EVALUATION OF NUTRIENT INDEX FOR SOIL FERTILITY OF SIDDAPURA CATCHMENT, KARNATAKA STATE

Sindhu.D

Assistant Professor, Department of Civil Engineering,
RVCE, Bengaluru, India

A.S. Ravikumar

Professor, Department of Civil Engineering, UVCE,
Bangalore University, Jnanabharati, Bengaluru, India

B. L. Shivakumar

Professor, Department of Civil Engineering,
M. S. Engineering College, Bengaluru, India

ABSTRACT

Soil quality standards are used as a means to maintain long-term soil productivity and these standards provide threshold values beyond which further alteration of soil properties would significantly change or impair the productivity potential of the soil. Suitability of the soils for a particular crop is an important factor from the productivity point of view. The importance of soil in supporting food crops requires due attention towards study of the chemical composition of soils in relation to crop needs. The study area chosen is Siddapura catchment which is a part of Harangi command area covered in Hassan, Madikeri and Mysore districts, Karnataka state. Geographically it lies between 75° 38' E and 76° 15' E longitude and 12° 24' N and 12° 46' N latitude, covering an area of 1522.4 km². The study area is covered in Survey of India (SOI) Toposheet numbers 48P/10, 48 P/11, 48 P/14, 48 P/15, 57 D/1, 57 D/2, 57 D/3 on 1:50,000 scale. The maximum length and width of the catchment is approximately equal to 37.53 km and 68.88 km respectively. In the present study, representative soil samples are collected from the field in different locations of the study area and are subjected to chemical analysis to determine the various macronutrients and micronutrients present and fertility status of the soils are determined from the nutrient index criteria. Results shows that based on the nutrient index criteria the soil fertility of Siddapura catchment can be categorized into low-low-medium (LLM) category with respect to available organic carbon, phosphorous and potassium concentrations.

Keywords: Siddapura catchment, nutrient index, soil fertility, macronutrients, micronutrients

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1. INTRODUCTION

Soil is a precious gift of nature to mankind. Ironically soil is most neglected resources on the earth. Soil is an everlasting treasure and a valuable asset that can produce good yield if managed properly. Soil fertility refers to the ability of a soil, to supply the nutrient elements required for optimum plant growth. It is measured in terms of the amount of the available nutrients present in the soil at any given time. The fertility status of soils can be evaluated using nutrient index methods and fertility indicators. In the present study an attempt has been made to evaluate the soil fertility using nutrient index method.

2. STUDY AREA

The study area chosen is Siddapura catchment which is a part of Harangi command area covered in Hassan, Madikeri and Mysore districts. Geographically it lies between $75^{\circ} 38' E$ and $76^{\circ} 15' E$ longitude and $12^{\circ} 24' N$ and $12^{\circ} 46' N$ latitude, covering an area of 1522.4 km^2 . The study area is covered in Survey of India (SOI) Toposheet numbers 48P/10, 48 P/11, 48 P/14, 48 P/15, 57 D/1, 57 D/2 and 57 D/3 on 1:50,000 scale. The maximum length and width of the catchment is approximately equal to 37.53 km and 68.88 km respectively. Figure 1 shows the location map of Siddapura catchment. Physiographically the study area divided into three regions from East to West as medium, semi malnad and malnad region. The malnad region forms a part of Western Ghats and is characterized by rolling plain. Madikeri is situated on the eastern and western slopes of the Western Ghats, covered with lush green forests, plantations and cultivated valleys. The southern, western and north-western portions are intersected by hill ranges and forests, subjected to heavy rainfall. The study area exposes a vast expanse of migmatite gneisses within which elongate rafts and enclaves of supracrustal rocks consisting of high grade schists occur. The soils in the catchment are loamy skeletal, clayey skeletal, fine and fine loamy and isohyperthermic and the group of soils are based on their differentiating morphological, physical and physio-chemical characteristics. The mean average annual rainfall in the catchment for 16 years is 1346.42 mm.

2. METHODOLOGY

2.1 Sample Collection and Analysis

In the present study the fertility of the soils of Siddapura catchment has been evaluated. 51 representative soil samples are collected from various locations in Siddapura catchment during June 2018 and November 2019 respectively. The details of soil sample locations are tabulated in Table 1. The sampling locations obtained using GPS are then converted into spatial data (Figure 2). Soil samples collected are subjected to chemical analysis for determining the various macronutrients such as pH, Electrical Conductivity (EC), organic carbon, available phosphorous, available potash and micronutrients like zinc, iron, copper, manganese and boron present in it.

