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Mapping Soil Fertility and its Spatial Variability in Tiruchirapalli District, Tamil Nadu Using GIS

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Delineation of available macro and micronutrients was carried out by collecting 318 geo referenced surface soil samples from 53 villages in 14 blocks covering nine taluks of Tiruchirapalli district, Tamil Nadu using Global positioning system (GPS) by following multistage stratified random sampling approach. The soil samples were analyzed for 12 chemical parameters and georeferenced data were used for the preparation of soil fertility maps using GIS. Results from the analytical data of 318 soil samples revealed that a major per cent of the samples was neutral to alkaline, non-saline, low to high in OC, low in available N, medium in available P and medium to high in available K. With regard to available S and micronutrients, Zn is predominantly deficient; B is moderate to sufficient while S, Fe, Cu, and Mn were in sufficient status. Based on Nutrient Index Value, the over all fertility rating is medium OC, low, medium and high and very high N, P, K and S, respectively; marginal Zn, high Fe, Cu and B and very high Mn. Making use of the analytical data and GPS readings the thematic soil fertility maps were generated by krigging in Arc-GIS software version 9.3. The maps clearly revealed that, a major area of the district was alkaline, non-saline, medium in OC, low, medium and high in available N,P and K, respectively with regard to available S and micronutrients, Zn was predominantly deficient, B was moderate while S, Fe, Cu and Mn were in sufficient status.

Key words: GIS, Soil fertility, Thematic maps, Tiruchirapalli district.

Decline in soil fertility endangers the maximum productivity and sustenance of soil health. Depending on the cropping pattern, leaching, erosion etc., soil looses a considerable amount of nutrient every year. If cropping is continued over a period of time without nutrients being restored in the soil, its fertility will be reduced and crop yields will decline. In this context, soil testing provides information regarding nutrient availability in soils, which forms the basis for the fertilizer recommendations for maximizing the crop yields. Advances including the Global Positioning System (GPS) and Geographic Information System (GIS) facilitate soil fertility mapping and provide quantitative support for decision and policy making to improve agricultural approaches towards balanced nutrition. GPS and GIS helps in collecting a systematic set of georeferenced samples and generating spatial data about the distribution of nutrients (Sharma, 2004). In the present study, an attempt has been made to evaluate the soil fertility status and their spatial variability in Tiruchirapalli district of Tamil Nadu.

Tiruchirapalli is the most centrally located district in Tamil Nadu state bound on the northeast by Permabalur district, northwest by Namakkal district, east by Thanjavur district, west by Karur district, southeast by Pudukkottai district and south by Sivagangai and Madurai. River cauvery flows through the length of the district and is the principal source of irrigation and water supply. The district is located approximately between 10° 40' - 11° 30'N and 78° 50' - 79 45' E. The total geographical area of the district is 4,40,383 ha with an annual mean rainfall of 842.6 mm, and mean annual temperature of 28º C. Tiruchirapalli district consists of Archean, cretaceous and quaternary geological formations. It is rich in minerals like limestone, gypsum, clay and feldspar.

Twenty seven soil series have been identified, out of which Irugur, Palaviduthi, Thulukkanur and Govindapuram series forms the major ones. Major crops cultivated in Tiruchirapalli district are rice, banana, sugarcane, coconut, cotton, betel, corn and groundnut. Tiruchirapalli district has nine taluks *viz*., Lalgudi, Manachanallur, Manapparai, Musiri, Srirangam, Thiruverumbur, Thottiyam, Thuraiyur and Tiruchirapalli.

Materials and Methods

Collection of soil samples

Based on multistage stratified random sampling method, a total of 318 samples were collected from 53 villages covering 10 per cent of the total villages

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in the district (Singh, 2010 and Subba Rao and Muralidharudu, 2011). Six soil samples representing three different farmers' categories based on resource base *viz.,* large (>3 ha), medium (1-3 ha) and small (< 1 ha) were collected from each selected village in the district. The GPS data (Latitude ºN and Longitude ºE) were recorded for each sampling site by using GPS **-** Garmin Etrex Vista HCX model.

