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Delineation and mapping of soil fertility status in and around the proposed paper board industry of TNPL unit II, Trichy district, Tamil Nadu

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Abstract
An investigation was carried out in Tiruchirappalli district of Tamil Nadu where the TNPL is planned to establish a paper board industry (TNPL Unit II) at Mondipatti village of Manaparai taluk. The investigation was carried out to assess the soil fertility status in and around the TNPL unit II to ensure the suitability of soil for different crops. Around 416 soil samples were collected at 200m grid sample interval and its properties including fertility status *viz.*, Available Nitrogen, Phosphorus and Potassium were assessed and their results were interpreted with statistical parameters such as standard deviation, minimum, maximum and mean. The maps were prepared for each parameter under GIS using Arc GIS V 10.1. The soils of area under investigation revealed that they were acidic to strongly alkaline (4.72 to 9.78) with non-saline. The soil Organic carbon content was low to high with value of 1.4 to 10.3 g kg^{-1} however, 84.8 per cent of area falls under lowest organic carbon status. The available nitrogen status of the samples was low to high with the value of 137 to 639 Kg ha^{-1} however, 60.3 per cent of area falls under low status, similarly for available phosphorus status also low to high with a value of 9 to 57Kg ha^{-1}however, 58.9 per cent falls under medium status. The available potassium status ranged from low to high with a value of 28to 989 Kg ha^{-1} however, 50.48 per cent of area falls under high status. Hence, the highest percentage of available N, P & K status of investigated area were falls under low, medium and high status, respectively. Based on the Nutrient Index Value of the study area falls in Low organic matter, medium in available Nitrogen and High in available phosphorus and potassium. Hence, the soil needs to be improved by addition of organic matter for enriching soil available nitrogen status.

Keywords: Organic carbon, phosphorus, organic matter, soil fertility

1. Introduction

Among the various industries, paper board and pulp industry are one of the major polluters of the environment. It has been categorized as one of the most polluting industries due to discharge of huge volumes of waste water (effluent) in the environment causing pollution of land (soil), air and water (Martin, 1998) [6]. India has secured 15th rank in the paper manufacturing and pulp industries in the world. The major states contributing are West Bengal, Andhra Pradesh, Gujarat, Orissa, Karnataka, Maharashtra, Uttar Pradesh, Tamil Nadu, Haryana, Kerala, Bihar and Assam.

The most important problem which the pulp and paper board industry is facing today is the disposal of tremendous volumes of waste water. On the other hand, wastewater is also a resource that can be applied for productive uses for agriculture and other allied activities (Kumar 2010) [4]. The paper board industry effluent is a source of plant nutrient due to presence of appreciable amounts of nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) along with zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) (Kumar and Chopra, 2012) [5]. The treated waste water can be discharged with proper precautions (continuous monitoring and irrigate through drip system) will reduce the contamination of the environment and can be used to increase the soil and crop productivity.

The treated effluent of proposed paper board industry could be effectively used to improve the soil and crop productivity in the TNPL Unit II area under agro-forestry system without affecting the environment, which could be monitored by way of periodical investigation of soil. The difference between the fertility status of soil before and after discharge of effluent may help to assess the changes of soil quality in and around the TNPL Unit II area based on the temporal assessment on soil fertility.

The GPS and GIS are a tool helps in collecting a systematic set of geo referenced samples and generating spatial data about the distribution of nutrients in the specified locations (Sharma 2004) [12]. The Geo referenced maps also help in monitoring changes in nutrient status over a period of time by revisiting to the same locations with the help of GPS. Hence, the present study was carried out to assess the soil fertility status and to prepare soil fertility maps using GPS and GIS techniques around the paper board industry (TNPL Unit II, Mondipatti, Manapari, Tricharppalli district) and its surrounding villages.

