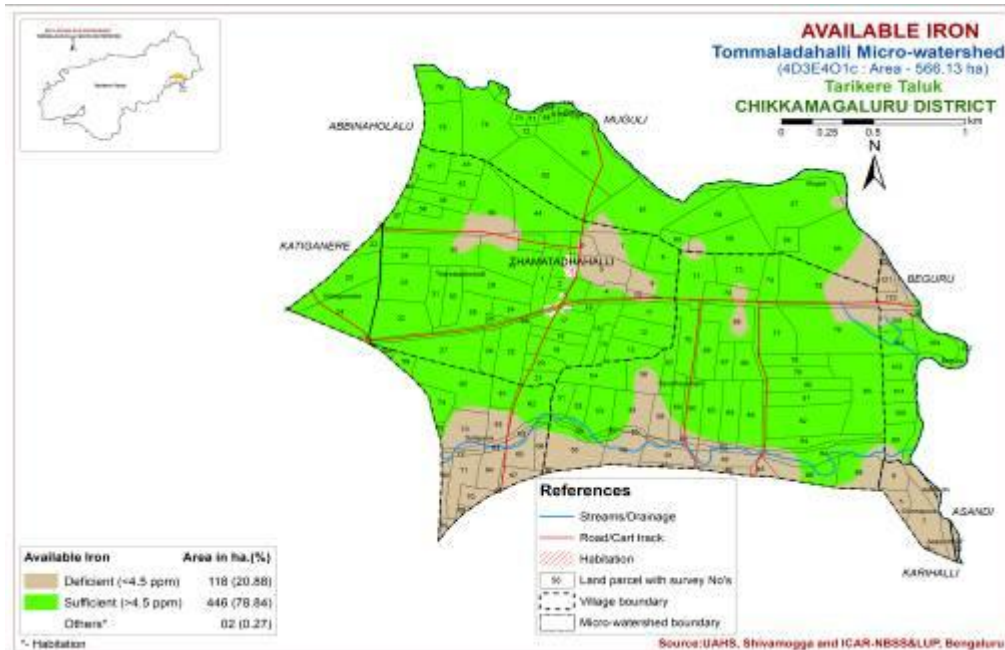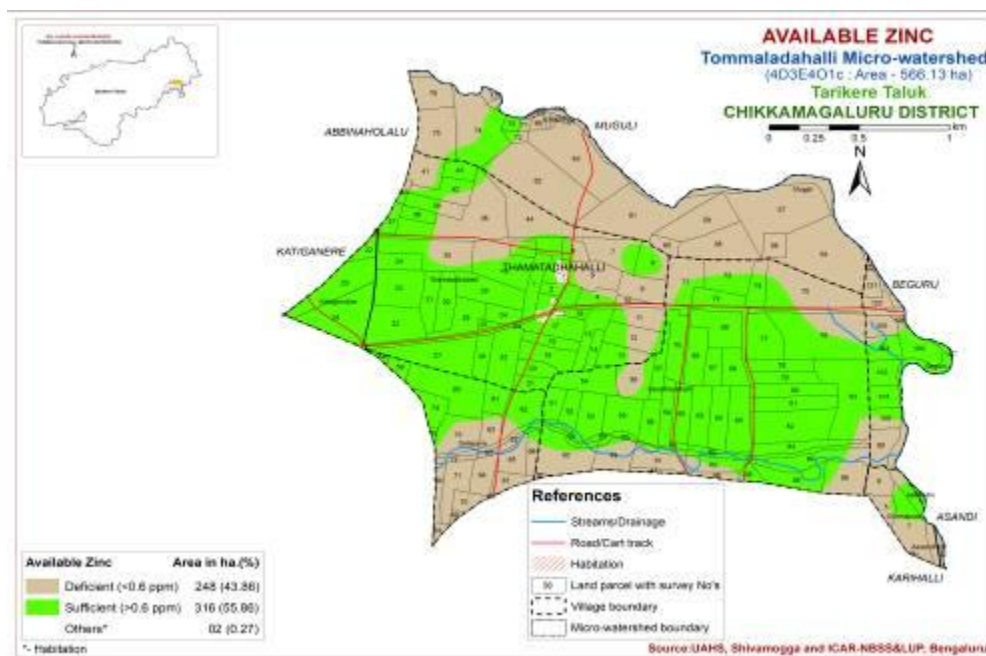**Fig.5** Available iron map of Tommaladahalli

Fig.6 Available iron map of Tommaladahalli

Soil pH ranged from neutral to alkaline in reaction (5.37 to 9.06). Salt content was very low indicates soils are non-saline in nature and organic carbon content was low to high (0.33 to 1.62 %), Available phosphorus content were low to medium (11.8 to 61.1 kg ha^{-1}). These variations of phosphorus in soils are may be due to variation in soil properties like clay content, CEC and P fixation capacity. Available micronutrients such as zinc and iron are deficient but copper and manganese were sufficient in these soils of micro-watershed.

Acknowledgement

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