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B Ushasri
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Kolhapur, Maharashtra, India

C Mukesh Kumar
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Kolhapur, Maharashtra, India

DS Patil
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Kolhapur, Maharashtra, India

RB Pawar
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Kolhapur, Maharashtra, India

Corresponding Author:
B Ushasri
Division of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Kolhapur, Maharashtra, India

GPS - GIS based soil fertility maps of micronutrient status of Bhudargad tehsil of Kolhapur district (M.S.)

B Ushasri, C Mukesh Kumar, DS Patil and RB Pawar

Abstract
The present study was conducted during the year 2015-2016 with an objectives to assess the micro nutrients status of soils of Bhudargad tehsil of Kolhapur district and delineate GPS - GIS based soil fertility maps and to correlate soil properties with available nutrients. One hundred and fifty geo-referenced soil samples were collected from study area using GPS. The DTPA extractable iron, manganese, zinc and copper in soils ranged from 7.68 to 46.56, 10.70 to 35.40, 0.10 to 2.96 and 1.0 to 7.5 mg kg^{-1}, respectively. Soils were sufficient in available iron, manganese and copper but 27.33 per cent soils were deficient in zinc. The pH, EC and $CaCO_3$ showed significant negative correlation with zinc, manganese and copper. Organic carbon was positively correlated with iron, zinc and manganese.

Keywords: Soil fertility maps, geographical information system, global positioning system

Introduction
Micronutrients though required in small quantities are very important in crop production. The deficiencies of some micronutrients are emerging fast with increase in area under intensive cropping and imbalance use of high analysis fertilizers. The information on micro nutrient status of Bhudargad tehsil based on "GPS-GIS" studies is very limited, therefore the present study was undertaken for delineating the micronutrient status of tehsil which can be used for ensuring balanced fertilization to crops by the farmers and planners.

Material Method
Bhudargad is one of the tehsil of Kolhapur district of Maharashtra state, India. The geographical area of tehsil is 64646 ha. It belongs to western Maharashtra region and comes under ghat zone with an elevation 125 m from MSL and annual average rainfall is 1846 mm. The major type of soils are red laterite and reddish brown with undulating uplands, foothills and sloping areas.

One hundred and fifty representative surface (22.5 cm) soil samples were collected randomly from 66 villages along with GPS reading by using hand held GPS. The samples were air dried in shade then powdered gently with a wooden mallet and sieved through 2 mm sieve then stored in clean polyethylene bags for further analysis. The samples were analysed for pH, EC, $CaCO_3$, and OC were estimated by adopting standard procedure. The DPTA extractable micronutrients (Fe, Mn, Zn and Cu) were analysed by adopting Spectrophotometry (Lindsay and Norvell, 1978) [5]. Soil fertility maps were prepared by using GPS reading and fertility maps of soils were prepared by employing Arc GIS 9.3 software.

Result and Discussion
The results of the study area are presented and discussed as follows.

Soil reaction (pH), EC (Electrical Conductivity) and per cent $CaCO_3$ eq
The pH of the 150 soil samples ranged from 5.50 to 8.00. The soils were mainly moderately acidic (50.67%) followed slightly acidic (26%), and slightly alkaline (23.33%).

The EC of the soils ranged from 0.02 to 1.48 dS m^{-1} lower values of electrical conductivity might be due to leaching of bases from soil profile under high rainfall and undulating topographic nature. The similar nature of observation for soil pH and EC were also recorded by Sannappa and Manjunath (2013) [13] in soils of Western Ghats of Karnataka, India.

Majority soils were slightly calcareous (61.33%). The content of $CaCO_3$ increased from escarpment towards the foot of hill, gentle sloping of land basin and flat land topography, this might be due to leaching of soluble calcium from hill slopes towards basin area. In general the per cent equivalent $CaCO_3$ contentare less than 5%, hence soils are very good for cultivation of cereals, pulses and fruit crops. The similar nature of observation for $CaCO_3$ in soil series of Kolhapur district were reported by Patil (2011) [10].

Organic Carbon

The organic carbon content of the soil ranged from 0.26 to 1.32 per cent low to very high with the mean value 0.74 per cent (moderately high).