Analysis of soil samples

Soil samples were processed and sieved through 2 mm sieve (0.2 mm sieve for organic carbon), labelled and stored. The samples were analysed for pH and EC (Jackson, 1973), organic carbon (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), available P (Olsen *et al.,*1954; Bray and Kurtz,1945), available K (Stanford and English, 1949), available S (Williams and Steinbergs, 1959), available Zn, Fe, Cu, and Mn (Lindsay and Norvell, 1978) and available Boron (Berger and Truog, 1944).

The analytical results of each soil sample was categorized as low, medium and high for organic carbon (OC) and macronutrients; as deficient, moderate and sufficient based on the critical limits for available S and micronutrients as followed in Tamil Nadu. Making use of the number of samples in each category, the per cent sample category and Nutrient Index Values (NIV) were computed using the formulae furnished below.

Per cent sample category

$$\text{Per cent sample category} = \frac{\text{No. of "Low" or "Medium" or "High" category}}{\text{Total no. of samples}} * 100$$

Nutrient index values and fertility rating

Nutrient index value was calculated from the proportion of soils under low, medium and high available nutrient categories, as represented by

$$NIV = \frac{[(PH*3)+ (PM*2)+ (PL*1)]}{100}$$

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).

The nutrient index values were 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. For available S and micronutrients, the ratings are very low (< 1.33), low (1.33-1.66), marginal (1.66-2.00) adequate (2.00-2.33), high (2.33-2.66) and very high (> 2.66). The taluks were categorized into different fertility ratings based on per cent sample category and NIV.

Generation of thematic soil fertility maps

Database on soil available nutrient status was generated in Microsoft Excel package at TNAU and the Soil fertility maps were prepared at Indian Institute of Soil Science, Bhopal by using Arc-GIS software version 9.3. The thematic maps on available nutrient status were generated by categorizing the fertility status as 'Low', 'Medium' and 'High' by showing appropriate legend for OC and available N,P and K; 'Deficient', 'Moderate' and 'Sufficient' for available S and micronutrients by krigging.

Result and Discussion

pH and Electrical conductivity

The pH of the surface soil ranged from 5.37 – 9.52 with a mean of 7.91, and about 87.1 per cent of the samples were found to be alkaline (Tables 1 and 2). Per cent sample category indicated that 0 -8.3 per cent under acidic, 0 – 16.7 per cent under neutral and 75-100 per cent under alkaline pH. Among the different pH ranges, the highest acidic category of 8.3 per cent was recorded in Thiruverumbur and Tiruchirapalli taluks and the highest neutral category of 16.7 per cent in Manachanallur, Thiruverumbur and Tiruchirapalli taluks, while Thuraiyur taluk recorded cent per cent alkaline category.

The electrical conductivity of the soil ranged from 0.02 to 2.96 dS m^{-1} with a mean of 0.43 dS m^{-1}. Tiruchirapalli taluk was found to have relatively higher percentage of slightly saline soils (41.7 %). Similarly Lalgudi, Manapparai, Musiri, Srirangam and Thottiyam taluks have also reported slightly saline condition. Results on EC indicated that the major soil samples were under non saline condition (92.0 %), which might be due to proper land management and inherent properties of soil (Sharma *et al*., 2008).

Organic carbon

The organic carbon status of the soil samples ranged from 0.12 to 2.67 with a mean value of 0.67 per cent (Tables 1, 2 and 4). The status was high in Lalgudi taluk (0.83%) followed by Srirangam (0.77 %); Manachanallur, Manapparai and Tiruchirapalli (0.70%); Thottiyam (0.67%) and the least was observed in Thuraiyur (0.48%) taluk. Organic carbon status of 29.5, 29.5 and 41.0 per cent of the samples was found to be low, medium and high, respectively. Nutrient index values ranged from 1.58 to 2.67 with low to high fertility rating, which is primarily due to high temperature leading to higher rate of organic matter decomposition and little or no organic matter additions (Rego *et al.* 2003).

