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RESEARCH ARTICLE :

GPS based soil fertility maps of village Baragaon Nandur, taluka Rahuri, Ahmednagar

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SUMMARY : The present study entitled, "GPS based soil fertility map of Village Baragaon Nandur, Taluka Rahuri, Ahmednagar, was carried out during the year 2015-16 at the Department of Soil Science and Agricultural Chemistry, Post Graduate Institute Mahatma Phule Krishi Vidyapeeth, Rahuri. The soil fertilitymapswere prepared by using Global Positioning System (GPS) to make awareness among the farmers regarding use of balanced fertilization according to soil test based recommendation and integrated nutrient management for higher and sustainable crop production. The geo-referenced surface soil (0-22.5 cm) samples were collected from Village Baragaon Nandur by using Differential Global Positioning System (D-GPS).The analogue soil fertility maps on 1:2500 scale were geo-referenced and digitized by using ArcGIS software. These maps were integrated in GIS to generate a composite database of GPS based soil of BaragaonNandur Village. Based on the generated soil fertility maps, the status of pH,EC, organic carbon, $CaCO_{3,}$ available N, available P and available K was assessed and suitable crops such as cotton, wheat, pulses, vegetables and fruit crops have been identified. The pH and EC of soils of Village Baragaon Nadur varied from 7.78 to 8.73 and 0.17 to 0.69 dSm^{-1},respectively. The organic carbon and calcium carbonate content in soils varied from 0.21 to 0.82 per cent and 5.25 to 15.75 per cent, respectively. The available nitrogen, phosphorus and potassium were ranged from 137.90 to 310.40, 6.37 to 27.12, and 257.60 to 763.20 kg ha^{-1}, respectively. The soil of Village BaragaonNanadur recorded a very low to moderate available nitrogen, very low to moderately high in available phosphorus and high to very high in available potassium. The exchangeable calcium and magnesium content in soils ranged from 22.21 to 37.30 and 9.03 to 19.60 [cmol (p+) kg^1], respectively. The exchangeable calcium was 100 per cent sufficient and only 5.77 per cent area found deficient in exchangeable Magnesium. The available Sulphur in soils were ranged from 6.5 to 29.75 mg kg^{-1}. Only 41.34 per cent area were found deficient. These maps will be helpful for the farming community of the study zone to use properly the macro nutrients for different crops thereby saving costly inputs with increase in production, productivity, crop quality.

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BACKGROUND AND OBJECTIVES

Soils are considered as the integral part of the landscape and their characteristics are largely governed by the landforms in which they are developed. Topographic maps, aerial photographs and remote sensing data provide useful tools for geomorphic analysis of the region and help in the soil survey and mapping (Pandey and Pofali, 1982). The remote sensing techniques in conjugation with conventional methods have been employed successfully in India and different parts of the world (Sehgal *et al*., 1988).

The life supporting systems of a country and socio-economic development of its people depends on the soils. More than ever before, a renewed attention is being given to soils due to rapidly declining land area for agriculture, declining in soil fertility and increasing soil degradation, land use policies and irrational and imbalanced use of inputs (Kanwar, 2004). All the above factors call for a paradigm shift in research away from the maximum crop production to the sustainability of the crop production system without degradation of soil health and environmental quality. Systematic study of morphology and taxonomy of soils provides information on nature and type of soil, their constraints, potential, capabilities and their suitability for various uses (Sehgal, 1996).

Soils of Maharashtra State have been broadly classified as 1) The laterites and lateritic soils 2) The costal saline and costal alluvium soils 3) Shallow medium and deep black soil 4) Gray and red soils of mixed parent materials and 5) Saline, saline-alkaline and non-saline-alkaline soils (Raychaudhari and Chakravarty, 1943).

Soil is a vital natural resource and should be used judiciously according to its potential to meet the increasing demands of ever growing population. To ensure optimum agricultural production, it is imperative to know best fact about our soils and their management to achieve sustainable production. The quality of soil needs to be looked into because presently the natural resources are being over exploited. Soils of Maharashtra State are categorized as poor in fertility and vary widely in genetic, morphological, physical, chemical and biological characteristics (Challa, 1995). The nutrient deficiencies started appearing in different areas due to introduction of intensive production systems after green revolution period. It is due to net removal rates of micronutrients by crops being higher under intensive productivity regimes (Kanwar, 2004). The nutrient deficiencies situation was further increased by the discontinuous and diversified use of organic manures and chemical fertilizers.

