International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(2): 2570-2576

Received: 18-01-2020
Accepted: 20-02-2020

Sumedh R Kashiwar
Dept. of Soil Science and Agricultural Chemistry, Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati University, Sriniketan, West Bengal, India

Manik Chandra Kundu
Assistant Professor,Dept. of Soil Science and Agricultural Chemistry, Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati University, Sriniketan, West Bengal, India

Usha R Dongarwar
Zonal Agricultural Research Station (Dr. P.D.K.V., Akola), Sindewahi, Chandrapur, Maharashtra, India

Corresponding Author:
Dr. Manik Chandra Kundu
Dept. of Soil Science and Agricultural Chemistry, Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati University, Sriniketan, West Bengal, India

Soil fertility appraisal of Bhandara block of Maharashtra using geospatial techniques

Sumedh R Kashiwar, Manik Chandra Kundu and Usha R Dongarwar

DOI: https://doi.org/10.22271/chemi.2020.v8.i2am.9136

Abstract
The geospatial techniques are playing a vital role in spatial assessment of soil nutrient variabilities. Study was undertaken to assess the available macronutrient and micro-nutrient status of Bhandara tehsil of Maharashtra with the help of GPS based one hundred forty-seven soil samples during the period of 2015-2018. The results recorded that pH of 70% samples were neutral in nature, non-saline and 72% samples were deficient in terms of oxidizable organic carbon. The mean values of 291.70 kg ha^{-1}, 37.07 kg ha^{-1}, 531.33 kg ha^{-1}, 11.94 kg ha^{-1}, 0.35 mg kg^{-1}, 4.44 mg kg^{-1}, 1.28 mg kg^{-1}, 7.66 mg kg^{-1} and 1.52 mg kg^{-1} for N, K, P, S, Zn, Fe, Cu, Mn and B respectively was recorded. The nutrient index values of nitrogen, phosphorus, potassium and sulphur were 1.5, 2.6, 3.0 and 1.6 respectively. In case of micronutrients, nutrient index values of zinc, iron, copper, manganese and boron were 1.0, 1.4, 2.8, 2.9 and 1.00 respectively.

Keywords: Nutrient status, spatial mapping, GPS, GIS, bhandara, maharashtra

Introduction

The soil plays the prime role in agriculture and supports all the living organisms on earth by supplying various food, fuel, fiber and essential things required (Kashiwar *et al*., 2019a; 2019b) [10, 11]. In the current 21st century the excessive growth in the population has pushed the farmers community toward the intensive cultivation of high yielding varieties for increasing the food production but it has tremendously declined the soil fertility status in the Indian soils (Kashiwar *et al*., 2019a; Arunkumar *et al*., 2016) [10, 1]. This is directly affecting the use fertilizer and production and productivity of many crops (Jena *et al*., 2016) [9]. The geospatial technologies are being widely adopted in agriculture due to its usefulness and effectiveness over conventional method. In current scenario there is a need of systematic mapping of the available soil nutrients for site specific nutrient management using soil fertility maps.

The modern spatial techniques are cost and time efficient over conventional methods. These techniques widely help in future policy making decisions (Kashiwar *et al*., 2019a; Kashiwar *et al*., 2016) [10, 12]. The Geospatial techniques of soil fertility mapping provide key support in making the future policy and provide support for decision as well as it effectively reduced the excessive use of chemical fertilizer and cost of cultivation (Kashiwar *et al*., 2019a [10]; Arunkumar *et al*., 2016) [10, 1]. With this background, a study was undertaken to assess the available macro- and micro-nutrient status of Bhandara tehsil of Maharashtra using geospatial techniques.

Material and methods

The Bhandara block is located between 21.265455 N and 20.966684 N latitude; between 79.486451 E and 79.835310 E longitude (Figure 1) in the state of Maharashtra, India. The georeferenced surface soil samples (0-15 cm) from 147 villages of Bhandara block were collected for macro and micro nutrient analysis. The Garmin GPSMAP 78S Marine GPS Navigator was used for the collection of georeferenced soil sample. The spatial thematic maps were generated using ArcGIS 10.4.1 by kriging as well as IDW interpolation technique in ArcGIS toolbox. The estimation of pH by glass electrode pH meter (Jackson, 1973) [8], electrical conductivity by electrical conductivity meter(Jackson, 1973) [8], organic carbon by wet oxidation method (Walkey and Black, 1934) [17], nitrogen by alkaline $KMnO_4$ method (Subbiah and Asija, 1956) [16], phosphorus by Bray's method (Bray and Kurtz, 1946) [2] and

Olsen's method (Olsen, 1954) [15], potassium by Ammonium Acetate method (Hanway and Heidel, 1952) [7] and sulphur by turbidimetric method using calcium chloride extractant (Chesnin and Yien, 1951) [3]. The micronutrients like zinc, iron, copper and manganese was estimated using DTPA extractant (Lindsay and Norvell, 1978) [13]. The boron was estimated using Azomethine- H method by spectrophotometer (Wolf, 1974) [18].