Figure 1. Location map of Siddapura catchment

2.2. Nutrient Index

To evaluate the soil fertility status of Siddapura catchment, available macro nutrients and micro nutrients in the soil are classified based on the specific rating chart (Table 3 and Table 4). The nutrient indices are calculated as follows:

$$\text{Nutrient Index} = \frac{(S_L + S_M + S_H)}{S_N} \quad (1)$$

where

S_L = 1xNumber of samples in low category

S_M = 2xNumber of samples in medium category

S_H = 3x Number of samples in high category

S_N = Total number of sample.

An area with a nutrient index value of 1.67 and below is considered as 'low', for the nutrient between 1.67 and 2.33 as 'medium', and above 2.33 as 'High' (Ramamoorthy and Bajaj, 1969).

3. RESULTS AND DISCUSSION

Results of the chemical analysis for the representative soil samples are summarized in Table 2(a) and Table (b). pH of the representative soil sample varies from 4.98 to 8.23. The concentration of EC varies from 1 to 153 mmhos/cm, concentration of organic carbon, available phosphorus and potash varies from 0.04% to 1.04%, 8kg/ha to 95kg/ha and 28kg/ha to 1200kg/ha respectively. Similarly the concentration of various micronutrients such as zinc, boron, iron, manganese, copper ranges from 0.01ppm to 1.78ppm, 0.015ppm to 2.81ppm, 0.16ppm to 15.17ppm, 0.08ppm to 8.69ppm, 0.01ppm to 34 ppm respectively.

Table 1 Details of the soil sampling locations of Siddapura catchment

Sl. No.	Sample Nos.	Sample Location	Latitude (N)	Longitude (E)	Elevatio(m)
1	S1	T. Mayagaudanahalli	12°41'16"	76°14'16.8"	894
2	S2	Tejuru	12°40'58.8"	76°14'16.8"	896
3	S3	Badakyatanahalli	12°39'25.2"	76°13'12"	875
4	S4	Nerole	12°37'12"	76°11'20.4"	835
5	S5	Dumme Mallapura	12°43'4.8"	76°7'19.2"	872
6	S6	Machagondanahalli	12°42'50.4"	76°0'21.6"	904
7	S7	Mokli	12°43'12"	76°4'44.4"	958
8	S8	Dodda Magge	12°41'2.4"	76°5'6"	866
9	S9	Konanuru	12°37'51.6"	76°3'7.2"	807
10	S10	Ramanathapura	12°36'36.9"	76°4'55.2"	838
11	S11	Doddahalli	12°39'0"	76°6'18"	858
12	S12	Kote Kapparavalli	12°39'57.6"	76°6'46.8"	896
13	S13	Koratigere	12°40'51.6"	76°6'25.2"	903
14	S14	Ankanatapur	12°40'44.4"	76°2'16.8"	850
15	S15	Bundashettihalli	12°44'13.2"	76°11'16.8"	889
16	S16	Keregodu	12°43'4.8"	76°10'58.8"	877
17	S17	Belavadi	12°39'54"	76°8'38.4"	873
18	S18	Karahalli	12°40'30"	76°9'32.4"	849
19	S19	Koratikere Kaval	12°38'49.2"	76°7'51.6"	902
20	S20	Vaddarahalli	12°34'58.8"	76°6'3.6"	849
21	S21	Mallapura	12°32'6"	76°6'0"	884
22	S22	Bettadpur	12°27'46.8"	76°6'7.2"	902
23	S23	Barse	12°25'58.8"	76°7'30"	901
24	S24	Adaguru	12°31'15.6"	76°1'37.2"	848
25	S25	Bayalakuppe	12°30'50.4"	76°3'18"	840
26	S26	Kanagalu	12°33'25.2"	76°1'37.2"	839
27	S27	Tamadahalli	12°28'33.6"	76°10'51.6"	844
28	S28	Honnenahalli	12°33'28.8"	76°13'55.2"	850
29	S29	Maluganahalli	12°36'32.4"	76°13'12"	782
30	S30	Maduranahalli	12°33'39.6"	76°9'3.6"	798
31	S31	Mavanur	12°32'9.6"	76°13'15.6"	794
32	S32	Ullenahalli	12°36'49.7"	76°1'47.6"	828
33	S33	Keshavatur	12°39'04.5"	76°00'19.4"	883
34	S34	Taragilele	12°16'1.2"	75°57'3.6"	910
35	S35	Yelakanur	12°32'32.6"	75°54'39.1"	902
36	S36	Madalapura	12°30'14.1"	75°56'15.1"	839
37	S37	Kudige	12°29'37.9"	75°57'26.2"	829
38	S38	Hulse	12°30'56.9"	75°58'8.6"	845
39	S39	Hebbale	12°32'7.9"	75°58'44.8"	856
40	S40	Kudumangalore	12°29'38.4"	75°55'8.4"	820
41	S41	Anekad	12°28'33.6"	75°55'8.4"	821
42	S42	Guddahosuru	12°30'50.4"	75°52'40.8"	862
43	S43	Andagove	12°28'26.4"	75°51'28.8"	934
44	S44	Madikeri	12°25'12"	75°44'2.4"	1102
45	S45	Karanangeri	12°25'55.2"	75°44'20.4"	1065
46	S46	Kalakeri	12°26'24.1"	75°42'22.2"	1119
47	S47	Monnageri	12°26'56.4"	75°41'34.8"	1101
48	S48	Galibeedu	12°29'13.2"	75°39'39.6"	1094
49	S49	Garagandur	12°30'36"	75°48'38.2"	916
50	S50	Garvale	12°34'40.8"	75°45'54"	1010
51	S51	Kerehosahalli	12°38'17.9"	75°62'32.2"	1074