Available N, P and K

The available nitrogen status in the surface soils ranged from 98 to 532 kg ha^{-1} with an overall mean value of 227 kg ha^{-1} (Tables 1, 3 and 4). Among the different taluks, Tiruchirapalli recorded the highest percentage of low available N status (100%) followed by Thuraiyur (93.8%), Thiruverumbur (91.7%), Musiri (90.5%), Srirangam (86.7%), Manachanallur and Thottiyam (83.3%). The lowest status was observed in Manapparai and Lalgudi taluks (80.6 % and 65 %),

respectively. The medium status was observed to the tune of 35.0 per cent. The higher status was observed in the range of 0.0 and 5.6 per cent. Nutrient index value for available nitrogen ranged from 1.00 to 1.35. The overall fertility rating for available nitrogen status was found to be low. As majority of soil is alkaline in nature, light texture and of calcareousness (41.9 %), the applied nitrogenous fertilizers would have been subjected to various losses, which might have resulted in low amount of available N in the soil. These results are in confirmation with the findings of Sharma *et al.* (2008).

Table 1. Range and mean values of available macro and micronutrients in different taluks of Tiruchirapalli district

Taluk	pH	EC (dS m-1)	OC (%)	N	P	K	S	Zn	Fe	Cu	Mn	B
				kg ha-1				mg kg-1				
Lalgudi	5.78-8.94 (8.00)	0.05-1.54 (0.50)	0.35-1.07 (0.83)	134-398 (258)	7-62 (11-22*) 21 (17*)	145-788 (374)	8.3-49.5 (30.0)	0.27-7.14 (1.86)	1.6-67.4 (25.5)	0.6-7.8 (3.6)	1.2-61.0 (28.6)	0.2-1.7 (0.9)
Manachanallur	6.60-8.60 (7.88)	0.10-0.47 (0.25)	0.15-1.09 (0.70)	154-392 (251)	6-35 11	152-622 (311)	9.5-36.5 (26.3)	0.14-4.65 (1.72)	3.0-24.0 (13.3)	0.4-2.9 (1.5)	1.7-57.8 (18.0)	0.2-1.5 (1.0)
Manapparai	6.26-8.97 (7.94)	0.02-1.57 (0.34)	0.17-1.08 (0.70)	126-392 (233)	6-46 (14-24*) 15 (19*)	107-663 (255)	20.3-44.8 (30.9)	0.36-7.10 (1.81)	0.6-38.8 (16.5)	0.5-5.6 (2.5)	4.1-59.7 (24.2)	0.6-2.1 (1.0)
Musiri	5.54-8.72 (7.97)	0.05-1.74 (0.41)	0.18-1.05 (0.63)	162-420 (221)	6-49 (19-50*) 19 (35*)	132-754 (312)	11.5-51.8 (32.6)	0.31-4.68 (0.96)	1.2-20.1 (8.2)	0.5-8.6 (2.1)	1.4-16.0 (10.6)	0.2-4.4 (1.0)
Srirangam	6.20-9.52 (8.08)	0.03-1.15 (0.34)	0.21-1.07 (0.77)	98-454 (214)	6-35 (8*) 16 (8*)	95-553 (211)	23.5-40.8 (31.6)	0.02-5.69 (1.29)	1.0-37.3 (15.3)	0.4-4.4 (1.9)	1.4-54.1 (10.3)	0.5-1.7 (0.9)
Thiruverumbur	5.57-8.80 (7.64)	0.04-0.46 (0.32)	0.20-0.98 (0.56)	143-302 (196)	6-31 (11*) 14 (11*)	108-656 (342)	28.0-40.3 (34.9)	0.41-3.14 (1.32)	7.1-34.0 (17.7)	0.8-4.4 (2.2)	4.8-14.5 (9.9)	1.1-1.9 (1.5)
Thottiyam	6.63-8.52 (7.88)	0.12-2.96 (0.55)	0.18-2.67 (0.67)	114-532 (237)	6-55 17	179-882 (406)	27.5-59.3 (37.4)	0.25-2.01 (0.84)	0.3-41.1 (10.1)	0.6-8.6 (2.0)	5.4-57.3 (21.7)	0.7-1.9 (1.3)
Thuraiyur	7.70-8.58 (8.15)	0.19-0.99 (0.43)	0.12-1.08 (0.48)	160-378 (220)	7-43 18	114-579 (276)	25.3-51.8 (33.6)	0.14-2.17 (0.82)	1.3-24.8 (10.1)	0.6-5.7 (2.9)	0.3-49.9 (13.2)	0.4-1.3 (0.8)
Tiruchirapalli	5.37-8.70 (7.68)	0.10-1.96 (0.76)	0.32-0.92 (0.70)	185-277 (214)	7-58 (40*) 6 (40*)	102-789 (247)	16.5-43.5 (31.1)	1.37-4.35 (2.38)	1.4-4.3 (2.4)	1.1-5.2 (2.8)	6.0-62.0 (19.8)	0.1 1.1 (0.9)
Over all mean/range	5.37-9.52 (7.91)	0.02-2.96 (0.43)	0.12-2.67 (0.67)	98-532 (227)	6-62 (8-50*) 15.2 (21.6*)	95-882 (304)	8.3-59.3 (32.0)	0.02-7.14 (1.44)	0.3-67.4 (13.2)	0.4-7.8 (2.39)	0.3-62.0 (17.4)	0.1-4.4 (1.03)

