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Original Research Article

Soil Fertility Mapping Using Remote Sensing and GIS in NSP Farms of ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India

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A B S T R A C T

Soil fertility parameter viz., pH, Electrical Conductivity (EC), available macro and micro nutrients were determined in surface soil samples taken 100 meter grid intervals from all five units of National Seed Project farms soils of Nadradra Deva University of Agriculture and Technology, Kumarganj Amaniganj block, Faizabad District of Uttar Pradesh. Based on data maps were prepared in GIS environment using Arc/Info 10.2.2. The surface soil sample have Soil reaction of all farm were alkaline (pH>8.5), and Organic Carbon content (0.60 to 5.0 g kg^{-1}), available Nitrogen (94.00 to 198.00 kg ha^{-1}), Phosphorous (5.10 to 11.70 kg ha^{-1}), and Iron (1.30 to 8.70 mg kg^{-1}) in all the farm units were low the available Potassium (112.30 to 119.80 kg ha^{-1}), Sulphur (3.50 to 15.20 mg kg^{-1}), Zinc (0.40 to 0.90 mg kg^{-1}), Manganese (1.00 to 6.00 mg kg^{-1}) and Cupper (0.10 to 0.60 mg kg^{-1}) was medium. While exchangeable Calcium (0.10 to 1.40 [cmol (p^{+}) kg^{-1}]) were low and Manganissium (1.20 to 11.00 [cmol (p^{+}) kg^{-1}]) was medium. In conformity with mean values described above, OC available N, P, and Fe were low and available K, S, Zn, Mn, Cu, was medium (100% area for each) suggesting maps are preferred over means values.

Keywords

Soil Fertility, GIS

Introduction

An excessive or imbalanced application of fertilizers not only wastes this limited costly resources, but also pollutes the environment. In the face of economic and environmental concerns, farmers face in increasing challenge of effective soil fertility management. An approach towards justifying such concerns is site specific nutrient management which takes into account spatial variations in nutrients status, thus cutting down the possibility of over or under use of fertilizer. Geographic information system (GIS) is a powerful tool which helps to integrate many types of spatial information such as agro-climatic zone, land use, soil management, *etc.* to derive useful information (Adornado and Yoshida 2008). Furthermore, GIS generated soil fertility maps may serve as a decision support tool for nutrient management (Iftikar *et al*. 2010). A number of studies on soil fertility mapping have been documented (Ravikumar *et al*. 2004). In India the land resources available for agriculture are shrinking. Our aim of optimizing the utilization of land resources with intensification of agriculture resulted either in the fast depletion of nutrients or

occasionally in their accumulation. It is therefore important to monitor the fertility status of soil from time to time with a view to monitor the soil health. For the sustainable use of the natural resources, a detailed charter of land resources giving its potential and constraints becomes pre-requisite for planning. The site specificity of agricultural research and technology results is largely measured from differences in two environmental variables: soil and climate. At present, most systems of land evaluation are interpretative classification. A general evaluation, based on limitations of land characteristics, is best illustrated in the USDA land capability classification.

Materials and Methods

Study sites

Geographically, National Seed Project Farm is located at Kumarganj, Faizabad District, Uttar Pradesh is situated at $26^0$34.011′N to $26^0$35.061′N latitude and $081^0$47.747′E to $081^0$45.858′E longitude with an elevation of about 113 amsl in the central Gangatic eastern Uttar Pradesh. The locations of the study area on IRS LISS-IV satellite data in (Fig. I) and table 1.

