"GPS-GIS BASED SOIL FERTILITY MAP OF KAGAL TEHSIL OF KOLHAPUR DISTRICT (M.S.)."

By

Miss. JADHAV RAJASHRI DNYANDEO.

(Reg.No.12 /107)

A thesis submitted to the

Mahatma Phule Krishi Vidyapeeth,

Rahuri- 413 722 Dist. Ahmednagar,

Maharashtra (India)

in partial fulfilment of the requirements for the Degree

of

MASTER OF SCIENCE (Agriculture)

in

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

DIVISION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY,

COLLEGE OF AGRICULTURE, KOLHAPUR - 416 004

MAHARASHTRA (INDIA)

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Approved by

Dr. D.S.Patil.
(Chairman and Research Guide)

Dr. R. B. Pawar
(Committee member)

Prof. M. R. Shewale
(Committee member)

DIVISION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
COLLEGE OF AGRICULTURE,
KOLHAPUR - 416 004
MAHARASHTRA (INDIA)
2014

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part there of has not been submitted by me or any other person to any other University or Institute for Award of a Degree or Diploma

Place: A.C. Kolhapur **(Miss.Jadhav.R.D.)**

Date: / / 2014

Dr. D. S.Patil
Associate Professor ,
Soil Science and Agril. Chemistry,
College of Agriculture, Kolhapur
Maharashtra state (India)

CERTIFICATE

This is to certify that, the thesis entitled **"GPS-GIS BASED SOIL FERTILITY MAP OF KAGAL TEHSIL OF KOLHAPUR DISTRICT (M.S.)."** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**, embodies the results of a piece of *bona-fide* research carried out by **Miss. JADHAV RAJASHRI DNYANDEO,** under my guidance and supervision and that no part of this thesis has been submitted for any other degree or diploma in other form.

The assistance and help received during the course of this investigation and sources of reference have been duly acknowledged.

Place : A.C. Kolhapur **(Dr.D.S.Patil.)**
Date : / /2014 Research Guide

Dr. G. G. Khot,
Associate Dean,
College of Agriculture,
Kolhapur- 416 004.
Maharashtra State (India)

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Place: A.C.Kolhapur **(Dr.G.G.Khot)**

Date: / /2014 Associate Dean

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Place : A.C.Kolhapur

Date : / /2014 *(Miss.Jadhav R.D.)*

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LIST OF ABBREVIATIONS

%	:	Per cent
°C	:	Degree Celsius
@	:	at the rate of
$CaCO_3$	:	Calcium carbonate
Cu	:	Copper
dS m^{-1}	:	Deci siemens per meter
DTPA	:	Diethylene Triamine Penta Acetic Acid
EC	:	Electric conductivity
EDTA	:	Ethylene Diamine Tetra Acetic Acid
et al.	:	*et alli* (and others)
Fe	:	Iron
Fig.	:	Figure
gm.	:	Gram
ha^{-1}	:	Per hectare
K	:	Potassium
kg ha^{-1}	:	Kilogram per hectare
Mn	:	Manganese
Mg	:	Milli gram
N	:	Nitrogen
O.C.	:	Organic carbon
P	:	Phosphorus
Ppm	:	Parts per million
s.e.	:	Standard error
Si	:	Silicon
Viz.	:	Namely
Zn	:	Zinc
**	:	Highly significant

ABSTRACT

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"GPS-GIS BASED SOIL FERTILITY MAP OF KAGAL TEHSIL OF KOLHAPUR DISTRICT (M.S.)."

Miss. JADHAV RAJASHRI DNYANDEO

A Candidate for the degree of

MASTER OF SCIENCE (AGRICULTURE)

in

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COLLEGE OF AGRICULTURE, KOLHAPUR

MAHARASHTRA (INDIA)

2014

.....

Research Guide : Dr. D.S.PATIL.

Department : Soil Science and Agricultural Chemistry

.....

GPS-GIS based soil fertility map of Kagal tehsil of Kolhapur district (M.S.) were assessed for chemical characteristics and available nutrient status along with correlation during year 2013-14.

The soils were moderately acidic (6.1) to moderately alkaline (8.6) in reaction with normal electrical conductivity while low (0.21%) to very high (1.8%) organic carbon. The calcium carbonate content in soil ranged from slightly calcareous (1.5%) to highly calcareous (14.0%).

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Abstract contd….. **Jadhav.R.D.**

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The available nitrogen ranged from very low (131.71 kg ha^{-1}) to moderate high(536.0 kg ha^{-1}), most of the soils are low (12.0 kg ha^{-1}) to high (33.8 kg ha^{-1}) in available phosphorus and very low (66.0 Kg ha^{-1}) to very high (999.0 kg $ha^{-1)}$ in potassium. The DTPA extractable micronutrients (Fe, Mn, Zn, Cu) ranged from 2.1-90.4, 14.4-106, 0.2-4.8 and 2.3-17.0 mg kg^{-1} respectively and 20.8% zinc shows deficiency.Calcium and magnesium were found to be dominant cations on the exchange complex on soil. Available sulphur ranged from very low (1.6 mg kg^{-1}) to moderate (12.8 mg kg^{-1}), the 62.80% sulphur under the low category and that of silicon low (16.5 mg kg^{-1}) to high (126.0 mg kg^{-1}). The pH was significantly correlated with sodium and silicon. EC was significantly correlated with sodium and copper. Organic carbon was significantly correlated with nitrogen, phosphorus and silicon. Fertility index of Kagal tehsil with respect to organic carbon, soil available nitrogen, phosphorus and potassium were medium (1.93), low (1.37), medium (1.61) and medium (2.02) respectively.

1. INTRODUCTION

Soil is natural body developed by natural forces acting on rocks and minerals. It is usually differentiated into horizons from mineral matter and organic constituents at variable depth which differ from the parent material in morphology, physical, chemical, biological characteristics. Soils are considered as the integral part of landscape and their characteristics are largely governed by land form in which they are developed. Soil is the life supporting system of country and socio economic development of people depends on soil. (Kanwar,2004). Soils are vital natural resource and information on their characteristic, classification, location, extends and distribution, potential and problem is imperative for any development planning in particular area. Timely and reliable information on soils with respect to their natural, extent, spatial distribution, potential and limitation is very crucial for optimal utilization of natural resource on sustained basis. The scientific approach to the collection of soil information of extensive areas began with first decade of twenty.

Soil fertility plays a key role in increasing crop production in the soil. It comprises not only in supply of nutrients but also their efficient management. The fertility status of soil indicates their nutrient supplying capability.Soils of Maharashtra state are categorized as poor in fertility and they vary widely in genetic, morphological, physical, chemical and biological characteristics. The soil fertility undergoes

change due to intensive cropping, manuring and fertilizer applications.

The soil test results of one farm need to have scope to be connected with the broader population of all farms in a given area. The ideal situation would be to sample every farm to get soil fertility status of all the farms, but we may not be able to sample each farm in the population, because it is too costly, troublesome and time consuming, especially with the multiple small farm holdings in many developing countries. We thus need to generalize results of sample farms to get information of entire area.

Soil fertility maps for nitrogen, phosphorus and potassium were prepared using soil test data generated by soil testing laboratories that functioned throughout the country (Ghosh and Hasan, 1979). Till date there is no major up-gradation in these maps. Singh et al. (2004) used point estimates for districts to prepare soil fertility maps of N, P and K for the states of Andhra Pradesh and Maharashtra. Ray and Dadhwal (2001) used satellite based RS data and GIS tools for estimating seasonal crop evapo-transpiration in Mahi Right Bank Canal (MRBC) command area of Gujarat, India.

The recent technologies like GPS and GIS thus have much to offer for preparing soil fertility maps. Global positioning system (GPS) is a space based navigation and positioning system administered by U.S military, which helps to determine the exact position of an object on the earth surface in terms of geographical co-ordinates (French, 1996). Geographic information system (GIS) is a computer system for

capturing, storing, querying and displaying geographical data (Chang, 2002). Once the soil fertility maps are created, it is possible to transform the information about the fertility status of the area; such maps provide site-specific recommendation, validation for soil fertility over the following years.

GPS-GIS are advanced tool for studying on site specific nutrient management which can be efficiently used for monitoring soil fertility status in Kagal tehsil of Kolhapur district (M.S.), and it is useful for ensuring balanced fertilization to crops. Systematic study of nutrients including assessment of primary, secondary and micronutrient status of soil with delineation of areas of nutrient deficiency or sufficiency.

Kagal tehsil of Kolhapur district (M.S.) falls under sub-mountain and Western Ghats zone. During last decades because of intensive cultivation of paddy and sugarcane crops and excessive use of irrigation water and heavy doses of fertilizer decline the soil health and fertility status. It is necessary to manage the soils by knowing the soil fertility status in relation to chemical properties. Total area of Kagal tehsil of Kolhapur district is 54,912 ha out of which 38,512 ha area under cultivation and 16,400 ha area is irrigated. Annual rainfall of Kagal tehsil is 746 mm.

The information of soil fertility status of Kagal tehsil based on “GPS-GIS” studies is very limited, therefore the present experiment is planned with following objectives:-

1. To assess the soil macro and micro nutrient status of Kagal tehsil of Kolhapur district and delineate the soil fertility map.
2. To correlate soil properties with available nutrients.
3. To evaluate fertility index of Kagal tehsil.

2. REVIEW OF LITERATURE

The present investigation was undertaken to study chemical characteristics, status of macronutrients and micronutrients of soils of Kagal tehsil of Kolhapur district. There were several reports published on chemical characteristics and available nutrient status in Maharashtra. Keeping in view, efforts are being made to present the pertinent literature on the various aspect of present investigation as follows:-

2.1 The introduction of GPS- GIS
2.2 Chemical properties of soil
2.3 Mapping of soil
2.4 Correlation analysis
2.5 Parker's fertility index

2.1 The introduction of GPS- GIS

2.1.1 Global Positioning System (GPS)

Global Positioning System (GPS) is a space based navigation and positioning system administered by U.S military, which helps to determine the exact position of an object on the earth surface in terms of geographical co-ordinates (French, 1996).

GPS is used extensively for GIS data collection (Pradeep, 2006). Apel *et al.* (2011) identified GPS based techniques are best for monitoring of river stages which is one of the basic observations required for understanding catchment hydrology and hydraulic systems. GPS technology

was utilized for practicing site-specific irrigation that reduced the water loss significantly (Charles *et al.*, 2011).

2.1.2 Geographic Information System (GIS)

GIS is a computerized spatial information system for supplying data or information for planning and policy making. According to the type and use of GIS, several definitions of GIS have been coined. GIS is a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and displaying of spatially referenced data for solving complex planning and management problems (Bernhardsen, 1999).

Clarke (2001) described GIS as an automated system for capture, storage, analysis and display of spatial data. Chang (2002) defined GIS as a computer system for capturing, storing, querying and displaying geographic data. Geographic information system is a computer system that can hold and use data describing places on earth's surface (Das, 2004). GIS can be defined as an organized collection of computer hardware and software designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information (ISSS, 2007).

Mandal and Sharma (2005) prepared a relational database for salt affected soils using GIS. They also generated the spatial and non-spatial information on salt-affected soils derived from remotely sensed data to manage soil salinity in irrigated agriculture.

2.2 Chemical Properties of soil

A combination of factor viz. climate, topography, chemical composition of parent material, is usually involved in development of soils and change in their properties.

2.2.1 Soil Reaction (pH)

Katkar (1994) studied Entisols of Nagpur region (Maharashtra) and reported that pH ranges from 6.7 to 7.5. However the depth wise decrease in soil pH was observed.

Durgude (1999) studied the salt affected soils of central campus farm, M.P.K.V., Rahuri (Maharashtra) and revealed that 1.66 per cent soils of potential cultivated area are saline, 5.92 per cent area saline sodic and 8.60 per cent are sodic. The pH of sodic soil ranged from 8.30 to 8.90.

Chichmalatpure *et. al*, (2008) Soil reaction reflects the nature of parent material and climate, which determine soil composition. It affects availability of various nutrients, activity of micro-organisms and controls many physical and chemical properties of soils. Higher the pH value may be due to basalt as a parent material, which is alkaline in nature.

Kadu (2007) studied the fertility status of soils of Parola tehsil of Jalgaon district (Maharashtra) and reported the soil pH varied from 7.1 to 8.9.

Sardeep Kour and Jalili (2008) analyzed the soil of different agro climatic zones of Jammu regions and reported that the pH range from 7.4 to 8.6, 6.5 to 8.4 and 6.7 to 7.2.

Jibhakate *et al* (2009) studied the physiochemical status of soils of Katol Tehsil of Nagpur District (Maharashtra) and recorded the values of pH of these soils ranged from 7.1 to 8.2 indicating neutral to alkaline reaction.

2.2.2 Electrical conductivity (EC)

Katkar, (1994) in general electrical conductivity increase with depth of soil profile of Entisols and Inceptisols of Nagpur district (Maharashtra).

Patil and Sonar (1994) analyzed twenty representative soil series of Maharashtra and reported that the EC ranged from 0.05 to 1.39 dS m^{-1}.

Anantwar *et al* (2000) reported that the range of EC value of Wardha District (Maharashtra) ranged from 0.32 to 0.43 dS m^{-1}. These salts were increased with depth.

2.2.3 Organic carbon

Katkar (1994) reported the range value of organic carbon from 0.07 to 0.93 and 0.12 to 0.63 per cent for Entisols and Inceptisols of Nagpur (Maharashtra) respectively. This result showed the higher content of organic carbon in Entisols than Inceptisols soil profiles.

Sohan Lal *et al* (1994) reported low content of organic carbon in Entisols and Inceptisols of Maharashtra, which decreased with depth. Ranges of organic carbon varied from 0.1 to 0.4 per cent.

2.2.4 Calcium Carbonate

Subha Rao and Sekhon (1991) reported that in general the swell shrink soils are moderate to highly calcareous in nature, in some Vertisols soil series of Maharashtra and Madhya Pradesh the range was 1.3 to 11.6 per cent.

Deshmukh and Rangacharya (1992) reported the $CaCO_3$ content in Vertisols of Akola (Maharashtra) from 0.6 to 4.5 per cent.

Katkar (1994) studied the Inceptisols of Nagpur district of Maharashtra and reported that $CaCO_3$ content from 7.5 to 25 per cent. The content of $CaCO_3$ found to be increase with depth of soil profile.

Anantwar *et al.* (2000) reported that range of $CaCO_3$ content in Vertisols of Wardha district of Maharashtra ranged from 5.2 to 9.8 per cent. In case of Entisols the range was from 2.8 to 4.2 per cent.

2.2.5. Macronutrients

Primary nutrients (N, P, K)

Patil *et al.* (1987) reported that the soils of bench terraces in Konkan (Maharashtra) were well supplied with total N and available K_2O, while they were found to be deficient in available P_2O_5.

Kadam (1993) analyzed the soils of Jalna District (Maharashtra) and reported that the available N content in these soils ranged from 157.43 to 220.63 kg ha^{-1}.

Kulkarni (1993) studied the soils of Nanded District (Maharashtra) and reported that the available N content range from 157.43 to 920.60 kg ha^{-1}.

Patil and Sonar (1994) studied widely spread swell – shrink soils of Maharashtra for available nutrient and micro- nutrients. These soils were found low in available N, very low to moderate in available P and moderate to high in available K. Available N, P, K ranged from 115 kg ha^{-1} to 225 kg ha^{-1}, 5.08 to 16.38 kg ha^{-1}, 224 kg ha^{-1} to 909 kg ha^{-1} respectively.

Ghuge (2002) reported that the available N content in Verisols, Inceptisols and Entisols ranged from 175.61 to 269.69, 144.50to 269.69 and 141.20 to 232.60 Kg ha^{-1} with mean value of 232.17, 206.82 and 183.49 Kg ha-^{1} N respectively in Ujana (Ahmadpur).

Majumdar *et al.* (2002) examined the available P of some acidic hill soils of Meghalaya and reported that available P content ranged from 1.91 to 10.59 mg kg^{-1}.

Waikar *et al.* (2004) reported that the available N, P and K content varied in between 137 to 251 kg ha^{-1}, 10.0 to 19.1 kg $ha^{-1}$and 303 to 512 kg ha^{-1} respectively in soils of Marathwada Region of Maharashtra state.

Tripathi and Sawarkar (2007) studied the four Vertisols pedons of Kymore plateau in Jabalpur district and observed that the available K content ranged from 84 to 368 Kg ha^{-1}.

Waghmare and Takankar (2007) analyzed 100 representative soil samples from Ausa and Nilanga Tehsil of Latur District of Maharashtra and noted that available N varied from 100.3 to 366.9 kg ha^{-1} and available P varied from 4.22 to 24.98 kg $ha^{-1}$and 4.22 to 28.13kg ha^{-1} respectively.

Jibhakate *et al.* (2009) studied the physico-chemical status in soils of Katol Tehsil, District Nagpur (Maharashtra) and found that the available N and K of these soils ranged from 135.37 to 321.73 kg ha^{-1} and 319.10 to 554.00 kg ha^{-1} respectively.

Secondary nutrients (Ca^{++}, Mg^{++}, S, Si)

Chinchmalatpure *et al.* (1998) reported that available calcium and magnesium content in soils of North Western part of Nagpur district of Maharashtra ranged from 2.8 to 32.8 cmol (p^{+}) Kg^{-1} and 0.2 to 12.4 cmol (p^{+}) Kg^{-1} respectively.

Aggarwal and Nayyar (1998) studied the available soil sulphur status and sulphur nutrition of wheat crop recorded that available sulphur content ranged between 14.0 to 35.2 ppm in the surface layer with an average value of 22.2 ppm indicating that the surface layer was higher in available sulphur than lower layer.

Challa *et al.* (2000) characterized some problematic Vertisols in Maharashtra Plateau. It is reported that calcium is the dominant cations in exchange complex with average value 24 cmol (p^{+}) kg^{-1}, it showed increasing trend with depth,

Magnesium showed irregular trends in distribution with depth and varies from 2.8 to 27.6 cmol (p^+) kg^{-1}.

Pandey *et al.* (2000) studied the availability of Phosphorus and Sulphur in Inceptisols of Central Uttar Pradesh and showed that the content of available P ranged from 7.70 to 55.4 kg ha^{-1}.

Kawade *et al.* (2005) reported that exchangeable calcium magnesium content in soils of Keliveli, District Akola (Maharashtra) varies from18.2 to 35.2 cmol (p^+) kg^{-1} and 5.3 to 14.4 cmol kg^{-1} respectively.

Nayak *et al.* (2006) studied swell-shrink soils of Vertisols order and found that exchangeable calcium and magnesium ranged from 10.1 to 30.5 cmol (p^+) kg^{-1} and 10.7 to 16.7 cmol (p^+) kg^{-1} respectively in Vidharbha region (Maharashtra).

Singh and Singh (2007) studied the sulphur forms insoil profiles of Mid-Western U.P. and concluded that content of SO_4-S ranged from 9.6 to 22.5 mg kg^{-1}.

2.2.6 Micronutrients

Pharande *et al.* (1996) studied widespread Vertisols and Alfisols soil series of Western Maharashtra for total and DTPA extractable micronutrient contents. The total Fe, Mn, Zn and Cu contents of Vertisols ranged 6.1 to 14.3 per cent, 870 to 3310, 74 to 311 and 174 to 560 mg kg-1 respectively.

Ram *et al.* (1999) reported that the available Mn content in soils of Bundelkhand (Uttar Pradesh) varied from 0.70 to 3.34 mg kg^{-1} with an average value of 2.28 mg kg^{-1}.

Dhage *et al.* (2000) reported that available Fe, Zn, and Mn content in soils of Shevgaon Tehsil of Ahmednagar District (Maharashtra) ranged between 2.22 to 9.06 mg kg^{-1}, 2.04 to 11.38 mg kg^{-1} and 8.98 to 45.83 mg kg^{-1} respectively.

Sarkar *et al* (2000) studied the Inceptisols and Vertisols of Madhubani District in Bihar and showed that the available Cu ranged from 0.3 to 4.8 ppm.

Patil and Meisheri (2004) studied surface soil samples from different soil type of Konkan region (Maharashtra) for DTPA extractable Zinc, copper, manganese and iron and their relationship with some soil properties. The contents of available Zn, Cu, Mn and Fe suggested that deficiency of Zn and Mn might be expected, however the available Cu and Fe was observed to be adequate.

Waghmare and Takankar (2007) studied the chemical properties and micronutrients of some soils of Ausa tehsil of Latur, Maharashtra and recorded that the Mn content of soils ranged from 1.23 to 13.57 mg kg^{-1} with an average value of 7.57 mg kg^{-1}.

2.3 Mapping of soil

Soils mapping and classification system have been used for the purpose of delineation, characterization, problem identification etc.

More *et al.* (1987) mapped Purna command area of Maharashtra. They observed that nearly 65 per cent of the soils were affected due to salinity. The per cent saline, saline-sodic, sodic and normal soils in the command area were 22.92, 14.58, 33.33 and 29.17, respectively.

Bhattacharya *et al.* (1989) surveyed Junnar tehsil of Pune district, Maharashtra to bring out basic information on soils and the land use pattern. Eighteen soil series were identified, classified, correlated and mapped as soil series associations into 21 units. Nearly 50 % of the area has very shallow soils, 15 % moderately deep soils and 25 % deep to very deep soils.

Bhattacharya *et al.* (1992) surveyed Ambegaon Tehsil of Pune District representing part of Western Maharashtra to bring out the basic soil information for suitable land use pattern. Four physiographic units covering the 37 per cent Hilly area, <1% Plateau and Pediment 21% area and pediment plains 25.3 % area of tehsil.

Verma *et al.* (1994) reported salt affected soils by remote sensing image interpretation of Etah, Aligarth, Manpuri and Mathura district of Uttar Pradesh in different mapping unit as S1 (<10 %) limited extensive area covered by salt, S2 (10-30 %) moderate extensive, S3 (30-50 %) extensive,

S4 (50-75%) very extensive and S5 (>75 %)extremely extensive area. They observed about 0.21 m ha area under salt affected soils.

Challa *et al.* (1995) mapped the soils of Maharashtra and reported the area under influence of chemical degradation (salinity and alkalinity) was to the tune of 1.06 m ha (3.4% of TGA) out of which 2.9 percent of extreme degree of chemical deterioration.

Durgude (1999) studied the salt affected soils of Central Campus Farm, M. P. K. V., Rahuri and reported that 1.66 per cent soils of potential cultivated area was saline, 5.92 percent area saline sodic and 8.60 per cent was sodic. The pH of sodic soil was ranged from 8.30 to 8.90. EC was ranged from 0.46 to 2.45 dS m^{-1} and ESP was varied from 5.0 to 24.8.