The Olsen-P ranged from 6.0 - 62.0 kg ha^{-1} and Bray-P ranged from 8 - 50 kg ha^{-1} with an overall mean value of 15.2 and 21.6 kg ha^{-1}, respectively. The overall per cent sample category under low, medium and high was 36.9, 38.4 and 24.7, respectively. Among the nine taluks, higher per cent of low category (70.8 %) was reported in Manachanallur taluk followed by Thiruverumbur and Thottiyam taluks (50 %). Nutrient index value for available phosphorus ranged from 1.38 to 2.33 with an overall rating of medium. This medium status of P in majority of the soils may be attributed to continuous application phosphatic fertilizers to crops, which would have resulted in buildup of phosphorus. The efficiency of applied P might also be very low making it in available form, slowly. These results are in confirmation with the findings of Sharma *et al*. (2008).

The overall range values recorded for available potassium status in surface soils of different taluks were 95 to 882 kg ha^{-1}. The mean values of available K indicated that the highest value of 406 kg ha^{-1} was recorded in Thottiyam taluk and the lowest in Srirangam taluk (211 kg ha^{-1}). The per cent sample category under low, medium and high ranged from 0.0 to16.7, 22.2 to 75.0 and 16.7 to 77.8, respectively. The highest per cent of low category of potassium was noticed in Srirangam taluk (16.7 %) followed by Thiruverumbur and Tiruchirapalli taluks (8.3 %) and Thuraiyur taluk (2.1%).The highest status of available K to the tune of 77.8 per cent was observed

in Thottiyam taluk. Nutrient index values ranged from 2.03 to 2.78, with medium to high status and an overall high fertility rating. The higher status of available K is attributed to the prevalence of Illite – a potassium rich mineral in these soils. Moreover, the ground water of Tiruchirapalli district is known to have considerable amount of dissolved potassium. Irrigation with such water also results in the accumulation of higher amounts of available K in these soils. The findings of Meena *et al.* (2006) confirm the results.

Table 2. Per cent sample category of soil pH, EC and organic carbon

Taluk	pH			EC (dS m^{-1})			OC (%)		
	acidic	neutral	alkaline	non-saline	slightly saline	saline	low	medium	high
Lalgudi	3.3	5.0	91.7	98.3	1.7	0.0	3.3	26.7	70.0
Manachanallur	0.0	16.7	83.3	100.0	0.0	0.0	20.8	29.2	50.0
Manapparai	1.4	6.9	91.7	93.1	6.9	0.0	23.6	30.6	45.8
Musiri	4.8	7.1	88.1	92.9	7.1	0.0	28.6	40.5	31.0
Srirangam	0.0	10.0	90.0	96.7	3.3	0.0	13.3	30.0	56.7
Thiruverumbur	8.3	16.7	75.0	100.0	0.0	0.0	41.7	33.3	25.0
Thottiyam	0.0	11.1	88.9	88.9	11.1	0.0	55.6	16.7	27.8
Thuraiyur	0.0	0.0	100.0	100.0	0.0	0.0	62.5	16.7	20.8
Tiruchirapalli	8.3	16.7	75.0	58.3	41.7	0.0	16.7	41.7	41.7
Over all mean/range	2.9	10.0	87.1	92.0	8.0	0.0	29.5	29.5	41.0

