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The Physio-chemical properties, available sulphur and micro nutrients status in soil of Tiruchirappalli District of Tamil Nadu, India

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Abstract
The study was undertaken with a view to assess the sulphur and micronutrient status in the soils of various blocks of Tiruchirappalli district of Tamil Nadu. The surface soil samples of Tiruchirappalli district were red loamy, acidic to alkaline (5.22 to 9.21) in reaction with salinity level of harmless (0.02 to 1.74 dS m^{-1}) in condition, low to medium in organic carbon (0.03 to 0.98) per cent and free calcium carbonate content of non-calcareous to moderately calcareous in nature (0.05 to 12.75%). The available sulphur content was low to high status (2.80 to 92.00 mg kg^{-1}), the DTPA extractable micronutrients such as Cu, Zn, Mn, Fe and HWSB content were varied from low to high with range values of 0.03 to 6.38 mg kg^{-1} for Cu, 0.13 to 4.81 mg kg^{-1} for Zn, 0.21 to 32.74 mg kg^{-1} for Mn, 2.16 to 42.05 mg kg^{-1} for Fe and 0.06 to 3.92 mg kg^{-1} for HWSB. Regarding available sulphur, it was observed that 11.59 per cent of the surface soils of Tiruchirappalli district are deficient. Zinc deficiency was the predominant in majority of soil samples (63.82%) followed by Cu (40.11%), B (16.18%), Fe (4.99%) and Mn (3.82%).

Keywords: Soil, organic carbon, sulphur, micro nutrients

Introduction
Agriculture is a very important sector for sustained growth of Indian economy. Soil is the basic natural resource for crop production and it supplies essential nutrients for plant growth, the food security and necessary components of human and animal food and the nutritional security of the country. However continuous cropping of high yielding varieties without proper substitution of inorganic fertilizers, non-addition of micronutrients, and less or no application of organic manures have caused excessive removal of essential nutrients from the soil reserves that eventually led to the deficiencies of micronutrients in soils. The deficiency may either be primarily due to their low contents or secondarily by soil factor that reduce the availability (Sharma and Chaudhary, 2007) [15]. Micronutrients are as essential as macronutrients but required in smaller quantities by plants. Crop growth, yield and quality of many crops may be affected if any one of the essential micronutrients is lacking in soil.
Sulphur is the fourth major nutrient element after nitrogen, phosphorus and potassium. Introduction of high yielding crop varieties, intensive and multiple cropping and decreased use of farmyard manure seem to have lead to a wide occurrence of sulphur deficiency and diverted the attention of the researchers towards this hitherto neglected element. It has been mentioned by Kanwar (1976) [7] that intensive farming practices are followed and use of concentrated fertilizers free from sulphur become more popular, the areas which are now presumed to contain adequate amount of sulphur may also begin to show sulphur deficiency. In countries like India where intensive cultivation is being followed, sulphur is one of the element that must not be overlooked. Sulphur deficiency in soils of Indian states varies from 5 to 83 per cent with an overall mean of 41 per cent (Singh, 2001) [16]. In India, despite the fact that macronutrients had a remarkable impact on crop production, devoid of micronutrients in the production system has caused excessive removal from the soil reserves that eventually led to the deficiencies of micronutrients in soils. It has been reported that the occurrence of Zn, Fe, Cu and Mn deficiencies was to an extent of 49%, 12%, 5% and 3%, respectively in India (Singh and Saha, 1995) [13].

Materials and Methods

The geo-referenced surface soil samples were collected from the villages of Tiruchirappalli district to assess the available sulphur and micronutrient status, preparation of thematic maps based on the nutrient availability for depicting the severity of sulphur and micronutrient status at blocks level. The particulars of study area, the method of soil sample collection, mapping of sulphur and micronutrient status at block level.

Description of study area

The Tiruchirappalli district of Tamil Nadu extends over an area of 4, 40,383 hectares. It is geographically bounded by Salem district in the North, Thanjavur district in the East, Sivaganga and Madurai district in the South and Karur district in the West. Geographically, it lies between 78° 10' to 79° 5' Eastern longitude and 10°15' to 11°2' Northern latitude with altitude of 90 m.