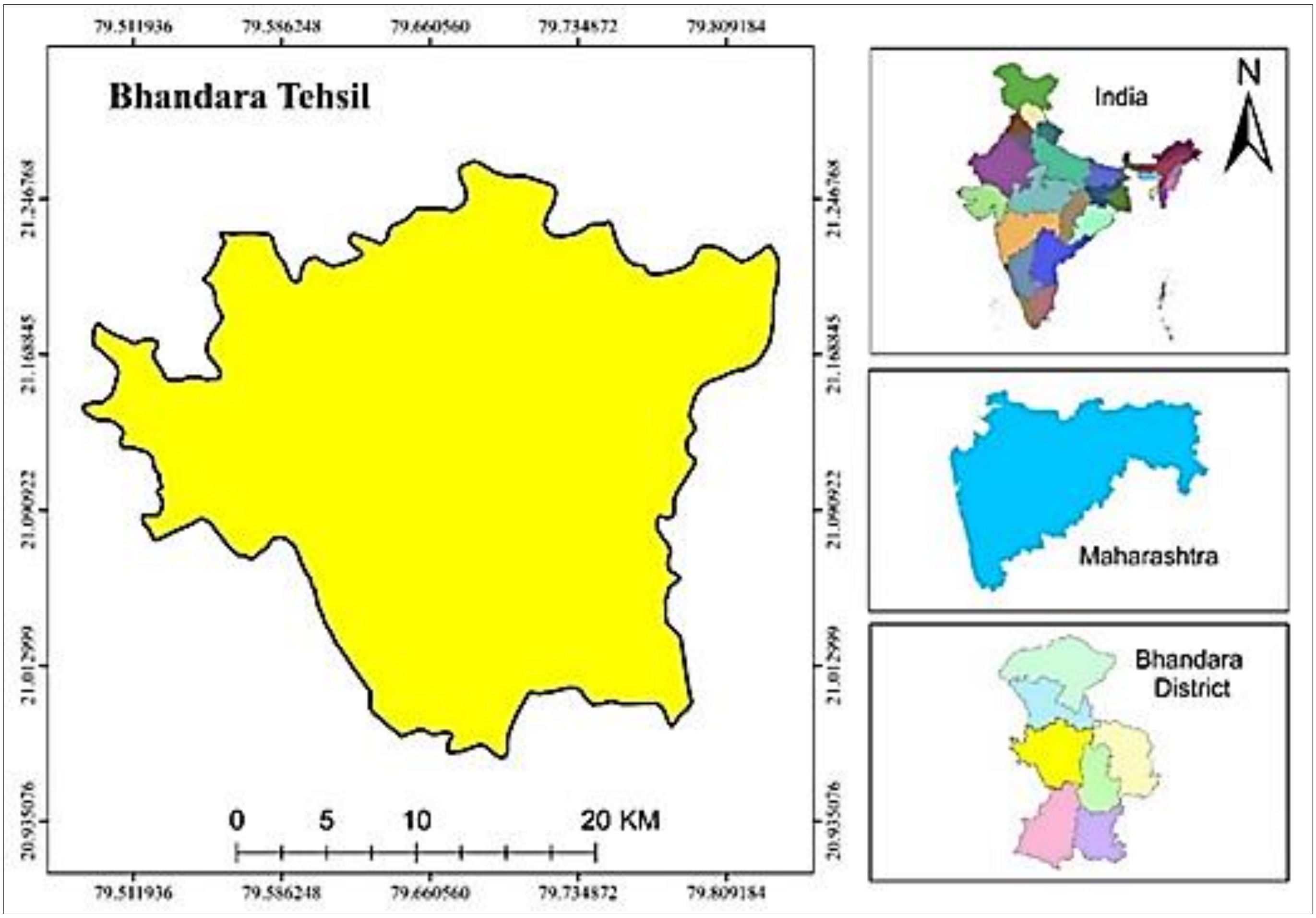

Fig 1: Location map of Bhandara block in Maharashtra

Result and Discussion

Physico-chemical properties of soils of Bhandara block

The average soil pH of Bhandara tehsil was 7.2 and ranging between 6.2 to 7.8. A village named 'Dighori' is recorded with 7.8 soil pH as highest and 'Mujbi' village soil was recorded with 6.2 as lowest. Around 2.7% of samples were acidic, 70.7% were neutral and 26.5% were alkaline in nature (Table 1). The electrical conductivity of entire tehsil was found in non-saline range (<1 dSm^{-1}) which was ranging from 0.19 to 0.70 dSm^{-1} (Table 1). The average organic carbon was 0.45% of which, lowest was recorded in 'Sonkund' village with 0.28% and 'Belgaon' was highest with 0.80% of organic carbon (Table 1). Around 72.8% samples were low, 25.9% were moderate and only 1.4% samples were found high in organic carbon content. The thematic maps of pH, electrical conductivity and organic carbon are presented in Fig.2, Fig.3 and Fig.4.