Available sulphur

The available sulphur status ranged from 8.3 to 59.3 mg kg^{-1} with a mean value of 32.0 mg kg^{-1} (Tables 1, 3 and 4). The mean available sulphur was found to be low in Manachanallur (26.3 mg kg^{-1}) taluk, while it was high in Thottiyam taluk (37.4 mg kg^{-1}). Deficient, moderate and sufficient sulphur status was noticed in 0.6, 1.5 and 97.9 per cent of the samples, respectively. Cent per cent sufficiency was observed in Manapparai, Srirangam, Thiruverumbur, Thottiyam, Thuraiyur and Tiruchirapalli taluks. The nutrient index values varied from 2.88 to 3.00 with very high S Status in the soil. This could be due to the continuous addition of sulphur containing agrochemicals, farm residues and organic manures. The results are in line with the findings of Patel and Patel (2008).

Table 3. Per cent sample category of soil available macronutrients status

Taluk	N			P			K			S		
	low	medium	high	low	medium	high	low	medium	high	low	medium	high
Lalgudi	65.0	35.0	0.0	10.0	51.7	38.3	0.0	36.7	63.3	1.7	6.7	91.7
Manachanallur	83.3	16.7	0.0	70.8	20.8	8.4	0.0	41.7	58.3	4.2	4.2	91.7
Manapparai	80.6	19.4	0.0	48.6	31.9	19.4	2.8	61.1	36.1	0.0	0.0	100.0
Musiri	90.5	9.5	0.0	31.0	33.3	35.7	0.0	54.8	45.2	0.0	2.4	97.6
Srirangam	86.7	10.0	3.3	40.0	43.3	16.7	16.7	63.3	20.0	0.0	0.0	100.0
Thiruverumbur	91.7	8.3	0.0	50.0	41.7	8.3	8.3	33.3	58.3	0.0	0.0	100.0
Thottiyam	83.3	11.1	5.6	50.0	33.3	16.7	0.0	22.2	77.8	0.0	0.0	100.0
Thuraiyur	93.8	6.3	0.0	14.6	56.3	29.2	2.1	58.3	39.6	0.0	0.0	100.0
Tiruchirapalli	100.0	0.0	0.0	16.7	33.3	50.0	8.3	75.0	16.7	0.0	0.0	100.0
Over all mean/range	86.1	12.9	1.0	36.9	38.4	24.7	4.2	49.6	46.2	0.6	1.5	97.9

Available micronutrients and boron

The range and mean values of micronutrients status in the soils of nine taluks in Tiruchirapalli district revealed that the available Zn status ranged from 0.02 to 7.14 mg kg^{-1} with a mean value of 1.44 mg kg^{-1}, while the available Fe status varied from 0.30 to 67.4 mg kg^{-1} with a mean value of 13.2 mg kg^{-1} (Tables 1, 5 and 6). With reference to available Mn status, the values ranged from 0.30 to 62.0 mg kg^{-1} with a mean value of 17.4 mg kg^{-1}. The available Cu status varied from 0.4 to 8.6 mg kg^{-1} with a mean value of 2.39 mg kg^{-1}. The data indicated that there exists great variation of micronutrient status among different taluks. Over all

mean values revealed that the available Cu, Fe and Mn levels are sufficient to meet the crop demand.

On an average, available Zn was predominantly deficient in all the taluks (51.1 %) followed by available Cu (19.7 %), Fe (12.4 %), Boron (3.0 %) and Mn (1.5 %). Zinc deficiency was observed to the tune of 33.3 to 85.4 per cent in Tiruchirapalli district and the present results are in line with the findings of Velu *et al*. (2008). The conversion of zinc cations to their oxides or hydroxides at higher pH, which are known to have lower solubility might be the reason for low zinc status.