Dhage *et al.* (2000) reported the available Fe, Zn, and Mn content in soils of Shevgaon tehsil of Ahmednagar district (Maharashtra) ranged between 2.22 to 9.06 mg kg^{-1}, 2.04 to 11.38 mg kg-1 and 8.98 to 45.83 mg kg^{-1} respectively.

Binita *et al.* (2008) prepared soil fertility map of Ghataprabha left bank canal command area of north Karnataka by GIS technique to assess the status of major nutrients viz. primary nutrient N, P, K and secondary nutrients (Ca, Mg, S) in the soils on different physiographic units are presented as range, mean and standard deviation.

Sharma et al. (2008) evaluated soil for mapping of micronutrient status and mapped soils of Amritsar District (Punjab). The map of various nutrient elements clearly

indicated the specific locates deficiency of nutrients and their constraint in crop production.

Patil *et al.* (2011) reported on spatial variability in fertility status of surface soil of Karlawad village of Dharwad district of Karnataka and the respective thematic maps were prepared on the basis of rating of nutrients.

2.4. Correlation analysis

Jadhav *et al.* (1978) studied the vertical distribution of Zinc and Iron in some citrus growing soils of Marathwada (Maharashtra), found no significant relationship between available zinc and iron with soil pH.

Malewar and Randhawa (1978) reported that available Zn and Mn content in soils of Marathwada (Maharashtra) has positive correlation with organic carbon and also reported positive significant relationship between available Zn and $CaCO_3$.

Patil and Shingte (1982) conducted study on micronutrient status of soils from drought prone area of Pune region of Maharashtra and recorded that the available Fe, Mn and Zn has significant positive relationship with organic carbon.

Mishra and Srivastava (1991) studied some red soil profile of Garhwal Himalayas and indicated that water soluble, exchangeable and available soil potassium had positive correlation with organic carbon and EC. Among different potassium forms, water soluble and exchangeable potassium were positively correlated with pH.

Pharande *et al.* (1996) studied important Vertisols and Alfisols soil series of Western Maharashtra indicated that the DTPA extractable Zn was significantly and positively correlated with EC and organic carbon.

Sharma *et al.* (2003) analyzed the soils from Nagar District in semiarid region of Rajasthan, observed that the available Zn, Cu, Fe and Mn were negatively correlated with soil pH.

Sharma *et al.* (2007) studied some soils of dry temperate zones of Himachal Pradesh, showed that the Fe status has negative correlation with soil pH and free calcium carbonate.

Indulkar *et al.* (2007) stated that the available N recorded positive significant correlation with pH, EC, organic carbon and $CaCO_3$, whereas available P showed negative correlation with $CaCO_3$ and the available K showed the positive significant relation with pH.

2.5 Soil fertility index

Singh *et al.* (2005) prescribed optimum doses of nutrients for targeted yield through soil fertility maps in Andhra Pradesh. District wise soil fertility maps were prepared by using the index values of nitrogen (N), Phosphorus (P) and potassium (K).

Panwar *et al.* (2011) examined the impact of land use on soil fertility in an Entisols in the Jalpaigure district of Humid Subtropical India. Soil fertility index varied from 13.13 in Arecanut plantation to 18.49 in forest. The evaluation factor

ranged from 5.32 in agriculture to 6.56 in forest. Person's correlation matrix reveled strongly significant positive correlation of soil fertility index and soil evaluation index with soil properties

Ravikumar and Somashekar (2013) studied the evaluation of nutrient index using organic carbon, available phosphorus and available potassium concentrations as a measure of soil fertility in Varahi river basin. They were characterized as low, medium, low category based on the nutrient index calculated with respect to organic carbon, available phosphorus and available potassium, respectively.

3. MATERIALS AND METHODS.

The details regarding the materials used and methods followed during the course of the present investigation have been given in this chapter.

3.1 MATERIAL

3.1.1 Location

The Kagal tehsil of Kolhapur district lies between 16^0 N latitude and 74^0 E longitudes. Total area of tehsil is 54,912 ha.

3.1.2 Climate

The climate of Kolhapur district is tropical similar to the other district of Bombay Deccan adjoining the Ghats. Total average annual rainfall of Kagal tehsil is 764 mm. Out of which 80 per cent receives from south west monsoon in June to September while rest of rainfall receives in the month of October and November from north- west monsoon

3.1.3 Hydrology

Total irrigated area of Kagal tehsil is 16,400 ha .Main source of irrigation are the river Dudhganga, Vedhganga. Water from river was used by lift irrigation or well for field irrigation.

3.1.4 Present Land Use and Natural Vegetation.

The major crops cultivated are Sugarcane, Paddy, Groundnut, Tobacco, and Soybean in large areas. The Forest trees like Teak wood, Neem are also on Bunds, field. Similarly a few grasses of ecological importance such as Kusali, Hariyali, Kurdu, etc. were appeared.

3.1.5 Soils

The soils occur on escarpment and piedmont plain of geomorphic unit followed by piedmont plain The soils occurred on escarpment plain showed lack of horizonization except in plough layer, were classified as Entisols .Whereas the soils which occur on lower pediment having one or two diagnostic horizon were classified as order Inceptisols. The soils which occur on piedmont plain nearly leveled to a very gentle slope deep to very deep showing vertic characters, high clay content cracky behavior were classified as Vertisols and some places Alfisols soil found.

3.2 METHODOLOGY

3.2.1 Experimental Details

Kagal tehsil of Kolhapur district has been selected to assess the soil macro and micro nutrient status and delineate the fertility map. The 35 villages were selected randomly in such a way that it should cover whole area of the tehsil. One ninety nine of representative soil samples were collected from thirty nine villages of Kagal tehsil along with GPS reading.

3.2.2 Collection and Processing of Soil Samples

Geo-referenced surface 22.5 cm soil samples representing different soils were collected from Kagal tehsil, Kolhapur district. The latitude and longitude of sampling sites were recorded with the help of differential Global Positioning system.

1. One ninety nine surface soil samples were collected.
2. Record of surveyed fields, latitude and longitude were maintained using GPS-GIS and maintained.
3. Crop data, data on use of fertilizers and manures were recorded.
4. The soil samples were collected with wooden peg to avoid iron contamination.

The samples were air dried and they were ground using wooden mortar and pestle and passed through 0.5 and 2 mm sieves. The sieved soil samples were stored in cloth bags with proper labeling for subsequent nutrient analysis. The soils were analyzed for different parameters.

3.2.3 Observations Recorded

1. Total area of tehsil-54,912 ha
2. GPS reading of each soil sample was collected on the spot.
3. Soil analysis
   Chemical Properties- pH, EC, $CaCO_3$,
   Organic carbon,Soil available N, soil available P
   available K, available S, available Si
   Exchangeable Ca, Mg and Na
   DTPA extractable micronutrients viz, Fe, Mn,
   Zn and Cu.

3.2.4 Methods used for soil analysis:

The methods used for chemical analysis of surveyed soils are given as below (Table.1)

Table.1 Standard analytical methods used for Chemical analysis of soil

Sr. No	Parameters	Methods used	References
1.	pH (1:2.5;Soil:Water)	Potentiometry	Jackson (1973)
2.	EC(1:2.5;Soil:Water)	Conductometry	Jackson (1973)
4.	Calcium carbonate	Rapid titration	Piper (1966)
5.	Organic carbon	Wet oxidation	Nelson and Sommer (1982)
6.	Available nitrogen	Alkaline permanganate	Subbiah and Asija (1956)
7.	Available phosphorus	Olsen (0.5 *M* sodium bicarbonate) (pH -8.50)	Watanabe and Olsen (1965)
8.	Available potassium	Flame photometry, 1*N* Ammonium acetate (pH - 7)	Knudsen and Peterson (1982)
9.	DTPA extractable micronutrients (Fe, Zn, Mn and Cu)	Atomic absorption spectrophotometry	Lindsay and Norvell (1978)
10.	Exchangeable calcium and magnesium	Versenate	Page (1982)
11.	Available Sulphur	Turbidimetry (Calcium chloride extractable)	Williams and Steinberg (1959)
12.	Available Silicon(1:10)	0.01*M* $CaCl_2$	Korndorfer *et al* (1999)
13.	Exchangeable Sodium	Flame photometery	Page *et al*(1982)

3.2.5 Statistical analysis:

The analytical data was statistically analyzed by using standard statistical methods.

Arc GIS software

Soil fertility maps based on GPS-GIS reading and fertility status of soils of Kagal tehsil were prepared by employing Arc GIS software. The maps are presented in plates from plate 2 to 16.

3.2.6 Parker's fertility Index

The Parker's nutrient index is used to compare soil conditions within a given region by categorizing the area into various categories on the basis of six tier system and used for calculation of fertility index.

$$\text{Parker Index} = \frac{(VL \times 0.5) + (L \times 1) + (M \times 1.5) + (MH \times 2) + (H \times 2.5) + (VH \times 3)}{\text{Total number of samples}}$$

Where,

VL = No. of samples in very low category.

L = No. of samples in low category.

M = No. of samples in moderate category.

MH = No. of samples in moderately high category.

H = No. of samples in high category.

VH = No. of samples in very high category.

Table.2. Ratings of pH, EC and $CaCO_3$ by six tier system.

pH (1:2.5)	Ratings	EC ($dS\ m^{-1}$) (1:2.5)	Ratings	$CaCO_3$ (%)	Ratings
<4.5	Extremely acidic	0-1.0	Normal	0-0.5	Non calcareous
4.6-5.5	Strongly acidic				
5.6-6.5	Moderately acidic	1.0-2.0	Poor seed emergence	0.5-1.0	Barely calcareous
6.6-6.9	Slightly acidic			1.0-2.0	Slightly calcareous
7.0	Neutral	2.0-3.0	Harmful to some crops eg. Pulses	2.0-5.0	Moderately calcareous
7.1-8.0	Slightly Alkaline				
8.1-9.0	Moderately alkaline				
9.1-10.0	Strongly alkaline	>3.0	Harmful to most of the crops	5.0-10	Calcareous
10.1-11.0	Very strongly alkaline			>10	Highly calcareous

Patil and Mali (1999)

Table.3. Six tier ratings of organic carbon and available primary nutrients (N, P, K).

Sr. No.	Ratings	Organic carbon (%)	Available nutrients (Kg ha^{-1})		
			N	P	K
1.	Very low	<0.20	<140	<7	<100
2.	Low	0.21-0.40	141-280	7.1-14	101-150
3.	Moderate	0.41-0.60	281-420	14.1-21	151-200
4.	Moderately high	0.61-0.80	421-560	21.1-28	201-250
5.	High	0.81-1.0	561-700	28.1-35	251-300
6.	Very high	>1.0	>700	>35	>300

Bangar and Zende (1987)

Table.4. Six tier ratings of available sulphur and available micronutrients (mg kg^{-1})

Sr. No	Ratings	S	Fe	Mn	Zn	Cu
1.	Very low	<5	<2.5	<1	<0.3	<0.1
2.	Low	5-10	2.5-4.5	1-2	0.3-0.6	0.1-0.2
3.	Medium	10-15	4.5-9.0	2-4	0.6-1.2	0.2-0.4
4.	Moderately high	15-20	9-18	4-8	1.2-1.8	0.4-0.8
5.	High	20-40	18-27	8-16	1.8-2.4	0.8-1.2
6.	Very high	>40	>27	>16	>2.4	>1.2
	Critical limit	10	4.5	2.0	0.6	0.2

Katkar and Patil (2010)

4. RESULTS AND DISCUSSION

The results of the investigation carried out during the year 2013-2014 with the aim to prepare the GPS-GIS based on soil fertility maps of Kagal tehsil of Kolhapur district (Maharashtra) are presented and interpreted in this chapter under following subheads.

4.1 Nutrients status of soil

The soil samples collected from Kagal tehsil of Kolhapur district were analyzed and the data pertaining to different parameters are categorized as per six tiers rating and presented in Table 5, 6, 7. The data pertaining to pH, electrical conductivity, and calcium carbonate are presented in Table 5. and depicted on GPS-GIS based maps (plate No.2,3,4) respectively.

4.1.1 Soil Reaction (pH)

The pH of the soils (1:2.5 soil: water suspension) ranged from 6.1(moderately acidic) to 8.6(moderately alkaline), Among the soil samples tested,5 per cent soils were moderately acidic followed by slightly acidic 9.0 per cent, 2.5 per cent soils are neutral and 52.76 per cent soils were moderately alkaline in nature (i.e soil samples were moderately acidic to moderately alkaline in nature) with the mean value 7.6. In general no definite depth wise trend in respect of soil pH was observed. The similar observations were also reported for Entisols, Inceptisols and Vertisols soils of Maharashtra by Thakur *et. al.* (1999), Anantwar *et. al.* (2000). In Vertisols, the pH in most cases increases with depth and

become alkaline in the sub surfaces. This might be due to bicarbonate precipitated as $CaCO_3$ due to high evaporative demand under semi-arid conditions.

4.1.2 Electrical conductivity (EC)

The EC value of soils of Kagal tehsil revealed from data it was 0.02 (normal) to 1.80 (poor seed emergence) dS m^{-1} with average mean value 0.74 dS m^{-1}(normal).These observations indicate that all the 99.49 per cent area are non saline in nature and suitable for good plant growth. The similar results were reviewed by Padole and Mahajan (2003) in swell-shrink soils of Vidharbha region (Maharashtra). The 0.5 per cent area comes under the category of poor seed emergence.

The variation of electrical conductivity of soils confirmed the impact of topography on accumulation of soluble salts on the soil surface and carbonates of Ca^{++} and Mg^{++} might have increase EC more than 1 dS m^{-1}.

Table 5. pH, EC and $CaCO_3$ content in soils of Kagal tehsil

<table>
<tr><th>Particular</th><th>pH
(1:2.5)</th><th>EC
(dS m^{-1})
(1:2.5)</th><th>CaCO3
(%)</th></tr>
<tr><td>Mean</td><td>7.6</td><td>0.74</td><td>6.9</td></tr>
<tr><td>Range</td><td>6.1-8.6</td><td>0.02-1.8</td><td>1.5-14</td></tr>
<tr><td rowspan="6">Category</td><td>Moderately acidic
10
(5.02%)</td><td>Normal
198
(99.49%)</td><td rowspan="2">Slightly calcareous
3
(1.50%)</td></tr>
<tr><td>Slightly acidic
18 (9.04%)</td><td rowspan="5">Poor seed emergence
1
(0.50%)</td></tr>
<tr><td rowspan="2">Neutral
5
(2.51%)</td><td>Moderately calcareous
54
(27.13%)</td></tr>
<tr><td>Calcareous
105
(52.76%)</td></tr>
<tr><td>Slightly alkaline
105
(52.76%)</td><td rowspan="2">Highly calcareous
37
(18.59%)</td></tr>
<tr><td>Moderately alkaline
61
(30.65%)</td></tr>
</table>

Total No. of soil samples-199, figures in parenthesis indicates in percentage.

4.1.3 Calcium carbonate content

The data in relation to calcium carbonate content are presented in table mentioned above, it is observed that, calcium carbonate content in soils ranged from 1.5 (slightly calcareous) to 14 per cent (Highly calcareous) with the mean value 6.9 per cent (calcareous). Out of all the soil samples collected, 1.5 per cent soil was slightly calcareous followed by 27.13 per cent soil samples are moderately calcareous and 52.76 per cent soil samples were calcareous. Calcareousness in the soil is due to the presence of both pedogenic and non pedogenic $CaCO_3$ (Pal. 2000a, 2009).

Organic carbon, available nitrogen, available phosphorus and available potassium are presented in Table 6. and depicted on GPS-GIS based maps (Plate No.4,5,6 and7) respectively.

4.1.4 Organic Carbon Content

The organic carbon content of soil ranged from 0.21 to 1.72 per cent (low to very high) with the mean value 0.70 per cent (moderately high).Out of the total area of the tehsil,19.59%, 24.12%, 20.10%, 21.50% and 14.57% area comes in very low, low, moderate, moderately high, high and very high category, respectively. High organic carbon in Vertisols might be due to cultivation of field crops, use of organic manures and fertilizers. (Talele *et al.*1992).

Vertisols have low organic matter due to low prevailing rainfall or aridity, which results in higher degree of

ions in organic matter. Absence of luxuriant vegetation further decreases level of organic matter in this soil.

Table6. Organic carbon and available nitrogen, phosphorus and potassium content in soils of Kagal tehsil

Particular	Organic carbon (%)	Available nutrients (Kg ha^{-1})		
		N	P	K
Mean	0.70	313.86	18.53	287.6
Range	0.21-1.72	131.71-536.	12-33.8	65-999
S.E ±	0.02	5.9	0.30	14.0
Very low	-	2 (1%)	-	17 (8.5%)
Low	39 (19.59%)	61 (30.65%)	24 (12.06%)	33 (16%)
Moderate	48 (24.12%)	120 (60.30%)	120 (60.30%)	29 (14.5%)
Moderately High	40 (20.10%)	16 (8.04%)	44 (22.11%)	31 (15.57%)
High	43 (21.60%)	-	11 (5.52%)	23 (11.55%)
Very high	29 (14.57%)	-	-	66 (33.16%)

Total No. of soil samples-199, figures in parenthesis indicates percentage.

4.1.5 Available Nitrogen

The available nitrogen content in the soils observed from data it ranged from 131.71 to 536.0 kg ha^{-1} (very low to moderately high) with the mean value 313.86 kg ha^{-1} (moderate).Out of total area of Kagal tehsil 30.65 per cent area comes under low category, 60.30 percent were categorized as moderate available nitrogen and 8.04 per cent area comes under the moderately high category. The similar results were recorded by Patil and Sonar (1994) in swell-shrink soils of Maharashtra. In general, the low available nitrogen in most of the area might be due to the higher pH, which declined the organic matter status by faster degradation resulted in low status.

4.1.6 Available Phosphorus

The data in relation to soil available phosphorus content were presented in above mentioned table, it ranged from 12.0 to 33.8 kg ha^{-1}(low to high) with the mean value 18.53 kg ha^{-1}(moderate) (i.e. low to high phosphorus status) Among the soil samples collected 12.06 per cent soil samples were in low category whereas, 60 per cent soil samples were in moderate and 22 per cent soil samples in moderately high followed by 5.5 percent soil samples were in high phosphorus content. Low status of available phosphorus in soil might be due to alkaline condition and high content of calcium carbonate in the soil.

4.1.7 Available Potassium

The available potassium is revealed from data, in the soils potassium ranged from 65.0 to 999.0 kg ha^{-1} (low to very high) with the mean value 287.6 kg ha^{-1}(High). Most of the soil samples collected showed very low to very high available potassium. The highest available potassium was 999.0 kg ha^{-1} and lowest was 65.0 kg ha^{-1}. The similar trends of available potassium were reported by Katariya (2001) in the soils of central research farm, central campus, M.P.K.V., Rahuri. Waikar *et al.*(2004) also reported vey high available K content in Marathwada region. Among the soil samples collected 8.5 per cent soil samples were in very low category whereas, 14.5 per cent soil samples were in moderate and 15.5 per cent soil samples in moderately high followed by 11.5 percent soil samples were in high and very high potassium content were 33.1per cent.

The high content of available K in the soil could be attributed to the dissolution and diffusion of K from internal crystal lattice of silicate clay minerals and may be due to high clay content and montmorillonite clay minerals present in soil (Durgude, 1999).

4.1.8 Exchangeable Calcium

The data in respect to exchangeable calcium is presented in Table 7 and depicted on GPS-GIS based map (Plate No.9). The exchangeable calcium in the soils of Kagal tehsil ranged from10.5 to 41.5 [cmol(p^+) Kg^{-1}] with the mean value 23.73 [cmol(p^+) Kg^{-1}]. Out of all the soil samples collected, 94.9 per cent were sufficient and 5.1 per cent were

deficient in exchangeable calcium, as the critical limit of available calcium is 15 [cmol(p^+)Kg^{-1}] (Durgude, 1999). The highest exchangeable calcium was 41.5 [cmol (p^+) Kg^{-1}] and lowest was 10.5 [cmol (p^+) kg^{-1}].

4.1.9 Exchangeable Magnesium

The data in relation to exchangeable magnesium is presented in Table 7 and depicted on GPS-GIS based map (Plate No.10). The exchangeable magnesium in the soils of Kagal tehsil ranged from 6.0 to 24.5 [cmol (p^+) kg^{-1}] with the mean value 13.11 [cmol (p^+) kg^{-1}]. Out of all the soil samples collected, 81.90 per cent were sufficient and 18.1 per cent were deficient in exchangeable magnesium, as the critical limit of available magnesium is 10 [cmol (p^+) kg^{-1}] (Durgude, 1999). The highest exchangeable magnesium was 24.5 [cmol (p^+) kg^{-1}] and lowest was 6.0 [cmol (p^+) kg^{-1}].

The deficiencies of magnesium might be due to the coarse texture of soil and heavy irrigation. The similar trends of results were observed by Mandal *et al.* (2005) in soils of Nagpur district and by Nayak *et al.* (2006) in swell-shrinks soils of Vidharbha region.

4.1.10 Exchangeable Sodium

The exchangeable sodium in the soils of Kagal tehsil ranged from 0.09 to 1.16 [cmol(p^+) kg^{-1}] with the mean value 0.81 [cmol(p^+) kg^{-1}].

Table 7. Status of exchangeable calcium and magnesium content in soils of Kagal tehsil

Particular	Exchangeable [cmol(p^+) Kg^{-1}]	
	Ca	**Mg**
Mean	23.73	13.11
Range	10.5-41.5	6-24.5
S.E ±	0.39	0.21
Sufficient	189 (94.97%)	163 (81.90%)
Deficient	10 (5.02%)	36 (18.09%)

For black soil critical limit of Ca and Mg is 15 and 10 cmol(p^+) Kg^{-1}, respectively (Durgude, 1999). Total number of soil samples-199, figures in parenthesis indicates percentage.

The data in relation to available sulphur, silicon, are presented in Table 8 and depicted on GPS-GIS based map (Plate No.11,12).respectively.

4.1.11 Available Sulphur

The available sulphur in the soils ranged from 1.6 to 12.8 mg kg^{-1} (very low to moderate) with the mean value 6.0 mg kg^{-1}(low). Among the soil samples collected 33.66 per cent soil samples were in very low category, 62.8 per cent soil samples were in low and 3.51 per cent in moderate sulphur content.

The total sulphur in soil was present in organic combination; therefore soils which are rich in organic matter will have high level of sulphur (Kanwar,2004). The results indicated that sufficiency of available sulphur was directly proportional to organic sulphur content of soil.