Soil analysis

The total one hundred sixty surface Soil samples were collected using a hand hold GPS from all the five farm units of NSP depth of 0-25cm at a grid 100 × 100 meter interval. The air-dried samples were ground with a wooden pestle and mortar and passed through (<2 mm) and analyzed for chemical and fertility parameters. The pH (1:2.5) and Electrical Conductivity (1:2.5) soil and water of soil were measured using standard procedures as described by Chopra and Kanwar (1976). Organic Carbon (OC) was determined by Walkely and Black (1965), Wet Oxidation method as described by Jackson (1973), Available nitrogen was determined by modified alkaline permanganate method as described by Subbiah and Asija (1956), Available phosphorus was determined by Olsen *et al*. (1954) method as described in Jackson (1973), Available potassium was extracted with neutral normal ammonium acetate (pH 7.0) and the content of potassium in the solution was estimated by Flame Photometer (Jackson, 1973), Available sulphur was extracted from the soil using 0.15 per cent calcium chloride solution and was determined by turbidometry method as outlined by Black (1965) using Spectrophotometer (Spectronic-20) at 420nm and Available micronutrients were determined by DTPA extractant in soil by Atomic Absorption Spectrophotometer. Variability of data was assessed using mean and standard deviation for each set of data. Soil fertility maps were prepared using ARC GIS v 10.2.2 employing kriging as the interpolation method. The ratings employed for deferent fertility parameters are presented in table 2.

Results and Discussion

Soil reaction and electrical conductivity

Results showed that soils varied widely in their soil properties content of available nutrients (table 3). The pH values are ranged from 8.66 to 10.39, 8.23 to 10.20, 7.10 to 9.50, 7.80 to 9.78 and 7.13 to 9.90 in farm unit I, II, II, IV and V is respectively. Most of the study area was under alkaline range. However, the soils of farm unit III, IV, and V soils were relatively low pH than of unit I and II soils this is might be variable due to presence of increase bases especially exchangeable sodium (Sivashankaran *et al.*, 1993). The Electrical Conductivity (EC) values are ranged from 0.13 to 1.15, 0.26 to

1.68, 0.03 to 0.66, 0.10 to 0.80 and 0.16 to 0.70 dSm^{-1} in farm unit I, II, III, IV and V is respectively. The soils of unit III were low in EC as compared to farm unit I, II, IV and V soils. The surface soil of relatively less saline which might be due to free drainage conditions which favored the removal of released salt by percolating water. Pillai and Natarajan (2004) also reported similar high EC values indicating the saline nature of soils of National Seed Project Farm soils. This can be attributed accumulation of salt. These results were similar to those of Sitanggag *et al.* (2006) in soils of Shikohpur watershed in Gurgaon district of Haryana.

Organic carbon

The organic carbon content values are ranged from 0.70 to 4.90, 0.60 to 4.70, 0.90 to 4.70, 0.60 to 4.80 and 0.80 to 5. gram per kilogram in farm unit I, II, III, IV and V is respectively. All the soils of the study area fall under low in organic carbon category. Walia and Rao (1996). The organic carbon was little higher in the soils of unit V in comparison to other farm units The reason for low organic carbon content in these farms soils might be attributed to the prevalence of tropical condition, where the degradation of organic matter occurs at a faster rate coupled with little or no addition of organic manures and low vegetative cover on the fields, thereby, leaving less chances of accumulation of organic carbon in the soils similar Nayak *et al.* (2002).

Available macronutrients

The available nitrogen status are ranged from 113.00 to 184.00, 94.00 to 172.00, 130.00 to 198.00, 130.00 to 194.00 and 146.00 to 198.00 kg per ha in farm unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under low in available nitrogen category. However, the available nitrogen content was lower in the soils of farm unit II as compared to I, III, IV and V farm units Major portion of the nitrogen pool is contributed by organic matter. The low organic matter content in this area due to faster degradation and consequent removal of organic matter coupled with lesser nitrogen fertilization leading to nitrogen deficiency. Govindarajan and Datta Biswas (1968). The available phosphorus content are ranged from 5.10 to 11.70, 7.00 to 10.70, 6.90 to 9.90, 6.90 to 9.80 and 7.40 to 9.70 and kg per ha in unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under low in available phosphorus category. However, the available phosphorus content was lower in the soils of farm unit II as compared to I, III, IV and V farm units The low values are due to phosphorus fixations with calcium at higher pH (above 8.0) and solubility of phosphorus containing minerals. In practices both type of reaction are taking place simultaneously in alkali soil because of the formation of tri-calcium phosphorus which is insoluble Bopathi and Sharma (2006). The available potassium content are ranged from 112.50 to 119.50, 112.30 to 119.70, 116.00 to 119.80, 114.00 to 119.80 and 114.80 to 119.50 kg per ha ha in farm unit I, II, III, IV and V is respectively. The soils of all the five farm units of National Seed Project Farm have in variably same content of available potassium and fall under low in available potassium category The available potassium was low because of lesser finer fractions in their A horizons and predominance of K rich micaceous and feldspar minerals in parent materials. Ravikumar (2006). The available sulphur content are ranged from ranged 7.30 to 15.20, 6.70 to 11.00, 3.50 to 11.00, 6.20 to 11.00 and 7.20 to 9.90 mg per in unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under low to medium available sulphur category. The