Table 1: Overall mean, range of soil properties and nutrient status in soil samples of Bhudargad tehsil

Particulars	Range	Mean
pH	5.50 – 8.00	6.60
EC (dS m^{-1})	0.02 – 1.48	0.27
$CaCO_3$ (%)	0.50 – 2.80	1.61
O.C (%)	0.26 – 1.32	0.74
Fe (mg kg^{-1})	7.68 – 46.56	26.07
Mn (mg kg^{-1})	10.70 – 35.40	25.44
Zn (mg kg^{-1})	0.10 - 2.96	0.98
Cu (mg kg^{-1})	1.00 – 7.50	3.17

DTPA extractable zinc

The DTPA extractable zinc in soils of Bhudargad tehsil ranged from 0.10 to 2.96 mg kg^{-1} with a mean value of 0.98 mg kg^{-1}. Out of all the soil samples collected 72.67 per cent samples were sufficient, 27.33 per cent samples were deficient (villages - Begawade, Pangine, Pal, Barve, Dindewadi, Ranewadi, pushpanagaon, Fanaswadi, Gargoti, Mudhal, Mahalwadi, Kumbharwadi, karwadi, Tirwade, Kudtarwadi, AnapB.K, Manglewadi, chandamwadi, AnapKH, Patgaon, Sukychiwadi, Bashyachawadi, Palyachawada, Ukirphatali, Anap, Navle, Varpewadi, Padkhambe) as the critical limit of available zinc is 0.6 mg kg^{-1} (Katyal, 1985) [3]. The deficiency in zinc might be due to intensive cultivation of field crops without application of zinc containing fertilizers, and other reasons are that, under alkaline conditions, the zinc cations converts to largely to their oxides or hydroxides, thereby lower the availability of zinc. The similar results were also reported by Meena *et al*. (2006) [7] in Tonk district of Rajasthan.

DTPA extractable iron

The DTPA extractable iron ranged from 7.68 to 46.56 mg kg^{-1} with a mean of 26.07 mg kg^{-1}. The 100 per cent soil samples were sufficient in DTPA extractable iron, as the critical limit of available iron was 4.5 mg kg^{-1}, (Takkar *et al*., 1989) [12]. The similar trend was also recorded by Thombare (2014) [17] in Hatkanangle tehsil of Kolhapur district, (Maharashtra).

DTPA extractable manganese

The manganese ranged from 10.74 to 35.42 mg kg^{-1} with a mean value 25.44 mg kg^{-1} and showed 100 per cent sufficient in DTPA extractable manganese above critical level (2.0 mg kg-1). 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 Mandavgade *et al*. (2015) [6] in soils of Northern tehsils Jintur, Selu and Pathri of Parbhani district, (Maharashtra).

DTPA extractable copper

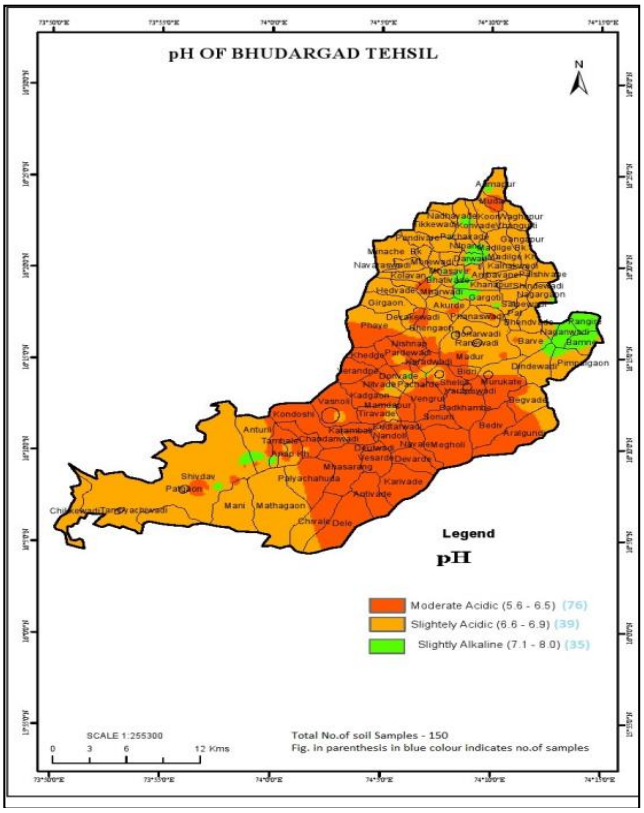
The DTPA extractable copper in soils ranged from 1.00 to 7.50 mg kg^{-1} with a mean value 3.17 mg kg^{-1}. All the soil samples were sufficient in DTPA extractable copper, as the critical limit of available copper is 0.2 mg kg^{-1} (Katyal and Randhava, 1983) [4].