4.1.12 Available silicon

The data of available silicon are mentioned in table. 8 it ranged from 16.5 (low) to 126.0 mg kg^{-1} (high) with the mean value 61.32 mg kg^{-1}. Among the soil samples collected 15.0 per cent soil samples were in low category, 38.19 percent moderate and 46.73 per cent soil samples in moderately high available silicon.

4.1.13 Available Micronutrients (Fe, Mn, Zn, Cu)

Every micro-nutrient element plays an important role in plant processes. Their significance in physiological processes and plant metabolism is equally important.

The data in relation to DTPA extractable micronutrients are presented in Table 8 and depicted on GPS-GIS based map (Plate No.13,14,15 and 16).respectively.

4.1.13.1 Available iron

The data of available of DTPA extractable Fe ranged from 2.1 to 90.4 mg kg^{-1} (very low to very high) with the mean value of 17.3 mg kg^{-1}(moderately high). All the soils showed sufficiency in iron content that is above critical level (4.5 mg kg^{-1}). Surface layer of Vertisols had sufficient Fe content and it decreases with depth (Pharande et al, 1996)

Table8. Status of available sulphur, silicon and micronutrients content in soils of Kagal tehsil.

Particular	Available nutrient (mg Kg^{-1})		Available micronutrient (mg Kg^{-1})			
	S	**Si**	**Zn**	**Fe**	**Mn**	**Cu**
Mean	7.2	61.32	0.88	17.3	30.61	6.82
Range	1.6 - 12.8	16.5- 126	0.2- 4.8	2.1- 90.4	14.4 - 106	2.3- 17
S.E ±	0.15	1.24	0.04	0.76	0.96	0.18
Very low	67 (33.66%)	-	7 (3.51%)	2 (1%)	-	-
Low	125 (62.81%)	30 (15%)	33 (16.58%)	2 (1%)	-	-
Moderate	7 (3.51%)	76 (38.19%)	114 (57.28%)	22 (11.05%)	-	-
Moderately High	-		33 (16.58%)	108 (54.27%)	-	-
High	-	93 (46.73%)	6 (3.01%)	42 (21.10%)	4 (2%)	-
Very high	-	-	6 (3.01%)	23 (11.55%)	195 (98%)	199 (100%)

Total no. sample: 199

4.1.13.2 Available Manganese

The value of DTPA extractable Mn ranged from 14.4 to 106.0 mg kg^{-1} (high to very high) with the mean value of 30.61 mg kg^{-1}.(very high) All the soils showed sufficiency in Mn content above critical level (2.0 mg kg^{-1}). The sufficiency of available Mn might be due to high organic matter content and optimum soil moisture content. The similar observations were reported by Shinde (2007) in soils of Udgir and Deoni tehsil of Latur district (Maharashtra).

4.1.13.3. Available Zinc

The data in respect to the zinc are mentioned in table 8.value of DTPA extractable Zn ranged from 0.2 to 4.8 mg kg^{-1} with the mean value of 0.88 mg kg^{-1}(medium).79.92% soil samples showed sufficiency in Zn content which is above critical level 0.6 mg k^{-1} (Katyal, 1985).

Out of total area of Kagal tehsil 3.5 per cent comes under very low category, 16.98 per cent comes under low, 57.2 per cent moderate followed by 16.58 per cent in moderately high Zn content and 3.6 per cent under high Zn content.

4.1.13.4. Available Copper

The value of DTPA extractable Cu ranged from 2.3 to 17.0 mg kg^{-1} (very high) with the mean value of 6.82 mg kg^{-1}. Cu content of soil is above critical level 0.2 mg kg^{-1} (Katyal and Randhva, 1983).

Out of total sampled area of Kagal tehsil 100 per cent comes under very high category.

4.2. Parker's fertility index

Parker's fertility index of Kagal tehsil for organic carbon, available nitrogen, available phosphorus, and available potassium are calculated on the basis of six tier system is 1.93, 1.37, 1.61 and 2.02 respectively. The tehsil is categorized as medium, low, medium and high with respect to fertility status on comparing with the values of Rammoorthy and Bajaj (1969).

4.3. Correlation of available nutrient with soil chemical properties of Kagal tehsil.

The correlation of available nitrogen, phosphorus, potassium, sulphur, silicon, DTPA extractable zinc, iron, manganese, copper, exchangeable calcium, magnesium and sodium with soil pH, EC, calcium carbonate and organic carbon of soils of Kagal tehsil are calculated. The correlation coefficients between soil properties and nutrients are reported in table 9.

The pH of soils of Kagal tehsil shows negative and significant correlation with available N (-0.242*). It is negatively and non-significantly correlated with Zn (-0.118) but negatively and significantly correlated with Fe (-0.316**), Mn (-0.401**) and Cu (-0.168*).

EC has positive significant correlation with Fe (0.144*) while negative significant correlation with Na(-0.175*).

Organic carbon has positively and significantly correlation with available nitrogen which is evident by 'r' values 0.616**. Indulkar *et al.* (2007) stated that available N

showed positive and significant correlation with organic carbon. Organic carbon showed positive and non-significant correlation with P (0.033), Mg (0.022) and Mn (0.031).

$CaCO_3$ was negatively and non-significantly correlated with phosphorus (-0.038) while negatively significantly correlated with S (-0.150*) and Mn (-0.260**).

Table 9. Correlation coefficient between chemical properties and available nutrients in soils of Kagal tehsil.

Chemical properties	Available nutrient (Kg ha^{-1})			Exchangeable cations cmol(p^+)kg^{-1}			Available nutrients (mg kg^{-1})					
	N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
pH	-0.242*	0.44	0.013	0.639**	0.059	0.903**	0.031	0.231**	-0.316**	-0.401**	-0.118	-0.168*
EC	0.111	-0.085	-0.016	-0.140	-0.036	-0.175*	-0.045	-0.038	0.144*	0.142*	0.016	0.158*
Organic Carbon	0.616**	0.033	0.189**	0.188**	0.022	-0.215**	-0.076	-0.111	0.254**	0.031	0.259**	0.330**
$CaCO_3$	-0.055	-0.038	0.086	0.163*	0.121	0.223**	-0.150*	-0.113	0.066	-0.260**	0.003	0.039

Total no. sample: 199

* Significant at 5% level: 0.142

** Significant at 1% level: 0.186

5. SUMMARY AND CONCLUSION

One ninety nine surface soil samples from Kagal tehsil of Kolhapur district were collected to delineate the fertility maps of macro and micro nutrients. The collected soil samples were analyzed by using standard analytical methods. The soil fertility GPS-GIS base map of available macro and micro nutrients were prepared by using geographical information system (GIS) and global positioning system (GPS). During the survey the latitude and longitude of sampling sites were recorded using global positioning system. The results are summarized and the conclusion were drawn are put forth in this chapter.

The soils of Kagal tehsil of Kolhapur district were found moderately acidic to moderately alkaline in reaction pH ranged from 6.1 to 8.6 (moderately acidic to moderately alkaline). Electrical conductivity content in the soils of Bange village of Kagal tehsil is normal. The EC of soils ranged from 0.02 to 1.80 dS m^{-1}. The organic carbon content of soil ranged from 0.21 to 1.72 per cent. The most of the soil samples were low to very high in organic carbon, where as 24.12 per cent soils were under moderate category. The organic carbon content in soil of Ekondi village (sample no : 13, 14, 17, 18) was low.

The calcium carbonate content in soil ranged from 1.5 to 14.0 per cent. Out of all the soil samples collected 1.5 per cent soil samples were slightly calcareous and 18.59 per cent soil samples were highly calcareous. Soils of Alabad, Haldawade Village showed highly calcareous status.

The soil available nitrogen ranged from 131.71 to 536.0 kg ha^{-1} which was categorized as very low to moderately high category, 1.0 per cent soil samples were categorized in very low available nitrogen and 8.04 per cent area come under moderately high category. Nitrogen status of soil was low in wannur village (sample no; 2,3,4,5,6). The available phosphorus was found low (12.06%) to high (5.5%) decreased with depth. The available potassium was ranged from 65.0 to 999.0 kg ha^{-1}. Available potassium status very low in Kurukali (sample no; 80) and vandur (sample no;120,122,123) village and very high in Sidhnerli, Mahakve, Bammni village.

The exchangeable calcium of soils of Kagal tehsil of Kolhapur district ranged from 10.5 to 41.5 cmol (p^+) kg^{-1}. Out of all the samples collected, 94.9 per cent were sufficient and 5.0 per cent were deficient in exchangeable calcium. Nidhori and Annur village showed deficient in calcium status. The exchangeable magnesium of soils of Kagal tehsil of Kolhapur district ranged from 6.0 to 24.5 cmol (p^+) kg^{-1} .Out of all the soil samples collected 81.90 per cent were sufficient and 18.0 per cent were deficient in exchangeable magnesium.

The available sulphur in soils of Kagal tehsil of Kolhapur district ranged from 1.6 to 12.8 mg kg^{-1}. Among the soil samples collected 33.66 per cent samples were in very low category, 62.8 per cent soil samples were in low, 3.51 per cent soil samples were in moderate sulphur content. The available silicon in soils of Kagal tehsil of Kolhapur district ranged from 16.5 to126.0 mg kg^{-1}(low to high). Available

Silicon status in wannur – (sample no. 3), Surupali-(sample no. 74), Mungali (sample no.100) has high.

The DTPA extractable micro-nutrients Fe (2.1 to 90.4 mg kg^{-1}) status high in some pockets Nidhori, Murgud. Mn (14.4 to 106.0 mg kg^{-1}), Zn (0.2 to 4.8 mg kg^{-1}) and Cu (2.3 to 17.0 mg kg^{-1}) were found to be sufficient in the soils.

The pH of soils of Kagal tehsil of Kolhapur district showed negative and significant correlation with available nitrogen (-0.242*). It has negative and non-significant correlation with Zn (-0.118). EC has positive and significant correlation with Fe (0.144*) while EC was negatively and significantly correlated with Na^{+} (-0.175*).

Organic carbon has positive and significant correlation with nitrogen which is evident by 'r' values 0.616**. Calcium carbonate was positively and non-significantly correlated with phosphorus (-0.038**).

CONCLUSIONS

1. Soils of Kagal tehsil ranged from moderately acidic (5%) to moderately alkaline (30.65%) in soil reaction, normal in salt content, Soils were slightly calcareous to highly calcareous in nature. organic carbon content of soils were moderately high to very high.

2. The soils were low (30.65%) to moderately high (8.04%) available nitrogen, soil available phosphorus categorized in moderate (60.30%) to high (5.5%) and moderate (14.5%) to very high (33.1%) in available potassium. The soils were sufficient in calcium and magnesium.

3. Available Sulphur content varies from low to medium and available silicon content ranged from low to high. All soil samples are sufficient DTPA extractable micronutrients Mn,Cu and some soil samples are deficient in Fe and Zn.

4. The pH was significantly correlated with sodium and silicon. EC was significantly correlated with Sodium and copper. Organic carbon was significantly correlated with nitrogen, potassium. Calcium carbonate negatively and non- significantly correlated with phosphorus.

5. Parkers fertility index of soils of Kagal tehsil with respect to organic carbon, soil available nitrogen, soil available phosphorus and potassium were medium, low, medium, and medium respectively, which provide information for increasing fertilizer use efficiency in future as well as eco-friendly management of soil.

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** **Originals not seen.**

7.APPENDIX

Chemical properties of soils of Kagal tehsil.

Sr. No.	GPS Reading	pH 1:2.5	EC dS m^{-1} 1:2.5	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
1. Wannur																	
1	N 16° 34'14.4'' E 074°16'32.5''	8.2	0.34	1.75	8.5	304.19	21.37	512.47	35.5	9.5	0.09	4.94	80.31	5.4	27.4	2.4	4.8
2.	N 16° 34'16.6'' E 074°16'34.3''	8.1	0.22	0.37	1.5	163.07	13.75	217.28	33.5	8.5	1.00	7.53	63.75	4.0	23.6	0.8	8.0
3.	N 16°34'52.9'' E 074°16'16.7''	8.0	0.23	0.44	5.5	191.29	16.75	173.82	29.5	10.0	0.98	5.94	96.89	5.6	20.8	0.6	5.4
4.	N 16°34'46.6'' E 074° 16'26.7''	7.9	0.46	0.58	5.0	254.01	15.36	239.00	22.5	13.5	0.94	5.94	67.57	5.0	22.0	0.4	5.6
5.	N 16°34'46.8'' E 074° 16'26.4''	8.3	0.27	0.39	9.5	169.34	22.24	195.55	36.0	10.5	1.06	7.11	62.47	6.8	16.8	1.6	5.6
6.	N 16°34'46.7'' E074°16'26.70''	8.0	0.17	0.37	7.5	159.93	20.22	152.09	24.5	13.5	0.98	5.44	61.19	8.0	45.2	0.4	5.8
2. Sidhnerle																	
7.	N 16°33'29.6'' E 074°15'49.5''	7.9	0.28	0.46	10.0	197.56	15.25	358.51	22.5	15.0	0.72	4.85	42.07	2.4	46.6	0.8	10.4
8.	N 16° 32'25.3 '' E 074°15'35.4''	7.2	0.17	0.85	6.5	363.77	14.67	999.48	21.5	9.5	0.64	5.77	51.00	5.2	56.0	0.4	9.8
9.	N 16°32'23.6'' E 074°15'13.4''	7.7	0.68	1.38	8.0	445.31	15.42	510.60	25.5	11.0	0.88	4.18	76.33	7.6	29.6	1.0	14.4
10.	N 16°32'39 '' E 074°15'15.7''	8.0	0.33	0.58	6.5	247.74	19.35	456.28	29.5	9.0	0.90	4.02	70.12	6.4	27.0	0.6	8.2
11.	N 16°32'39.4'' E 074°15'00.1''	8.0	0.19	1.40	5.5	454.00	29.81	956.03	29.0	10.0	0.96	5.44	61.51	2.1	34.4	2.0	13.8
12.	N 16°36'40.3'' E 074°24'11.6''	7.8	0.48	0.25	10.5	159.93	17.16	141.23	26.0	12	0.82	4.77	72.67	6.2	22.2	0.6	8.8
3. Ekondi																	
13.	N 16°33'05.9'' E 074°14'08.1''	6.9	0.21	0.21	3.0	285.37	15.48	206.41	25.5	9.5	0.46	7.62	76.33	4.4	64.4	3.0	9.4
14.	N 16° 33' 04.7'' E 074°14'03.5''	6.9	0.12	0.29	3.0	294.78	16.17	195.55	20.5	15.5	0.44	8.12	77.77	6.6	90.4	0.8	7.0

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
15.	N 16° 33'16'' E 074°14'10''	7.0	1.00	0.87	2.0	310.40	17.04	336.78	24.0	15	0.50	10.97	72.64	9.4	36.4	0.2	5.6
16.	N 16°33'35.4'' E 074°14'09.1''	7.2	0.42	0.68	3.5	297.92	33.85	499.74	22.5	11.0	0.62	5.77	75.22	18.2	58.2	4.4	10.8
17.	N 16° 33'44.3'' E 074°14'11.1''	7.2	0.18	0.29	5.0	288.51	28.31	130.36	24.5	8.0	0.66	6.95	38.25	17.2	34.0	0.8	6.4
18.	N 16°33'18.2'' E 074°13'36.8''	7.3	0.24	0.30	4.0	304.19	21.66	662.70	27.5	10.5	0.64	6.28	40.79	26.0	15.8	1.0	11.2
4.Bamni																	
19.	N 16° 32' 36.7'' E 074°14'25.1''	6.7	0.59	0.83	8.0	366.91	14.15	977.76	22.5	9.5	0.54	7.95	36.97	25.6	106.2	1.2	5.8
20.	N 16° 32'27.5" E 074° 48'22.9"	8.1	0.27	0.60	7.5	279.10	19.76	488.88	28.5	14.5	1.02	7.45	84.14	16.4	28.6	1.2	8.8
21.	N 16°32'11.16" E 074°14'24.2"	8.2	0.15	0.64	6.5	260.28	22.82	890.84	20.5	24.5	1.04	5.44	73.94	11.8	21.8	0.6	5.6
22.	N 16° 32'11.5" E 074° 14'40.8"	8.1	0.60	1.10	10.5	354.36	28.08	966.89	33.0	9.0	1.00	7.45	84.14	15.2	22.6	1.6	8.8
23.	N 16° 32'8.9" E 074° 14'11.4"	7.9	0.28	0.78	6.0	301.05	13.63	282.46	27.5	10.5	0.96	5.94	67.57	6.4	26.8	0.8	3.2
24.	N 16° 31'55" E 074° 14'8.4"	7.7	0.16	0.31	5.0	310.46	17.44	239.00	25.5	11.0	0.74	5.61	82.87	8.8	30.4	1.4	4.8
5.Shendur																	
25.	N 16° 30'59.3" E 074° 14'23.6"	7.5	0.12	0.46	5.5	247.74	15.02	108.64	22.5	10.0	0.80	7.20	53.54	9.4	31.8	0.2	4.4
26.	N 16° 30'55.2" E 074° 14'36.7"	7.8	0.18	0.62	5.0	228.92	20.16	293.32	16.5	20.0	0.72	6.61	65.02	14	51.2	1.4	8.0
27.	N 16° 31'14.7" E 074° 15'3.7"	8.4	0.24	0.29	6.5	291.64	21.20	358.51	31.0	9.5	1.10	5.61	43.34	9.2	21.0	0.6	3.6
28.	N 16° 31'16.1" E 074°15'13.3"	8.1	0.23	0.42	8.0	269.69	29.64	554.06	33.5	9.0	1.00	7.45	84.14	13.2	30.8	0.4	4.8
29.	N 16° 31'24.6" E 074° 15'18.8"	8.6	0.22	0.25	4.5	241.47	20.10	260.73	32.0	11.0	1.16	4.27	62.47	11.6	15.6	0.6	3.4

Sr. No	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
30.	N 16° 31'34.1" E 074°15'21.67"	8.0	0.14	0.29	6.0	351.23	17.56	347.64	34.5	7.0	0.94	4.02	65.02	8.4	30.0	0.8	6.8
6.Kagal																	
31.	N 16° 34'42.8" E 074°19'16.3"	7.8	0.15	1.60	3.0	232.06	14.04	141.33	26.0	10.5	0.90	6.61	72.67	13	34.8	0.8	8.2
32.	N 16° 34'39.7" E 074°19'39.2"	7.7	0.11	1.00	5.0	254.01	14.38	228.14	25.0	11.0	0.94	6.95	76.5	14.2	32.6	1.2	7.8
33.	N 16° 34'43.4" E 074° 20'06.2"	8.0	0.36	1.40	6.0	335.55	24.15	890.84	28.5	11.5	0.78	8.20	44.62	9.0	26.2	1.8	8.2
34.	N 16° 33'34.7" E 074°19'48.7"	7.7	0.09	1.00	2.0	357.50	14.56	260.73	24.5	12.5	1.14	5.61	76.50	8.0	52.6	0.4	6.6
35.	N 16° 33'28.3" E 074° 19'48.7"	7.3	0.64	1.10	4.0	329.28	27.61	445.42	23	14.5	1.00	8.62	57.37	17.2	47.0	1.4	7.4
36.	N 16° 33'54.1" E 074°19'13.3"	8.4	0.26	1.30	3.5	363.77	30.62	532.33	30.5	15.5	1.10	4.43	72.67	13.4	26.8	0.8	7.4
7.M.Sangav																	
37.	N 16° 34'37.2" E 074°21'01.2"	7.4	0.21	0.48	3.5	341.82	19.81	315.05	21.0	11.0	0.74	10.05	62.47	10.2	33.0	0.8	6.0
38.	N 16°34'34.2" E 074°21'22.5"	7.9	0.30	1.00	4.5	301.05	15.54	329.25	27.0	10.5	0.94	8.20	42.07	12.6	14.4	0.6	5.4
39.	N 16° 34'21.3" E 074° 21'7.5"	8.3	0.35	0.95	6.5	241.47	20.22	249.87	33.0	15.5	0.60	7.20	66.29	8.2	16.6	0.8	3.8
40.	N 16° 34'5.9" E 074°20'45.1"	8.5	0.33	0.83	5.5	269.69	26.34	206.41	33.5	16.0	1.14	9.04	22.94	11.6	18.8	0.8	5.0
41.	N 16° 33'45.4" E 074°20'42.7"	8.0	0.38	0.48	6.0	413.95	24.15	445.42	29.5	10.5	0.92	8.62	28.04	18.0	22.4	0.2	5.4
42.	N 16° 33'40.6" E 074°20'50.5"	8.4	0.21	0.81	3.5	310.46	21.84	249.87	32.0	10.5	1.06	8.12	35.69	7.8	16.2	0.8	5.0
8.K.Sangav																	
43.	N 16° 31'16" E 074°24'30."4	8.0	0.42	0.68	9.0	304.19	22.07	391.10	22.0	16.5	0.92	7.95	72.67	8.8	15.6	2.0	4.6
44.	N 16° 35'22.6" E 074°21'51.5"	7.9	0.31	0.48	8.5	244.60	18.20	456.28	20.5	17.0	0.88	5.19	67.57	10.8	16.6	0.6	5.4