Methods and Materials

Soil sampling, processing and analysis

Depending on the variability of soils series, a total of 416 soil samples were collected from the plough layer (0 to 30 cm depth) at an approximate interval of 200m grid (Fig. 1) with the help of hand held global positioning system (GPS) over the TNPL Unit II and Surrounding villageswith comprises 14 revenue villages*viz*., Thoghamalai, Kalladai, Vadacheri, Pillur, Padaripatti, Porundalur, Uthupatti, Iedaiyapatti, Chittanantham, K.Periyapatti, Mondipatti, Thoppampatti, Chattrapatti and Kannudiyanpatti of Manaparai taluk, Tiruchirappalli district, Tamil Nadu. Each Village maps of Manaparai taluk which consist of village boundaries were scanned in tiff format and imported to an Arc GIS Software version 10.1. Soil samples were air dried and ground to pass through a 2 mm sieve. The pH of the soil sample was measured in a 1:2.5 soil/water suspension and EC of the soil sample was measured in a 1:2.5 soil/water extract (Jackson, 1973). The soil organic carbon estimated by wet digestion method with cromic acid and sulfuric acid was outlined by Walkley and Black (1934) [17], available Nitrogen by alkaline permanganate method was outline by Subbiah and Asija (1956) [14]. The available phosphorus was extracted by Olsen's Extractant (0.5 N $NaHCO_3$ at pH 8.5) (Olsen 1954) [7] and Bray's Method (Bray 1945) [1]. The color developed with freshly prepared reagent B (ascorbic acid) was measured with the help of spectrophotometer at 660 nm wave length (Jackson, 1973) [2] Available potassium was extracted with Neutral Normal Ammonium acetate (N NH_4OAc) and then measured by flame photometer (Jackson, 1973) [2].

The analytical results of each soil sample was categorized as low, medium and high categories for OC and macronutrients as followed in Tamil Nadu. Making use of the number of samples in each category, the per cent sample in each category and nutrient index values (NIV) were computed using the formulae furnished below.

Per cent sample category

$$Per\ cent = \frac{\text{No. of "low (L)" or "medium (M)" or "high (H)" category}}{\text{Total no. of samples}} X100$$

Nutrient index values and fertility rating

Nutrient index value (NIV) was calculated from the proportion of soils under low, medium and high available nutrient categories in the investigated area, as represented by.

$$\text{NIV} = \frac{[(P_H x3) + (P_M x2) + (P_L x1)]}{100}$$

where, NIV = nutrient index value; P_L, P_M and P_H are the percentage of soil samples falling in the category of low, medium and high nutrient status and given weightage of one, two and three respectively (Ramamoorthy and Bajaj 1969) [9]. The index values are rated into various categories *viz.*, low (<1.67), medium (1.67-2.33) and high (>2.33) for OC and available N, P and K.

Generation of maps

The Ground Control points were identified for the district and based on them the map was geo-referenced. The 14 revenue village boundaries *viz*., Thoghamalai, Kalladai, Vadacheri, Pillur, Padaripatti, Porundalur, Uthupatti, Iedaiyapatti, Chittanantham, K. Periyapatti, Mondipatti, Thoppampatti, Chattrapatti and Kannudiyanpatti were digitized in polyconic mode in. shp format. After digitization, the necessary corrections were done to clean block and revenue village layer for topology building. The villages were assigned different identity in the layer to assign various attributes in the database. Through Arc catalog software, the columns for pH, Electrical conductivity, organic carbon and available N, P, K were added in the layer to enter the attribute data. The available nutrient data were imported from Ms-Excel and assigned to polygon attribute table in the layer. From the attribute database, different thematic layers were reclassified to generate various thematic maps on available nutrients of N, P and K values. The suitable annotations like legend, palettes, north arrow and scale were composed on thematic maps. The thematic maps of pH, EC, OC and available N, P, K of TNPL Unit II Surrounding villages of Manaparai,
Tiruchirappalli district in Tamil Nadu are thus generated and presented. The samples were analyzed, averaged nutrient status and prepared thematic map by using of Arc GIS 10.1 version.

Result and Discussion

Soil reaction and Electrical conductivity

Soils of the TNPL Unit II Mondipatti and its surrounding villages were acidic to strongly alkaline in reaction (4.72 to 9.78) with a mean pH of 7.55 and standard deviation of 1.13 (table 3). Out of 416 locations 88 sample locations were falls under acidic condition (21.2 %), 62 locations were falls under neutral in pH (44.9 %), 266 locations were recorded Alkali in pH (63.9 %) which might be due to the higher degree of base saturation (Sharma *et al.* 2008) [13]. and the higher pH of soils could be due to calcareousness, sodicity, low intensity of leaching and accumulation of bases (Prabhavathi *et al.*, 2013) [8]. The electrical conductivity of soil in the TNPL Unit II Mondipatti was in the range of 0.01 to 1.82 dSm^{-1}. Out of 416 samples, all the samples were falls under non- saline in nature. The different categories of pH and EC classes were interpolated in thematic map fig. (2 and 3). The non-saline nature of a major per cent of the soil samples might be due to proper management and inherent properties of soil as also reported by Sharma *et al.* (2008) [13].