The deficiencies of nutrients are now a days manifested and reported, but it is more of area, soil, crop and situation specific. Arnon and Stout (1939) enunciated the deficiency of any nutrient whether macro or micro can be eliminated only by application and provision of that nutrient and not by substitution of other in adequate amount. It holds true even today. It is also relevant to quote Liebig's law which state that the plant growth and development and ultimate economic yield is limited by the nutrient present in least available amount. Thus, the deficient one is decisive in their use to correct that deficiency. There are several reports, indicated that N, P and K nutrients are not giving as much response as before, due to the situation that have been explained to macronutrient deficiency (Kanwar, 2004). Intensification of agriculture aimed at obtaining the highest yields per unit time per unit area. There is increasing concern of yield stagnation owing to the state of fatigue to the soils which have depleted their nutrients status. The emergence of multi-nutrient deficiencies in the crop efficient zones of many soils is the consequences of intensive cropping.

The manifestation of nutrient deficiencies in soils and crop can be attributed to many factors resulting in their less availability. The major factor is anthropogenic in nature. The human intervention has led to present situation, due to lack of adequate knowledge of nutrient fertilizer application, management, inadequate and costly analytical facilities for testing and delineation of nutrient deficiencies in soils and crops. The situation is more aggravated because of depletion of nutrients from soils due to increasing crop productivity without their replacement.

Adoption of high yielding varieties and intensive cropping together with shift towards the use of high NPK fertilizers has caused decline in the level of micronutrients in soils below normal at which productivity of crops cannot be sustained. The deficiency of micronutrients has become major constraint for productivity and sustainability of soils (Yadav and Meena, 2009).

Global positioning system (GPS) and geographical information system (GIS) are advanced tools for studying on site specific nutrient management which can be efficiently used for monitoring soil fertility changes. The geo-referenced nutrient status of soils in Village Baragaon Nandur, Taluka Rahuri, dist-Ahmednagar would be useful for ensuring balanced fertilization to crops that demands the systematic study of macro as well as micronutrients status for assessment of nutrient status of soils to delineation of nutrient deficiency or sufficiency.

Study area :

The Village Baragaon Nandur is boundary between region located in between 19° - 21'N latitude and 74°-35' E longitude and covers total geographical area of 3845 ha. The elevation is 500m above mean sea level. The Village Baragaon Nandur, is situated about 38 km away from Ahmednagar city.

Soils of Village Baragaon Nandur is derived from the igneous rocks *viz*. Basalt (Deccan trap) which is basic in nature containing mainly feldspars, augite and small amount of titaniferrous magnetite mineral. In the vesicular rocks the any of daloidal cavities are filled with mineral like zeolite and quartz.

The soils of Village Baragaon Nandur are under the cultivation of Jowar, Bajara, Wheat, Gram, Pigeonpea, Soybean, Black Gram, Safflower, Sugarcane and Cotton crops. The natural vegetation grown comprises of dry deciduous tree species and some grasses. The dominant tree species are *Acasiaarabica, Azadirachtaindica, Zizyphusjujuba, Mangiferaindica, Prosopisjuliflora, Typhaangustata*.

The climate is usually hot and potential evapo-transpiration (PET) is far excess of the precipitation and is classified as semi-aired tropical. Village Baragaon Nandur, Taluka Rahuri, dist- Ahmednagar experience a hot spell from the month of March and May, with rains from June to September. The mean annual maximum and minimum temperatures were ranged from 32.9^{0}C and 18.8^{0}C, respectively. The Village Baragaon Nandur has annual precipitation of 517.8 mm. The rainfall is torrential, erratic, scanty and ill distributed.

RESOURCES AND METHODS

Geo-referenced surface (0-22.5cm) soil samples representing different survey numbers were collected from Village BaragaonNandur. The latitude, longitude and altitude of sampling sites were recorded with the help of Differential Global Position System, while sampling from each site following procedure were taken into account-

– The grid soil sample at 200m apart were carried out and the soil samples from each point was collected.

– Total 104 soil samples were collected from every grid spot located on cadastral map.

– Recorded of surveyed fields, latitude, longitude and altitude was maintained.