Figure 2 Soil sampling locations in Siddapura catchment

3.1. Classification of Soils

The values obtained from chemical analysis of soil samples are used to classify the soils based on the rating chart with respect to available macronutrients and micronutrients present in the soil as shown in table 3 and table 4 respectively.

3.1.1. Soil pH

The soil pH is an important parameter which measures hydrogen ion concentration in the soil to indicate its acidic and alkaline nature of the soil. Based on pH values soils are classified as acidic, neutral and alkaline category. From Table 3 it is observed that around 75% of the soil samples have fall under neutral pH category.

3.1.2. Electrical Conductivity

Electrical Conductivity plays a major role in salinity of soils as it expresses the soluble salts present in the soil. Lesser the EC value, low will be the salinity value of soil and vice versa. Based on EC values soils are categorized into normal, critical and high category (Table 3). 2% of the representative samples of the study area fall under critical zone and 98% under high salinity zone.

3.1.3. Organic Carbon

Organic matter has a vital role in agricultural soils, it supplies plant nutrients, improves soil structure, improve water infiltration and retention, feeds soil micro flora and fauna, and enhance the retention and cycling of applied fertilizer (Johnston, 2007). The study reveals that about 73% of the soil samples have low organic carbon content, 18% medium and 10% of soil sample have low organic content.

3.1.4. Available Phosphorus

Phosphorus is the second key plant nutrient and is required by all living organisms and every living cell which exists in soil in both organic and inorganic forms. In the present study around 55%, 39% and 6% of the soil samples fall under low, medium and high category respectively.

3.1.5. Available Potassium

Potassium is important in the photosynthetic process. Based on the values of available potassium soils are classified as low, medium and high category (Table 3). In the present study around 61% of the representative soil samples lie in the medium category and 20% under low and high category respectively.

3.2. Available Micronutrients

Plants need very small quantities of certain elements for their nutrition such as zinc, copper, iron, manganese and boron. Based on the quantity of micronutrients present in the soil, zinc and iron are classified into three categories such as low, marginal and adequate. Similarly copper, manganese and boron are classified low and adequate categories. The study reveals that with respect to zinc 92% of the representative soil samples have low zinc content. Zinc deficient soils can be reclaimed by the application of zinc sulphate or spraying zinc based compounds. Boron is found to be low in 88% of soil samples. Boron deficiencies can be corrected by applying suitable proportions of zinc sulphate and borax respectively. Iron and manganese are in adequate ranges in a majority of soils.

3.3. Soil Nutrient Indices

The soil nutrient indices are obtained by classification of soils into low, medium and high categories with respect to available macronutrient and micronutrients. Nutrient index calculated for the soil samples are shown in Table 5.