Table 1: Status of Physico-chemical properties of Bhandara block of Maharashtra

Particular/Soil properties	Range	Mean	SD	CV
pH	6.2-7.8	7.20	0.30	0.05
EC	0.20-0.70	0.30	0.10	0.20
OC	0.28-0.80	0.45	0.10	0.30

Macro-nutrient status in soils of Bhandara block

Available nitrogen status

The soil samples were recorded with mean available nitrogen content of 291.70 N kg ha^{-1} from which, village 'Wadipar' was recorded with lowest available nitrogen (121.17 N kg ha^{-1}) and soil of 'Khokurala' village was highest in nitrogen (537.35 N kg ha^{-1}) content. Around 51.7% samples were low, 48.3% were medium and none of the samples were recorded high nitrogen content in Bhandara tehsil. The nutrient index value (NIV) for nitrogen for 147 samples was 1.5 (Table 2 and Fig 5). Similar results were also observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Available phosphorous status

The mean available phosphorous (P) content of 147 soil samples was 37.07 kg ha^{-1} from which, 'Salebadi' village was lowest (9.83 kg ha^{-1}) and 'Kothurna' village was recorded with the highest in phosphorous (124.93 kg ha^{-1}) availability. The available phosphorus content of 3.4% samples was low, 36.1% were medium and 60.5% were high in phosphorus content. (Table 2 and Fig 6). The NIV for available phosphorus of 147 soil samples of Bhandara block was 2.6 (Table 3 and Fig 6). Similar results were also observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Available potassium status

The average available potassium (K) content throughout the samples was 531.33 kg ha^{-1} from which soil of village 'Palgaon' was recorded with lowest value of 258.05 kg ha^{-1} and 'Chikhalbodi' village was recorded with highest availability of potassium (941.37 kg ha^{-1}). The NIV for available K of 147 soil samples of Bhandara block was 3.0. (Table 2 and Fig 7). The similar results were observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Table 2: Status of available macro-nutrient in soils of Bhandara block of Maharashtra

Particular/Soil properties	Range	Mean	SD	CV	NIV
Available N	121.2-537.4	291.7	125.4	0.4	1.5
Available P	9.8-124.9	37.1	18.9	0.5	2.6
Available K	258.0-941.4	531.3	149.3	0.3	3.0
Available S	3.7-41.6	11.9	6.5	0.5	1.6

Available sulphur status

The available Sulphur (S) content of around 42.2% soil samples was low, 51.0% were medium and only 6.8% were recorded with higher content. The mean value of 11.94 kg ha^{-1} was recorded from 147 soil samples from which, village 'Gopiwada' was the lowest (3.74 kg ha^{-1}) and 'Bela' village was recorded with highest (41.63 kg ha^{-1}) availability of sulphur. In terms of nutrient index, it was recorded with 1.6 (Table 2 and Fig. 8). Similar results were reported by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Micro-nutrient status in soils of Bhandara block

DTPA extractable zinc

The DTPA extractable zinc (Zn) content of 97.3% soil samples was low and only 2.7% samples were recorded with medium values. The mean value recorded was 0.35 mg kg^{-1}. The village 'Garda Jangli' was recorded with lowest zinc (0.22 mg kg^{-1}) and soil of 'Pimpalgaon' was found with higher (1.53 mg kg^{-1}) content of DTPA extractable zinc. The nutrient index of DTPA extractable zinc was 1.0 (Table 3 and Fig 9). Similar results were observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

DTPA extractable iron

The DTPA extractable iron (Fe) content of 57.8% soil samples was low and 42.2% samples were recorded with medium values. Its mean value recorded was 4.44 mg kg^{-1}. The village 'Chikhal Pahela' was recorded with lowest iron (0.64 mg kg^{-1}) and soil of 'Dawadipar' was found with higher (14.27 mg kg^{-1}) content of DTPA extractable iron. The nutrient index of DTPA extractable iron was 1.4 (Table 3 and Fig 10). Similar results were observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

DTPA extractable copper

The DTPA extractable copper (Cu) content of 20.4% soil samples was medium and 79.6% soil samples were recorded with high values. The mean value recorded was 1.28 mg kg^{-1}. The village 'Silli' was recorded with lowest copper (0.34 Cu mg kg^{-1}) and soil of 'Dabha' was found with higher (2.84 Cu mg kg^{-1}) content of DTPA extractable copper. The nutrient index of DTPA extractable copper was 2.8 (Table 3 and Fig 11). Similar result was observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Table 3: Status of available Micro-nutrient in Soils of Bhandara block of Maharashtra

Particular/Soil properties	Range	Mean	SD	CV	NIV
Available Zn	0.2-1.5	0.4	0.1	0.4	1.0
Available Fe	0.6-14.3	4.4	2.7	0.6	1.4
Available Cu	0.3-2.8	1.3	0.6	0.5	2.8
Available Mn	1.5-16.4	7.7	2.7	0.4	2.9
Available B	0.2-4.3	1.5	0.5	0.3	1.0

DTPA extractable manganese

The DTPA extractable manganese (Mn) content of 2.0% soil samples was low, 8.8% were medium and 89.1% were recorded with high values. The mean value recorded was 7.7 mg kg^{-1}. The village 'Surewada' was recorded with lowest manganese (1.5 mg kg^{-1}) and soil of 'Pindkepar' was found with higher (16.4 mg kg^{-1}) content of DTPA extractable manganese. The nutrient index of DTPA extractable manganese was 2.9 (Table 3 and Fig 12). Similar result was observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14].