– The data on crops and use of fertilizers and manures were also recorded.

– The soil samples from selected site were collected by using stainless steel auger to avoid iron contamination.

Soil samples were brought to the laboratory and air dried under shade avoiding contamination with foreign materials and then crushed with a wooden pestle. The sample is then screened through a 2mm sieve and the pebbles, stones and roots were rejected. About 0.5 to 1 kg of air dried crushed soil sample was put in the plastic sample bottle, lebelled and stacked on the open sample racks for analysis. The analysis of soil samples have been done by using standard methods *i.e*. pH (1:2.5), EC (1:2.5), organic carbon (Walkley and Black method, 1934), available nitrogen (Alkaline Permanganate method), available phosphorus (Bray's No.-1), available potassium (Ammonium acetate method), Polygons were superimposed on the geo-referred map. Latitude, longitude and analysis data were entered into attributed table and linked to Arc GIS software for making thematic

Table A : Standard analytical methods used for chemical properties of soil

Sr. No.	Parameters	Method used	Reference
Chemical properties			
1.	pH (1:2.5)	Potentiometric	Jackson (1973)
2.	EC (1:2.5)	Conductometric	Jackson (1973)
3.	Organic carbon	Wet oxidation method	Nelson and Sommer (1982)
4.	$CaCO_3$	Acid neutralization	Piper (1966)
5.	Available nitrogen	Alkaline permanganate method	Subbiah and Asija (1956)
6.	Available phosphorus	0.5 *M* $NaHCO_3$ (pH 8.5)	Watanabe and Olsen (1965)
7.	Available potassium	(N *N*Ammonium acetate)	Jackson (1973)

soil fertility maps.

OBSERVATIONS AND ANALYSIS

The results of the present investigation entitled, "GPS based soil fertility maps of Village BaragaonNandur, Taluka Rahuri, Dist- Ahmednagar (M.S)", carried out during the year 2015-2016 with the view to study the nutrient status of soils of Village BaragaonNandur are presented and discussed in this chapter under following subheads. The 104 soil samples collected were analyzed and the data pertaining to different parameters are categorized as per the six tier rating. The chemical properties and the status from 104 soil sample are presented and discussed under following sub heads.

The pH of the soils ranged from 7.78 to 8.73 with the mean of 8.27. Among the 104 soil samples tested, 93.27 per cent soils were moderately alkaline and remaining 6.73 per cent soils were slightly alkaline. The highest soil pH was 8.73 (19°22.437N-0.74°36.070E) and the lowest was 7.78 (19°21.966N-0.74°35.607E). Similar results on soil reaction for alkalinity were reported by Katariya (2011) in soil collected from the Water Management Project-Block A, Central Campus,

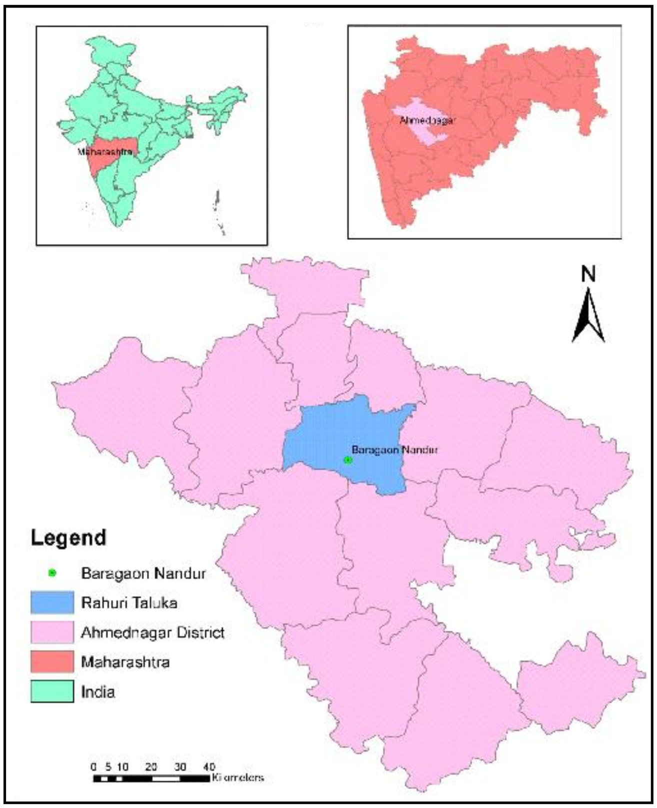

Plate 1a: Base map of Baragaon Nandur village, Rahuri taluka, Ahmednagar district, MH