The average annual rainfall is 842.6 mm. The contribution of South West, North East monsoons, winter rainfall and summer rainfall are 32.43%, 46.85%, 4.8% and 15.90% respectively. There are two cropping seasons *viz*. Kuruvai (June-July) and Samba (August).

Major portion of the district is covered by plain topography. Gneissic group of rocks of Archean period consisting of granitoid mica gneiss, granitic gneiss leptinites, mixed and composite gneiss are found at different places. The dominant minerals found in the district are limestone, gypsum, garnet sand and limonite. The crystalline lime stones of Precambrian age are mainly distributed in parts of Tiruchirappalli. Deep black is the predominant soil in the district accounting for 32.2 percent followed by the deep red soil with 25.12 percent.

The present study area comprises the Tiruchirappalli district consisting of 9 taluks, 14 blocks and 408 Panchayat villages. The geographic area of the taluks and number of samples comprising the Tiruchirappalli district.

Collection and processing of geo-referenced surface soil samples

Totally 1584 geo-referenced surface soil samples covering all the villages in fourteen blocks of Tiruchirappalli district were collected randomly at 0 - 15 cm depth by adopting the standard procedures of soil sample collection. The Global Positioning System (GPS) data (Eastern Longitude and Northern Latitude) were collected from each sampling sites distributed over the entire Tiruchirappalli district by using GPS.

The collected soil samples were air dried, gently bound, sieved (2 mm sieve) and preserved in serially labeled polythene bags for further analysis. Locations of soil sampling sites of Tiruchirappalli district were marked on base map 1: 50,000 scale prepared from State Revenue Maps and digitized using Arc-GIS.

Soil analysis

The surface soil samples were analyzed for various soil properties by adopting standard procedures. The methods employed are described below.

a. Soil reaction (pH)

The pH of soil was estimated by employing potentiometry method using soil water suspension in the ratio of 1: 2.5 (Jackson, 1973) [6].

b. Electrical conductivity (EC)

The electrical conductivity of soil was estimated by employing conductometry method in the soil water suspension in the ratio of 1: 2.5 (Jackson, 1973) [6].

c. Organic carbon (OC)

The organic carbon content of soil was estimated by chromic acid wet digestion method (Walkley and Black, 1934) [17].

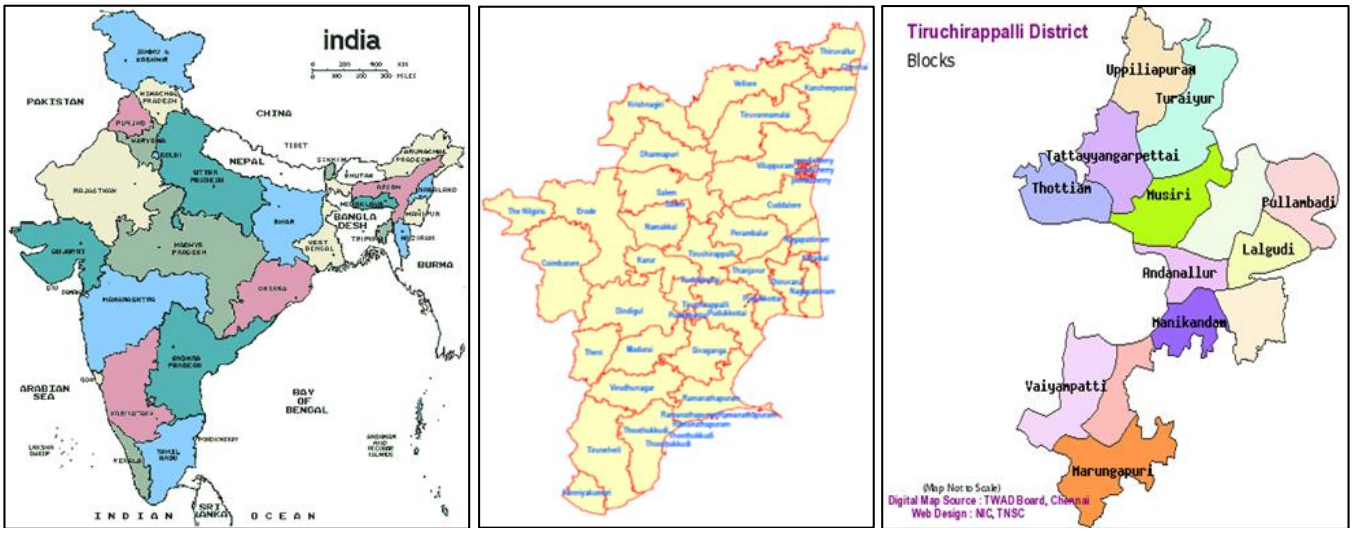

Fig 1: Location map of Tiruchirappalli district

d. Calcium Carbonate ($CaCO_3$)