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
45.	N 16° 35'27.4" E 074°22'13.9"	7.1	0.14	0.57	6.5	210.11	16.52	173.82	19.5	16.0	0.58	3.18	52.27	12.0	27.8	0.4	4.6
46.	N 16° 35'23.1" E 074° 22'31.5"	7.5	0.20	0.87	13.0	241.47	16.46	195.55	21.5	15.5	0.78	3.76	53.54	7.4	19.6	0.6	5.8
47.	N 16° 35'21.6" E 074°22'46.9"	7.2	0.19	0.62	13.0	279.10	14.21	119.50	21.0	15.0	0.64	4.52	49.72	7.0	16.4	0.4	3.6
48.	N 16° 35'29.3" E 074°22'46.8"	8.3	0.15	0.95	7.0	254.01	18.54	380.24	22.5	18.0	0.98	5.02	44.62	8.4	16.6	1.0	6.2
9.Mahakve																	
49.	N 16° 28'17" E 074°17'13.5"	8.2	0.48	1.07	6.5	376.32	17.68	434.56	22.0	17.0	1.04	8.79	43.34	13.8	26.0	1.4	16.2
50.	N 16° 28'3.7" E 074°17'15.2"	7.1	0.23	1.40	11.5	269.69	21.20	901.71	19.5	16.0	0.60	5.19	52.63	10.6	44.6	4.8	8.6
51.	N 16° 28'13.9" E 074°16'50.8"	8.2	0.20	0.97	4.5	285.37	22.18	352.73	31.0	10.5	0.98	10.05	53.54	12.2	19.8	0.6	5.8
52.	N 16° 27'56.3" E 074°16'48.9"	8.0	0.96	0.70	5.5	329.28	22.99	945.16	22.0	17.5	0.94	9.12	45.89	12.2	22.4	0.6	4.4
10.Aanur																	
53.	N 16° 27'36" E 074°16'42.1"	7.9	0.87	0.21	2.5	275.96	20.33	241.23	27.0	10.5	0.94	7.28	58.64	14.6	23.2	1.0	4.2
54.	N 16° 27'29.7" E 074°16'32.7"	7.4	0.25	0.48	3.5	294.78	16.77	265.18	16.0	16.0	0.74	5.86	62.47	19.2	36.8	0.4	6.6
55.	N 16° 27'20.6" E 074°16'21.4"	8.0	0.49	0.25	5.0	282.24	21.49	228.14	22.0	17.5	0.96	7.28	76.50	12.2	27.6	0.6	4.0
56.	N 16° 27'10.6" E 074°16'16.7"	8.0	0.23	0.89	3.0	304.19	28.08	119.50	15.0	23.0	0.92	8.12	70.12	11.2	17.0	1.2	9.2
57.	N 16° 26'56.7" E 074°16'3.6"	6.9	0.49	0.39	4.0	315.23	13.28	249.87	19.5	16.0	0.46	8.79	77.77	12.6	28.0	1.4	6.8
58.	N 16° 26'52.8" E 074°15'56.7"	7.4	0.23	0.35	5.0	329.28	18.02	162.96	16.5	16.0	0.72	9.21	65.02	17.0	36.8	0.6	8.4
11.Bange																	
59.	N 16° 26'48" E 074°15'49.6"	7.3	0.41	0.48	8.5	282.24	22.07	249.87	23.0	14.5	0.66	4.87	40.79	13.4	19.0	1.0	6.2
60	N 16° 26'41.3" E 074°15'42.9"	7.2	0.33	0.29	5.0	288.51	15.31	184.68	22.5	14.5	0.62	7.87	53.54	12.4	43.2	0.6	4.4

Sr. NO.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol (P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
61.	N 16° 26'33.4" E 074°15'34.6"	7.0	0.16	0.32	5.5	150.5	15.71	352.09	21.5	14.0	0.58	9.38	70.12	22.0	29.2	0.6	5.4
62.	N 16° 26'25.4" E 074°15'24.3"	7.4	1.8	0.44	7.0	301.05	16.98	738.75	20.5	13.0	0.72	9.56	80.32	14.8	24.4	1.0	7.4
63.	N 16° 26'4" E 074°15'25.3"	6.9	0.18	0.30	4.5	288.51	13.0	297.96	23.5	11.5	0.50	3.75	89.25	17.6	54.6	0.8	6.4
64.	N 16° 26'7" E 074°15'24.1"	7.6	0.80	0.27	6.0	269.69	17.56	673.56	23.0	15.0	0.80	4.69	85.42	9.8	20.2	0.8	7.6
12.Songe																	
65.	N 16° 25'55.3" E 074°15'28"	7.5	0.52	0.68	8.5	304.19	25.30	130.36	22.5	10.0	0.78	9.38	63.75	11.6	37.8	0.6	6.0
66.	N 16° 25'43.8" E 074° 15'32.4"	7.9	0.25	0.50	6.5	244.60	15.08	271.60	23.5	14.0	0.90	8.62	65.02	10.4	21.0	1.0	4.4
67.	N 16° 25'32.4" E 074°15'31.1"	8.0	0.17	0.46	8.0	285.37	22.07	119.50	24.0	15.5	0.96	7.45	68.84	8.2	21.2	0.8	4.2
68.	N 16° 25'32.2" E 074°15'23.9"	7.2	0.36	0.70	8.5	351.23	16.35	239.00	16.0	21.0	0.64	5.77	76.50	14.4	47.6	1.0	5.4
69.	N 16° 25'41.6" E 074°15'41.2"	7.6	0.40	0.89	6.5	414.95	18.83	814.80	19.5	15.0	0.84	9.04	82.87	17.2	21.6	1.0	8.4
70.	N 16° 25'43.2" E 074°16'34"	8.0	0.40	0.54	3.5	373.18	20.39	293.32	18.5	21.0	0.92	8.29	72.67	9.6	19.2	0.6	5.4
13.Surupli																	
71.	N 16° 25'24.2" E 074°15'10"	7.4	0.15	0.33	7.0	366.91	21.55	141.23	16.0	15.5	0.72	3.60	62.47	13.2	24.6	1.0	6.4
72.	N 16° 25'10.4" E 074°14'52.1"	6.5	0.12	0.44	4.0	392.00	15.48	119.50	15.0	14.5	0.50	4.02	43.34	21.6	56.8	0.8	7.4
73.	N 16° 25'5.5" E 074°14'41.8"	7.5	0.23	0.50	5.0	464.12	22.01	130.36	16.5	16.0	0.74	8.37	79.04	18.0	29.2	0.8	5.2
74.	N 16° 25'2.6" E 074°14'34.5"	8.0	0.25	0.68	5.5	429.63	24.84	141.23	23.5	16.5	0.78	7.45	109.64	11.8	19.4	0.4	4.6
75.	N 16° 24'26.8" E 074°14'41.7"	7.9	0.42	0.95	6.0	533.12	26.34	217.28	21.5	16.0	0.70	6.95	57.37	11.0	32.4	0.8	5.0
76.	N 16° 24'38.8" E 074°14'40.2"	8.2	0.15	0.23	5.5	489.21	22.59	108.64	24.0	17.0	0.96	9.21	59.92	9.6	18.2	0.4	5.8

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
14.Kurukli																	
77.	N 16° 24'46.0" E 074°14'35"	8.0	0.34	1.59	7.5	398.27	22.30	391.64	25.5	15.5	0.98	3.18	72.67	11.2	30.0	1.4	5.8
78.	N 16° 24'59.1" E 074° 14'25.8"	7.4	0.40	1.20	6.0	348.09	19.18	304.19	21.0	11.0	0.74	2.51	62.47	9.6	37.2	0.8	5.4
79.	N 16° 24'53.1" E 074°14'55.5"	7.2	0.18	0.64	5.5	363.77	14.61	173.82	16.0	13.0	0.64	3.68	75.22	12.6	58.0	2.2	16.6
80.	N 16° 24'51.5" E 074°13'57.9"	7.6	0.13	0.78	5.0	385.72	17.21	97.77	15.0	13.5	0.84	7.37	53.54	26.0	61.8	1.0	8.4
81.	N 16° 24'42.4" E 074°13'49.4"	7.0	0.31	0.85	5.5	354.36	20.97	304.19	15.0	11.0	0.52	4.69	59.92	15.8	47.0	1.2	9.8
15.Lingnur																	
82.	N 16° 24'30" E 074°19'53.4"	8.4	0.25	0.25	3.5	338.68	28.77	249.87	28.0	7.5	1.08	2.51	72.67	12.6	26.6	0.4	4.2
83.	N 16° 24'30.1" E 074°19'47.1"	8.1	0.23	0.76	5.0	354.36	20.56	173.82	16.0	14.0	1.02	2.09	84.14	13.4	26.8	2.8	5.0
84.	N 16° 24'36.6" E 074°19'31.6"	8.4	0.19	0.44	4.5	379.45	29.46	325.92	17.0	15.0	1.06	3.09	72.67	19.4	42.8	1.0	8.6
85.	N 16° 24'32.8" E 074°19'26.8"	8.0	0.17	1.00	6.0	385.72	21.26	173.82	16.0	19.0	0.98	4.18	61.19	18.0	55.8	1.0	7.4
86.	N 16° 24'17.5" E 074°19'23.9"	8.2	0.09	0.91	6.5	392.00	23.16	195.55	15.5	13.0	0.94	6.70	68.84	16.6	34.4	0.6	7.8
87.	N 16° 23'59.6" E 074°19'15.5"	8.3	0.23	0.23	10.5	395.13	25.13	152.09	16.5	18.0	1.00	5.02	66.29	13.2	25.2	0.4	3.8
16.Kardyal																	
88.	N 16° 22'44.1" E 074°18'53.3"	7.6	0.15	0.81	5.5	301.05	17.21	130.36	16.5	18.0	0.84	6.70	40.77	11.2	28.6	0.4	3.0
89.	N 16° 22'58.6" E 074°18'42.4"	7.8	0.09	0.87	5.5	304.19	18.02	173.82	17.5	14.0	0.60	5.90	38.25	15.8	46.4	1.0	7.6
90.	N 16° 22'49.9" E 074°18'16.9"	8.2	0.32	0.56	12.0	310.46	21.08	97.77	19.0	18.5	0.70	3.51	45.91	13.2	24.4	0.4	7.6
91.	N 16° 22'42.5" E 074°18'10.4"	8.1	0.12	0.58	6.0	313.60	20.10	141.23	19.5	20.0	0.90	7.28	84.14	19.8	45.4	1.2	9.6
92.	N 16° 22'39.1" E 074°17'42.6"	7.7	0.12	0.33	7.5	304.19	17.39	282.46	18.5	18.5	0.94	5.61	82.87	14.0	23.6	0.8	4.6

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
93.	N 16° 22'36.5" E 074° 17'24.5"	8.2	0.29	0.39	8.5	307.32	21.66	249.87	19.0	16.0	1.02	5.44	68.85	11.2	21.4	0.4	4.4
17.Jainyal																	
94	N 16° 22'12.8" E 074° 18' 31.6"	8.2	0.20	0.62	7.0	257.15	22.18	336.78	31.5	10.5	1.0	7.87	67.57	12.4	24.8	0.6	2.3
95	N 16° 22'12" E 074° 18' 20.8"	8.0	0.13	0.31	8.5	294.78	16.40	260.73	28.5	11.0	0.92	3.51	65.02	13.8	40.6	0.8	3.5
96	N 16° 22'6.4" E 074° 18' 9.5"	8.1	0.12	0.68	4.0	304.19	17.85	325.92	32.0	8.5	0.94	7.20	93.07	14.8	35.2	0.6	3.4
97	N 16° 22'59.1" E 074° 18'13.3"	8.1	0.20	0.52	8.5	232.06	18.02	380.24	31.5	9.5	0.92	4.69	84.35	12.4	25.0	0.8	2.7
98	N 16° 21'47.4" E 074° 18'15"	8.0	0.26	0.33	5.0	147.39	15.02	358.51	32.5	13.5	0.88	6.44	43.35	16.0	31.4	0.8	4.8
99.	N 16° 21'38.7" E 074° 18'9.3"	7.4	0.34	0.95	10.5	351.23	15.94	597.52	26.0	13.0	0.80	3.60	53.55	15.0	23.0	1.0	2.6
18.Mugali																	
100	N 16° 21'33.1" E 074° 16 02.2"	8.0	0.18	0.64	8.5	282.20	15.19	271.60	27.0	12.5	0.96	4.94	126.22	11.8	24.4	0.6	5.0
101	N 16° 21'39.7" E 074° 17'44.9"	8.1	0.22	0.87	10.0	382.59	18.02	249.87	31.5	9.5	0.98	7.20	93.67	14.0	25.8	0.4	4.8
102	N 16° 21'40.4" E 074° 17' 39.2"	8.5	0.22	0.46	7.5	200.70	26.11	391.10	33.0	8.5	1.08	6.36	76.50	10.8	21.8	0.4	5.4
103	N 16° 21'38.7" E 074° 17'28.6"	8.2	0.24	0.56	8.5	241.47	24.55	239.00	32.0	10.5	1.00	6.86	67.57	11.2	23.4	1.2	4.4
104	N 16° 21'30.5" E 074° 17'26.7"	8.0	0.13	0.73	9.5	169.34	17.56	97.77	27.5	11.5	1.02	5.61	47.17	11.6	32.0	0.4	4.8
105	N 16° 21'2" E 074° 17'21.5"	7.7	0.27	0.33	6.5	147.39	19.18	108.64	25.5	11.0	0.92	6.11	82.87	14.2	39.8	0.8	5.0
19.Kapshi																	
106	N 16° 20'17.9" E 074° 17'16.4"	8.5	0.37	0.60	6.0	263.42	27.44	456.28	30.5	12.5	1.08	2.26	61.20	20.6	19.4	0.6	5.0
107	N 16° 79'53.9" E 074° 17'14.6"	8.5	0.34	0.58	7.5	254.01	17.91	186.84	31.5	11.5	1.06	1.67	72.67	12.0	21.6	0.8	5.4

Sr. NO.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
108	N 16° 19'51.4" E 074° 17'3.2"	8.1	0.19	0.44	8.5	194.43	15.71	173.82	31.0	10.5	1.00	2.42	84.15	14.4	23.4	0.6	5.0
109	N 16° 20'4.2" E 074° 16'4.7"	8.3	0.16	0.54	9.0	238.33	20.04	173.82	30.5	12.0	1.02	2.01	66.30	11.6	25.4	0.2	8.0
110	N 16° 20'12.9" E 074° 17'18.6"	8.2	0.15	0.48	10.5	210.11	16.69	162.96	32.0	9.5	1.04	2.93	73.95	12.6	24.4	0.6	5.2
111	N 16° 20'29.4" E 074° 17'48.1"	8.1	0.16	0.60	9.5	266.56	16.46	130.36	31.5	9.5	0.98	3.51	84.15	10.8	39.4	0.6	7.0
20.Karnur																	
112	N 16° 20'29.4" E 074° 17'48.1"	8.3	0.26	0.64	6.0	285.37	14.15	152.09	30.5	12.0	1.04	8.12	91.80	13.2	20.2	0.4	5.8
113	N 16° 32'53.4" E 074° 18'28.4"	7.9	0.13	0.50	3.0	222.65	14.56	141.23	22.5	15.0	0.98	5.94	67.57	13.8	50.4	0.6	7.0
114	N 16° 32'44.3" E 074° 18'7"	8.0	0.16	0.70	2.5	310.46	14.09	119.50	24.5	14.5	1.02	8.29	61.20	30.8	28.0	0.6	5.4
115	N 16° 32'46.7" E 074° 18'8.3"	8.2	0.13	0.23	4.5	131.71	13.86	99.77	32.0	9.5	1.00	5.44	73.95	16.4	24.4	0.2	5.0
116	N 16° 33'1.4" E 074° 17'48.3"	8.2	0.32	0.42	3.3	191.20	13.00	315.85	31.0	10.5	0.96	4.60	59.92	14.8	27.6	0.6	5.6
117	N 16° 33'33" E 074° 17'45.2"	8.3	0.15	0.23	4.0	159.93	13.28	119.50	32.5	9.0	1.06	8.12	66.30	15.8	20.0	0.2	3.0
21.Vandur																	
118	N 16° 33'10.5" E 074° 17'34.4"	8.3	0.19	0.27	12.0	134.84	21.08	108.64	30.0	12.5	1.08	8.96	62.47	13.2	24.0	0.6	4.6
119	N 16° 33'03.5" E 074° 17'24.3"	8.4	0.35	0.68	12.0	335.55	17.04	119.50	31.0	12.0	1.02	9.63	35.70	14.0	22.8	0.8	8.0
120	N 16° 32'54.0" E 074° 17'16.1"	8.1	0.22	0.33	10.0	163.07	15.19	76.04	41.5	8.0	1.00	12.56	84.15	13.6	20.2	0.6	6.4
121	N 16° 32'46.3" E 074° 17'13.9"	7.5	0.33	0.42	9.0	206.97	13.63	217.28	28.5	10.5	0.92	8.37	40.80	12.0	18.2	0.2	4.4
122	N 16° 32'40.4" E 074° 17'0.4"	8.0	0.17	0.62	5.5	304.00	21.32	99.77	29.5	9.0	0.94	8.29	72.67	15	39.0	0.6	5.4
123	N 16° 32'38.6" E 074° 16'47.2"	7.7	0.16	0.58	6.5	285.37	23.09	65.18	28.0	11.0	0.90	5.61	82.87	22.8	44.2	0.4	6.4

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
22.Shankarwadi																	
124	N 16° 32'6.7" E 074°15'5"	7.4	0.24	0.74	6.0	360.64	16.81	282.46	20.0	12.0	0.74	7.45	91.80	25.6	21.4	0.8	5.6
125	N 16° 32'4" E 074°15'48.8"	7.0	0.30	0.48	13.5	232.06	15.48	108.64	22.0	14.5	0.50	7.78	70.12	15.4	18.8	0.4	6.4
126	N 16° 31'54.8" E 074°15'32.8"	7.0	0.06	0.52	2.0	254.01	16.40	86.91	16.5	15.5	0.54	3.85	72.67	16.4	33.0	0.6	6.6
127	N 16° 32'2.1" E 074°15'42"	7.9	0.17	0.68	11.0	332.41	19.06	173.82	18.0	13.0	0.96	5.94	57.37	18.8	24.6	0.8	6.0
128	N 16° 32'4.5" E 074°15'34.4"	7.5	0.211	0.99	4.5	482.94	17.79	130.36	25.5	9.0	0.84	4.60	53.55	11.4	26.0	0.6	8.4
129	N 16° 32'3.6" E 074°15'24.3"	7.1	0.23	1.32	6.5	536.25	17.16	76.04	16.5	12.5	0.64	5.61	66.30	19	37.2	0.4	10.2
23.Gorambe																	
130	N 16° 29'17.3" E 074°14'12.2"	8.3	0.09	1.26	6.5	492.35	24.32	239.00	27.5	6.0	1.04	4.69	67.57	51.0	29.0	1.2	5.6
131	N 16° 29'10.5" E 074°14'16.8"	8.4	0.11	0.76	8.5	366.91	28.02	97.77	30.0	14.0	1.08	2.93	72.67	14.4	18.2	0.4	5.2
132	N 16° 28'5.5" E 074°14'36.6"	8.1	0.29	0.81	11.0	388.86	20.10	358.51	26.5	14.0	1.00	7.28	84.15	13.8	28.4	1.4	7.2
133	N 16° 28'51.3" E 074°15'11"	7.5	0.13	0.52	4.0	247.74	23.80	217.28	22.0	12.5	0.94	6.28	63.75	14.6	75.0	0.6	8.0
134	N 16° 28'50.6" E 074°14'30.9"	8.0	0.22	1.13	7.0	495.48	18.20	130.36	24.4	15.5	0.98	3.93	70.12	30.0	25.6	0.8	11.6
135	N 16° 28'43.5" E 074°14'8.4"	7.7	0.30	0.76	6.5	348.09	18.08	282.46	22.0	14.5	0.88	5.36	82.87	26.2	70.2	1.2	8.2
24.Kenvade																	
136	N 16° 28'43.6" E 074°13'56.6"	8.2	0.16	0.62	14.0	285.37	19.35	184.68	27.0	14.5	1.02	8.20	39.52	35.8	22.8	0.6	9.6
137	N 16° 28'59.8" E 074°13'14.1"	8.1	0.61	0.89	8.0	407.08	23.11	239.00	26.5	14.5	0.98	7.95	84.15	12.6	24.8	1.4	5.6
138	N 16° 28'57.4" E 074°13'36.9"	8.4	0.16	0.68	7.5	310.46	22.30	86.19	26.5	16.5	1.10	7.28	72.67	10.2	18.0	0.6	5.2
139	N 16° 23'44.1" E 074°13'40.7"	8.3	0.36	0.76	6.5	344.96	24.12	206.41	27.5	14.5	1.00	6.70	62.47	11.2	21.6	1.0	7.0

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
140	N 16° 28'31.3" E 074° 13'41"	8.0	0.19	0.91	5.5	410.81	13.17	108.64	24.5	14.0	0.98	6.28	45.90	13.6	24.4	1.6	8.4
141	N 16° 28'21" E 074° 19'29"	7.8	0.35	0.78	10.5	351.23	17.21	130.36	21.5	17.5	0.92	5.61	63.75	12.8	30.0	0.4	6.2
25.Savarde																	
142	N 16° 28'12.1" E 074° 12'59.8"	8.1	0.48	0.68	12.0	304.19	20.39	304.19	26.5	15.5	0.98	7.28	84.15	12.8	40.6	0.4	4.6
143	N 16° 28'06.2" E 074° 12'58.2"	7.8	0.19	0.81	9.0	360.64	15.88	206.41	18.0	17.0	0.92	6.6	72.67	15.4	39.2	1.2	4.2
144	N 16° 28'00.2" E 074° 12'37.8"	8.2	0.36	0.56	10.0	247.74	21.03	260.73	27.0	14.0	1.04	3.68	45.90	17.2	34.8	1.0	7.0
145	N 16° 27'52.6" E 074° 12'30.8"	8.3	0.16	0.78	13.0	341.82	16.46	108.64	27.5	16.0	1.06	7.53	62.47	20.2	37.0	0.6	6.0
146	N 16° 27'43" E 074° 12'12"	7.4	0.14	0.72	8.0	313.60	15.31	445.42	22.0	12.5	0.78	2,51	53.55	13.8	22.6	1.4	8.0
147	N 16° 27'20.9" E 074° 12'27.9"	7.9	0.18	0.50	8.0	216.38	19.99	488.88	28.0	10.5	0.94	5.94	58.65	10.6	34.6	0.8	8.2
26.Chondal.																	
148	N 16° 26'09.6" E 074° 12'07.8"	6.8	0.26	0.81	7.5	413.95	12.88	586.65	16.0	14.0	0.40	2.51	26.77	10.2	37.8	1.8	6.0
149	N 16° 26'05.3" E 074° 12'02.8"	6.9	0.11	0.89	6.5	417.08	12.82	130.36	20.5	15.5	0.44	7.62	17.85	12.0	37.0	0.6	4.8
150	N 16° 25'53.9" E 074° 12'23.1"	6.9	0.10	0.89	6.5	410.81	15.48	195.55	23.0	13.0	0.48	3.56	66.30	14.8	39.2	0.8	3.8
151	N 16° 26'3.4" E 074° 12'52.5"	7.1	0.12	0.68	10.5	307.32	15.77	86.91	24.0	11.5	0.60	5.19	40.80	19.2	37.6	0.6	4.6
152	N 16° 26'11.6" E 074° 12'56.5"	7.8	0.26	0.70	5.5	316.73	19.29	65.18	23.5	13.5	0.92	6.53	61.20	21.8	23.2	0.4	7.2
153	N 16° 26'17.5" E 074° 13'5.2"	6.4	0.09	1.13	9.0	486.08	15.12	260.73	15.5	14.0	0.34	7.11	34.42	25.2	34.8	1.0	4.2
27.Bhadgav																	