Organic Carbon

Soil organic carbon (OC) content of TNPL Unit II surrounding village ranged from low to high (1.4 to 10.3g kg^{-1}) with mean of 0.34 and standard deviation of ± 0.09 g kg^{-1}. The organic carbon content was falls under low, medium and high status in the study area. Out of 416 locations, 351 locations fall under low organic carbon content (84.8 %) followed by medium status were in 59 locations (14.2 %) and high in 6 locations and the Nutrient Index Value was falls under low ratings. The different categories of organic carbon classes were interpolated in thematic map fig. (4). The reason for low OC content, which is primarily due to high temperature leading to higher rate of organic matter decomposition (Kameriya 1995) [3]. and also due to little or no organic matter additions as reported by Rego *et al.* (2003) [11].

Available Nitrogen

The available Nitrogen status in surface soil samples of TNPL Unit II mondipatti and surrounding villages were ranged from 137 to 639 Kg ha^{-1}(low to high) with mean and standard deviation of 270 and ± 70 Kg ha^{-1}respectively. Among the 416 locations, 251 locations (60.3%) and 154 locations (37%) were found to low and medium category of available nitrogen status, whereas in 11 locations (2.6%) the status fall under the high category and the medium category of nutrient index value were recorded. The different categories of available nitrogen classes were interpolated in thematic map fig. (5). The low nitrogen content may be due to poor soil management, varied application of FYM and nitrogenous fertilizers, possibility of loss of nitrogen through leaching and volatilization due to rainfall and soil properties. The medium and high status were attributed to higher availability and application of organic manure and low microbial mineralization (Thangasamy *et al*., 2005) [15].

Available Phosphorus

The available phosphorus status in soils of TNPL Unit II and its surrounding villages were ranged from 9 to 57 Kg ha^{-1}with mean and standard deviation of 24 Kg ha^{-1} and ± 18 Kg ha^{-1}. Among the 416 locations, 245 locations (58.9 %) and 158 locations (37.98%) were found to medium and high available phosphorus status, whereas in 13 locations (3.13%) the status fall under the low category and the Nutrient Index Value was falls under high ratings. The different categories of available phosphorus classes were interpolated in thematic map fig. (6). The low P availability in these soils is related to pH, calcareousness and low organic matter content as reported by Ravikumar *et al*. (2007) [10].

Available Potassium

The available potassium status in surface soil sample of TNPL unit II and its surrounding villages were ranged from 28 to 989 Kg ha^{-1}with mean and standard deviation of 329 and ± 201 Kg ha^{-1}respectively. Out of 416 locations, 47were recorded in low (11.3%) potassium status, the medium status was observed in 159 locations (38.2%) and 210 locations (50.48 %) were found to high available K status. The different categories of available potassium classes were interpolated in thematic map fig (7) and the Nutrient Index Value was falls under high ratings. The high potassium status might be due to predomination of K- rich micaceous and feldspar minerals in parent material, similar results were observed by Vara Prasad Rao (2008) [16].

Table 1: Soil Physiochemical Properties of TNPL Unit II and its Surrounding Villages

Parameters / Nutrients	Minimum	Maximum	Mean	St.Dev	Per cent sample category					
					Acidic/ Non Saline		Neutral/ Slightly saline		Alkaline/ Saline	
					No. of samples	%	No. of samples	%	No. of samples	%
pH	4.72	9.84	7.57	1.07	79	19	84	20.2	253	60.79
EC (dSm^{-1})	0.01	1.96	0.24	0.41	416	100	-	-	-	-

Table 2: Soil fertility status of TNPL Unit II and its Surrounding Villages

Parameters / Nutrients	Minimum	Maximum	Mean	St.Dev	Per cent sample category						NIV
					Low		Medium		high		
					No. of samples	%	No. of samples	%	No. of samples	%	
OC (%)	0.14	1.03	0.39	0.09	351	84.8	6	1.4	59	14.2	1.30
Available N (Kg ha^{-1})	137	639	270	70	251	60.3	11	2.6	154	37	1.77
Available P (Kg ha^{-1})	9	57	24	18	13	3.13	245	58.9	158	37.98	2.35
Available K (Kg ha^{-1})	28	989	329	201	47	11.30	159	38.2	210	50.48	2.39