The soil free calcium carbonate was determined by employing rapid titration method (Piper, 1966) [12].

e. Available Sulphur

The available sulphur content of the soil was estimated by 0.15% $CaCl_2$ method. 5 g of soil was Shaked with 50 ml of 0.15% $CaCl_2$ for 30 minutes in a reciprocating shaker. An aliquot of 2.5 ml of extract was pipetted out into a 25 ml volumetric flask and 10 ml sodium acetate – acetic acid buffer, 1 g $BaCl_2$ and 1 ml freshly prepared gum acacia were added. The volume was made up with distilled water and shaken well, and then the absorbance of this solution was read in a spectrophotometer at 420 nm after adjusting the meter to zero per unit absorbance with the blank and the sulphate

content was calculated using the standard curve (Williams and Steinberg, 1959) [19].

f. DTPA extractable micronutrients

The available micronutrients were extracted with DTPA (0.005 M Diethylene Triamine Penta Acetic Acid + 0.1 M Triethanolamine + 0.01 M $CaC1_2$) extractant adjusted to pH 7.3 ± 0.5 using 1:1 dilute HCl at 1:2 ratio (Soil: DTPA-extractant) after shaking for two hours, filtered through Whatman No.42 filter paper. The DTPA extractable copper, zinc, manganese and iron were estimated in the extractant using Atomic Absorption Spectrometer (Lindsay and Norvell, 1978) [8].

g. Available boron

Azomethine-H solution was prepared by dissolving 0.45 g of 4-methoxy azomethine–H reagent in 100 ml of one percent ascorbic acid. The buffer solution was prepared by dissolving 250 g of ammonium acetate and 15 g of Di-Sodium salt of EDTA (Ethylene Diamine Tetra Acetic acid) in 400 ml of double distilled water. All the reagents were dissolved and 125 ml of acetic acid was added to the solution and mixed thoroughly (Bingham, 1982) [3].

Twenty grams of soil sample was transferred to a conical flask, to which 40 ml of double distilled water and 0.5 g of activated charcoal were added. The contents were kept in a water bath maintained at 60ºC for half an hour and filtered through Whatman No.42 filter paper. 5 ml of filtrate was pipetted out into 25 ml volumetric flask, to which 4 ml of buffer and four ml of Azomethine – H were added and allowed for half an hour for colour development. The volume was made up to 25 ml and the color intensity was measured at 420 nm using UV-Visible Spectrophotometer (Berger and Troug, 1945) [17].

Table 1: Proforma for soil sampling site descriptions

Soil Sample No		**Sampling Date**	
Soil sample details			
1.	District		
2.	Taluk		
3.	Block		
4.	Revenue Village Name		
5.	Geo- coordinates by GPS	Eº	Nº
6.	Field survey No.		
7.	Field location / land mark		
8.	Major soil type		
9.	Field condition at the time of soil sampling	Dry: Wet: Fallow: Cropped:	
Farmer details			
10.	Name of the farmer	Mr.	
11.	Address		
Crop and field details			
12.	Major crops cultivated		
13.	Cropping sequence		
14.	System of cultivation	Dry: Wet: Irrigated:	
15.	Fertilization practices	N: P: K: NPK Only:	
		NPK + Micronutrients: No practices:	
16.	GM/OM practices	Yes: No:	
17.	Source of irrigation	River: Tank / Lake: Canal: Bore well: Well:	
18.	If any other		

Table 2: Number of geo-referenced soil samples collected from different blocks of Tiruchirappalli district

S. No.	Taluk	Block	No. of panchayat villages	Number of samples
1.	Lalgudi	Lalgudi	43	172
		Pullambadi	32	128
2.	Manapparai	Manapparai	21	84
		Vaiyampatti	18	72
		Marungapuri	49	196
3.	Manachanallur	Manachanallur	31	124
4.	Musiri	Musiri	32	128
		Thathayangarpettai	26	104
5.	Srirangam	Andanallur	21	84
6.	Tiruchirappalli	Manikandam	22	88
7.	Thottiyam	Thottiyam	26	104
8.	Thuraiyur	Thuraiyur	34	136
		Uppliliapuram	18	72
9.	Thiruverumbur	Thiruverumbur	23	92
Total			396	1584

Categorizations of samples based on critical limits

The analytical results of each soil samples were categorized into low, medium and high categories based on the critical limit of available sulphur and micronutrient. The percent sample at each category was assessed for each element at block level.