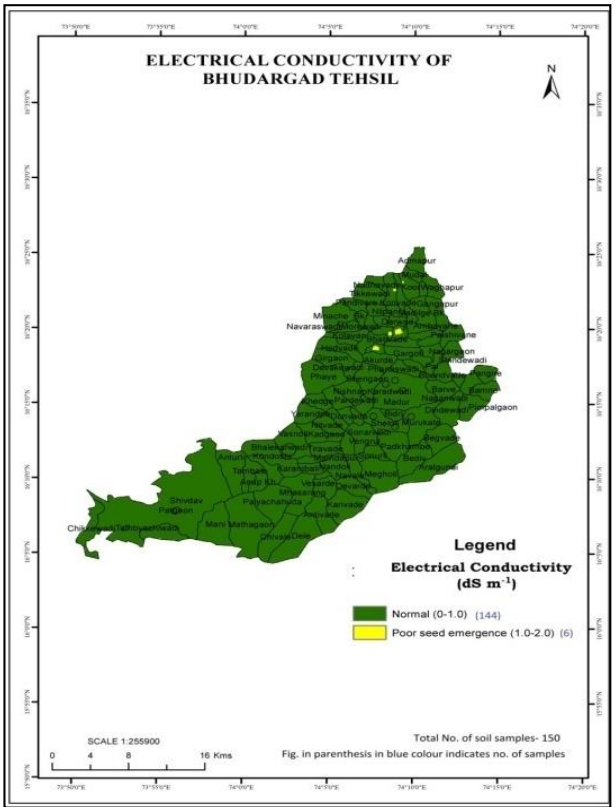
Correlation

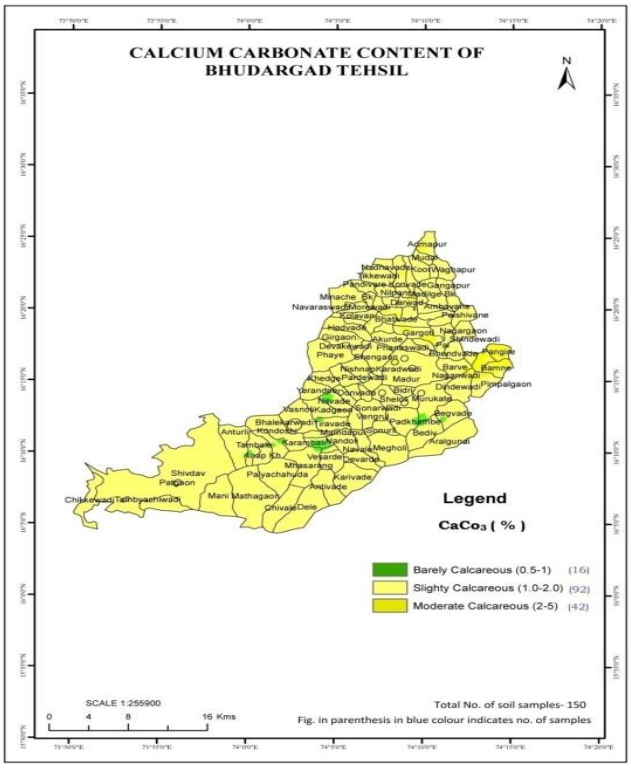
A significant positive co-relation of available Fe with Organic carbon (r = 0.020) was observed. The results were in close agreement with findings of Murthy and Murthy (2005) and the negative correlation of available Fe with soil pH and $CaCO_3$ indicated that there was a precipitation of available iron into insoluble products which supports the classical phenomenon of lime induced iron deficiency. A negative correlation of available zinc with pH, EC and $CaCO_3$ but it was positively correlated with organic carbon (r = 0.098). This could be attributed to the presence of organic matter that release the Zn from the parent material and increase their solubility. The available Mn and Cu was significantly negatively correlated with pH, EC and $CaCO_3$. Similar results were also reported by Sharma *et al* (2003) [15].

