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

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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 show 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
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° 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 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.
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:

\[ Nutrient\ Index = \frac{(S_L + S_M + S_H)}{S_N} \]

where

- \( S_L \) = 1\times\text{Number of samples in low category}
- \( S_M \) = 2\times\text{Number of samples in medium category}
- \( S_H \) = 3\times\text{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 95kh/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) | Elevation(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          | Badakayanahalli  | 12°39'25.2" | 76°13'12"   | 875         |
| 4       | S4          | Nerole           | 12°37'12"  | 75°11'20.4" | 835         |
| 5       | S5          | Domme 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          | Doddagagge       | 12°41'2.4"  | 76°5'6"     | 866         |
| 9       | S9          | Konauru          | 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         | Ankanatapu       | 12°40'44.4" | 76°2'16.8"  | 850         |
| 15      | S15         | Bundashethihalli | 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°0'19.4"  | 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         | Guddahosore      | 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        |
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 oil 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.

Figure 2 Soil sampling locations in Siddapura catchment
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 category 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 soils 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                          |
| S2         | 6.57 | 5                     | 0.2                 | 82                          | 123                     | 0.12                          |
| S3         | 6.72 | 5                     | 0.04               | 21                          | 256                     | 0.05                          |
| S4         | 6.96 | 12                    | 0.14               | 22                          | 135                     | 0.28                          |
| S5         | 7.75 | 18                    | 0.39               | 40                          | 134                     | 0.41                          |
| S6         | 7.4  | 9                     | 0.22               | 52                          | 208                     | 0.35                          |
| S7         | 6.42 | 5                     | 0.42               | 26                          | 123                     | 0.13                          |
| S8         | 6.58 | 6                     | 0.28               | 18                          | 115                     | 0.13                          |
| S9         | 7.25 | 2                     | 0.05               | 16                          | 272                     | 0.07                          |
| S10        | 7.36 | 7                     | 0.28               | 17                          | 135                     | 0.15                          |
| S11        | 7.74 | 31                    | 0.58               | 95                          | 123                     | 1.78                          |
| S12        | 6.72 | 7                     | 0.32               | 30                          | 115                     | 0.34                          |
| S13        | 5.73 | 5                     | 0.22               | 32                          | 235                     | 0.09                          |
| S14        | 6.33 | 6                     | 0.46               | 41                          | 96                      | 0.45                          |
| S15        | 6.46 | 3                     | 0.22               | 23                          | 125                     | 0.1                           |
| S16        | 6.73 | 3                     | 0.24               | 24                          | 261                     | 0.42                          |
| S17        | 5.01 | 9                     | 0.15               | 25                          | 219                     | 0.1                           |
| S18        | 5.75 | 5                     | 0.27               | 23                          | 122                     | 0.19                          |
| S19        | 5.23 | 4                     | 0.33               | 19                          | 153                     | 0.08                          |
| S20        | 6.45 | 6                     | 0.14               | 21                          | 115                     | 0.14                          |
| S21        | 7.55 | 11                    | 0.24               | 24                          | 159                     | 0.03                          |
| S22        | 6.96 | 17                    | 0.28               | 21                          | 325                     | 0.11                          |
| S23        | 7.43 | 8                     | 0.28               | 36                          | 267                     | 0.1                           |
| S24        | 7.88 | 20                    | 0.6                | 30                          | 273                     | 0.41                          |
| S25        | 7.73 | 14                    | 0.41               | 22                          | 170                     | 0.24                          |
| S26        | 7.86 | 9                     | 0.46               | 57                          | 202                     | 0.15                          |
| S27        | 6.65 | 15                    | 0.52               | 21                          | 105                     | 0.16                          |

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                          |
| S29       | 6.28 | 5                     | 0.26               | 22                          | 179                     | 0.05                          |
| S30       | 6.39 | 4                     | 0.35               | 22                          | 125                     | 0.05                          |
| S31       | 6.91 | 7                     | 0.38               | 26                          | 181                     | 0.1                           |
| S32       | 5.34 | 8                     | 0.292              | 13                          | 125                     | 0.04                          |
| S33       | 4.98 | 153                   | 0.473              | 14                          | 1050                    | 0.02                          |
| S34       | 7.35 | 60                    | 0.492              | 10                          | 239                     | 0.34                          |
| S35       | 7.06 | 24                    | 0.515              | 12                          | 825                     | 0.59                          |
| S36       | 5.82 | 9                     | 0.383              | 13                          | 60                      | 0.37                          |
| S37       | 5.75 | 5                     | 0.477              | 10                          | 82                      | 0.17                          |
| S38       | 6.25 | 11                    | 0.333              | 11                          | 32                      | 0.27                          |
| S39       | 8.17 | 26                    | 0.582              | 14                          | 28                      | 0.09                          |
| S40       | 6.64 | 14                    | 0.615              | 13                          | 273                     | 0.08                          |
| S41       | 7.1  | 13                    | 0.29               | 16                          | 129                     | 0.06                          |
| S42       | 8.23 | 18                    | 0.356              | 14                          | 1100                    | 0.25                          |
| S43       | 7.27 | 16                    | 1.041              | 18                          | 820                     | 0.71                          |
| S44       | 6.83 | 8                     | 0.801              | 32                          | 250                     | 0.31                          |
| S45       | 7.26 | 17                    | 0.987              | 8                           | 207                     | 0.37                          |
| S46       | 5.4  | 4                     | 0.589              | 12                          | 800                     | 0.26                          |
| S47       | 5.5  | 3                     | 0.386              | 10                          | 900                     | 0.01                          |
| S48       | 5.03 | 1                     | 0.604              | 11                          | 1200                    | 0.39                          |
| S49       | 6.06 | 3                     | 0.636              | 14                          | 266                     | 0.59                          |
| S50       | 6.16 | 7                     | 0.767              | 33                          | 515                     | 0.11                          |
| S51       | 6.21 | 4                     | 0.821              | 11                          | 387                     | 0.32                          |

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### 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      |
|                |      |      | ---         | ---            | ---                | ---      |
|                |      |      | 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      |
|                |      |      | ---         | ---            | ---                | ---      |
|                |      |      | 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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