Table 4. Nutrient index values and fertility rating of OC and macronutrients

Taluk	NIV					Fertility rating				
	OC	N	P	K	S	OC	N	P	K	S
Lalgudi	2.67	1.35	2.28	2.63	2.90	high	low	medium	high	very high
Manachanallur	2.29	1.17	1.38	2.58	2.88	medium	low	low	high	very high
Manapparai	2.22	1.19	1.71	2.33	3.00	medium	low	medium	medium	very high
Musiri	2.02	1.10	2.05	2.45	2.98	medium	low	medium	high	very high
Srirangam	2.43	1.17	1.77	2.03	3.00	high	low	medium	medium	very high
Thiruverumbur	1.83	1.08	1.58	2.50	3.00	medium	low	low	high	very high
Thottiyam	1.72	1.22	1.67	2.78	3.00	medium	low	medium	high	very high
Thuraiyur	1.58	1.06	2.15	2.38	3.00	low	low	medium	high	very high
Tiruchirapalli	2.25	1.00	2.33	2.08	3.00	medium	low	medium	medium	very high
Over all mean/range	2.11	1.15	1.88	2.42	2.97	medium	low	medium	high	very high

Almost all the taluks had sufficient Fe availability with a mean fertility rating of high based on NIV. With reference to Cu, Thottiyam (38.9 %), Manachanallur (29.2 %), Musiri (28.6 %), Srirangam (23.3%), Manapparai (18.1%), Thiruverumbur (16.7 %) and Lalgudi (10 %) taluks showed higher per cent in available Cu deficiency as compared to other taluks, with a mean fertility rating of 'high' based on NIV. Agricultural practices can add copper to soils through application of manure or inorganic fertilizers (Nóvoa-Muñoz *et al.,* 2007; Nicholson *et al*., 2003). Soils of Manachanallur, Srirangam, Musiri, Thuraiyur and Lalgudi taluks had low Mn deficiency (4.2, 3.3, 2.4, 2.1 and 1.7 %, respectively) while the soils of Manapparai, Thiruverumbur, Thottiyam and Tiruchirapalli taluks exhibited no Mn deficiency. The per cent sufficiency of Mn was 97.4 in the soils of the study area, which might be due to the fact that decomposition of soil organic matter releases micronutrients and also reduces the pH locally, increasing the solubility of cationic micronutrients (Sharma and Chaudhary, 2007).

Table 5. Per cent sample category of soil available micronutrient status

Taluk	Zinc			Iron			Copper			Manganese			HWSB		
	D	M	S	D	M	S	D	M	S	D	M	S	D	M	S
Lalgudi	45.0	28.3	26.7	5.0	8.3	86.7	10.0	6.7	83.3	1.7	0.0	98.3	10.0	31.7	58.3
Manachanallur	33.3	37.5	29.2	4.2	4.2	91.7	29.2	41.7	29.2	4.2	0.0	95.8	4.2	54.2	41.7
Manapparai	34.7	27.8	37.5	19.4	8.3	72.2	18.1	11.1	70.8	0.0	0.0	100.0	0.0	47.2	52.8
Musiri	78.6	11.9	9.5	19.0	33.3	47.6	28.6	19.0	52.4	2.4	0.0	97.6	2.4	61.9	35.7
Srirangam	66.7	10.0	23.3	6.7	16.7	76.7	23.3	16.7	60.0	3.3	10.0	86.7	0.0	76.7	23.3
Thiruverumbur	50.0	25.0	25.0	0.0	8.3	91.7	16.7	25.0	58.3	0.0	0.0	100.0	0.0	0.0	100.0
Thottiyam	66.7	27.8	5.6	44.4	16.7	38.9	38.9	33.3	27.8	0.0	0.0	100.0	0.0	33.3	66.7
Thuraiyur	85.4	10.4	4.2	12.5	18.8	68.8	4.2	18.8	77.1	2.1	0.0	97.9	2.1	81.3	16.7
Tiruchirapalli	0.0	41.7	58.3	0.0	41.7	58.3	8.3	25.0	66.7	0.0	0.0	100.0	8.3	58.3	33.3
Over all mean/range	51.1	24.5	24.4	12.4	17.4	70.2	19.7	21.9	58.4	1.5	1.1	97.4	3.0	49.4	47.6

The available boron status ranged from 0.10 to 4.4 mg kg^{-1} with an overall mean status of 1.03 mg kg^{-1}. Thiruverumbur taluk recorded the highest mean available boron status of 1.5 mg kg^{-1} and Thuraiyur taluk recorded the lowest mean status of 0.80 mg kg^{-1}. The per cent sample category under deficient, moderate

and sufficient were 3.0, 49.4 and 47.6, respectively and the cent per cent sufficiency was noticed in Thiruverumbur taluk. The NIV ranged from 2.15 to 3.00 with adequate to very high fertility ratings. High levels of boron in these soils might be mainly due to natural availability of boron in such soils or due to the continued use of irrigation water with increased levels of soluble salts including boron (Bradford *et al.,* 1996).