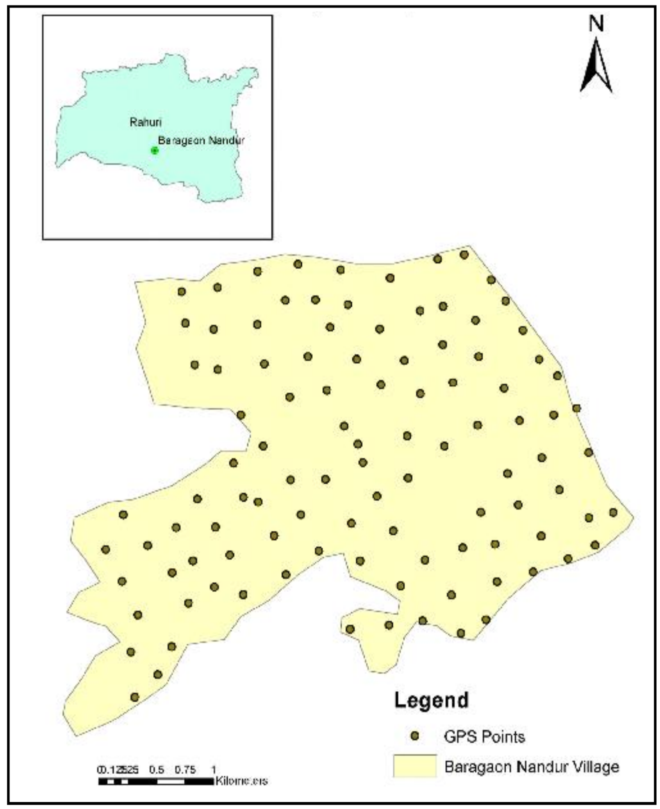

Plate 1b: GPS map of Baragaon Nandur village, Rahuri taluka, Ahmednagar district, MH

Table 1: Status of some chemical properties in soils of village

Particulars	pH (1:2.5)	EC (dSm^{-1}) (1:2.5)	Organic carbon (%)	$CaCO_3$ (%)
Mean	8.27	0.35	0.49	8.94
Range	7.78-8.73	0.17-0.69	0.21-0.82	5.25-15.75
Category	Slightly alkaline (6.73%)	Normal (100%)	Low (23.08%)	Medium (84.62%)
			Moderate (57.70%)	High (14.42%)
	Moderately alkaline (93.27%)		Moderately high (17.30%)	Harmful (0.96%)
			High (1.92%)	

M.P.K.V., Rahuri.

The data related to electrical conductivity of soils from Village BaragaonNandur are presented in Table 1 and is depicted on map (Plate 3). The EC of soil samples collected were ranged from 0.17 to 0.69 dSm^{-1} with the mean of 0.35 dSm^{-1}. The highest soil EC was 0.69 (19°22.135N-0.74°36.438E) and the lowest was 0.17 (19°22.438N-0.74°36.660E). The EC values indicated that all analysed soil samples (100%) are found normal in total soluble salt content and suitable for healthy plant growth. Majority of cultivated area from Village BaragaonNandur are naturally sloppy have natural drains is the cause for observed 100 per cent soils as normal soil for salt content. The similar results were reviewed and reported by Padole and Mahajan (2003) in swell-shrink soils of Vidharbha region.

The data on organic carbon content in soils from Village BaragaonNandur are presented in Table 1 and depicted on map (Plate 4) and that ranged from 0.21 to 0.82 per cent with a mean of 0.49 per cent. The organic carbon content of soil samples were found low (23.08 %), moderate (57.70%), moderately high (17.30 %), high (1.92%). The highest Organic carbon was 0.82 per cent (19°22.357N-0.74°37.396E) and the lowest was 0.21 per cent (19°21.488N-0.74°35.567E). The similar type of study and observation were reported by Meena (2009) andKhade (2012) in Central Research Farm of M.P.K.V, Rahuri.