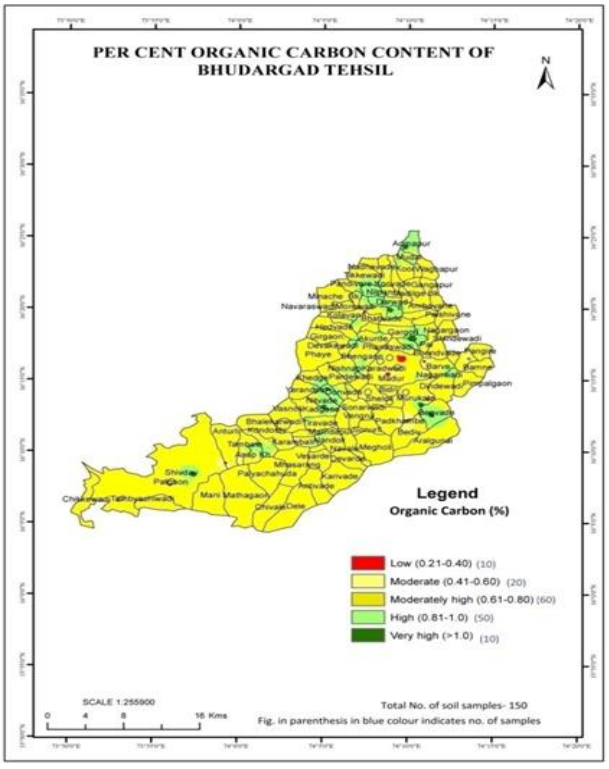
Table 2: Correlation of DTPA Extractable micronutrients content in soils of Bhudargad tehsil

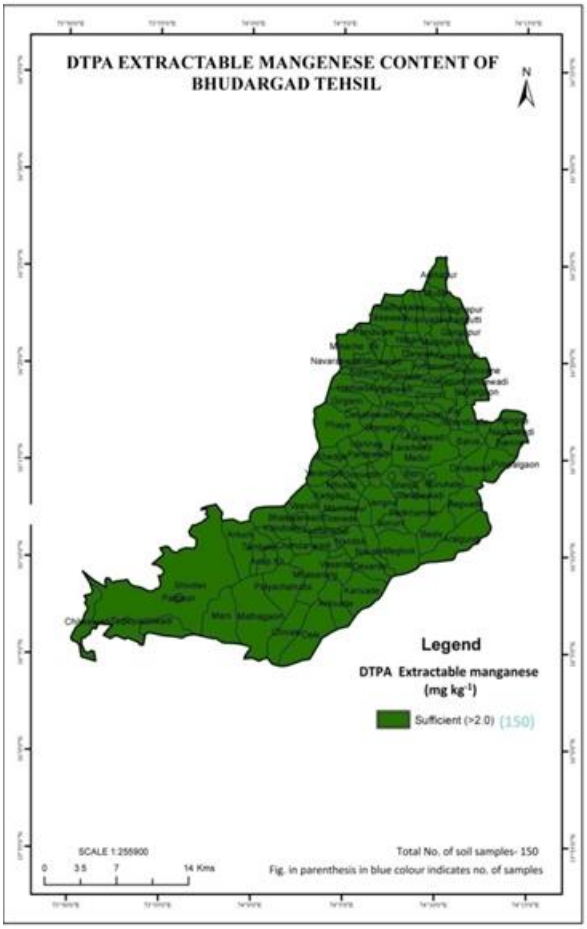
Available nutrients	Physico - chemical properties			
	pH	EC	OC	$CaCO_3$
Fe	-0.007	0.152	0.020	-0.064
Zn	-0.536**	-0.260**	0.098	-0.425**
Mn	-0.666**	-0.280**	0.054	-0.565**
Cu	-0.193*	-0.028	0.169*	-0.204*