soils of farm unit I have relatively more available sulphur in compression to farm units II, III, IV and V The high amounts of sulphur in surface samples is mainly because of acid reaction and low EC values. Sharma and Gangwar (1997).

Table.1 Particulars of National Seed Project Farms

Sl. No.	Unit Number	Name of the farm	Total area (ha.)	Land use
1	I	Amrahar	55	85% Agriculture
2	II	Biroulijham	40	75% Agriculture
3	III	Tikti	41	Entirely Agriculture
4	IV	Akma	40	Entirely Agriculture
5	V	Nagipur	30	80% Agriculture

Table.2 Soil Fertility ratings for available nutrients

Nutrients	**Fertility ratings**		
	Low	**Medium**	**High**
Organic Carbon (g kg^{-1})	< 0.5	0.5-0.75	> 0.75
Available N (kg ha^{-1})	< 280	280-560	> 560
Available P (kg ha^{-1})	< 10	10-25	> 25
Available K (kg ha^{-1})	< 110	110-280	> 280
Available S mg kg^{-1}	< 10	10-30	> 30
DTPA extractable nutrient			
Available Zn mg kg^{-1}	0-0.6	06-1.0	> 1.0
Available Mn mg kg^{-1}	0-2.0	2.0-3.0	> 3.0
Available Cu mg kg^{-1}	0-0.2	0.2-0.6	> 0.6
Available Fe mg kg^{-1}	0-4.5	4.5-5.6	>5.6

Table.3 Fertility parameters of soils of National Sees Project Farm soils

Soil fertility parameters	Unit I		Unit II		Unit III		Unit IV		Unit V	
	Amrahar (46*)		Biroulijham (32*)		Tikti (30*)		Akma (34*)		Nagipur (18*)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
pH (1:2.5)	9.51	0.31	9.36	0.55	8.98	0.66	8.95	0.38	8.58	0.74
EC (1:2.5) dS/m	0.43	0.26	0.75	0.34	0.19	0.15	0.35	0.18	0.33	0.16
Organic Carbon (g kg^{-1})	2.78,	1.05	2.97	1.21	2.82	1.15	3.03	1.11	4.06	0.61
Available N (kg ha^{-1})	146.89	20.12	138.97	18.31	169.93	16.66	163.88	17.67	173.78	14.49
Available P (kg ha^{-1})	8.27	1.10	8.58	0.80	8.39	0.83	8.54	0.78	8.51	0.77
Available K (kg ha^{-1})	116.98	1.82	116.39	2.35	118.30	0.94	117.95	1.24	117.96	1.27
Available S (mg kg^{-1})	10.59	1.98	8.57	0.95	8.58	1.25	8.62	0.93	8.53	0.68
Available Zn (mg kg^{-1})	0.67	0.11	0.72	0.10	0.74	0.09	0.74	0.09	0.76	0.09
Available Mn (mg kg^{-1})	3.33	1.32	2.94	1.08	3.03	1.07	3.26	1.24	3.61	1.38
Available Cu (mg kg^{-1})	0.37	0.13	0.38	0.12	0.37	0.07	0.45	0.10	0.44	0.11
Available Fe (mg kg^{-1})	3.58	1.28	2.65	2.65	3.34	1.02	4.80	1.44	4.61	1.12