Hot water-soluble boron

The average hot water-soluble boron content was 1.52 mg kg^{-1} and ranging between 0.17 to 4.28 mg kg^{-1}. The 'Singori' village was recorded with lowest boron (0.17 mg kg^{-1}) content and 'Ajimabad' village was highest in boron (4.28 mg kg^{-1}) availability. Similar result was observed by Kashiwar *et al*., 2019b [11]; 2019a [10]; 2018 [12]; Dongarwar *et al*., 2015 [4]; 2018b [5]; 2018a [6]; Mali & Raut, 2001[14]. In boron content, 100% of soil samples were low and the NIV for the 147 soil samples of Bhandara block was 1.00 (Table 3 and Fig 13).

Conclusion

The study revealed that the soils of 104 and 39 villages of Bhandara block are neutral and alkaline in nature respectively. The nitrogen content was found deficient in major part of the study area. Whereas, the availability of phosphorus and potassium was found excessive in most of the parts. The availability of micronutrients like copper and manganese was excessively but zinc, iron and boron were deficient in most of the parts of study area. The rice-wheat and sugarcane growing farmers of the study area neglects towards the application of micronutrients which has resulted in poor fertility status of the area. The use of biofertilizers like Trichoderma, Azotobacter, Rhizobium, Pseudomonas etc. along with organic manures like farm yard manure, compost can boost up the soil nutrient status.