The data on calcium carbonate status are presented in Table 1 and depicted on map (Plate 5). The calcium carbonate content in soils of Village BaragaonNandur ranged from the 5.25 to 15.75 per cent with an average of 8.94 per cent. Among the 104 soil samples collected, 84.62 per cent samples were found as medium and 14.42 per cent are high in $CaCO_3$ content. The highest soil $CaCO_3$ was 15.75 per cent (19°22.588N-0.74°35.943E) and the lowest was 5.25 per cent (19°21.799N-0.74°35.993E). It is well documented in the literature that the calcareousness is common in soils of arid and semi-arid climate particularly in Vertisols (Black soils) due to precipitation of carbonates and bicarbonates. The similar trend of $CaCO_3$ content reported in soils of Block C Central Campus M.P.K.V, Rahuri (Durgude, 1999). The high amount of $CaCO_3$ in sodic soil of purna valley

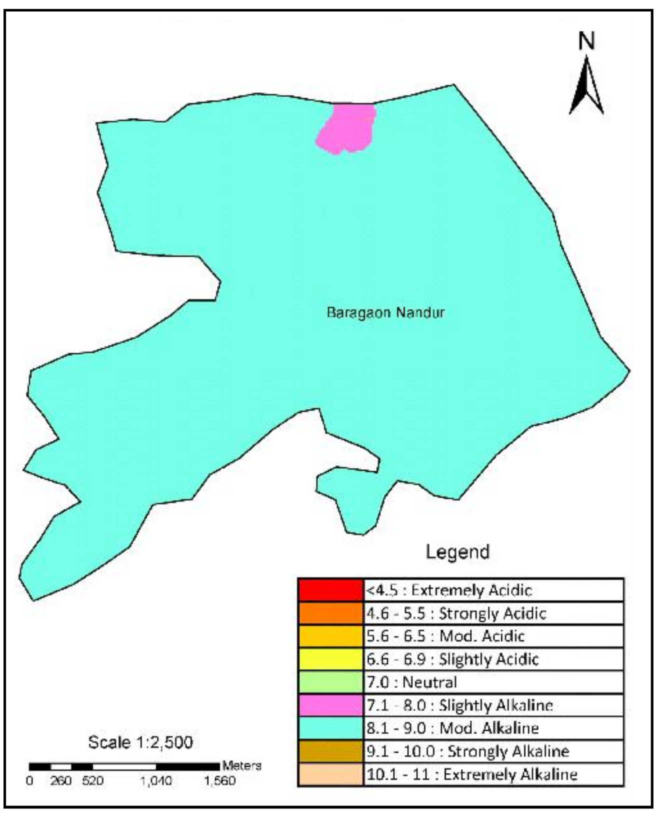