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
154	N 16° 25'49.5" E 074°11'58.4"	7.8	0.31	0.85	6.5	382.59	15.31	336.78	24.0	11.0	0.92	7.78	38.25	24.2	29.6	0.6	6.0
155	N 16° 25'41.3" E 074°12'3.0"	6.8	0.30	0.44	6.5	197.56	12.24	282.46	16.0	10.0	0.46	6.86	26.77	19.2	27.0	1.0	3.8
156	N 16° 25'32.8" E 074°12'8.3"	6.4	0.28	0.78	4.5	348.09	15.42	130.36	15.5	13.0	0.40	11.64	43.35	21.0	28.0	0.6	3.8
157	N 16° 25'16.9" E 074°12'12.1"	8.0	0.11	0.85	8.5	376.32	19.64	86.91	20.5	15.0	0.98	8.54	47.17	22.2	21.2	1.2	10.2
158	N 16°24'551.4" E 074°11'59.3"	6.4	0.40	1.30	3.5	467.26	15.48	401.96	15.5	12.5	0.26	11.89	38.25	28.4	22.4	0.8	17.2
159	N 16° 24'52.8" E 074°11' 49.8"	7.3	0.15	0.79	7.5	351.23	19.58	152.09	23.5	13.5	0.68	12.89	40.89	25.2	43.0	0.6	7.2
28.Kurne																	
160	N 16° 24'49.4" E 074°11'35.5"	6.4	0.48	1.50	6.0	420.22	12.88	336.78	15.5	12.0	0.24	5.36	43.35	24.2	61.0	0.4	6.4
161	N 16° 24'44.0" E 074°11'16.4"	6.4	0.29	0.74	3.5	326.14	14.79	239.00	16.0	13.0	0.26	5.86	38.25	19.2	45.8	1.0	3.6
162	N 16° 24'45.4" E 074°10'55.1"	7.9	0.30	0.83	5.0	363.77	16.12	184.68	23.5	14.0	0.94	7.53	47.17	21	34.6	0.6	6.6
163	N 16° 24'51.7" E 074°10'56.0"	6.9	0.11	1.0	4.0	410.81	14.44	86.91	21.0	14.5	0.46	3.75	63.75	20.4	45.8	0.8	5.0
164	N 16° 24'38.8" E 074°10'46.5"	6.2	0.08	1.13	4.5	417.08	13.57	206.41	16.5	9.5	0.22	4.43	70.12	22.2	21.8	1.2	7.4
165	N 16° 24'43.6" E 074°10'43.9"	7.9	0.54	1.00	7.0	401.40	17.21	162.96	23.5	13.5	0.90	5.94	58.65	16.4	21.4	0.6	5.2
29.Nidhori																	
166	N 16° 24'25.2" E 074°10'35.9"	7.1	0.13	0.45	3.0	200.70	15.60	619.24	20.5	14.5	0.60	7.9	66.30	28.4	41.6	1.2	8.0
167	N 16° 24'20.4" E 074°10'25.7"	6.2	099	0.39	3.0	178.75	13.05	217.29	12.5	11.5	0.22	4.43	51.00	40.2	58.2	1.0	12.6
168	N 16° 24'06.3" E 074°10'31.8"	6.9	0.23	0.70	4.5	316.73	12.01	282.46	13.5	11.5	0.46	6.86	43.35	46.6	42.2	0.8	11.8
169	N 16° 24'06.3" E 074°10'13.4"	6.3	0.37	1.30	5.0	410.81	17.04	119.50	14.0	12.5	0.24	4.52	63.75	32.2	57.6	0.6	8.8

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
170	N 16° 24'15.8" E 074°10'04.0"	6.1	0.11	0.85	3.5	382.59	14.38	195.55	14.5	11.5	0.20	4.35	58.65	33.2	22.6	0.8	4.6
171	N 16° 24'17.6" E 074°09'49.5"	6.9	0.12	1.18	4.0	398.27	12.13	228.14	10.5	8.5	0.34	5.02	47.17	90.4	22.6	1.2	8.2
30.Borvade																	
172	N 16° 25'28.2" E 074°08'19.5"	7.8	0.36	1.60	10.5	420.22	19.47	293.00	24.0	12.0	0.90	6.36	47.17	37.2	22.4	1.6	9.6
173	N 16° 25'31.1" E 074°08'15.5"	7.7	0.09	1.50	8.5	426.49	20.22	228.14	20.5	14.5	0.88	5.36	63.75	33.4	20.6	0.6	9.4
174	N 16° 25'17.7" E 074°08' 17.1"	7.4	0.20	0.93	3.0	395.13	13.40	315.05	25.5	9.0	0.74	3.85	54.82	19.2	20.0	1.2	9.0
175	N 16° 25'02.8" E 074°08'16.7"	6.8	0.12	0.74	3.0	351.23	12.42	282.46	22.0	10.5	0.38	4.52	43.35	18.8	19.6	0.6	4.6
176	N 16° 25'02.8" E 074°08' 19"	6.7	0.07	0.89	7.5	385.72	13.28	304.19	19.5	13.0	0.34	5.02	66.30	14.2	22.6	0.4	7.0
177	N 16° 24'31.3" E 074°08' 48.5"	7.6	0.36	1.20	8.5	401.40	18.20	195.55	23.5	12.0	0.80	5.27	53.55	29.8	22.4	3.0	13.4
31.Murgad																	
178	N 16° 24'03.0" E 074°14' 47.3"	6.6	0.10	1.60	7.0	417.08	13.17	282.46	16.0	15.5	0.30	4.02	31.87	19.2	22.4	1.0	10
179	N 16° 23'35.2" E 074°11' 46.8"	6.9	0.16	0.83	10.5	373.18	14.79	315.05	24.0	11.0	0.46	2.51	17.85	41.4	22.6	0.4	8.2
180	N 16° 23'25.5" E 074°12' 07.7"	6.8	0.07	0.81	5.0	366.91	14.96	304.19	24.5	8.0	0.38	4.52	44.62	41.8	22.1	0.6	5.8
32.Daulatwadi																	
181	N 16° 22'54.3" E 074°12' 59"	6.7	0.10	0.54	7.0	241.47	14.44	293.32	16.0	15.5	0.34	2.93	28.05	32.2	21.8	1.2	8.8
182	N 16° 22'37.8" E 074°13' 29.3"	7.4	0.15	0.78	8.0	329.28	18.48	315.05	23.5	14.0	0.74	3.60	76.50	41.0	22.0	1.0	11.4
183	N 16° 22'10.7" E 074°14' 00.9"	7.5	0.12	0.81	10.0	338.68	19.58	195.55	28.0	10.0	0.80	3.35	57.37	21.2	22.2	0.8	7.0
33.Haldawade																	

Sr. No.	GPS Reading	pH 1:2.5	EC 1:2.5 dS m^{-1}	O.C. %	$CaCO_3$ %	Available nutrient Kg ha^{-1}			Exchangeable. cmol(P^+) kg^{-1}			Available nutrient mg kg^{-1}		DTPA Extractable Micronutrient mg kg^{-1}			
						N	P	K	Ca	Mg	Na	S	Si	Fe	Mn	Zn	Cu
184	N 16° 22'08.3" E 074°14'10.1"	7.7	0.10	1.10	11.5	392.00	16.46	380.24	23.5	13.5	0.86	5.36	67.57	51.2	22.6	1.6	8.6
185	N 16° 22'02.5" E 074°14' 09.4"	7.2	0.10	0.68	11.0	285.37	13.75	640.97	16.5	15.0	0.66	4.52	51.00	67.8	22.4	0.6	9.4
186	N 16° 21'53.3" E 074°14'23.1"	7.6	0.21	1.30	13.5	395.13	28.31	488.88	22.0	13.0	0.80	5.27	53.35	23.4	22.2	2.0	9.0
187	N 16° 21'53.7" E 074°14'21.3"	8.5	0.12	0.21	12.5	206.97	15.36	521.47	27.0	15.0	1.12	6.93	25.50	16.0	21.8	1.4	9.8
188	N 16° 21'50.1" E 074°14'24.6"	8.1	0.22	1.30	11.5	398.27	15.60	217.28	17.5	15.5	0.90	2.51	43.35	40.2	20.6	0.4	11.8
189	N 16° 21'44" E 074°14'42.3"	7.7	0.12	0.64	13.5	304.19	21.37	228.14	24.0	12.0	0.82	3.51	40.80	18.2	22.6	1.4	11.0
34.Belvade																	
190	N 16° 21'15.8" E 074°15'11.6"	8.0	0.13	0.44	7.50	210.11	21.37	782.20	29.5	9.5	0.92	2.93	16.57	20.6	22.4	0.8	8.8
191	N 16° 21'07.8" E 074°15' 16.9"	8.4	0.06	0.25	10.5	141.12	18.37	347.64	27.0	14.5	1.06	7.51	35.70	20.8	20.4	0.6	6.0
192	N 16° 21'09.9" E 074°15'16.5"	7.8	0.02	0.35	7.0	181.88	13.75	260.73	24.0	12.5	0.86	3.17	66.30	17.4	22.4	0.6	5.2
193	N 16° 20'54.7" E 074°15'24.1"	8.3	0.10	0.83	14.0	310.46	19.29	619.24	27.5	15.5	1.02	6.61	57.37	26.2	35.0	0.4	7.2
194	N 16° 20'55.6" E 074°15'25.7"	7.8	0.02	0.29	10.0	153.64	13.28	271.60	22.0	14.5	0.90	2.59	41.17	20.6	22.4	0.8	7.2
195	N 16° 20'26.5" E 074°15'43.5"	7.6	0.58	0.52	7.5	244.60	12.07	488.88	25.5	9.0	0.80	5.27	67.57	24.6	22.2	1.4	10.2
35.Aalabad																	
196	N 16° 20'17.2" E 074°15'50.4"	8.2	0.10	0.97	10.6	454.72	15.94	521.47	27.0	15.0	1.00	5.44	39.52	22.2	21.6	0.4	6.8
197	N 16° 20'15.9" E 074°15'46.4"	8.0	0.23	0.58	10.9	285.37	17.04	282.46	24.5	16.0	0.92	8.54	72.67	14.2	21.8	1.0	8.6
198	N 16° 20'01.8" E 074°16'13.1"	8.3	0.15	0.52	10.7	272.83	18.48	358.51	27.5	15.5	1.02	5.86	51.00	21.2	21.2	0.6	8.2
199	N 16° 20'02.2" E 074°16'16.8"	7.9	0.18	0.89	10.6	385.72	15.48	260.73	23.5	11.5	0.94	4.52	65.02	18.8	20.4	0.4	7.4

8.VITA

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Of
MASTER OF SCIENCE (AGRICULTURE)
in
SOIL SCIENCE AND AGRICULTURE CHEMISTRY
2014

Title of Thesis : "GPS-GIS based soil fertility map of KAGAL tehsil of Kolhapur district (M.S.)"

Major field : Soil Science

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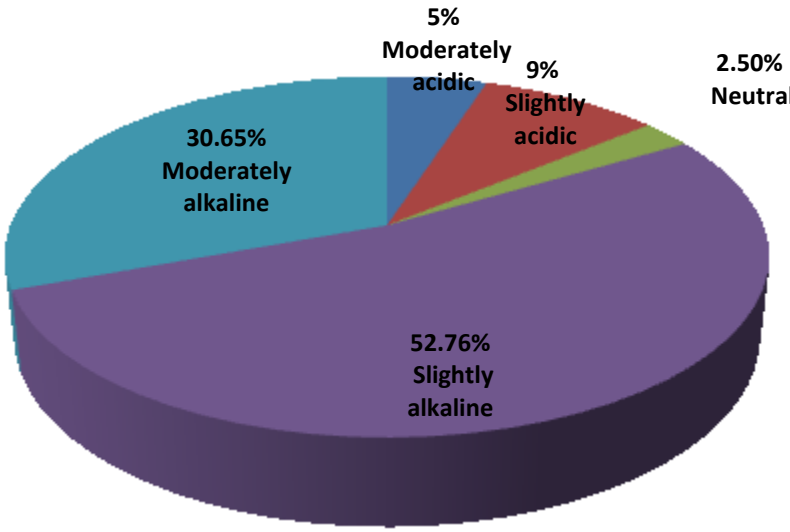