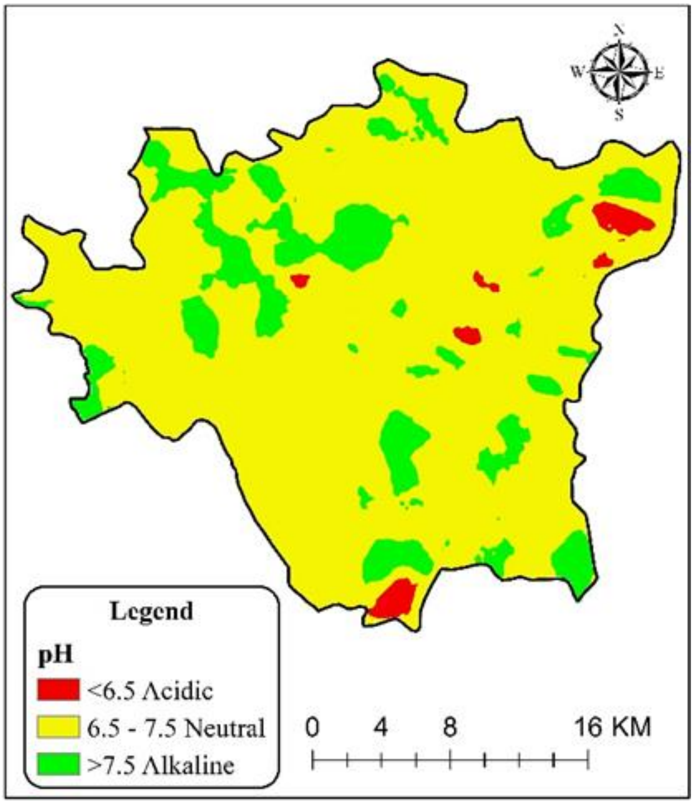

Fig 2: Thematic map of soil pH

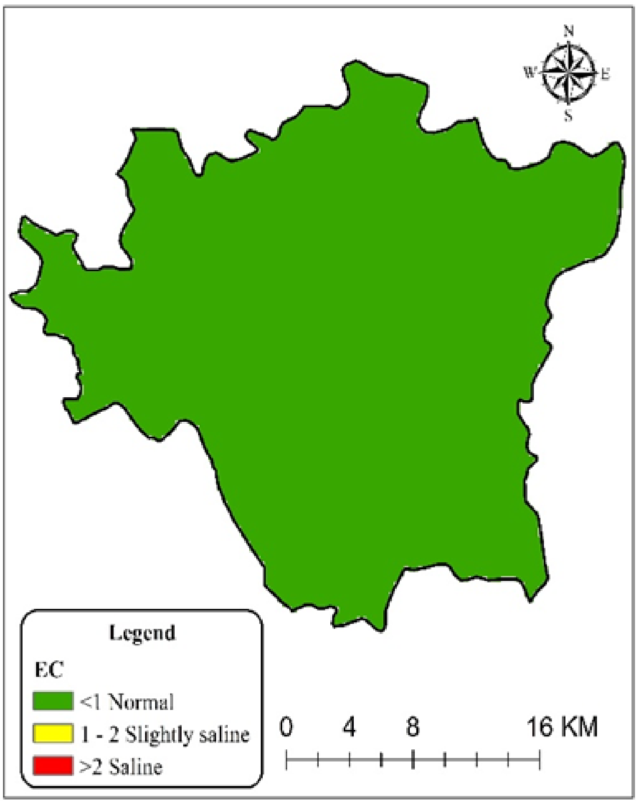

Fig 3: Thematic map of soil EC

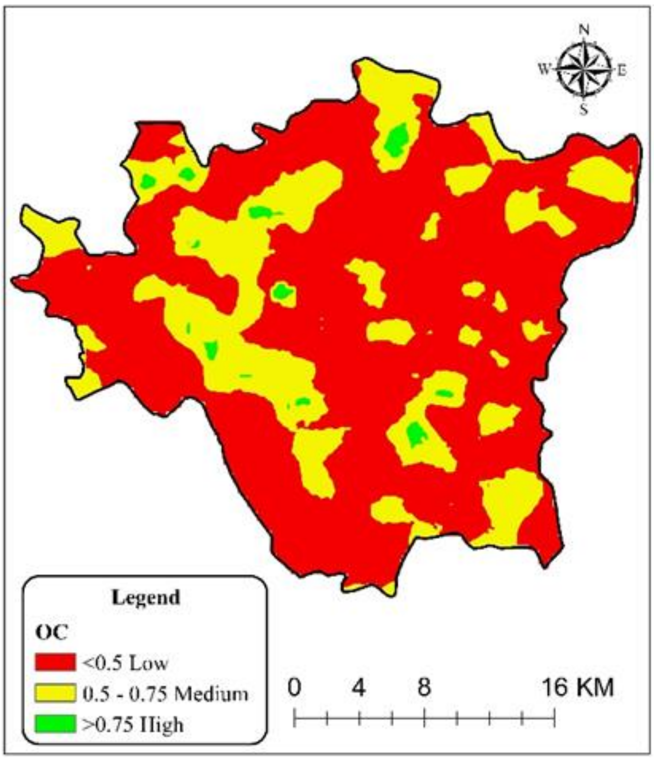

Fig 4: Thematic map of soil OC

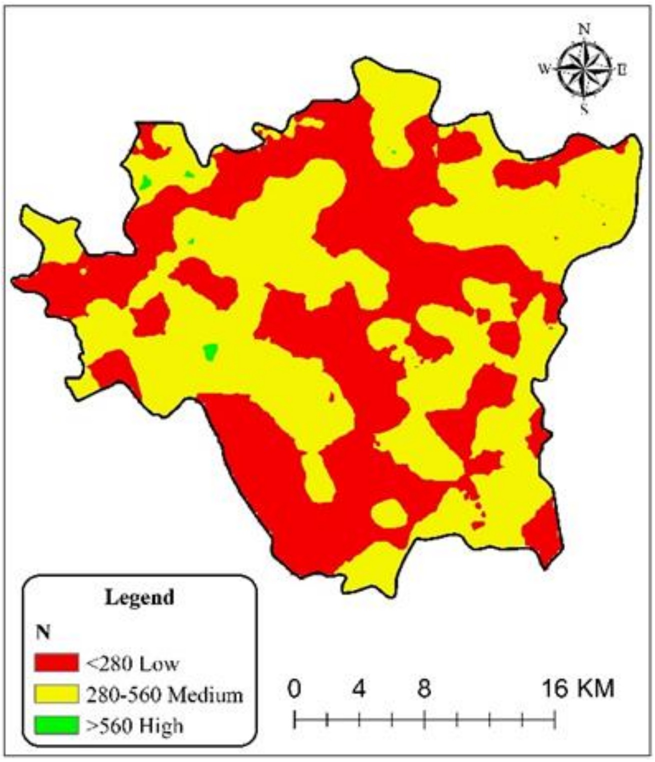

Fig 5: Thematic map of soil nitrogen

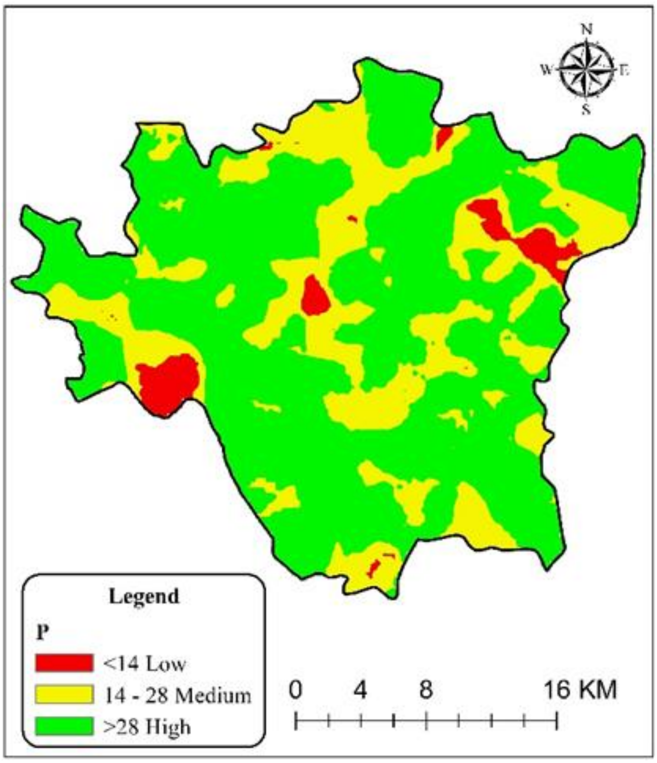

Fig. 6: Thematic map of soil phosphorus

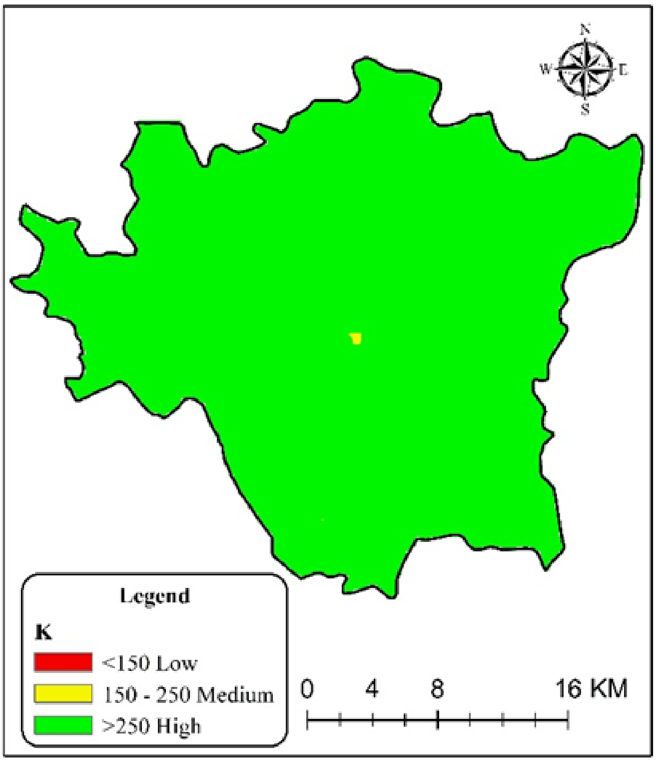

Fig 7: Thematic map of soil potassium

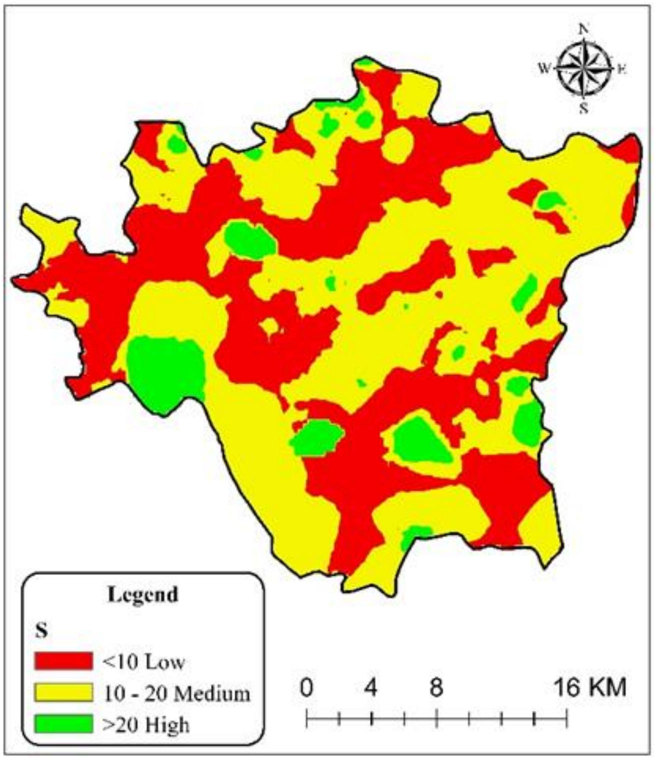

Fig 8: Thematic map of soil Sulphur

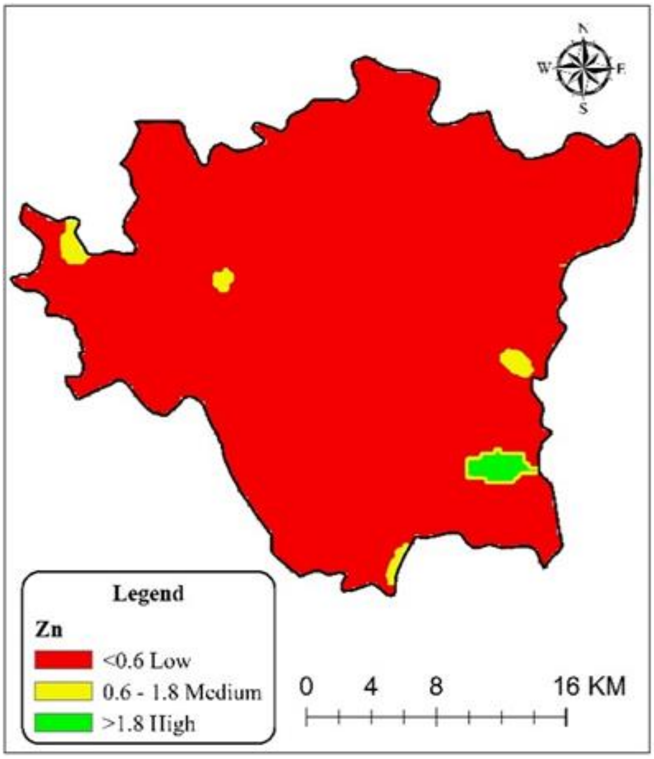

Fig 9: Thematic map of soil zinc

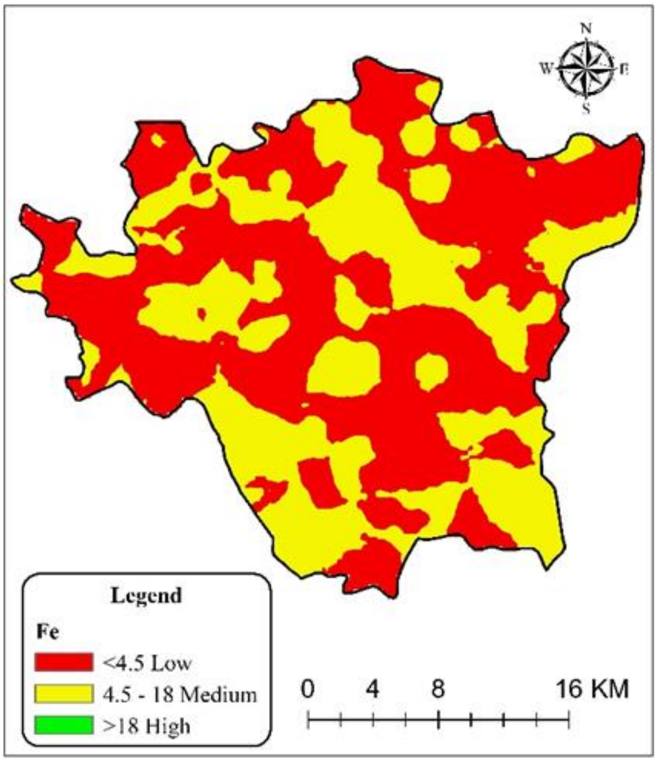

Fig 10: Thematic map of soil iron

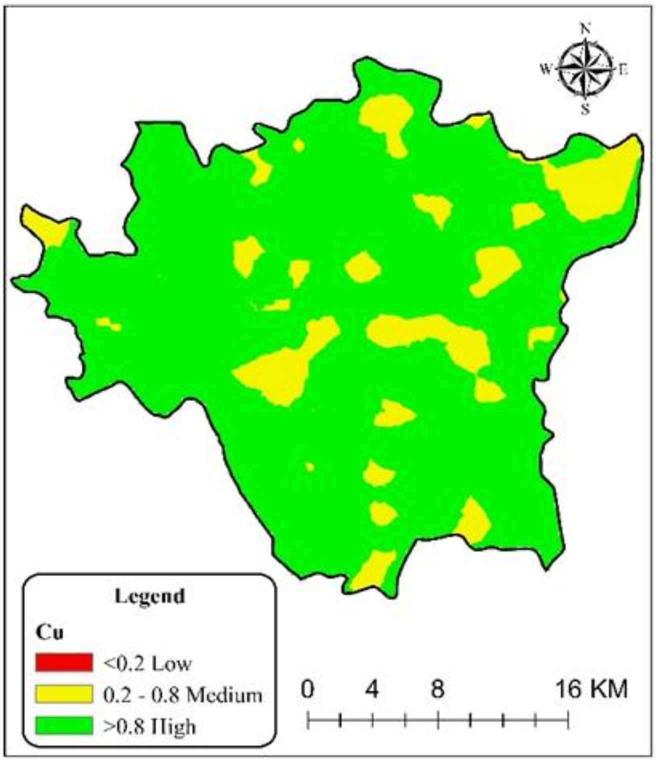

Fig 11: Thematic map of soil copper

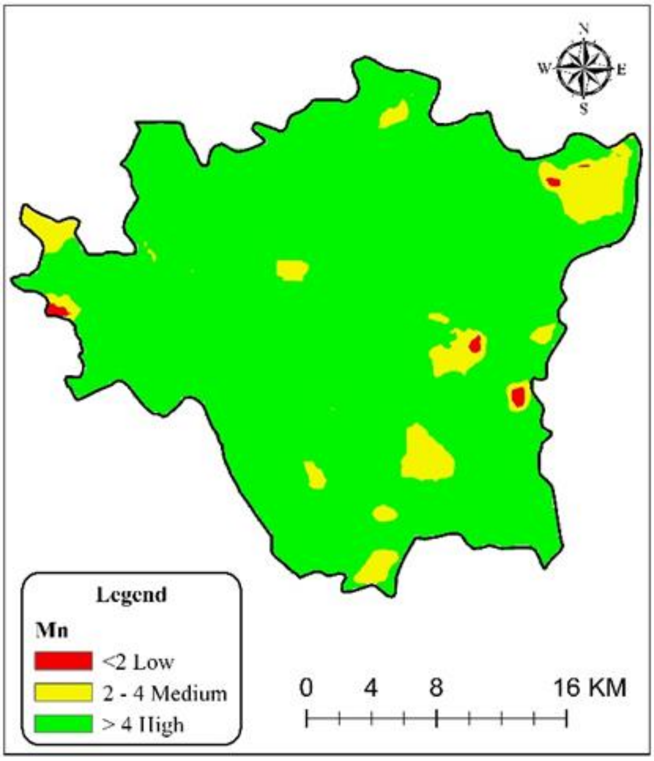

Fig. 12: Thematic map of soil manganese

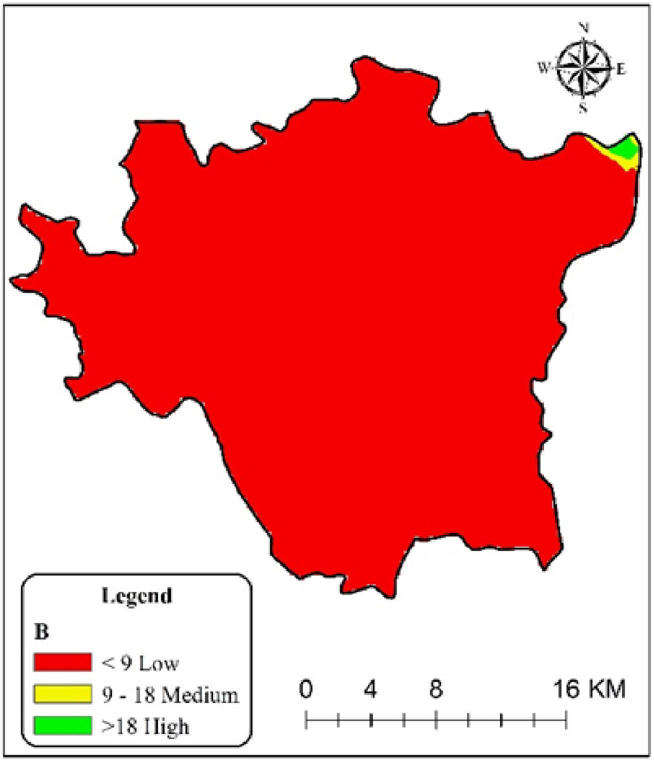

Fig. 13: Thematic map of soil boron

References

1. Arunkumar V, Patil SG, Paramasivan M. Mapping of Available Nutrient Status of Thirunavalur Village, Villupuram district, Tamil Nadu using Geographic Information System. Madras Agri. J. 2016; 103(2013): 219-222.