*Figures in parenthesis indicate total number of soil samples

Fig.1 Location of the National Seed Project Farms with IRS LISS-IV satellite image

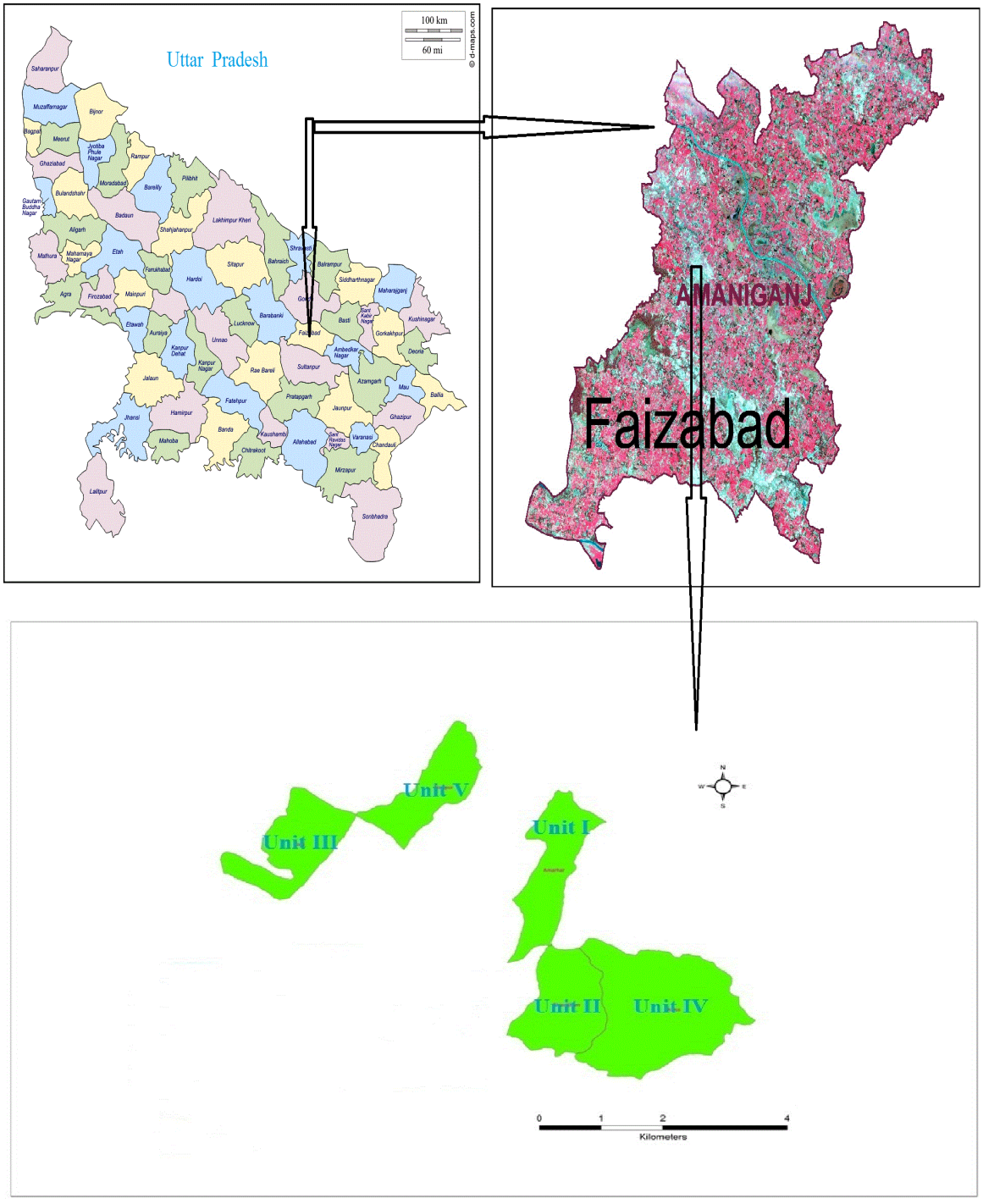