Thematic soil fertility maps

The thematic maps depicting the soil fertility status of Tiruchirapalli district were generated using sampling point data and by krigging. The soil fertility maps pertaining to 12 chemical parameters are depicted in Fig. 1 and the per cent area under different fertility category is furnished in Table 7.

Table 6. Nutrient index values and fertility rating of micronutrients

Taluk	NIV					Fertility rating				
	Zn	Fe	Cu	Mn	HSWB	Zn	Fe	Cu	Mn	HSWB
Lalgudi	1.82	2.82	2.73	2.97	2.48	marginal	very high	very high	very high	high
Manachanallur	1.96	2.88	2.00	2.92	2.38	marginal	very high	marginal	very high	high
Manapparai	2.03	2.53	2.53	3.00	2.53	adequate	high	high	very high	high
Musiri	1.31	2.29	2.24	2.95	2.33	very low	adequate	adequate	very high	adequate
Srirangam	1.57	2.70	2.37	2.83	2.23	low	very high	high	very high	adequate
Thiruverumbur	1.75	2.92	2.42	3.00	3.00	marginal	very high	high	very high	very high
Thottiyam	1.39	1.94	1.89	3.00	2.67	low	marginal	marginal	very high	very high
Thuraiyur	1.19	2.56	2.73	2.96	2.15	very low	high	very high	very high	adequate
Tiruchirapalli	2.58	2.58	2.58	3.00	2.25	high	high	high	very high	adequate
Over all mean/range	1.73	2.58	2.39	2.96	2.45	marginal	high	high	very high	high

Thematic mapping on soil pH, EC and organic carbon

With regard to soil pH, the soils are predominantly alkaline followed by neutral and acidic. Out of the total geographical area, 0, 5 and 95 per cent of the area is under acidic, neutral and alkaline, respectively. In the case of EC, cent per cent of the area is under non-saline condition. The organic carbon status was predominantly medium, accounting 63 per cent of the total area followed by high (24%) and low (13%) status.

Table 7. Per cent area under different fertility categories based on soil fertility maps