Table 3: Critical limits (mg kg^{-1}) of available sulphur and micronutrients.

Element	Low (Deficient)	Medium (Moderate)	High (Sufficient)
Sulphur	< 10	10 - 15	> 15
Copper	< 1.2	1.2 - 1.8	> 1.8
Zinc	< 1.2	1.2 -1.8	> 1.8
Manganese	< 2.0	2.0 - 4.0	> 4.0
Iron	< 3.7	3.7 - 8.0	> 8.0
Boron	< 0.46	0.46 -1.0	1.0

(Anon., 2003) [2]

Statistical analysis

The database on the analysis of soil available micronutrient content were developed using Microsoft Excel page, in order to determine the inter relationship between available micronutrients and soil characteristics and the simple correlation was used (Sundar Raj *et al.,* 1972). The simple correlation (bi-variate analysis) was executed by using SPSS 161.0 data editor software.

Results and Discussion

The present study was conducted with the major objectives of assessment of each block in Tiruchirappalli district for available micronutrient status, to determine the relationship with soil characteristics and available sulphur and micronutrients.

Surface soil characteristics of Tiruchirappalli district

1. Soil pH

The pH of the surface soils of different blocks in Tiruchirappalli district varied widely from 5.22 to 9.21 with overall mean value of 7.43. However, majority of blocks had neutral pH. Out of fourteen blocks the lowest mean pH of 7.12 and the highest mean pH of 7.75 was recorded in Musiri and Thottiyam block respectively. The mean pH values recorded were 7.58 in Lalgudi, 7.37 in Pullambadi, 7.42 in Vaiyampatti, 7.23 in Marungapuri, 7.63 in Manachanallur, 7.41 in Thathayangarpettai, 7.27 in Andanallur, 7.59 in Manikandam, 7.53 in Thuraiyur, 7.37 in Uppliliapuram, 7.34 in Manapparai and 7.42 in Thiruverumbur.

2. Electrical Conductivity

The electrical conductivity of the surface soils ranged from 0.02 to 1.74 dS m^{-1}, with an overall mean value of 0.38 dS m^{-1}. In general, almost all soils had low level of salinity and posed no problem in the selection of crops. Out of fourteen blocks lowest mean EC of 0.20 dS $m^{-1}$and the highest mean EC of 0.52 dS m^{-1} was recorded in Thiruverumbur and Uppliliapuram respectively. The mean EC values recorded were 0.42 in Lalgudi, 0.46 dS m^{-1} in Pullambadi, 0.51 dS m^{-1} in Vaiyampatti, 0.30 dS m^{-1} in Marungapuri, 0.37 dS m^{-1} in Manachanallur, 0.43 dS m^{-1} in Musiri, 0.46 dS m^{-1} in Thathayangarpettai, 0.36 dS m^{-1} in Andanallur and Manikandam, 0.21 dS m^{-1} in Thottiyam, 0.31 dS m^{-1} in Thuraiyur and 0.46 dS m^{-1} in Manapparai.

3. Organic Carbon

The organic carbon content of surface soils in different blocks of Tiruchirappalli district ranged from 0.03 to 0.98 percent. Based on low (< 0.50%), medium (0.50 – 0.75%) and high (> 0.75%) status, all blocks fall under medium levels of organic carbon with an overall mean value of 0.54%. Manapparai block had the highest mean value of 0.68 percent of organic carbon content followed by Uppliliapuram (0.67%), Lalgudi block (0.58%) and Pullambadi (0.54%). Other blocks like Vaiyampatti (0.61%), Marungapuri and Musiri (0.49%), Manachanallur and Thathayangarpettai (0.55%), Manikandam (0.41%), Thuraiyur and Andanallur (0.54%),Thottiyam and Thiruverumbur recorded similar values of 0.51%.