2. Bray R, Kurtz LT. Determination of Total, Organic, and Available Forms of Phosphorus in Soils. Soil Sci. 1945; 59(1):39-46.
3. Chesnin L, Yien CH. Turbidimetric determination of available sulfates 1. Soil Sci. Soc. Am. J. 1951; 15(C):149-151.
4. Dongarwar UR, Khedikar GR, Kashiwar SR, Dongarwar L. Effect of different Organic Sources Available with Farmers on Paddy (Oryza sativa) in Bhandara District of Maharashtra Effect of different Organic Sources Available with Farmers on Paddy (Oryza sativa) in Bhandara District of Maharashtra. J. Agril. Engg. Food Tech. 2015; 2(2):142-144.

5. Dongarwar UR, Patke N, Dongarwar LN, Kashiwar SR. Effect of Row Spacing on Growth, Yield and Economics of Direct Seeded Rice in Eastern Vidharbha Zone of Maharashtra, India. Int. J. Current Microbiol. Appl. Sci. 2018b; 7(07):2930-2941. doi:10.20546/ijcmas.2018.707.343.
6. Dongarwar UR, Patke N, Dongarwar LN, Kashiwar SR. Impact of Different Seed Rates on Yield and Economics of Direct Seeded Rice in Eastern Vidharbha Zone of Maharashtra, India. Int. J. Current Microbiol. Appl. Sci. 2018a; 7(3):32-42. doi:10.20546/ijcmas.2018.703.004.
7. Hanway JJ, Heidel H. Soil analysis methods as used in Iowa state college soil testing laboratory. Iowa Agriculture, 1952.
8. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973, 498.
9. Jena B, Nayak RK, Das J, Parida RK, Sethi D. Secondary and Micro Nutrient mapping in forest soils of Kandhamal district, Odisha. Agropedology. 2016; 26(01):79-86.
10. Kashiwar SR, Kundu MC, Dongarwar UR. Assessment and mapping of soil nutrient status of Sakoli tehsil of Bhandara district of Maharashtra using GIS techniques. J Pharmacogn. Phytochem. 2019a; 8(5):1900-1905.
11. Kashiwar SR, Kundu MC, Dongarwar UR. Delineation and GPS-GIS based mapping of available macro and micronutrients of soils of Lakhani block of Bhandara, Maharashtra. Int. J. Chem. Stud. 2019b; 7(5):2312-2318.