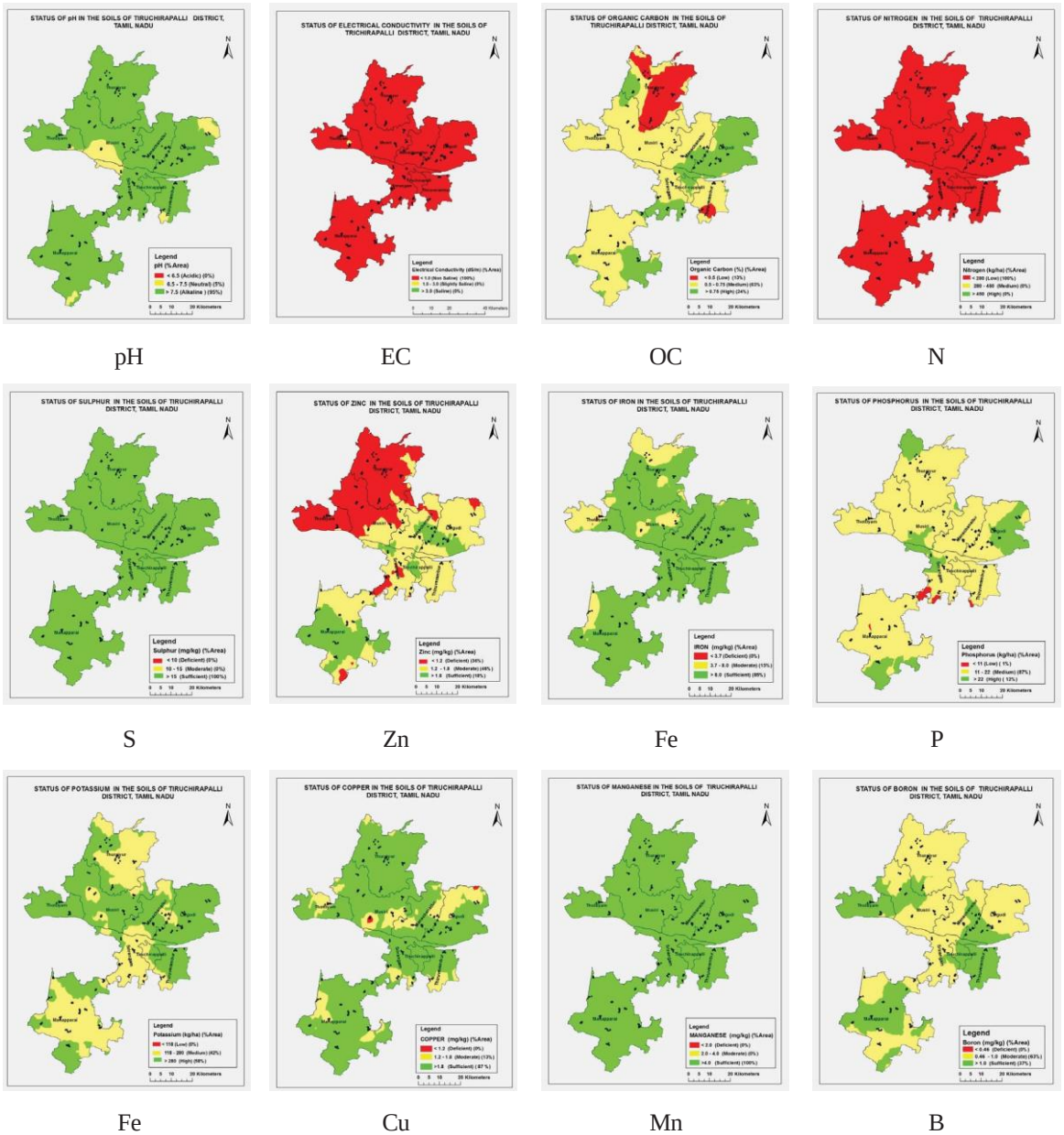
Parameters	Per cent category		
	Acidic/ non- saline/ low/ deficient	Neutral/slightly saline / medium/ moderate	Alkaline / saline / high / sufficient
pH	0	5	95
Electrical conductivity	100	0	0
Organic carbon	13	63	24
Available nitrogen	100	0	0
Available phosphorus	1	87	12
Available potassium	0	42	58
Available sulphur	0	0	100
Available zinc	36	46	18
Available iron	0	15	85
Available copper	0	13	87
Available manganese	0	0	100
Available boron	0	63	37

Thematic mapping on available N, P, K, S and micronutrients

Almost the entire area was under 'low' category with regard to available N and no medium and high category was noticed. In the case of available P, the status was predominantly under medium (87 %) followed by high (12 %) and only one per cent area showed P in low category. About 58 per cent of the area was under high available K and 42 per cent under medium category, while the available S status was cent per cent sufficient in the district.

With respect to available Zn, 46 per cent of area was under moderate category followed by deficient (36 %) and sufficient (18 %). About 85 per cent of the total area is under sufficient status for available Fe followed by moderate status (15%). In case of available Cu, sufficiency was observed in 87 per cent, while moderate status was reported in 13 per cent of the area. With respect to available Mn, cent per cent sufficiency was recorded in the whole district. In case of available B, moderate status was observed in 63 per cent area followed sufficiency status in 37 per cent of the area.

Fig. 1 Soil fertility maps of Tiruchirapalli district, Tamil Nadu (availability status)



Conclusion

The soil fertility maps clearly revealed that, major area Tiruchirapalli district in Tamil Nadu is alkaline, non-saline and medium in OC; low, medium and high in available N, P and K, respectively while the available sulphur status is found to be sufficient. Among the micronutrients, Zn is predominantly deficient, B is moderate, while all others are in

sufficient status. The deficient nutrients have to be restored through chemical fertilizers and/or organic manures to maintain sustainable soil fertility status. Therefore, to mitigate the issue of correcting nutrient deficiencies STCR-IPNS recommendations along with micronutrient recommendations are to be followed for sustained crop production and soil fertility.

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