4. Free Calcium Carbonate

The free calcium carbonate content of surface soils in Tiruchirappalli district was in the range of 0.05 to 12.75 percent. Among all the blocks, the lowest mean value for $CaCO_3$ of 2.37 percent was registered in Andanallur block while the Thathayangarpettai block had recorded the highest calcium carbonate content of 7.69 percent. The mean calcium carbonate content recorded were, 6.03% in Lalgudi, 5.62% in Pullambadi, 6.92% Vaiyampatti, 5.24% in Marungapuri and Musiri, 5.93% in Manachanallur, 5.27% in Manikandam, 4.61% in Thottiyam, 5.59% in Thuraiyur, 6.22% in Uppliliapuram, 6.69% in Manapparai and 5.25% in Thiruverumbur.

5. Available Sulphur

The available sulphur in Tiruchirappalli district ranged from 2.80 to 92.00 mg kg^{-1}, with a mean of 23.62 mg kg^{-1}, which falls under high category. Among all the blocks the lowest mean value of available sulphur of 16.12 mg kg^{-1} was recorded in Musiri block while the Marungapuri block had recorded the highest available sulphur content of 43.63 mg kg^{-1}. The remaining blocks like Lalgudi, Pullambadi, Vaiyampatti, Manachanallur, Thathayangarpettai, Andanallur, Manikandam, Thottiyam, Thuraiyur, Uppliliapuram, Manapparai and Thiruverumbur had S content of 21.04, 23.38, 25.07, 21.14, 17.65, 18.47, 19.99, 21.45, 29.69, 23.11, 19.19 and 30.76 mg kg^{-1} respectively.

6. Available Micronutrients

6.1. Available Copper

The content of DTPA-Cu in the soils of Tiruchirappalli district ranged from 0.03 to 6.38 mg kg^{-1} with mean value of 1.51 mg kg^{-1}. The highest mean value of 2.62 mg kg^{-1} was recorded in soils of Manikandam block and the lowest mean value was recorded in Uppliliapuram (0.92 mg kg^{-1}) and Thuraiyur (0.97 mg kg^{-1}). The remaining blocks like Lalgudi, Pullambadi, Vaiyampatti, Marungapuri, Manachanallur, Musiri, Thathayangarpettai, Andanallur, Thottiyam, Manapparai, and Thiruverumbur were found to have Cu content of 1.47, 1.48, 1.29, 1.94, 1.44, 1.57, 1.35, 1.21, 1.67, 1.92 and 1.35 mg kg^{-1} respectively.

6.2. Available Zinc

The DTPA-Zn content of soils of Tiruchirappalli district ranged from 0.013 to 4.81 mg kg^{-1} with mean value of 1.09 mg kg^{-1}. The soils of Thathayangarpettai (1.92 mg kg^{-1}) block recorded the highest mean value for DTPA–Zn and lowest mean value recorded in soil of Musiri block (0.72 mg kg^{-1}). The remaining blocks like Lalgudi, Pullambadi, Vaiyampatti, Marungapuri, Manachanallur, Andanallur, Manikandam, Thottiyam, Thuraiyur, Uppliliapuram, Manapparai and Thiruverumbur recorded Zn content of 0.89, 1.09, 0.86, 0.89, 1.01, 1.77, 1.20, 1.30, 0.97, 0.98, 0.80 and 0.98 mg kg^{-1} respectively.

6.3. Available Manganese

The content of DTPA-Mn ranged from 0.21 to 32.74 mg kg^{-1}. The soils of Andanallur block recorded the highest mean value (21.68 mg kg^{-1}) followed by Thathayangarpettai (18.08 mg kg^{-1}), while lowest mean value was recorded in Marungapuri (8.55 mg kg^{-1}) block**.** Other blocks like Lalgudi, Pullambadi, Vaiyampatti, Manachanallur, Musiri, Manikandam, Thottiyam, Thuraiyur, Uppliliapuram, Manapparai and Thiruverumbur recorded 13.86, 13.72, 12.14, 13.49, 16.82, 10.32, 12.80, 10.75, 14.70, 13.93 and 11.39 mg kg^{-1} of DTPA-Mn respectively.