Chart No.1. pH content in soils of Kagal tehsil

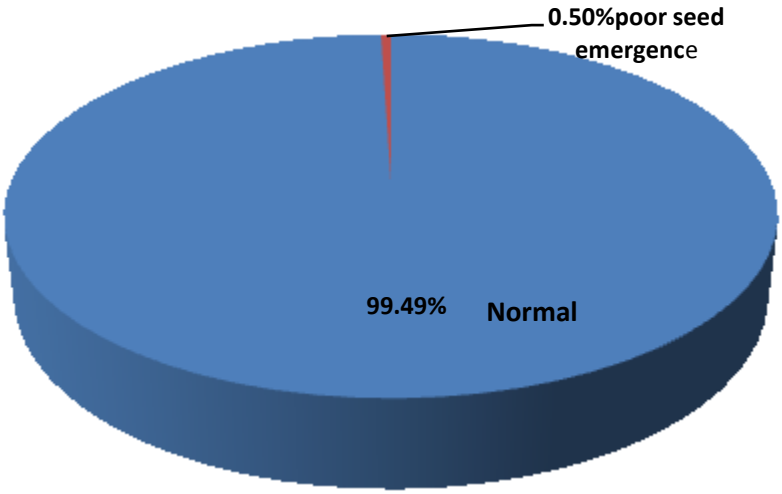

Chart No.2. EC content in soils of Kagal tehsil

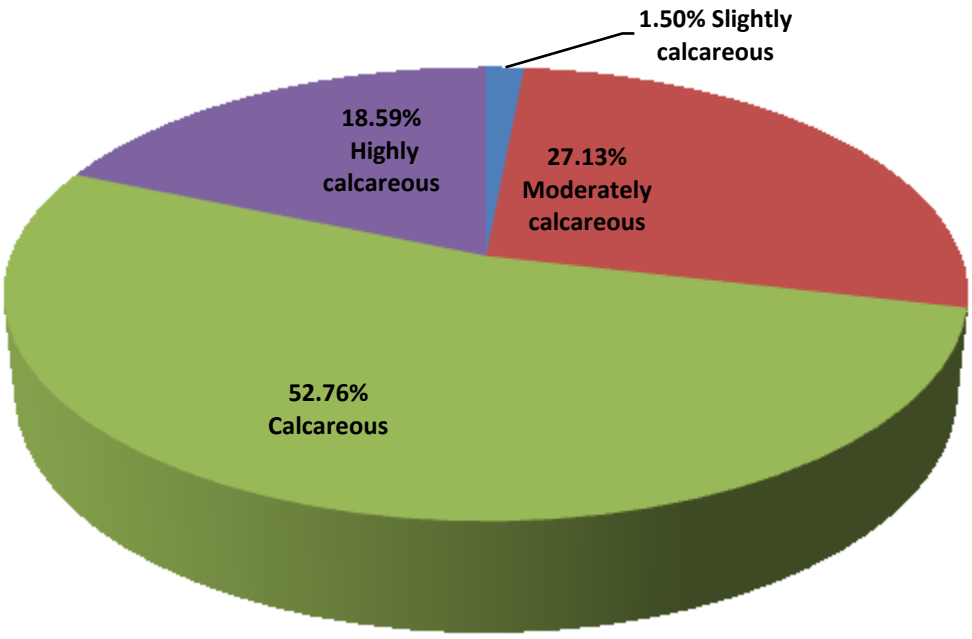

Chart No. 3. Per cent Calcium Carbonate in soils of Kagal tehsil

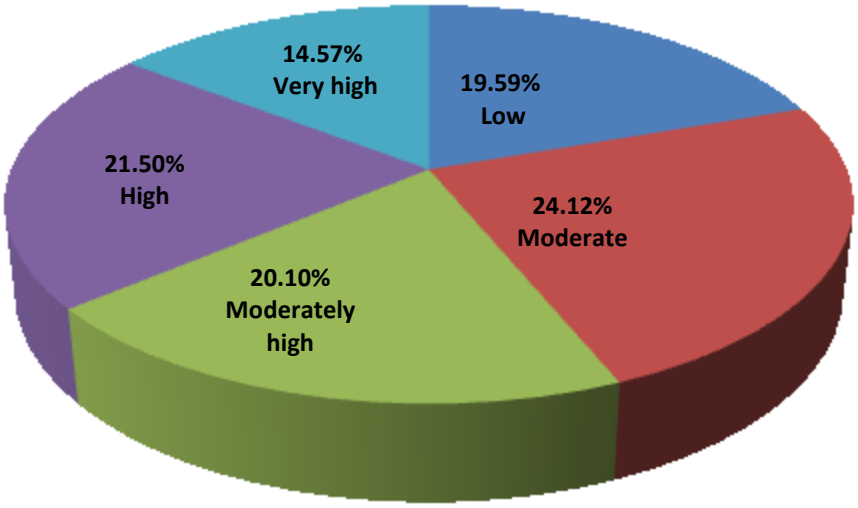

Chart.No. 4. Per cent Organic Carbon content in soils of Kagal tehsil

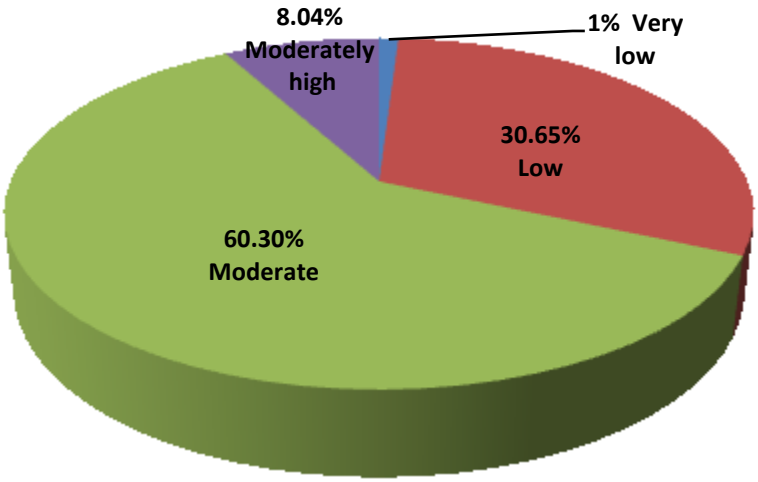

Chart 5. Avail.'N' content in soils of Kagal tehsil

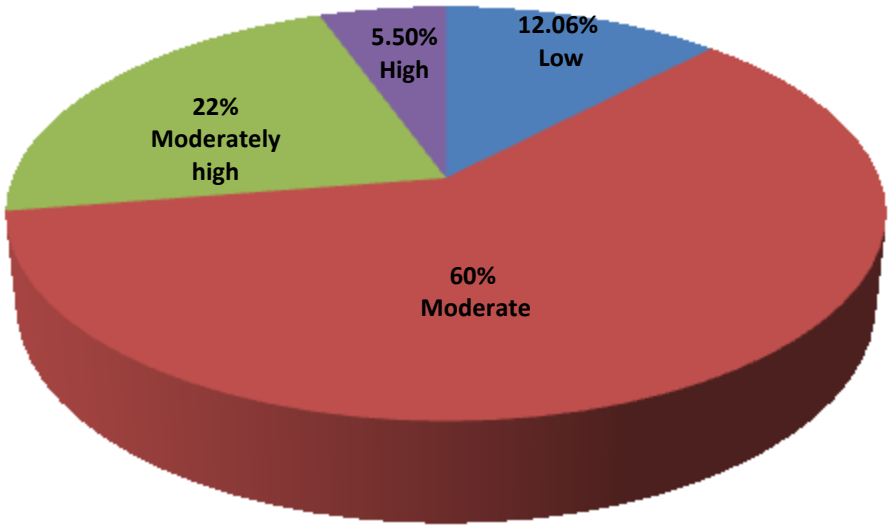

Chart 6. Avail.'P' content in soils of Kagal tehsil

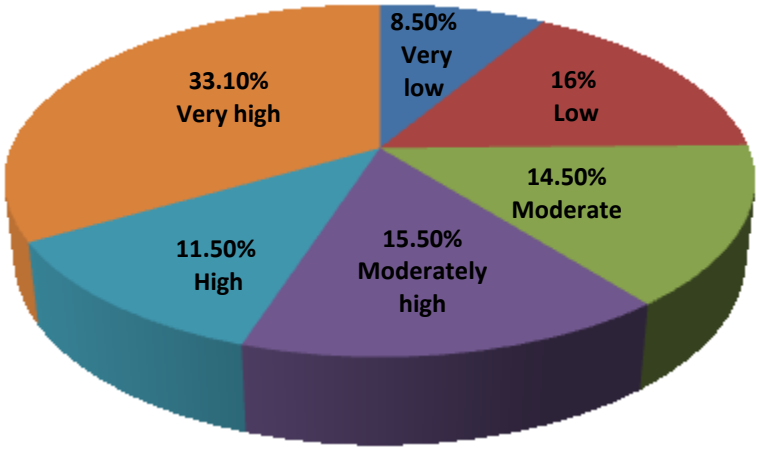

Chart 7. Avail. 'K' content in soils of Kagal tehsil

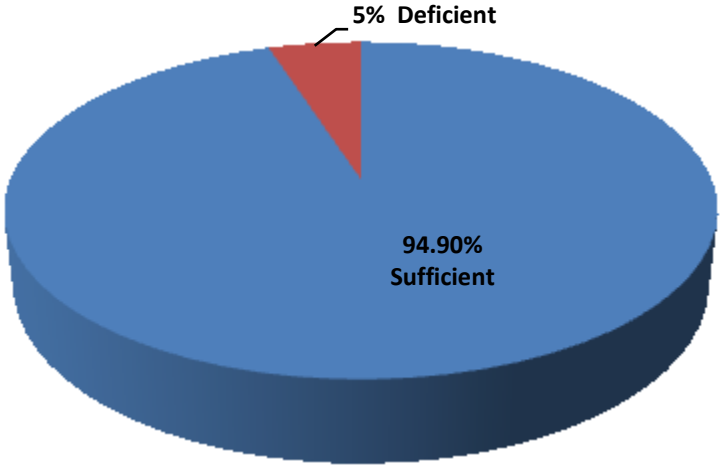

Chart No. 8.Exchangeable Calcium content in soils of Kagal tehsil

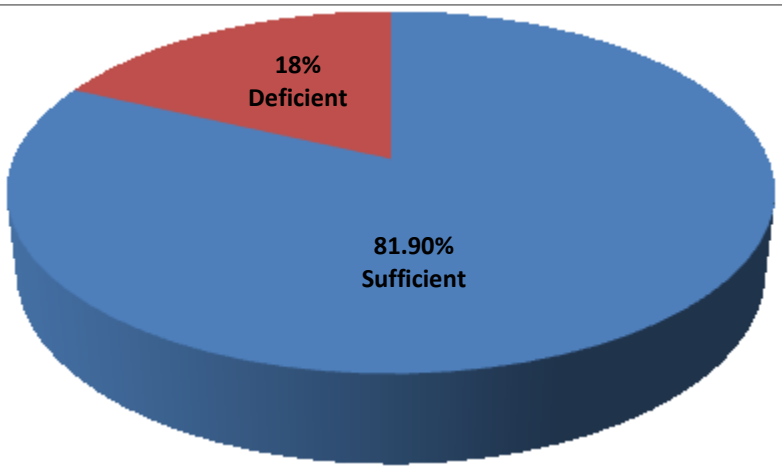

Chart No.9. Exchangeable Magnesium content in soils of Kagal tehsil

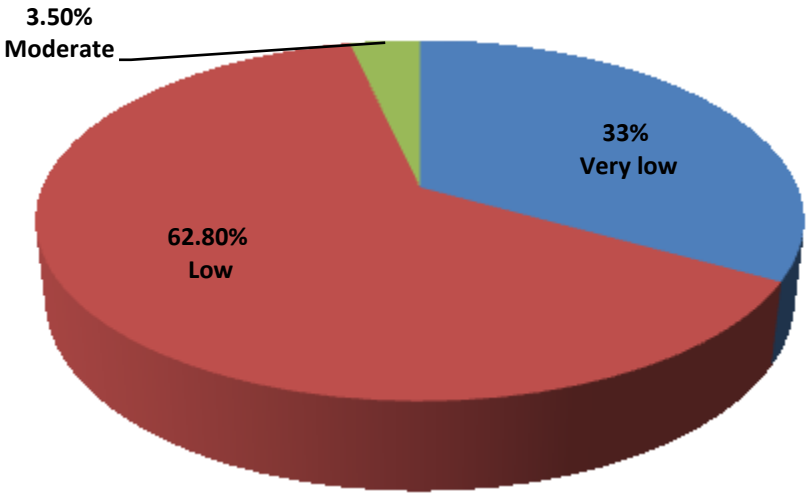

Chart No.10. Avail.Sulphur content in soils of Kagal tehsil

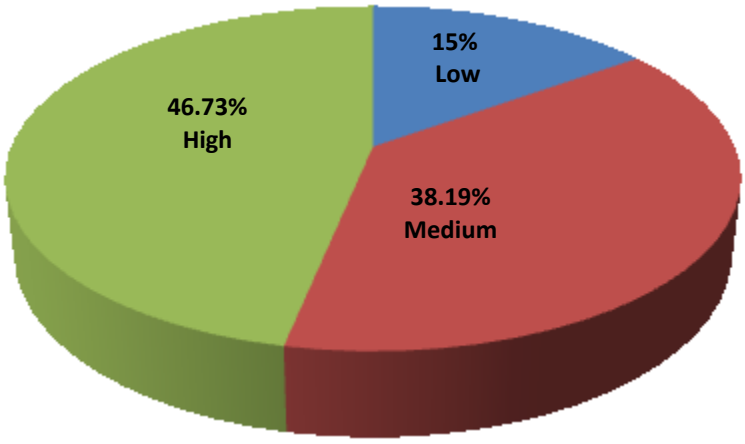

Chart No.11.Avail.Silicon content in soils of Kagal tehsil

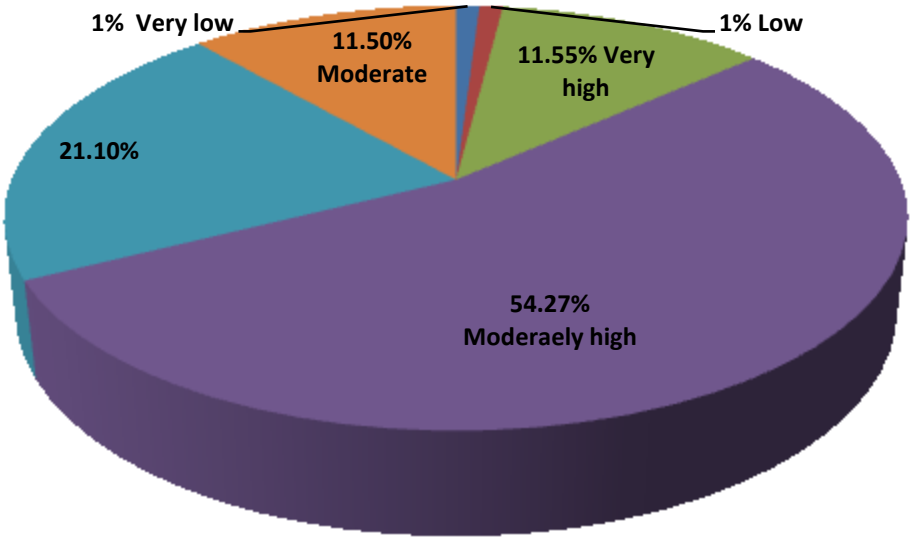

Chart No.12.Iron content in soils of Kagal tehsil

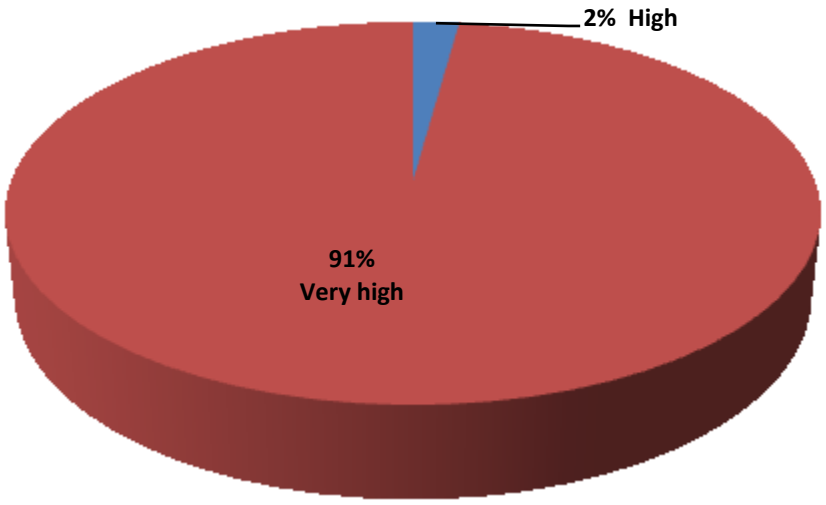

Chart No.13.Manganese content in soils of Kagal tehsil

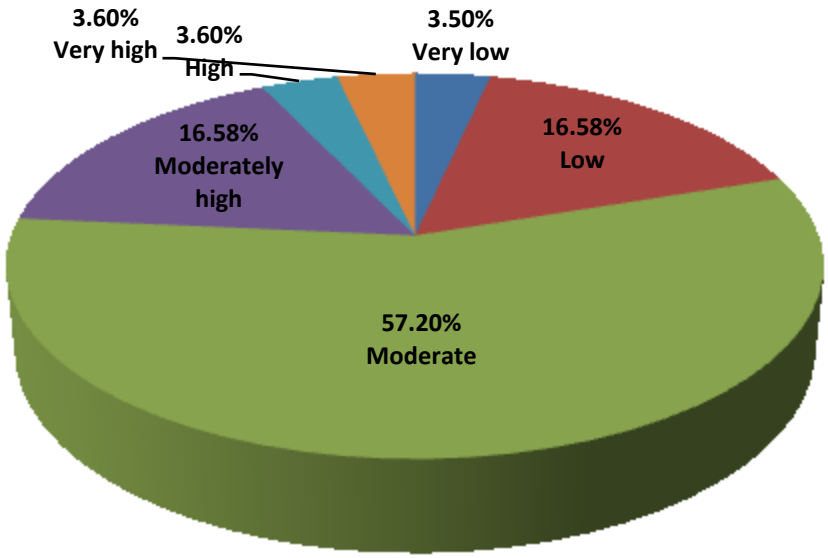

Chart No -15 Zinc content in soils of Kagal

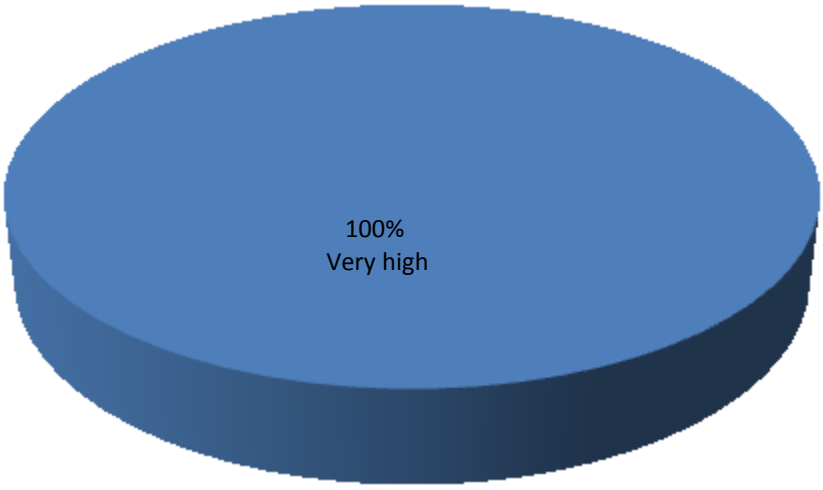

Chart No.16.Copper Content in soils of Kagal tehsil

Plate-12 GPS-GIS based map showing available silicon content in soils of Kagal tehsil

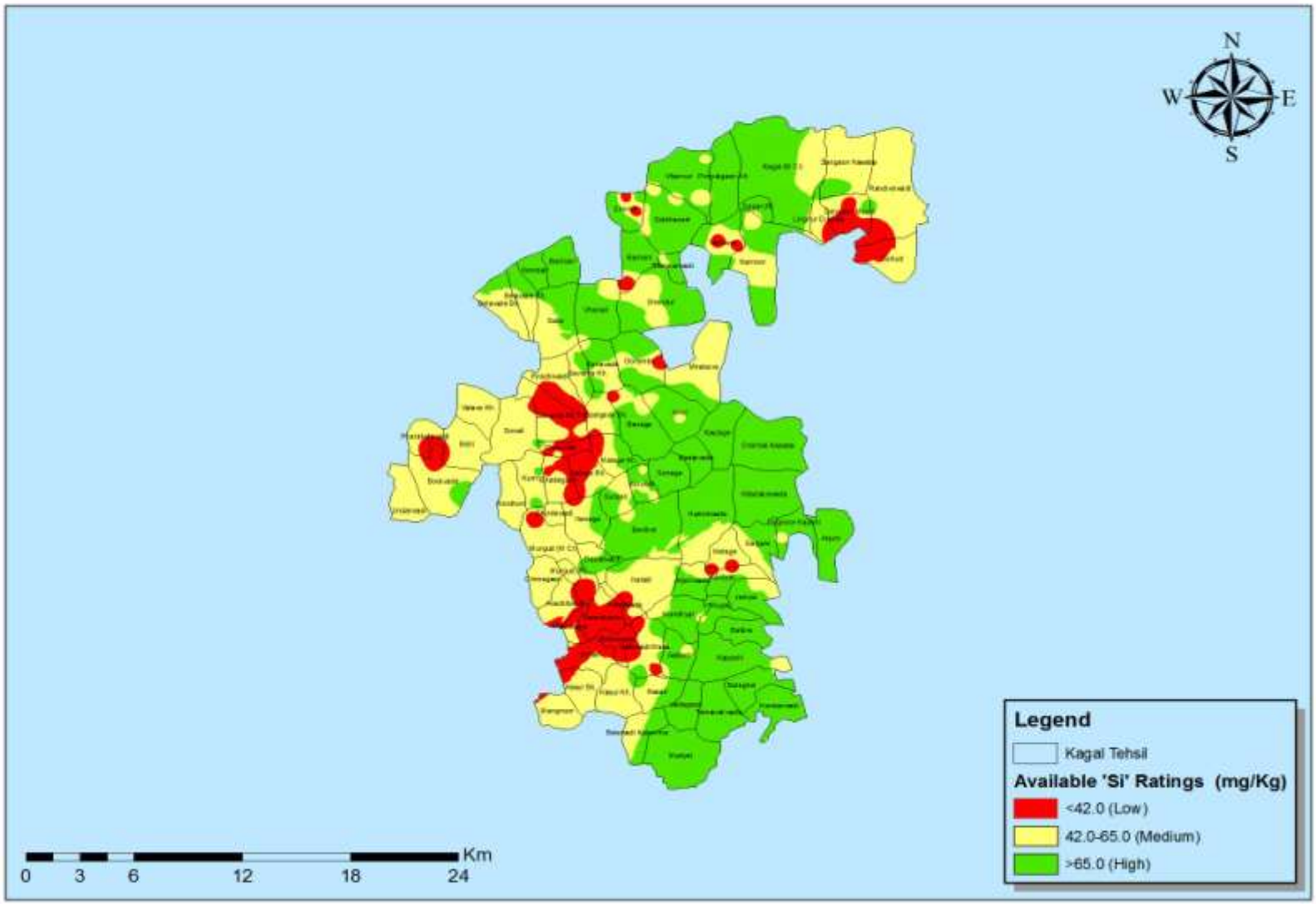

Plate-8 GPS-GIS based map showing available potassium content in soils of Kagal tehsil

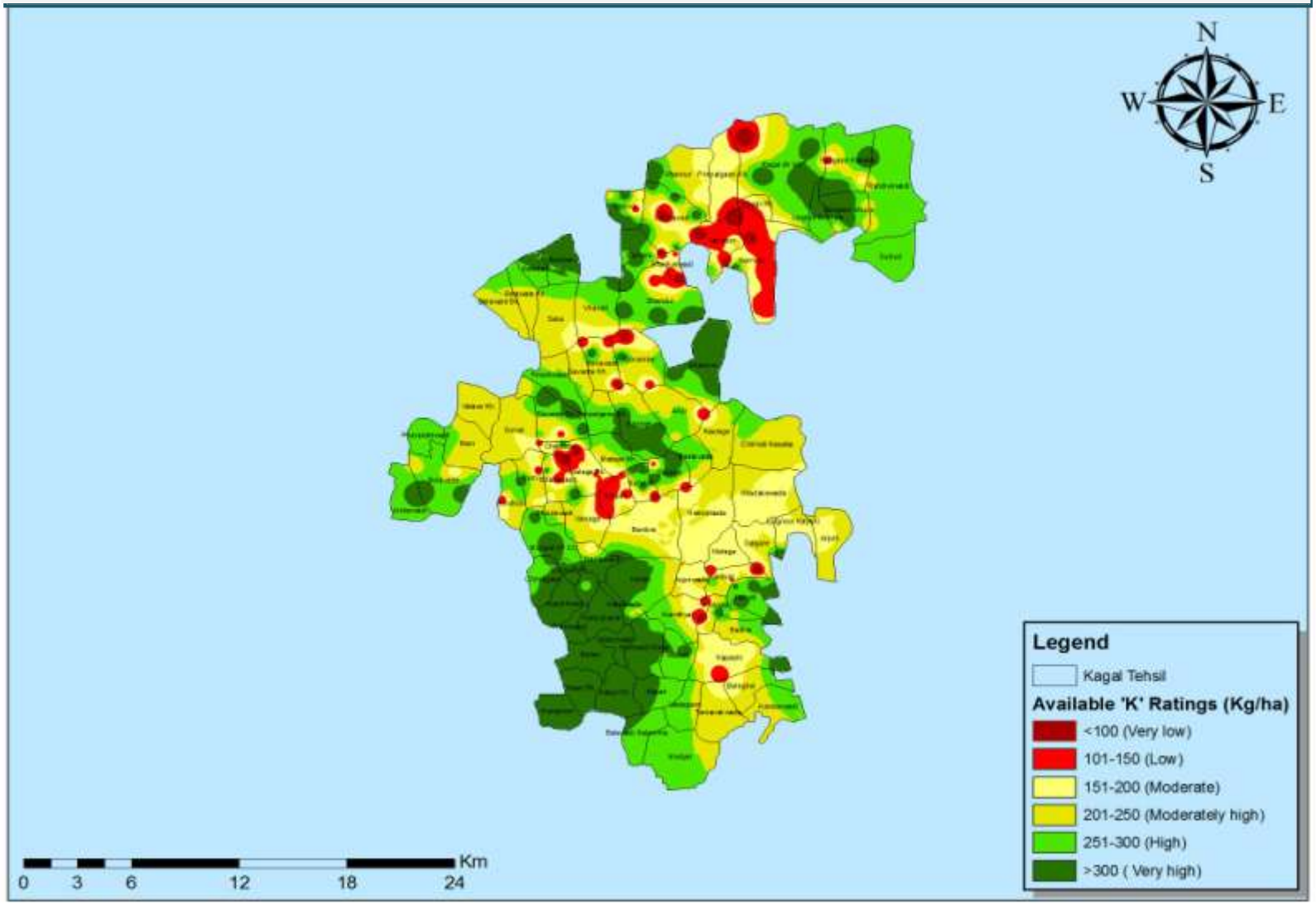

Plate-7 GPS-GIS based map showing available phosphorus content in soils of Kagal tehsil

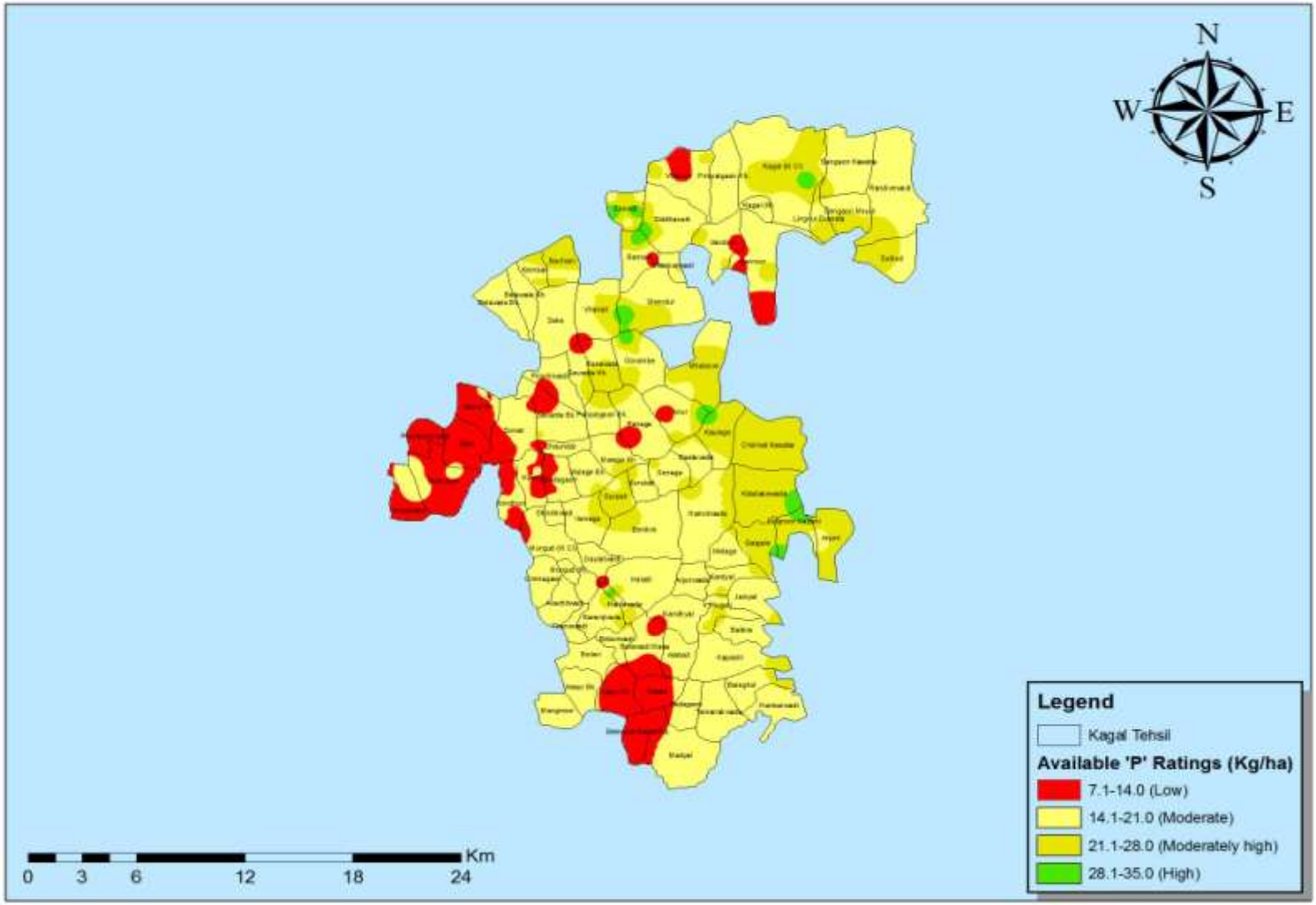

Plate-11 GPS-GIS based map showing available sulphur content in soils of Kagal tehsil