12. Kashiwar SR, Nath T, Kumar D, Kundu MC, Dongarwa UR, Rajput BS *et al*. Evaluation of Soil Fertility Status of Rajiv Gandhi South Campus (Banaras Hindu University), Mirzapur, Uttar Pradesh by Using GIS. Int. J. Current Microbiol. Appl. Sci. 2018; (7):3825-3836.
13. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper 1. Soil Sci. Soc. Am. J. 1978; 42(3):421-428. doi:10.2136/sssaj1978.03615995004200030009x.
14. Mali CV, Raut PD. Available sulphur and physico-chemical characteristics of oilseed dominated area of Latur district. J. Maha. Agril. Uni. 2001; 26(1-3):117-118.
15. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States Department of Agriculture; Washington., 1954.
16. Subbiah BV, Asija GL. A Rapid Procedure for the Estimation of Available Nitrogen in Soils. Curr. Sci. 1956; 25(8):259-260.
17. Walkley A, Black IA. An Examination of the Degtjareff Method for Determining Soil Organic Matter, and A Proposed Modification of the Chromic Acid Titration Method. Soil Sci. 1934; 37(1):29-38. doi:10.1097/00010694-193401000-00003.
18. Wolf B. Improvements in the azomethine- H method for the determination of boron. Commun. Soil Sci. Plant Anal. 1974; 5(1):39-44.