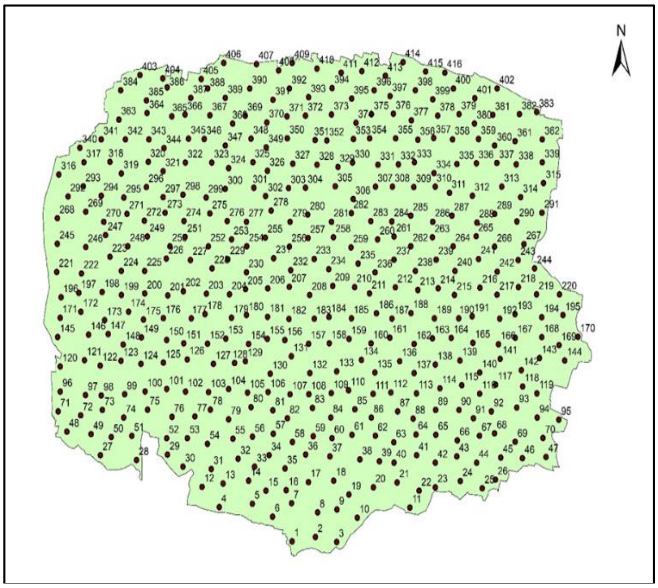

Fig 1: Location Map of Grid Sampling Study Area

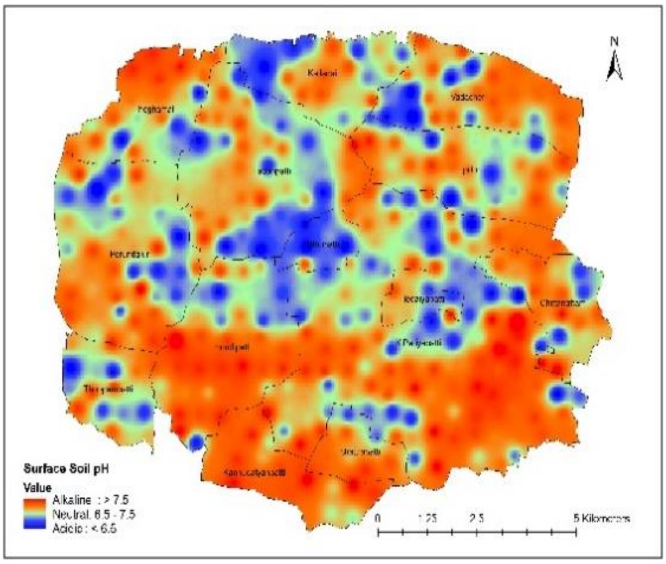

Fig 2: Soli Reaction (pH) Statue of TNPL Unit II and Its Surrounding Villages

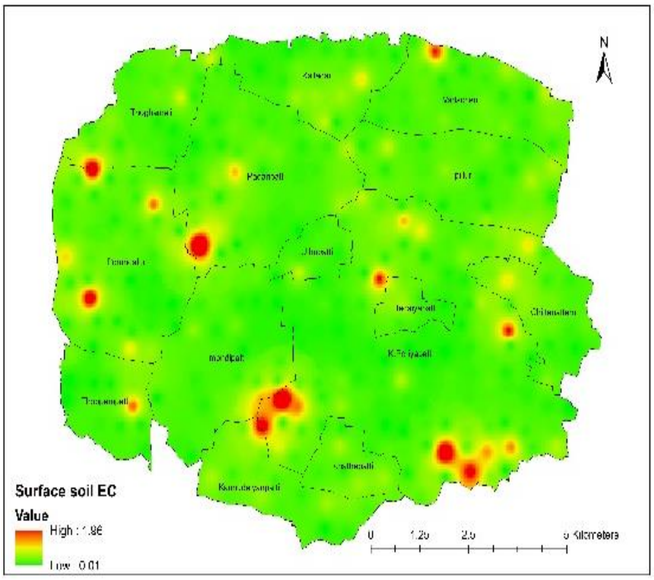

Fig 3: Soil Electrical Conductivity of TNPL Unit II and its Surrounding Villages

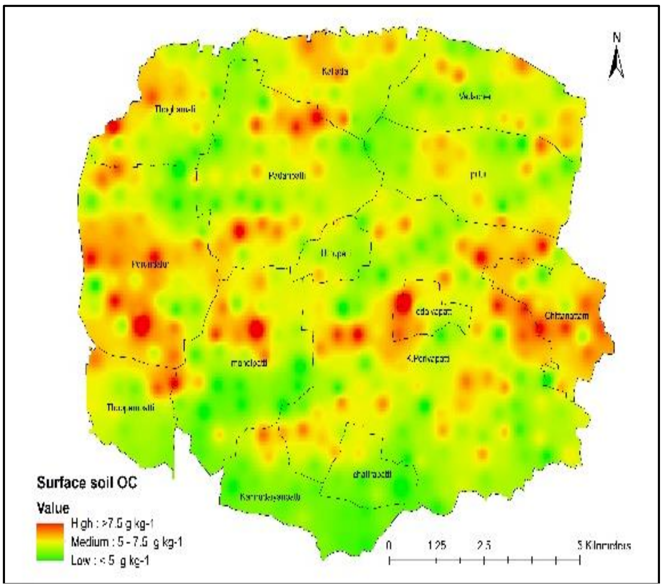

Fig 4: Soil Organic Carbon Status of TNN. Unit II and its Surrounding Villages