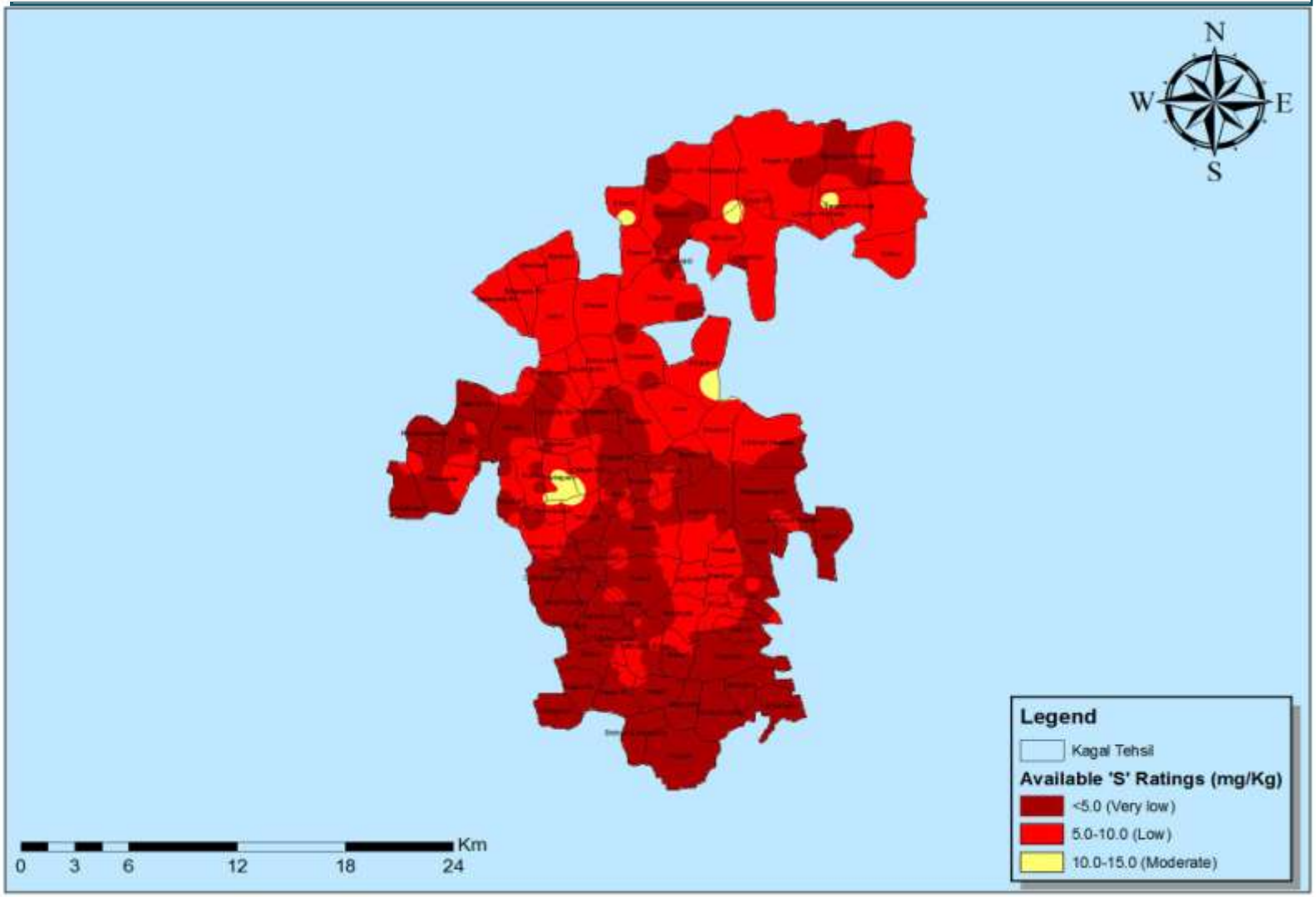

Plate-5 GPS-GIS based map showing calcium carbonate content in soils of Kagal tehsil

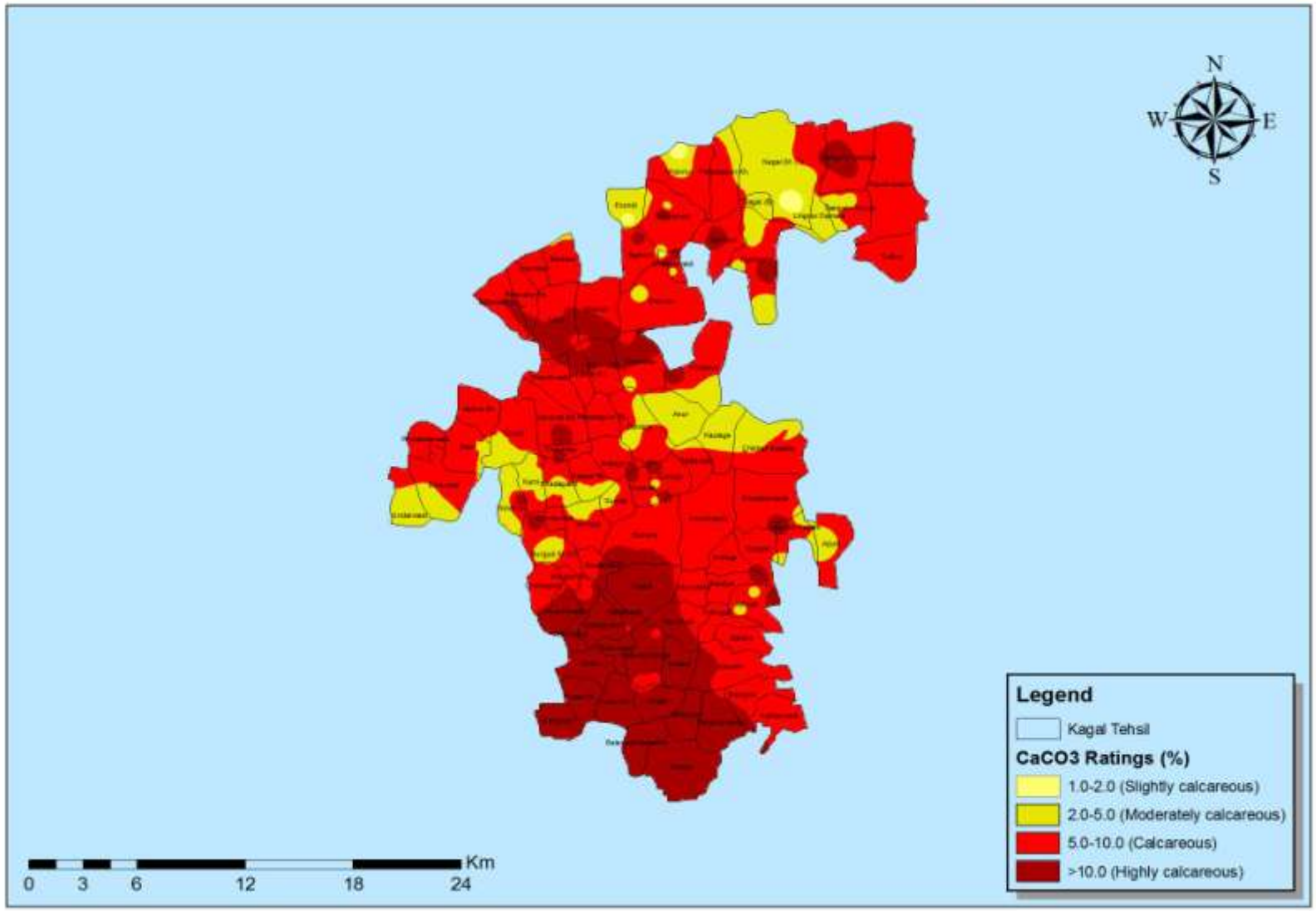

Plate-16 GPS-GIS based map showing DTPA extractable copper content in soils of Kagal tehsil

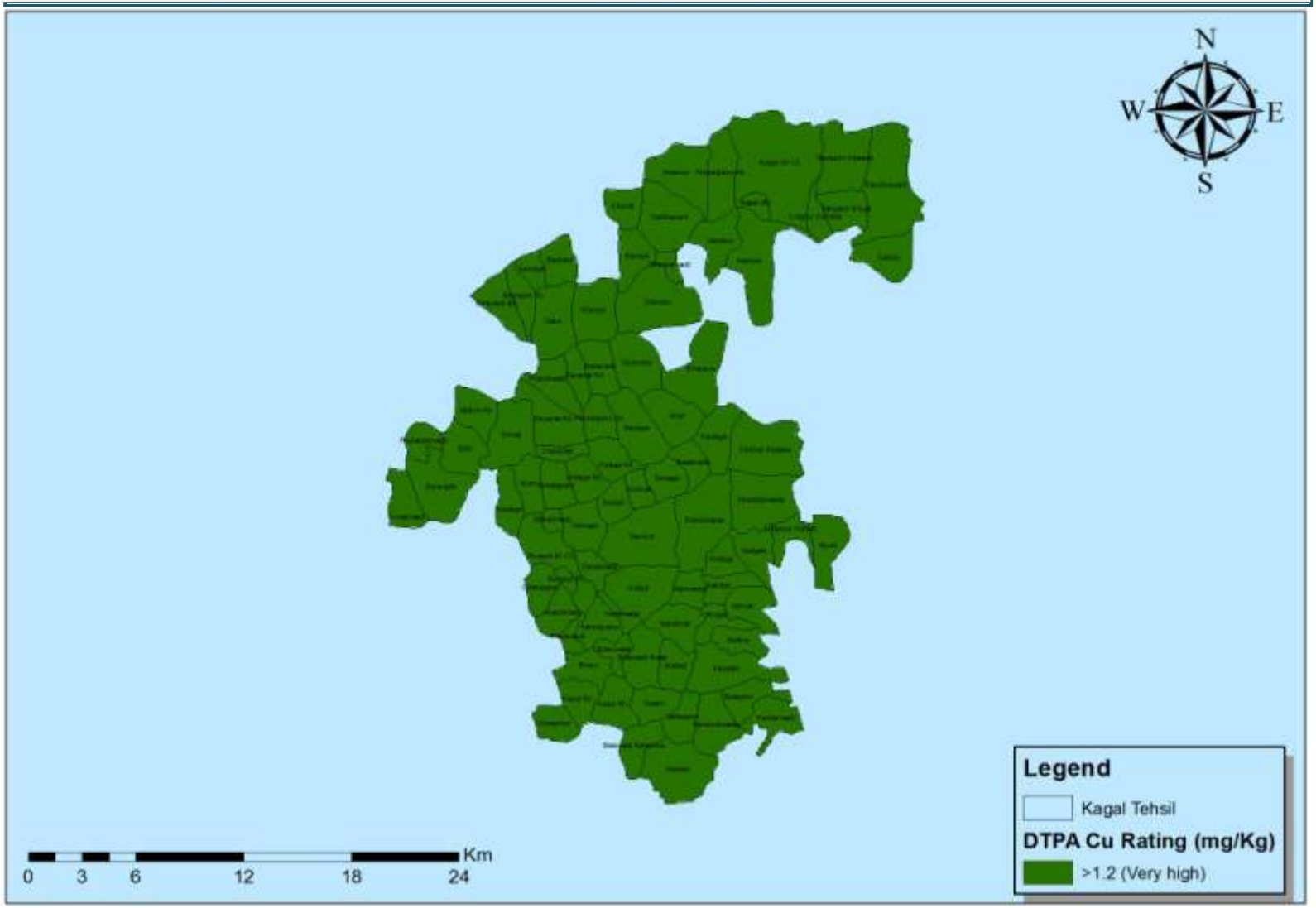

Plate-3 GPS-GIS based map showing electrical conductivity in soils of Kagal tehsil

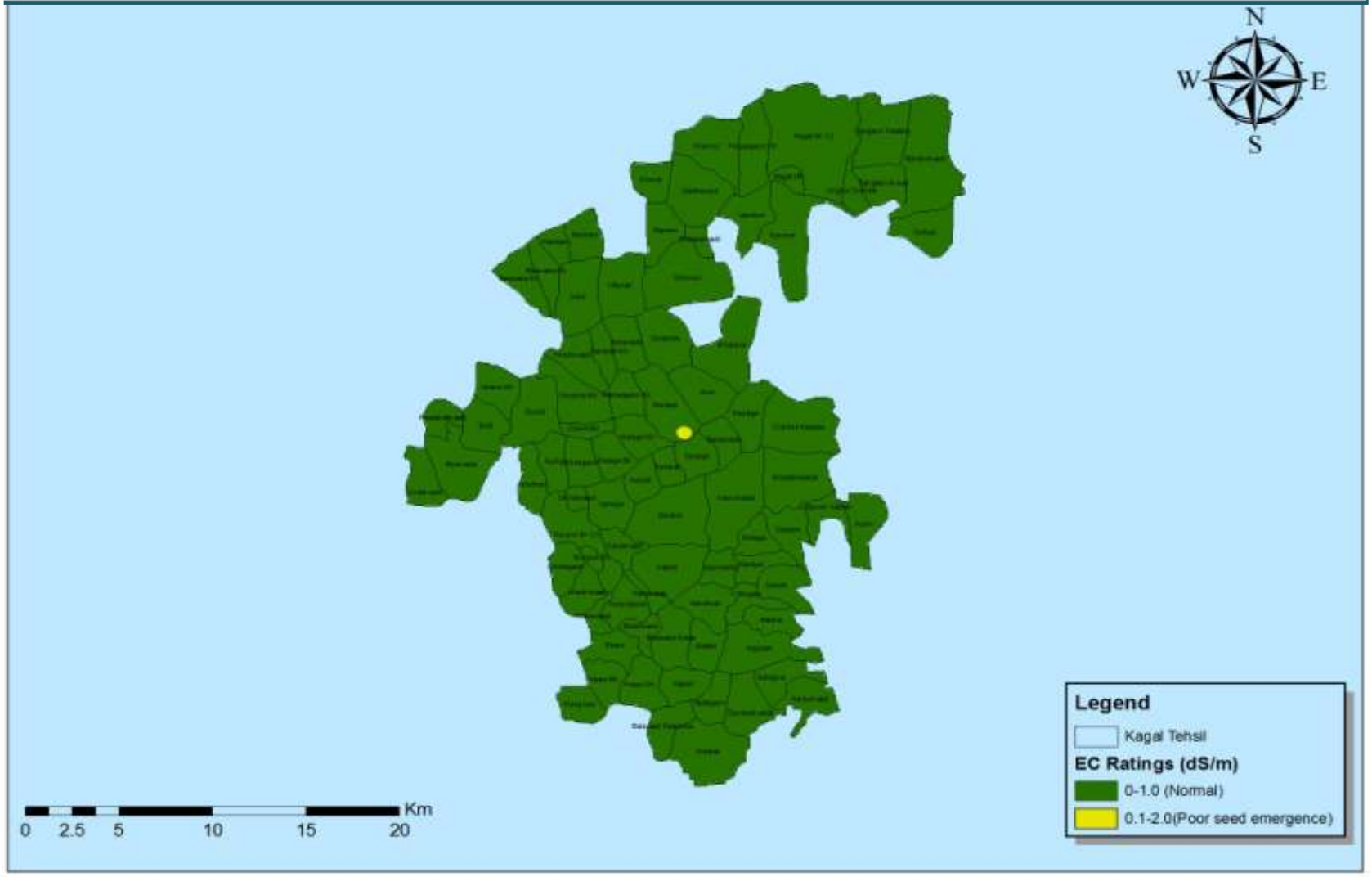

Plate-10 GPS-GIS based map showing exchangeable magnesium content in soils of Kagal tehsil

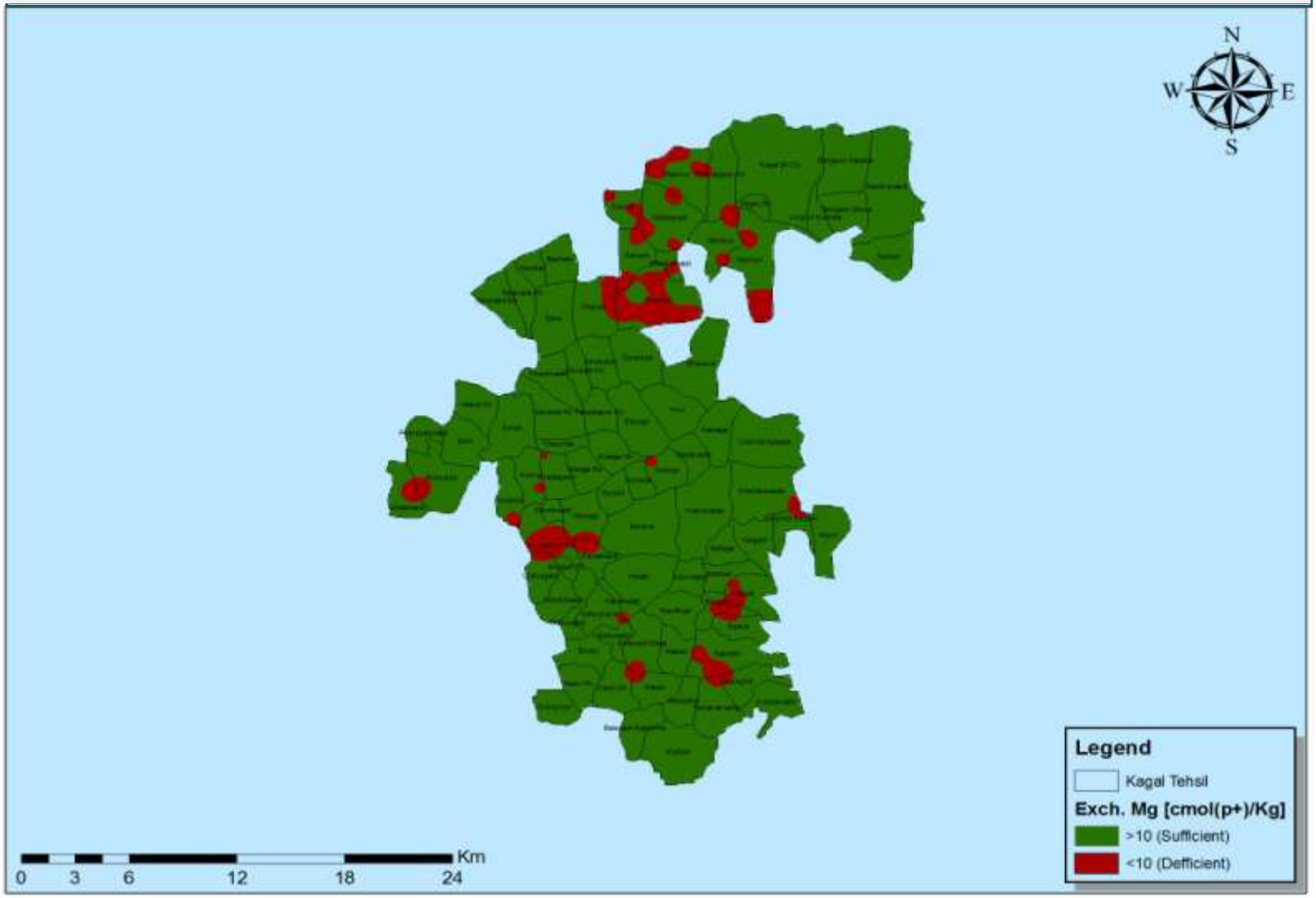

Plate-9 GPS-GIS based map showing exchangeable calcium content in soils of Kagal tehsil

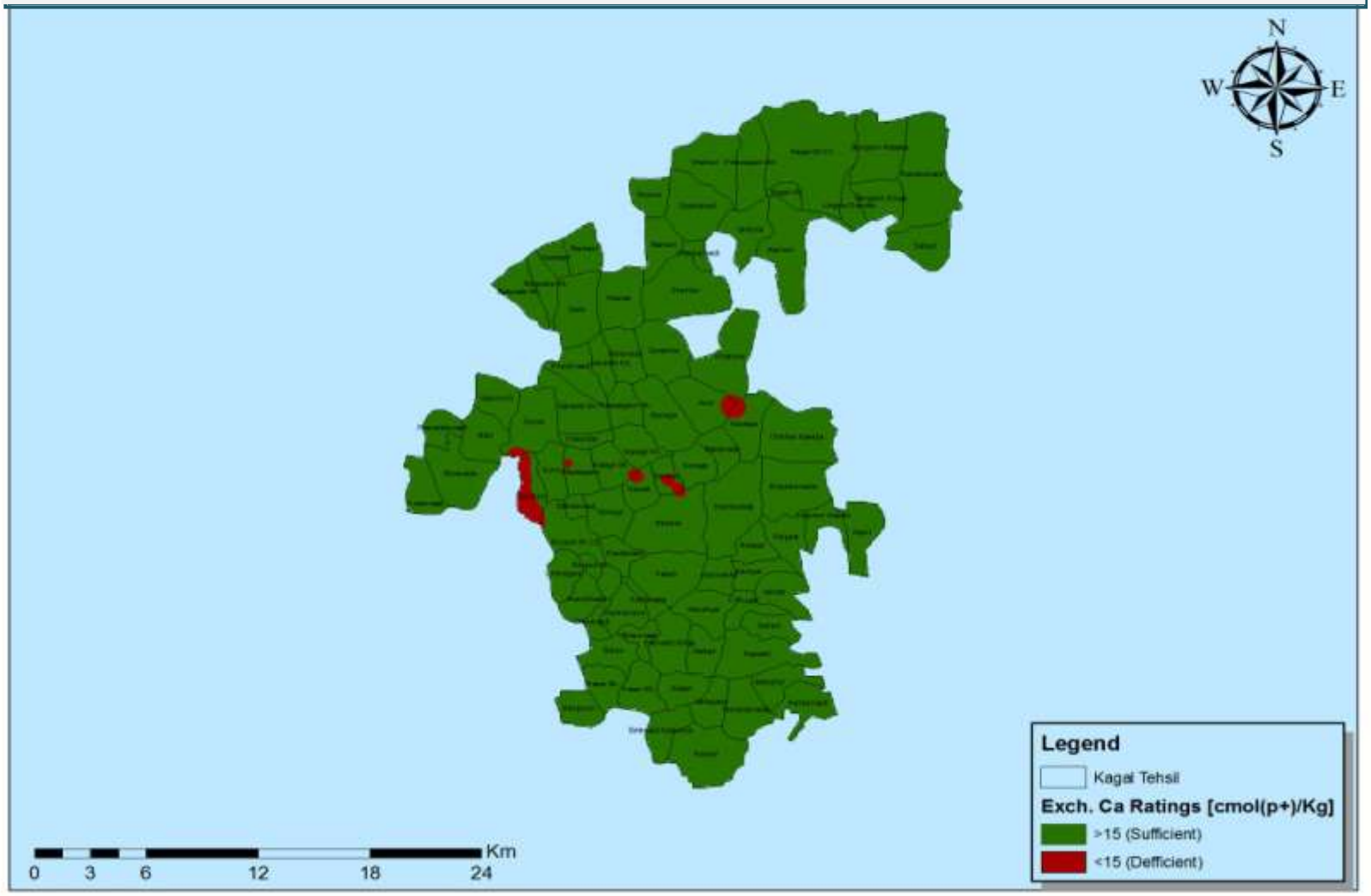

Plate-13 GPS-GIS based map showing DTPA extractable iron content in soils of Kagal tehsil