6.4. Available Iron

The available iron varied from 2.16 to 42.05 mg kg^{-1}. The highest mean value was observed in Thottiyam (16.66 mg kg^{-1}) followed by Vaiyampatti (16.63 mg kg^{-1}) and the lowest mean value was in Musiri block (10.29 mg kg^{-1}). The remaining blocks *viz.*, Lalgudi, Pullambadi, Marungapuri, Manachanallur, Thathayangarpettai, Andanallur, Manikandam, Thuraiyur, Uppliliapuram, Manapparai and Thiruverumbur recorded 14.88, 14.38, 15.75, 14.53, 15.98, 13.13, 16.15, 15.99, 13.23, 13.54 and 13.04 mg kg^{-1} respectively.

6.5. Available Boron

The hot water soluble boron in the soils of Tiruchirappalli district varied from 0.06 to 3.92 mg kg^{-1} with mean value of 1.03 mg kg^{-1}. The soils of Marungapuri block registered the highest mean value of 1.58 mg kg^{-1} respectively. Among the blocks, Manapparai had the lowest mean value of 0.61 mg kg^{-1} for hot water extractable boron. Other blocks like Lalgudi, Pullambadi, Vaiyampatti, Manachanallur, Musiri, Thathayangarpettai, Andanallur, Manikandam, Thottiyam, Thuraiyur, Uppliliapuram, and Thiruverumbur recorded 0.94, 1.10, 1.02, 1.58, 0.94, 0.94, 0.87, 0.86, 1.40, 0.97, 1.11, 0.87, and 1.23 mg kg^{-1} respectively.

The soils pH of different blocks was acidic to alkaline (pH 5.22 to 9.21) with mean of 7.43. The low pH was observed in Maniyankuruchi village in Marungapuri block which may be due to migration of bases, the higher pH in Pirattiyur village of Manikandam block may be due to high degree of base saturation. Similar finding were also reported by Gajbe *et al.* (1976) [5]. Among this, a majority of the samples fall under neutral category which is ideally suited for cultivation of wide range of crops.

The electrical conductivity of Tiruchirappalli district ranged from 0.02 - 1.74 dS m^{-1}, with a mean of 0.38 dS m^{-1}. The lowest value of EC (0.02 dS m^{-1}) was recorded in almost all the blocks and the highest (1.74 dS m^{-1}) in Alunthur village of Manikandam block.

The organic carbon content in the soil of Tiruchirappalli district was in the range of low to high status, but majority of the samples were in medium range (0.50%) for all the 14 blocks. The lowest percentage of organic carbon (0.03%) was recorded in Algapuri villages of Upililiapuram block. The lower organic carbon content of soil may be ascribed to higher temperature of Manikandam block which hasten the rate of oxidation of organic matter. The lower organic carbon content in surface soil may be due to rapid oxidation and decomposition of organic matter (Saha *et al*. 1996, Mustapha *et al*., 2011) [13, 9].

The mean free $CaCO_3$ content was 5.61 percent, most of the samples analyzed indicate that the soils are slightly calcareous as majority of the samples have slight free lime content. The lowest value (0.50%) was recorded in Nammbukuruchi village of Pullambadi block and the highest (12.75%) was observed in Moovanur villages of Musiri block. This could be due to calcification process in the soils as reported by Pandey *et al.* (2000) [10].

Available micronutrient status

1. Available Sulphur

Regarding available sulphur, 66.82 percent samples were found to be high. The available sulphur ranged from 2.80-92.00 mg kg^{-1} in the soils of different blocks of the study area with an average of 23.62 mg kg^{-1}. The lowest quantity (2.80 mg kg^{-1}) was recorded in Kottapalayam village of Upililiapuram and the higher content was recorded in Orathur village (92.00 mg kg^{-1}) of Pullambadi block. The higher concentration of available sulphur in these soils may be due to continous addition of S containing agrochemicals, farm residues and organic manures. This finding are in agreement with Patel and Patel (2008) [11].

2 Available Copper

The available Cu ranged between 0.06 to 6.38 mg kg^{-1} in the soils of different blocks of the study area with an average value of 1.51mg kg^{-1}. Considering 1.2 mg kg^{-1} as the critical limit for available copper in the soil (Anon, 2003) [2], the copper status was found to be marginal, as 40.11 percent of the samples were found to be with low copper content. The lowest value (0.06 mg kg^{-1}) was recorded in Balkrishnampatti village of Upililiapuram and the highest (6.38 mg kg^{-1}) was recorded in Sitambhur village of Musiri block. The data reveals that available Cu is low for Tiruchirappalli district. This might be due to high amount of organic matter content. These results are in conformation with finding of Sharma *et al.* (2004) [14].