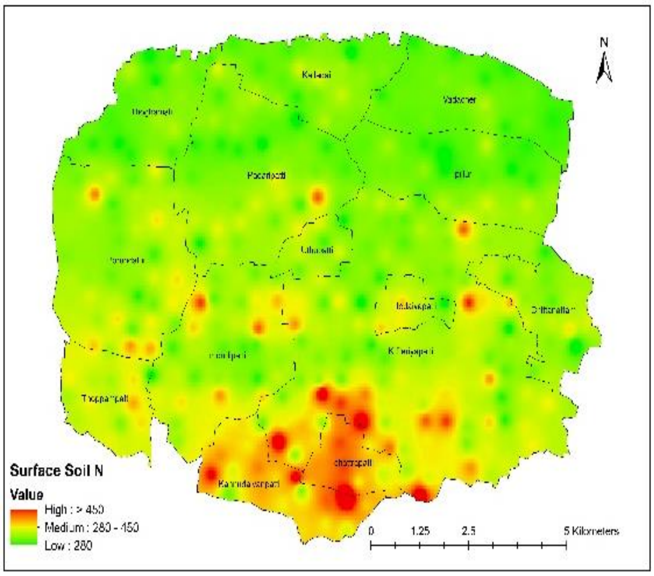

Fig 5: Soil Available Nitrogen Status of TNPL Unit II and its Surrounding Villages

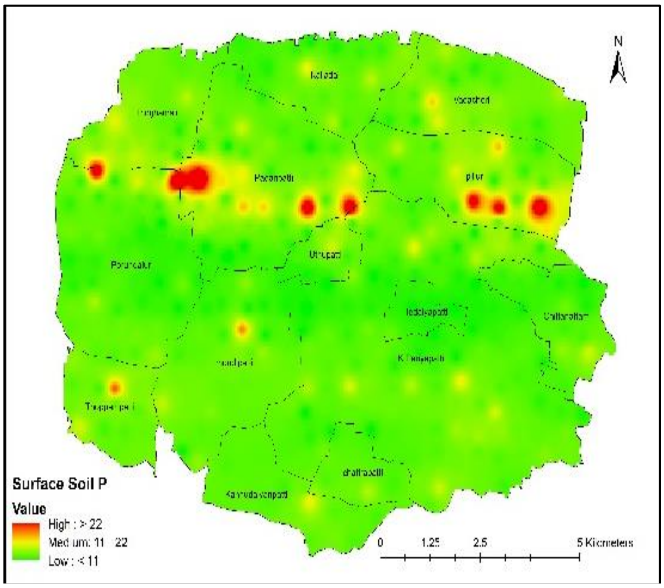

Fig 6: Soil Available Phosphorus Status of TNPL Unit II and its surrounding Villages

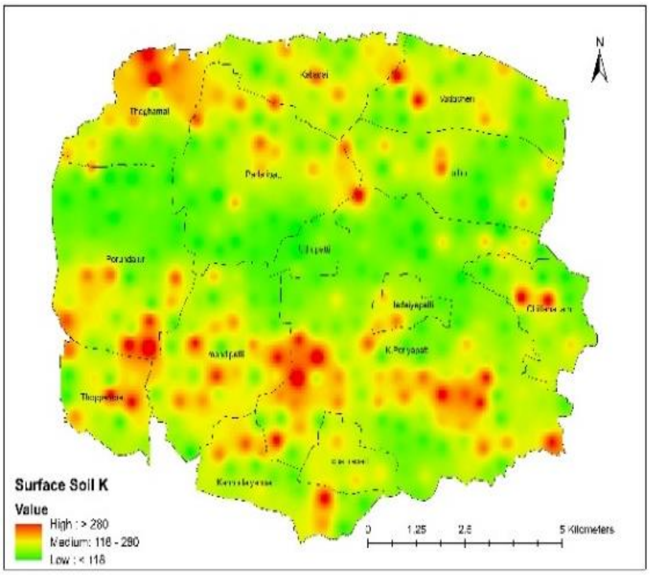

Fig 7: Soil Available Potassium Unbar of TNPL Unit II and Its SunaundIng Villages