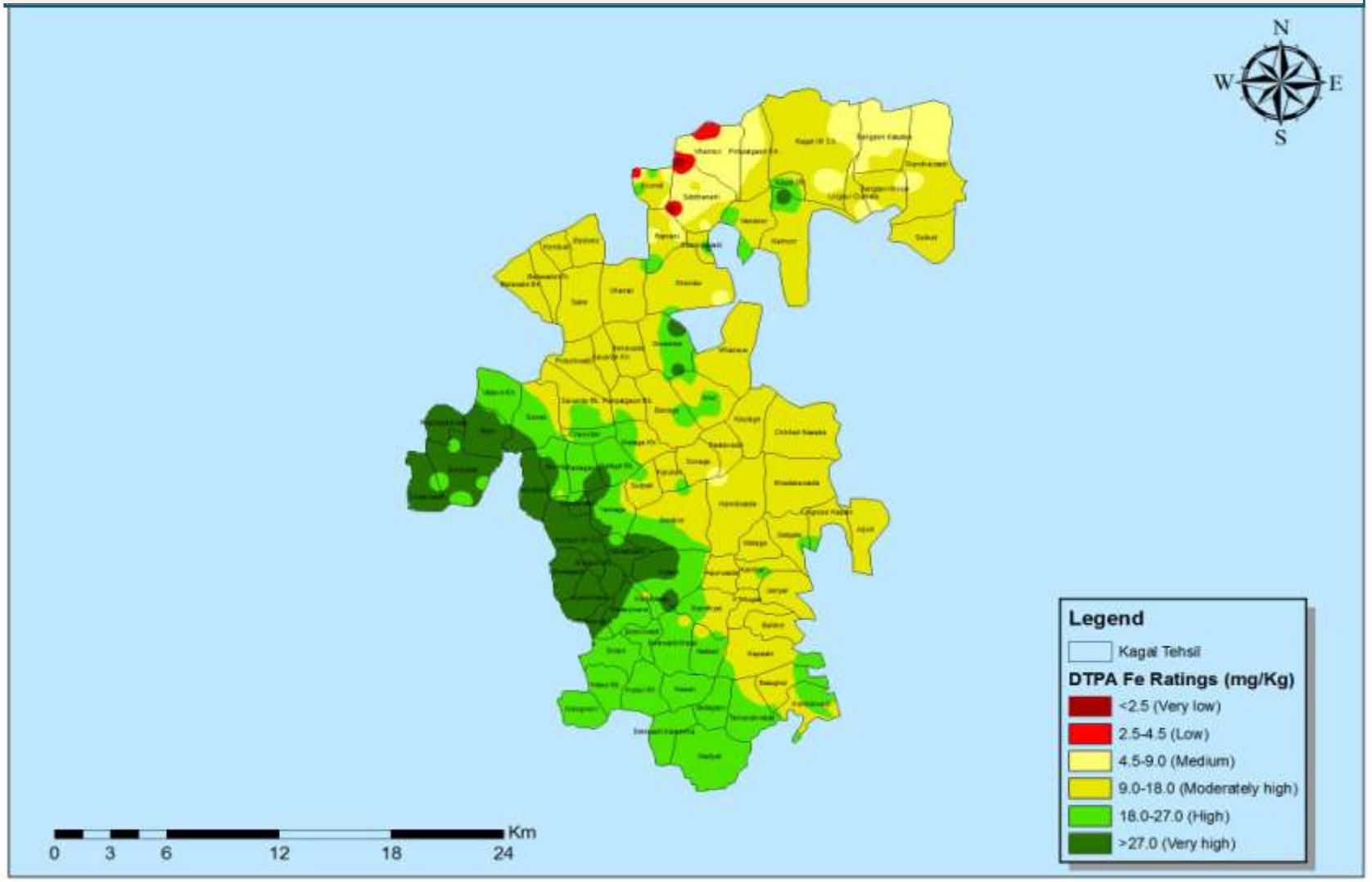

Plate-14 GPS-GIS based map showing DTPA extractable manganese content in soils of Kagal tehsil

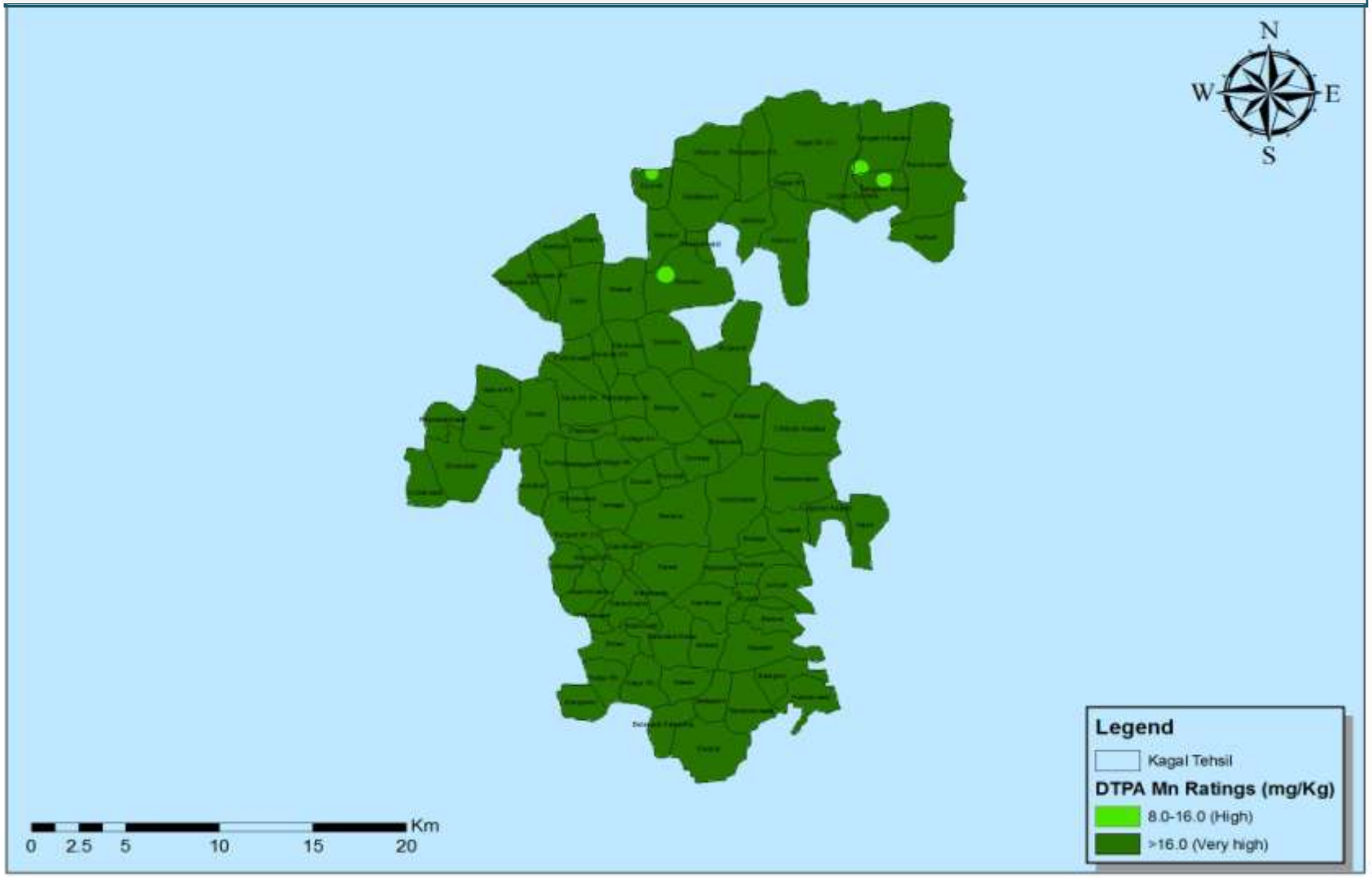

Plate-6 GPS-GIS based map showing available nitrogen content in soils of Kagal tehsil

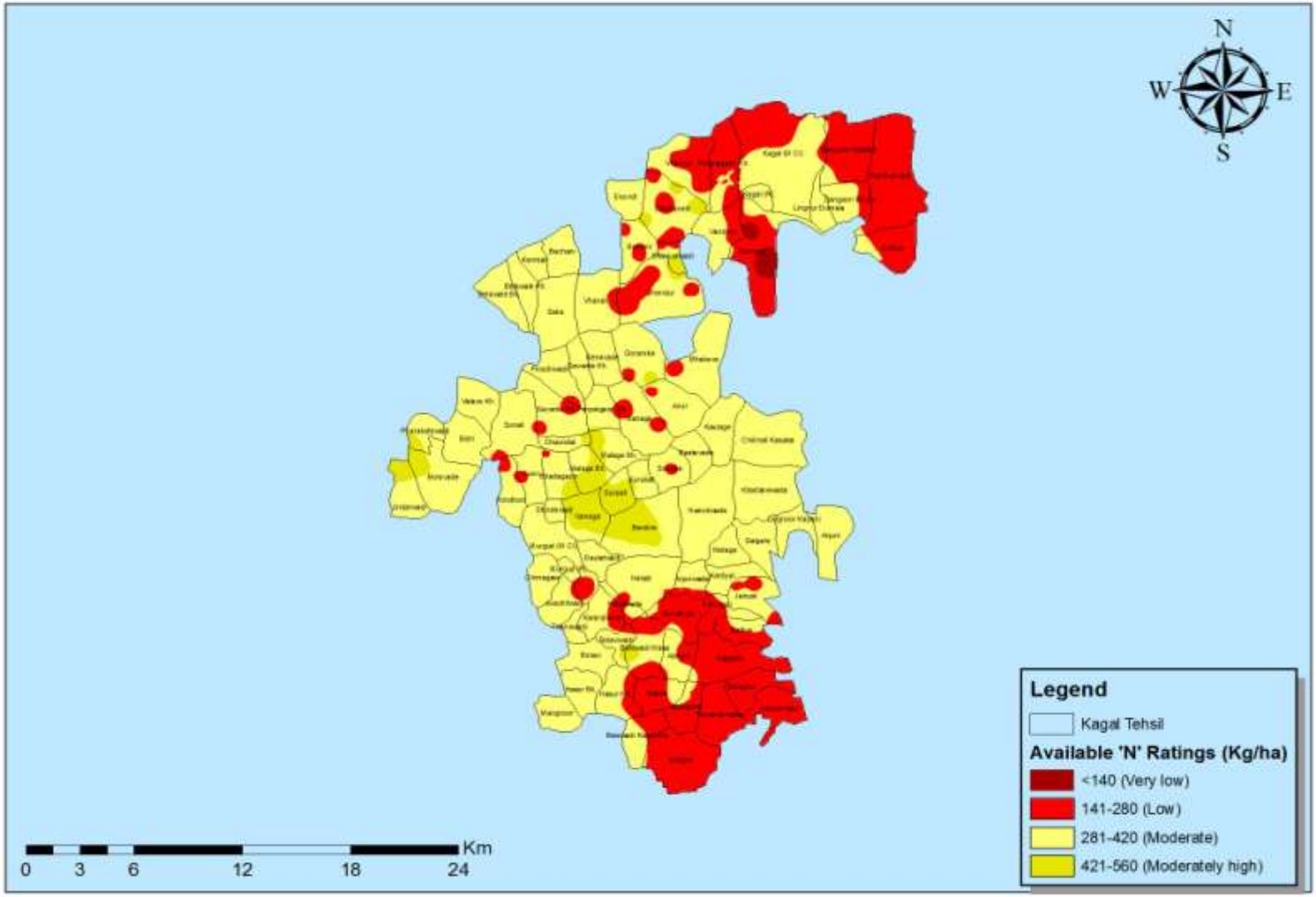

Plate-4 GPS-GIS based map showing organic carbon content in soils of Kagal tehsil

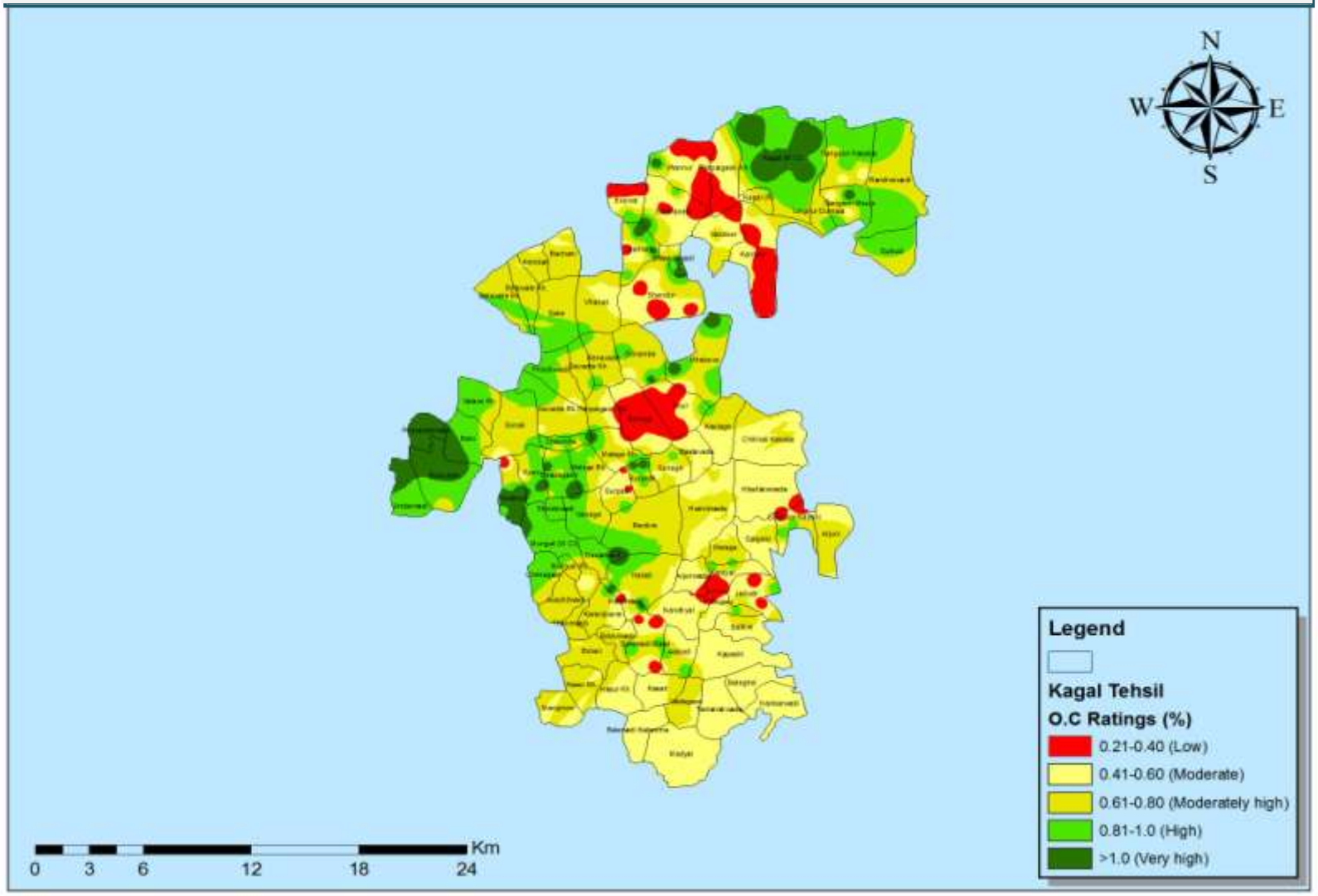

Plate-2 GPS-GIS based map showing pH in soils of Kagal tehsil

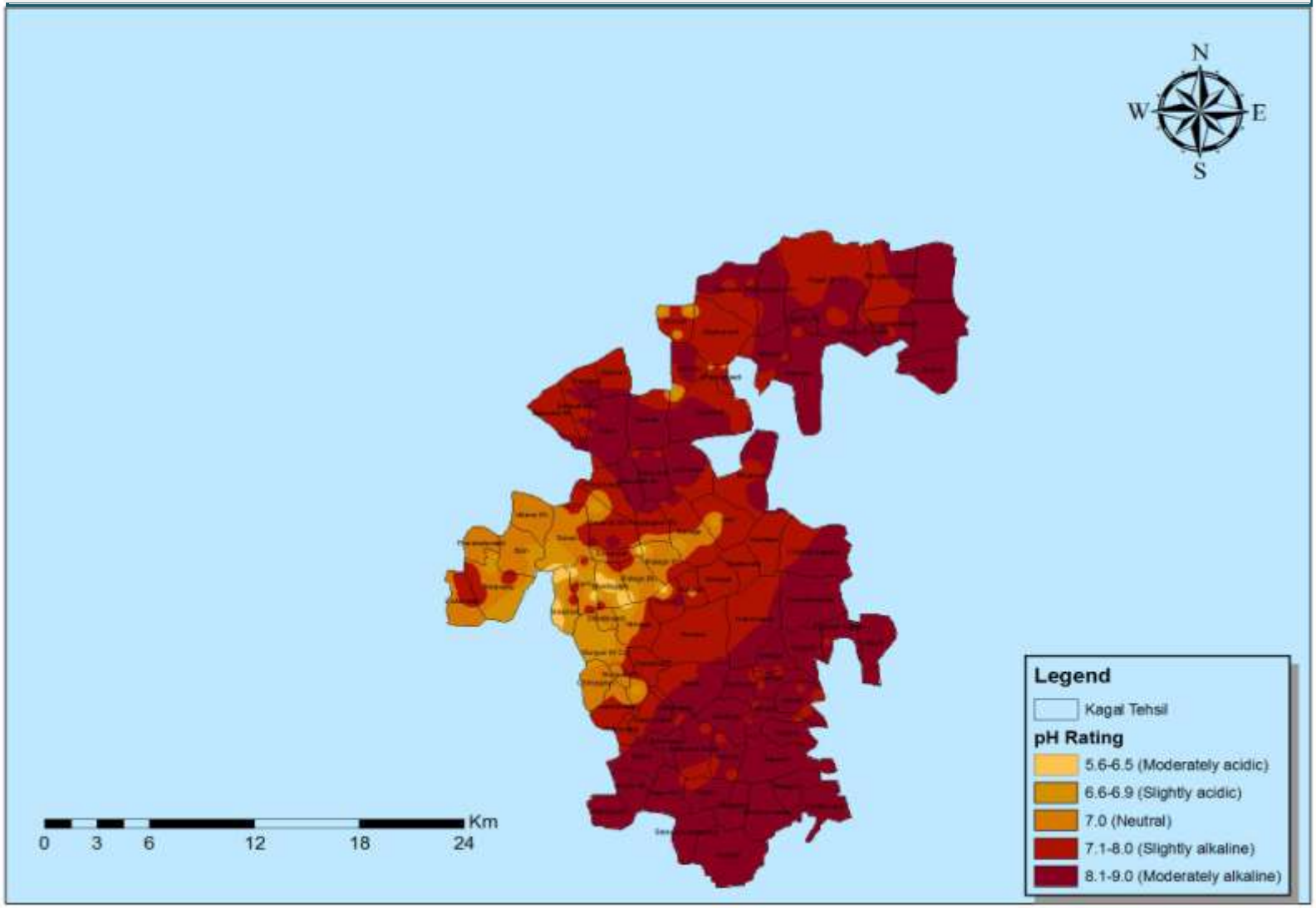

Plate-15 GPS-GIS based map showing DTPA extractable zinc content in soils of Kagal tehsil

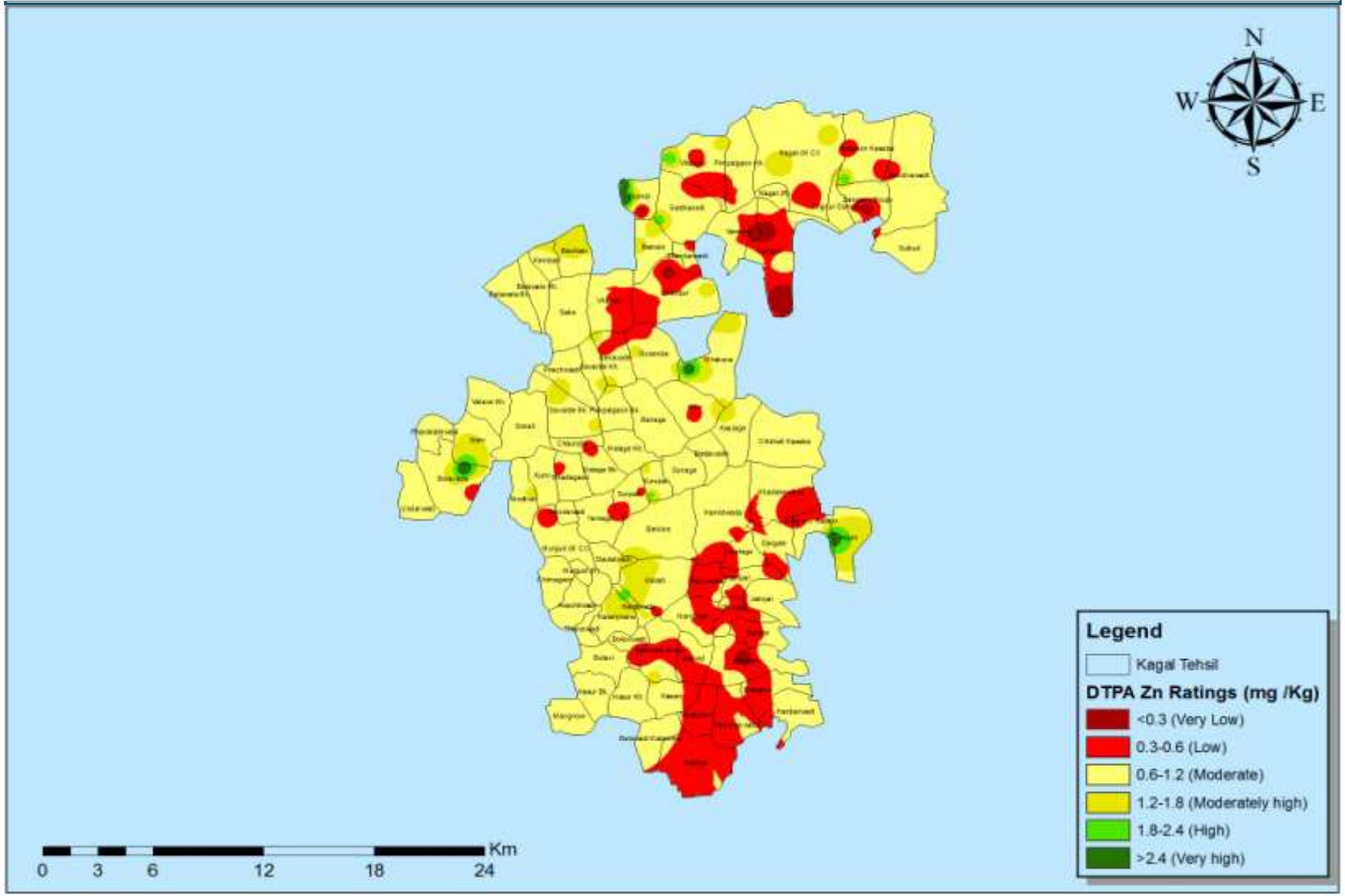

Plate -1 GPS GIS based map showing location of Kagal tehsil