3 Available Zinc

A wide variation in DTPA-Zn content of various blocks of Tiruchirappalli district was observed which varied from 0.13 to 4.81 mg kg^{-1} with a mean value of 1.51 mg kg^{-1} soil. The lowest value (0.13 mg kg^{-1}) was noticed in A. Rettiyapatti village of Vayamptti blocks and the highest value (4.23 mg kg^{-1}) in T. Puthur village of Musiri block. Considering the critical limit of available Zn which is 1.2 mg kg^{-1} (Krishnaswamy *et al.*, 1994).

4 Available Manganese

The content of available manganese varied from 0.21 to 32.74 mg kg^{-1} with an average of 13.73 mg kg^{-1} soil during the survey. As per the critical limit of 2 mg kg^{-1} in Tiruchirappalli district concerned, 84.85 percent of total samples analyzed were sufficient in manganese content to support crop growth. Higher availability of Mn may be because these regions are dominant in rice growing areas and this status is similar to the findings of Weerarathana (1989) [18].

5 Available Iron

The content of DTPA-Fe varied from 2.16 to 42.05 mg kg^{-1} with an average of 14.58 mg kg^{-1} in soil. The DTPA-Fe was found to be sufficient (>3.7 mg kg^{-1}) in 95.01 percent samples of this district. Among the blocks studied, Thottiyam and Vaiyampatti blocks showed the

highest mean for number of samples with respect to available Fe. This can be attributed to low amount of $CaCO_3$ and medium amount of organic carbon present in soils of this block. Increase in available Fe in solution could be attributed to the formation of complexes of Fe^{2+} with organic acids produced during anaerobic decomposition of green manure and also due to sharp decrease in pH and increase in ionic strength (Ponnamperuma, 1977) [18].

6 Hot water extractable Boron

The hot water soluble boron content varied from 0.06 to 3.92 mg kg^{-1} with an overall mean value of 1.03 mg kg^{-1} in soil of Tiruchirappalli district and 83.40 percent of samples were found to be sufficient (>0.46 mg kg^{-1} soil). Higher B availability in the soil may be due to inherent higher B content of the soil and favourable soil reaction which was in line with findings of Datta and Munna Ram (1993) [4], Bradford *et al*. (1996) [4] and Adeboye (2011) [1].

Conclusion

- The soils of Tiruchirappalli district was found to be acidic to alkaline (pH: 5.22 – 9.21) in reaction with salinity level harmless to critical (EC: 0.02 – 1.74 dS m^{-1}). The organic carbon content ranged from low to high (0.03 – 0.98%) and the free $CaCO_3$ content of non-calcareous to moderately calcareous in nature (0.50 – 12.75%).
- The available sulphur content varied from low to high (2.80-92.00), the DTPA extractable micronutrients such as Fe, Zn, Mn, Cu and HWSB content varied from 2.16 to 42.05 mg kg^{-1}, 0.13 to 4.81 mg kg^{-1}, 0.21-32.74 mg kg^{-1}, 0.03 to 6.38 mg kg^{-1} and 0.06 to 3.92 mg kg^{-1} respectively.
- DTPA-Fe and DTPA-Mn was found to be very high in this district. Only 4.99 per cent sample come under low (deficient) category for DTPA-Fe 3.82 per cent samples were deficient in DTPA-Mn.
- DTPA-Cu was found to be in "Marginal' category for this district. About 40.11 per cent of samples were grouped in low category, whereas 33.67 per cent sample was found to be high in DTPA-Cu.
- DTPA-Zn was low for Tiruchirappalli district. About 63.82 per cent samples were low (deficient) in DTPA-Zn. In Manapparai block, the maximum number (90.47%) of samples are low in DTPA-Zn.
- HWSB was adequate for Tiruchirappalli district. Uppliliapuram block (20.83%) samples was found to contain maximum number of samples under low category and Marungapuri block (66.66%) samples was found to contain maximum number of samples under high category.

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