Plate 2: Map of pH in soils of Baragaon Nandur village

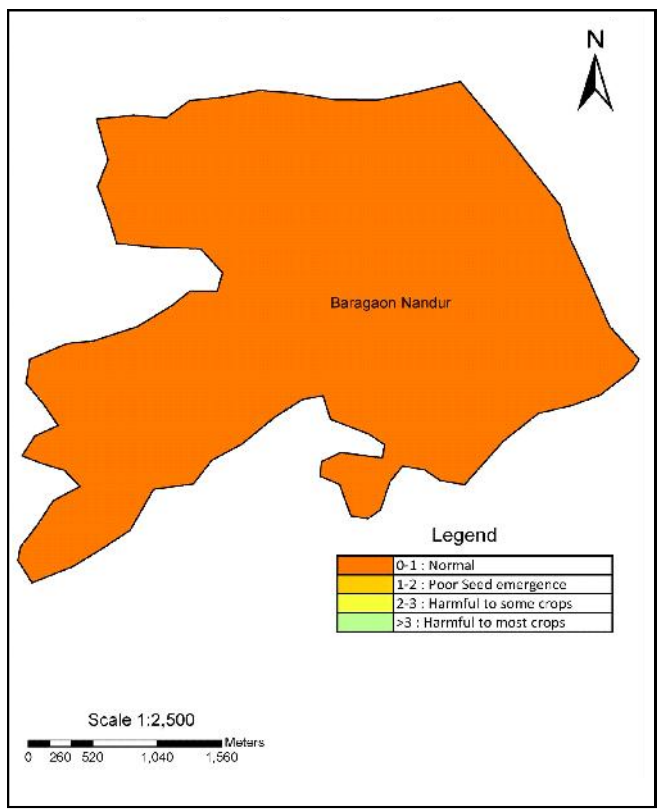

Plate 3: Map of EC (dS/m) in soils of Baragaaon Nandur village

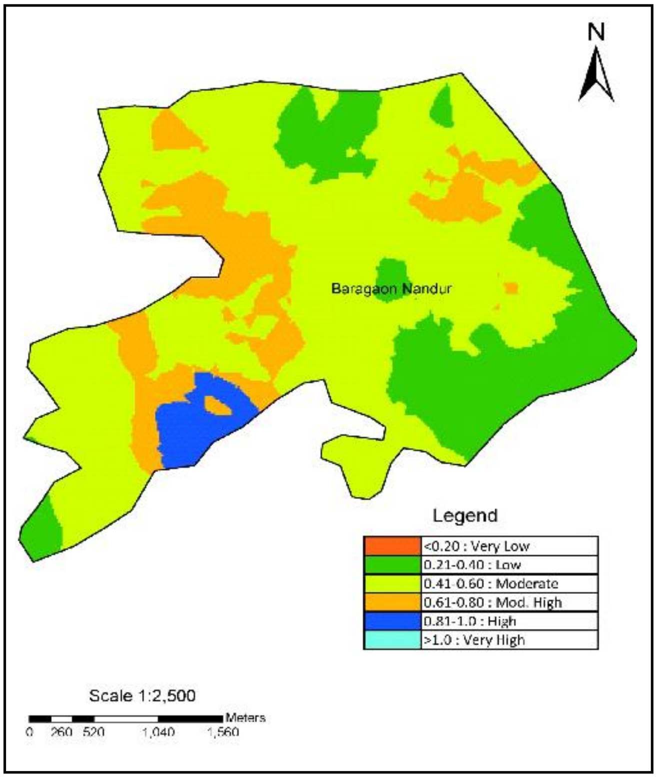

Plate 4: Map of organic carbon (%) in soils of Baragaon Nandur village

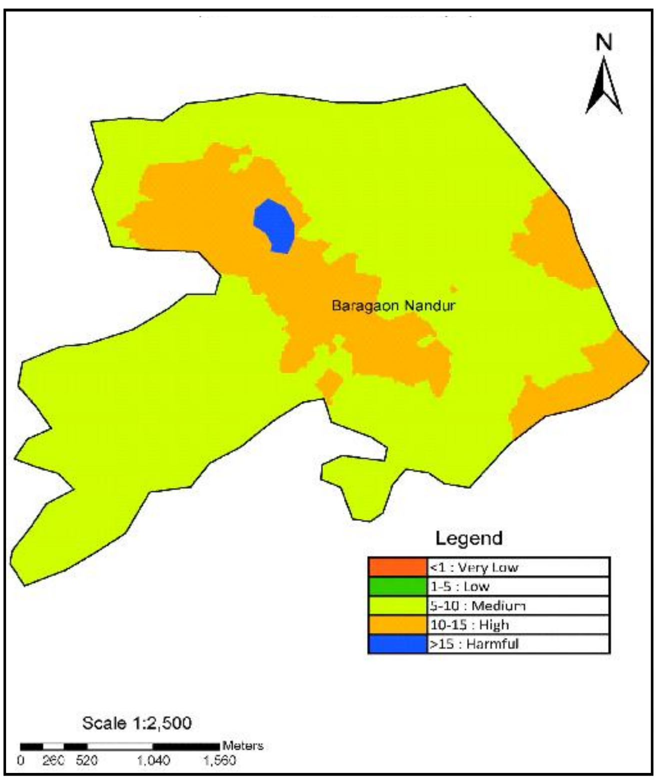

Plate 5: Map of calcium carbonate (%) in soils of Baragaon Nandur village

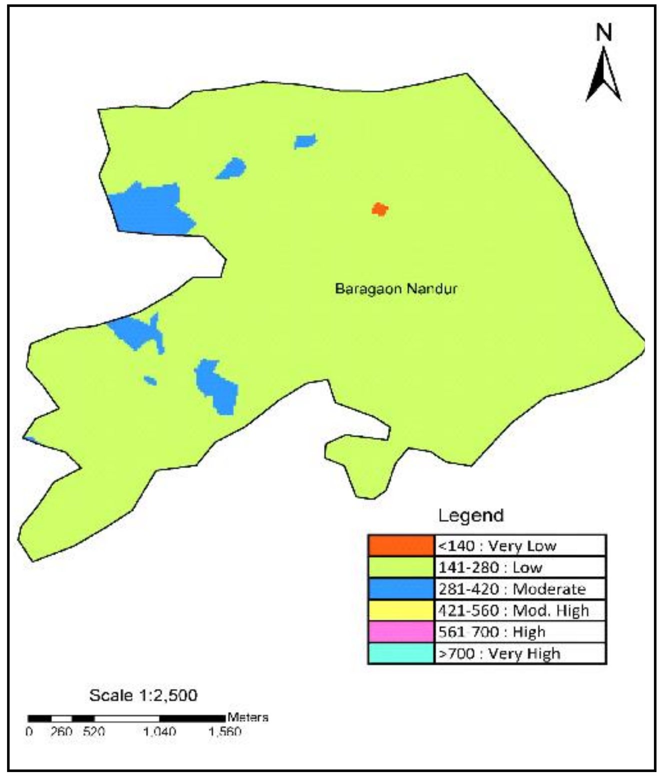

Plate 6: Map of available nitrogen (kg/ha) in soils of Baragaaon Nandur village

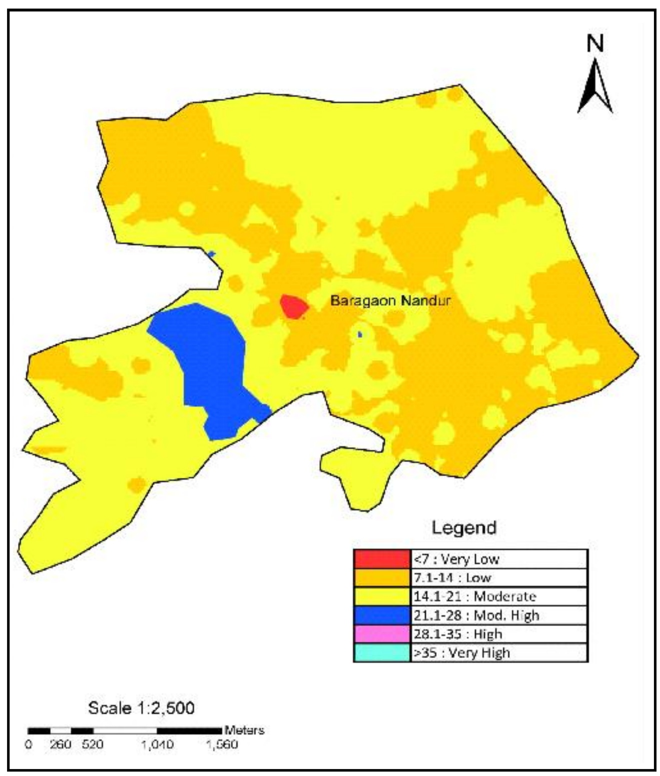

Plate 7: Map of available phosphorus (kg/ha) in soils of Baragaaon Nandur village

of Maharastra were also reported by Balpande *et al.* (1996) and Bhattacharyya *et al.* (1994) in saline-sodicVertisols of Gujarat.

The available nitrogen status of studied soils are presented in Table 2 and depicted on map (Plate 6). The available nitrogen in soils of Village BaragaonNandur ranged from 137.9 to 310.4 kg ha^{-1} with an average of 229.61 $kgha^{-1}$. The highest available nitrogen observed was 310.4 kg ha^{-1} (19°22.354N-0.74°35.825E) and the lowest was 137.9 kg ha^{-1} (19°21.437N-0.74°35.070E). Soil samples collected from Baragaon Nandur Village were categorized as very low (0.96%), low (87.50 %) and moderate (11.54%) in available nitrogen, that indicated the majority of soils are low in available nitrogen content. It is well established that organic carbon has positive correlation with available nitrogen the data reported on organic carbon content in study soils confirm the observer status of available nitrogen in study soils are in good agreement with present study report. The similar observation with respect to available nitrogen were recorded by Katariya (2011) in soils of the Water Management Project-Block A., Meena (2009) in Central Research Farm, Central Campus, M.P.K.V, Rahuri.