Conclusions

It can be concluded that based on thematic maps, a major area of TNPL Unit II surrounding villages were alkaline, non-saline, low in OC and available nitrogen status, medium in available P and high in value of available K. The geo referenced sampling sites can be revisited with the help of GPS, which helps in monitoring the temporal changes in soil fertility status in further to study the impact of treated effluent irrigation to Agro-forestry system. Further, it will be useful to the researchers, planners, policy makers, extension workers of the State Department of Agriculture, fertilizer industries and farmers for implementing the soil fertility improvement programme in view of the impact of TNPL unit II paper board industry which utilizes the treated effluent for its Agro-forestry system.

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Reference

1. Bray RH, Kurtz LT. Determination of total, organic and available forms of phosphorus in soils. Soil Science. 1945; 59:39-45.
2. Jackson ML. Soil Chemical Analysis. Prentice hall of India (Pvt.) Ltd., New Delhi, 1973.
3. Kameriya PR. Characterization of soils of agro climatic zone of transitional plain of inland drainage (Zone II-A) of Rajasthan, Ph.D. Thesis, R.A.U., Bikaner, 1995.
4. Kumar V, Chopra AK, Pathak C, Pathak S. Agro-potentiality of Paper Mill Effluent on the characteristics of *Trigonellafoenum-graecum* L. (Fenugreek) New York Sci. J., 2010; 3(5):68-77
5. Kumar V, Chopra AK. Effect of paper mill effluent irrigation on agronomical characteristics of *Vigna radiata* (L.) in two different seasons. Comm. Soil Sci. Plant Anal. 2012a. 43(16):2142-2166.
DOI: 10.1080/00103624.2012.697236.
6. Martin P. River pollution in India: An overview, In Chari, I. K. Ed. Employment News. 1998; XXII(82):1-2.
7. Olsen SR, Cole CV, Watanabe FS, Dean L. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A. Circular, 939. U.S. Govt. Printing Office, Washington DC. 1954.
8. Prabhavathi M, Patil SL, Raizada A. Assessment of soil fertility status for sustainable crop production in a watershed of semi-arid tropics in southern India. Indian Journal of Soil Conservation. 2013; 41(2):151-157.
9. Ramamoorthy B, Bajaj JC. Available N, P and K status of Indian soils. Fertiliser News. 1969; 14:24-26.
10. Ravikumar MA, Patil PL, Dasog GS. Mapping of nutrients status of 48A distributary of Malaprabha right bank command of Karnataka by GIS technique. I-Major Nutrients. Karnataka Journal of Agricultural Sciences 2007; 20:735-737.
11. Rego TJ, Rao VN, Seeling B, Pardhasaradhi G, Kumar Rao JVDK. Nutrient balances a guide to improving sorghum and groundnut based dry land cropping systems in semiarid tropical India. Field Crops Research. 2003; 81:53-68.
12. Sharma PK. Emerging technologies of remote sensing and GIS for the development of spatial data structure. Journal of the Indian Society of Soil Science. 2004; 52: 384-406.
13. Sharma PK, Sood A, Setia RK, Tur NS, Deepak Mehra, Harpinder Singh. Mapping of macronutrients in soils of Amritsar District (Punjab) – A GIS approach. Journal of the Indian Society of Soil Science. 2008; 56:34-41.
14. Subbiah BV, Asija GL. A rapid procedure for estimation of available nitrogen in soils. Current. Science. 1956; 25:259-260.
15. Thangasamy A, Naidu MVS, Ramavatharam N, Raghava Reddy C. Characterization, classification and evaluation of soil resources in Sivagiri micro watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. Journal of the Indian Society of Soil Science. 2005; 53:11-21.
16. Vara Prasad Rao, Naidu AP, MVS, Ramavatharam N, Rama Rao G. Characterization, classification and evaluation of soils on different landforms in Ramachandrapuram mandal and Chittoor district in Andhra Pradesh and sustainable land use planning. Journal of the Indian Society of Soil Science. 2008; 56:23-33.
17. Walkley A, Black IA. An examination of the Degtja reff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science. 1934; 37:29-38.