Fig.2 Status of Organic Carbon, Nitrogen, Phophorous, Calcium and Iron

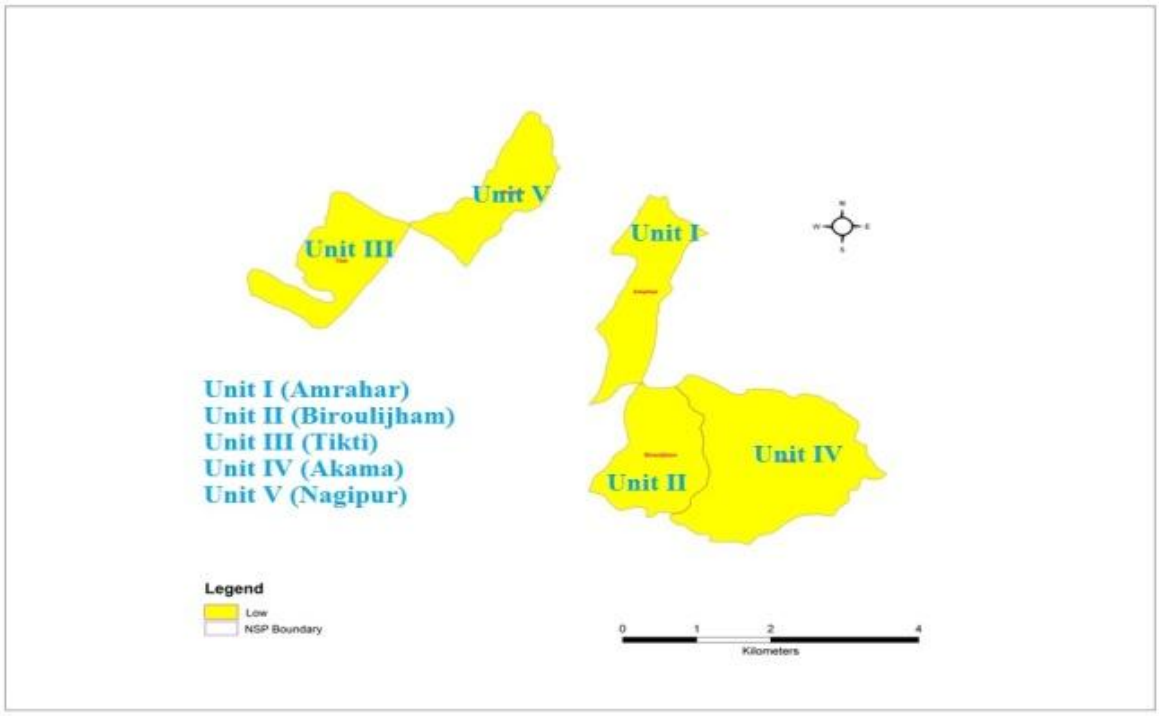
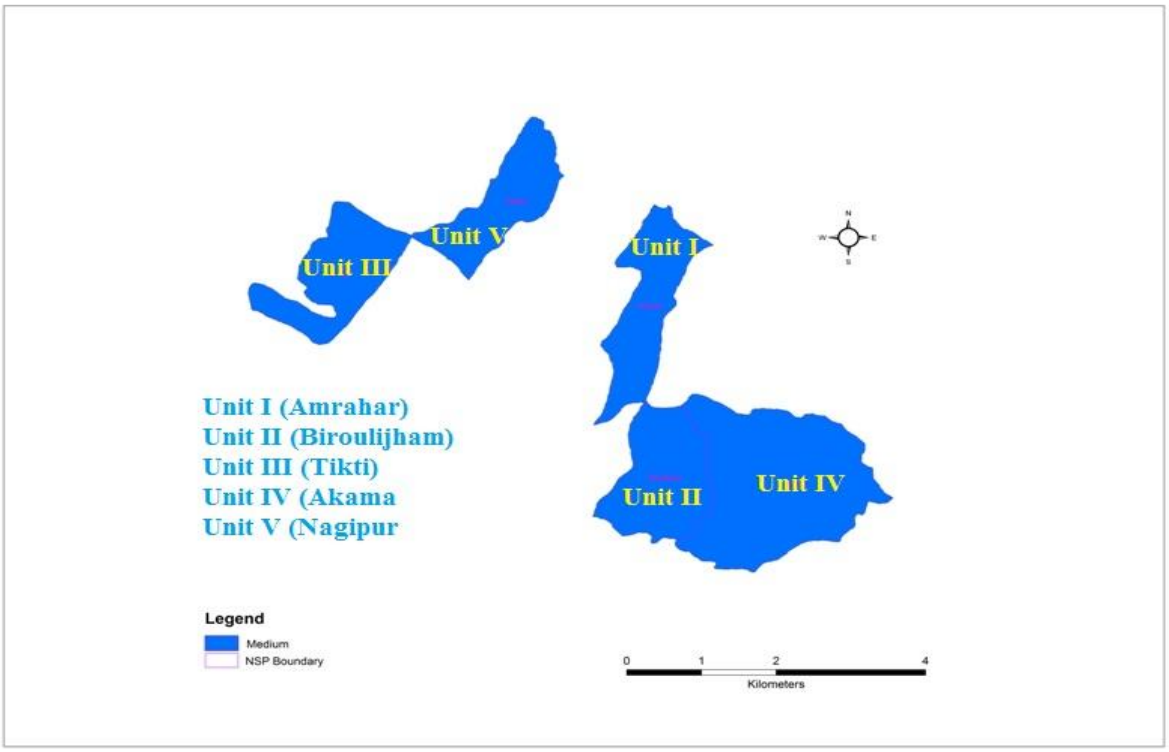