The data with respect to available phosphorus status are presented in Table 2 and depicted on map (Plate 7). The available phosphorus in soils of Village Baragaon Nandur was ranged from 6.37 to 27.12 kg ha^{-1} with an average of 14.71 kg ha^{-1}. The highest available phosphorus was 27.12 kg ha^{-1} (19°21.620N-0.74° 36.535E) and the lowest was 6.37 kg ha^{-1} (19°22.058N-0.74°36.250E). Among the 104 soil samples collected, 0.96 per cent samples were in very low, 44.24 per cent in low, 46.15 per cent in moderate and 8.65 per cent found moderately in high categories were observed. Low status of available phosphorus in 46.15 per cent soils, might be due to their alkaline condition and high content of $CaCO_3$ in the soil. The similar reason for low available phosphorus was reported by Katariya (2011) in soils of the Water Management Project-Block A Central Campus M.P.K.V, Rahuri and by Pandey *et al.* (2000) in Inceptisols of Central Uttar Pradesh.

The data on available potassium status in soils are presented in Table 2 and depicted on map (Plate 8). The available potassium in soils of Village Baragaon Nandur was ranged from 257.6 to 762.3 kg ha^{-1} with an average of 467.82 kg ha^{-1}. The highest available potassium was 762.3 kg ha^{-1} (19°22.309N-0.74°37.013E) and the lowest was 257.6 kg ha^{-1} (19°21.688N-0.74°36.750E). Among the 104 soil samples collected, 9.61 per cent soils are

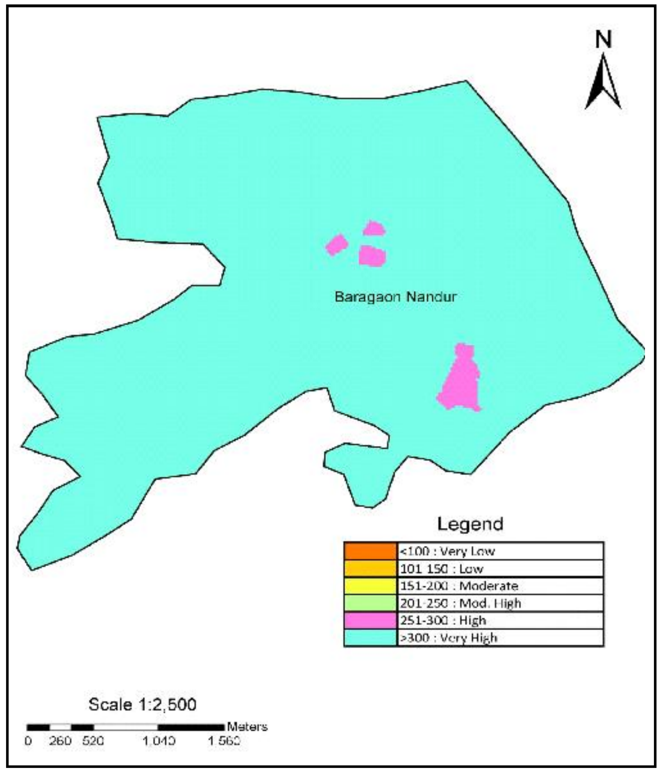

Plate 8: Map of available potassium (kg/ha) in soils of Baragaaon Nandur village

Table 2 : Status of available macronutrients (N,P,K) in soils of village Baragaon Nandur

Particulars	Available nutrients (kg ha^{-1})		
	N	P	K
Mean	229.61	14.71	467.82
Range	137.9-310.4	6.37-27.12	257.6-763.2
Category	Very low (0.96%)	Very low (0.96%)	High (9.61%)
		Low (44.24%)	
	Low (87.50%)	Moderate (46.15%)	Very high (90.39%)
	Moderate (11.54%)	Moderately high (8.65%)	

high, and 90.39 per cent samples are very high in category. In general the available K status of soils of Village Baragaon Nandur were very high in status, which could be attributed due to the dissolution and diffusion process of K from internal crystal lattice of silicate clay minerals and may also be due to also high clay content and montemorillonitic clay minerals in soils (Durgude, 1999). The similar trend of available K were reported by Katariya (2011) in soils of water management Project-Block A and Meena (2009) in Central Research Farm, Central Campus, MPKV, Rahuri.

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