3.3.1. Soil Fertility Map

The fertility map indicates the soil fertility status with regard to organic carbon, available phosphorus, available potassium and micronutrients. Indices obtained can be depicted on an outline map of the study area with the help of concentric circles of different colours for individual soil characteristics. The outer circle represents index for nitrogen, second inner circle for phosphorus and inner circle for potash. Red colour is usually used to indicate low index, yellow for medium, green for high index. The pH is indicated by coloring the area outside the concentric circles using red for acidic, yellow for normal, blue for alkaline. Salinity is indicated by S1, S2, and S3 respectively for normal, critical and injurious. Based on the nutrient index criteria the soil fertility of Siddapura catchment can be categorized into low-low-medium (LLM) category with respect to available organic carbon, phosphorous and potassium concentrations. Figure 3 and Figure 4 shows the soil fertility map for available micronutrients and macronutrients of Siddapura catchment respectively.

4. CONCLUSIONS

The study reveals that, pH of the soil samples of the area are in normal range in most of the soils with respect to salt content. The level of electrical conductivity is high, levels of organic carbon; available phosphorus and available potassium are respectively in low, low to medium and medium to low ranges.

Table 2(a) Results of chemical analysis tests of soil samples of Siddapura catchment

Sample No.	pH	EC (mmhos/cm) at 25°C	Organic Carbon (%)	Available Phosphorus (kg/ha)	Available Potash (kg/ha)	Available micronutrients (ppm)				
						Zinc	Iron	Copper	Manganese	Boron
S1	6.49	9	0.29	20	196	0.11	1.36	0.21	1.17	0.28
S2	6.57	5	0.2	82	123	0.12	6.56	0.23	0.64	0.2
S3	6.72	5	0.04	21	256	0.05	0.6	0.03	0.10	0.28
S4	6.96	12	0.14	22	135	0.28	1.29	0.23	0.91	0.42
S5	7.75	18	0.39	40	134	0.41	0.93	0.56	0.12	0.45
S6	7.4	9	0.22	52	208	0.35	2.76	0.4	2.32	0.2
S7	6.42	5	0.42	26	123	0.13	9.66	0.19	3.19	0.31
S8	6.58	6	0.28	18	115	0.13	2.01	0.49	2.17	0.22
S9	7.25	11	0.05	16	272	0.07	0.61	0.04	0.40	0.27
S10	7.36	7	0.28	17	135	0.15	2.34	0.76	1.94	0.35
S11	7.74	31	0.58	95	123	1.78	1.78	0.33	1.00	0.77
S12	6.72	7	0.32	30	115	0.34	8.57	0.55	1.37	0.24
S13	5.73	5	0.22	32	235	0.09	6.55	0.05	3.63	0.3
S14	6.33	6	0.46	41	96	0.45	11.27	1.03	3.89	0.28
S15	6.46	3	0.22	23	125	0.1	4.31	0.3	2.92	0.31
S16	6.73	3	0.24	24	261	0.42	3.18	0.4	2.52	0.27
S17	5.01	9	0.15	25	219	0.1	5.57	0.3	7.67	0.3
S18	5.75	5	0.27	23	122	0.19	7.13	0.41	4.4	0.26
S19	5.23	4	0.33	19	153	0.08	5.54	0.2	5.45	0.31
S20	6.45	6	0.14	21	115	0.14	1.86	0.17	0.84	0.3
S21	7.55	11	0.24	24	159	0.03	0.16	0.02	0.08	0.31
S22	6.96	17	0.28	21	325	0.11	8.69	0.46	5.54	0.3
S23	7.43	8	0.28	36	267	0.1	2.2	0.34	1.18	0.35
S24	7.88	20	0.6	30	273	0.41	0.92	0.75	0.73	0.23
S25	7.73	14	0.41	22	170	0.24	3.08	0.4	0.47	0.31
S26	7.86	9	0.46	57	202	0.15	1.83	0.43	1.07	0.3
S27	6.65	15	0.52	21	105	0.16	5.18	1.8	6.64	0.27

Table 2(b) Results of chemical analysis tests of soil samples of Siddapura catchment