Fig.3 Status of Potassium, Manganese, Sulphur, Zinc and Cupper



Available micronutrients

The available zinc content are ranged from 0.40 to 0.90, 0.50 to 0.90, 0.60 to 0.90, 0.60 to 0.90 and 0.60 to 0.90 mg per kg in farm unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under medium in available zinc category. The farm unit I was relatively low in available zinc as compared to farm unit II, III, IV and V. The available manganese content are ranged from 1.00 to 5.00, 2.00 to 6.00, 2.00 to 5.00, 1.00 to 6.00 and 2.00 to 6.00 mg per kg in farm unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under medium to high in available Manganese category. The farm unit I and II were relatively than low in available manganese and farm units II, III, IV and V. The available cupper content are ranged from 0.10 to 0.60, 0.20 to 0.60, 0.20 to 0.50, 0.20 to 0.60 and 0.20 to 0.60 mg per kg in farm unit I, II, III, IV and V is respectively. All the soils of National Seed Project Farm fall under medium in available cupper category. The soils of farm unit I and III have little less content of available copper than farm unit II, IV and V. The available iron content are ranged from 1.30 to 6.50, 1.30 to 4.70, 2.00 to 5.00, 2.00 to 8.70 and 2.00 to 6.50 and mg per kg in farm unit I, II, III, IV and V is respectively. The soils of farm units I, II, and III of National Seed Project Farm fall under low in available iron category. While the soils of farm units IV and V fall under medium category.

In conclusion, soil reaction of all farm soils was alkaline which is attributed to the presence of leaching of salts from the soil along with runoff and drainage water due to moderately low rainfall existing in the area deposition of salts from the physiographic units. The organic carbon content in all the farms was low to medium due to low vegetative cover the soil erosion and warmer climate leading to low accumulation of organic carbon in the study area. The available nitrogen, phosphorus and potassium were low, low to medium and medium respectively. The low nitrogen content is attributed to the low organic carbon due to warmer climate and low vegetative cover coupled with little nitrogen fertilization.

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