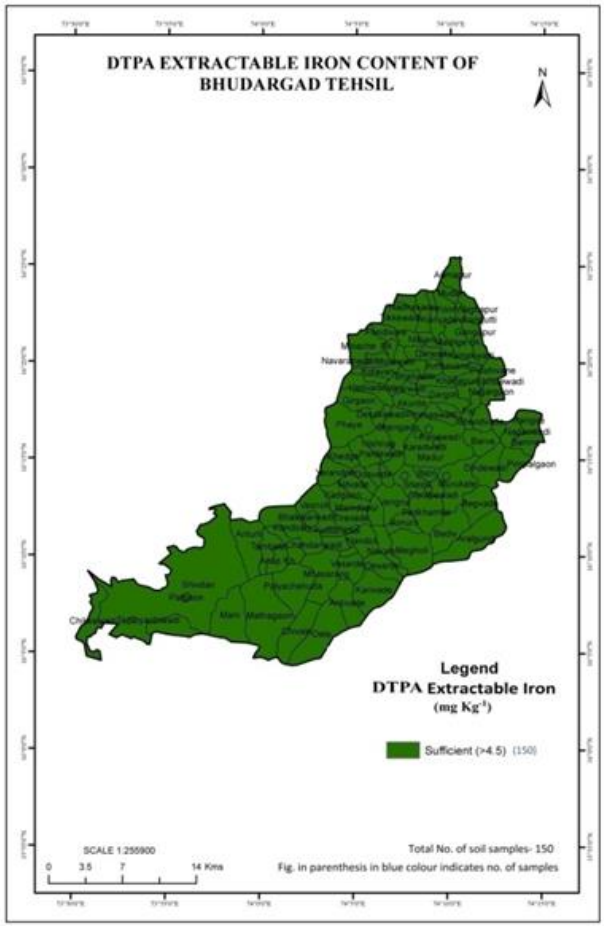

pH OF BHUDARGAD TEHSIL
N
Legend
pH
Moderate Acidic (5.6 - 6.5) (76)
Slightely Acidic (6.6 - 6.9) (39)
Slightly Alkaline (7.1 - 8.0) (35)
SCALE 1:255300
0 3 6 12 Kms
Total No.of soil Samples - 150
Fig. in parenthesis in blue colour indicates no.of samples

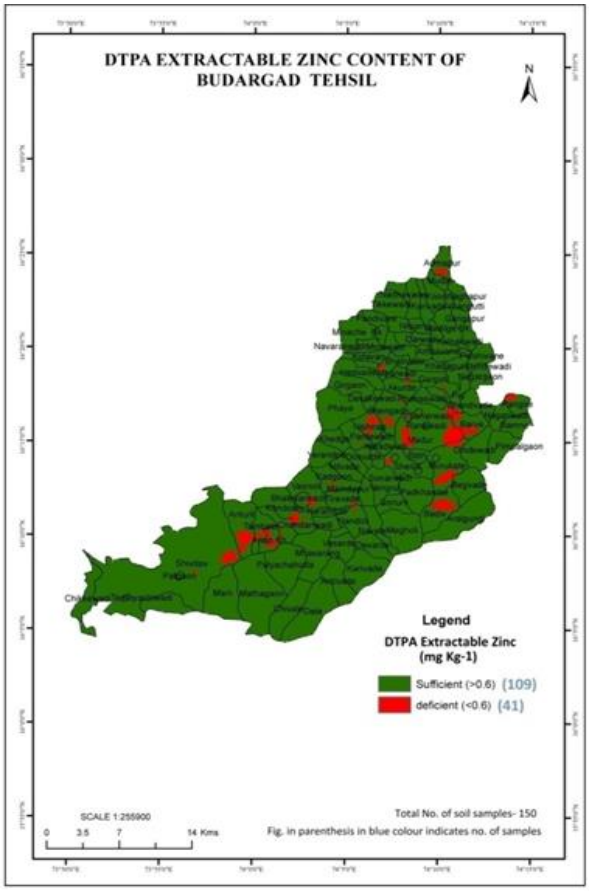

ELECTRICAL CONDUCTIVITY OF BHUDARGAD TEHSIL
N
Legend
Electrical Conductivity (dS m-1)
Normal (0-1.0) (144)
Poor seed emergence (1.0-2.0) (6)
SCALE 1:255900
0 4 8 16 Kms
Total No. of soil samples- 150
Fig. in parenthesis in blue colour indicates no. of samples


CALCIUM CARBONATE CONTENT OF BHUDARGAD TEHSIL
N
Legend
CaCo3 (%)
Barely Calcareous (0.5-1) (16)
Slighty Calcareous (1.0-2.0) (92)
Moderate Calcareous (2-5) (42)
SCALE 1:255900
0 4 8 16 Kms
Total No. of soil samples- 150
Fig. in parenthesis in blue colour indicates no. of samples