Sample No.	pH	EC (mmhos/cm) at 25°C	Organic Carbon (%)	Available Phosphorus (kg/ha)	Available Potash (kg/ha)	Available micronutrients (ppm)				
						Zinc	Iron	Copper	Manganese	Boron
S28	6.21	6	0.24	21	246	0.11	5.55	34	4.88	0.35
S29	6.28	5	0.26	22	179	0.05	3.91	0.17	2.32	0.26
S30	6.39	4	0.35	22	125	0.05	1.21	0.13	1.4	0.23
S31	6.91	7	0.38	26	181	0.1	0.72	0.21	1.67	0.41
S32	5.34	8	0.292	13	125	0.04	2.46	0.46	4.8	0.094
S33	4.98	153	0.473	14	1050	0.02	6.59	0.52	5.54	0.017
S34	7.35	60	0.492	10	239	0.34	9.21	0.7	5.56	1.396
S35	7.06	24	0.515	12	825	0.59	7.87	0.7	2.66	0.351
S36	5.82	9	0.383	13	60	0.37	14.53	0.64	3.9	0.401
S37	5.75	5	0.477	10	82	0.17	15.17	1.09	7.93	0.532
S38	6.25	11	0.333	11	32	0.27	14.1	0.28	6.23	0.1
S39	8.17	26	0.582	14	28	0.09	7.15	0.63	2.78	0.423
S40	6.64	14	0.615	13	273	0.08	1.82	0.25	3.22	0.015
S41	7.1	13	0.29	16	129	0.06	1.2	0.13	2.04	0.908
S42	8.23	18	0.356	14	1100	0.25	8.95	0.01	4.34	0.016
S43	7.27	16	1.041	18	820	0.71	12.26	0.39	4.71	0.122
S44	6.83	8	0.801	32	250	0.31	11.76	0.71	3.26	1.334
S45	7.26	17	0.987	8	207	0.37	14.12	1.16	7.91	0.151
S46	5.4	4	0.589	12	800	0.26	12.54	1.48	8.69	0.161
S47	5.5	3	0.386	10	900	0.01	5.24	0.82	2.53	0.354
S48	5.03	1	0.604	11	1200	0.39	10.51	0.05	8.28	0.172
S49	6.06	3	0.636	14	266	0.59	9.46	1.46	7.74	0.186
S50	6.16	7	0.767	33	515	0.11	4.34	0.99	5.2	2.808
S51	6.21	4	0.821	11	387	0.32	10.51	0.5	6.9	0.084

Table 3 Classification and available macronutrients in soils of Siddapura catchment

Parameter	Min.	Max.	Range	No. of Samples	No. of Samples (%)	Category
Soil pH	4.98	8.23	Below 6	11	22	Acidic
			6 to 8	38	75	Neutral
			Above 8	2	4	Alkaline
Electrical Conductivity (mmhos/cm)	1	153	Below 1	Nil	Nil	Normal
			1 to 2	1	2	Critical
			Above 2	50	98	High
Organic carbon (as a measure of nitrogen) (%)	0.04	1.04	Below 0.5	37	73	Low
			0.5 to 0.75	9	18	Medium
			Above 0.75	5	10	High
Available phosphorus (kg/ha)	8	95	Below 22	28	55	Low
			22 to 54	20	39	Medium
			Above 54	3	6	High
Available potassium (kg/ha)	28	1200	Below 123	10	20	Low
			123-296	31	61	Medium
			Above 296	10	20	High

Table 4 Classification and available macronutrients in soils of Siddapura catchment

Parameter	Min.	Max.	Range	No. of Samples	No. of Samples (%)	Category
Zinc (ppm)	0.01	1.78	Below 0.5	47	92	Low
			0.5 to 1.0	3	6	Marginal
			Above 1.0	1	2	Adequate
Boron (ppm)	0.015	2.81	Below 0.5	45	88	Low
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			Above 0.5	6	12	Adequate
Iron (ppm)	0.16	15.17	Below 2.5	17	33	Low
			2.5 to 4.5	7	14	Marginal
			Above 4.5	27	53	Adequate
Manganese (ppm)	0.08	8.69	Below 1.0	9	18	Low
			---	---	---	---
			Above 1.0	42	82	Adequate
Copper (ppm)	0.01	34	Below 0.2	11	22	Low
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			Above 0.2	40	78	Adequate

Table 5 Nutrient index values for the soils samples of Siddapura catchment

Characteristics	Nutrient Index	Remarks
Soil pH	1.82	Normal
Electrical Conductivity (mmhos/cm)	2.98	Injurious
Organic Carbon (as a measure of nitrogen) %	1.37	Low
Available Phosphorus	1.51	Low
Available Potassium	2.00	Medium

Figure.3 Available micronutrient levels for Siddapura catchment

Figure.4 Soil fertility map of Siddapura catchment

Zinc is found to have low values whereas copper, iron and manganese are in adequate ranges in a majority of soils. Based on the nutrient index criteria the soil fertility of Siddapura catchment can be categorized into low-low-medium (LLM) category with respect to available organic carbon, phosphorous and potassium concentrations. Suitable management practices such as increased use of organic nutrients, sustainable land use and cropping systems needs to be adopted to increase the fertility status of the soil.

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