PER CENT ORGANIC CARBON CONTENT OF BHUDARGAD TEHSIL
N
Legend
Organic Carbon (%)
Low (0.21-0.40) (10)
Moderate (0.41-0.60) (20)
Moderately high (0.61-0.80) (60)
High (0.81-1.0) (50)
Very high (>1.0) (10)
SCALE 1:255900
0 4 8 16 Kms
Total No. of soil samples- 150
Fig. in parenthesis in blue colour indicates no. of samples







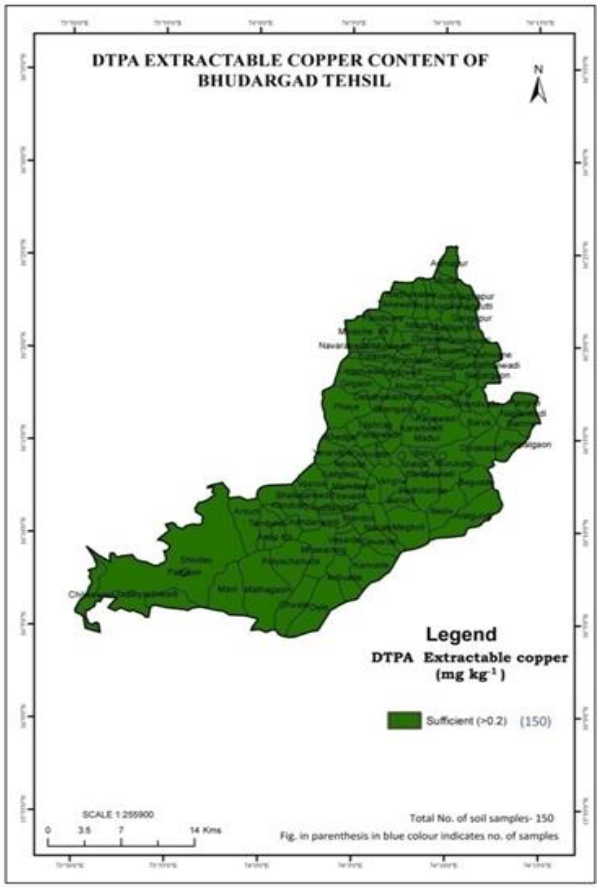
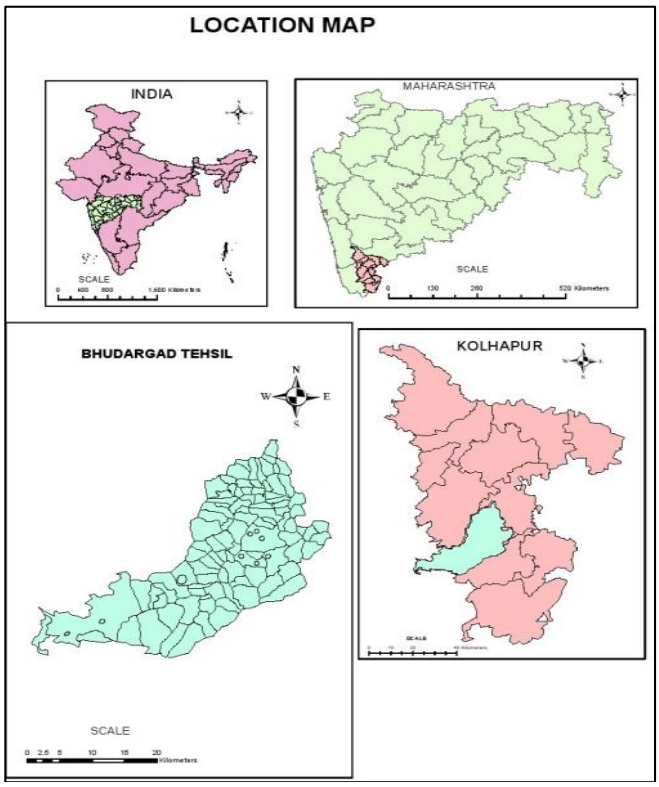


Fig 1: GPS-GIS based soil fertility maps of Bhudargad tehsil of Kolhapur district of Maharashtra state.



Location map of study area

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