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## Delineation of boron status in Tirunelveli district of Tamil Nadu using GIS and GPS techniques

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**Abstract**

A study was undertaken in Tirunelveli district of Tamil Nadu with a view to assess the Boron status of soils at block level. A sum of 1,798 geo-referenced surface soil samples from nineteen blocks of Tirunelveli district representing different soil units as per the soil map prepared on 1:50,000 scales was collected randomly at 0-15 cm depth using Global Positioning System. The soil samples were analysed for available hot water soluble boron and the hot water soluble boron content varied from 0.01 to 5.52 mg kg<sup>-1</sup> soil. Analytical results and the GPS data was used for the preparation of thematic maps showing spatial distribution of micronutrients status block wise in the district. Locations of soil sampling sites of Tirunelveli district were marked on base map on 1: 50,000 scales prepared from State Revenue Maps and digitized using Arc-info GIS. The delineation study thus clearly indicates that, the hot water soluble boron was found to be low in Pappakudi and Cheranmahadevi blocks and in rest of the blocks it exhibited medium to high status.

**Keywords:** Hot water-Soluble Boron, GPS, GIS, thematic maps

**1. Introduction**

Soil micronutrients play a vital role in the growth, development, yield of plant besides the information on the nutritional status of an area, and thus go a long way in planning judicious fertilizers and soil management practices to develop economically viable alternatives for farming community. The estimation, characterization and comparison of micronutrients of soil are important issues in site-specific crop management, precision farming and sustainable agriculture (Deb, 1997) <sup>[1]</sup>. Presently, the boron (B) and sulphur (S) deficiencies are emerging in Kanchipuram, the Nilgiris, Coimbatore and Kanyakumari districts.

In the context of today changing scenario, there is a need to generate the spatial data of micronutrients using frontier technologies like Global Positioning System (GPS) and Geographical Information System (GIS). The GPS has revolutionized positioning concept though it started primarily as a satellite-based radio navigation system providing precise, three-dimensional position navigation and time information. The GIS provides scientists, planners, managers and decision makers an efficient way of combining and analyzing geo-referenced and descriptive data from different sources (soils, vegetation, geology, land covers and others) for better understanding and management of natural resources (Fernandez *et al.* 1993) <sup>[2]</sup>. The thematic maps for individual nutrient (Zn, Fe, Cu and Mn) is prepared by using GIS software (Nayak *et al.*, 2006) <sup>[3]</sup> and multi micronutrient maps are generated by integrating individual maps of Fe, Mn, Zn and Cu in the GIS (Sood *et al.* 2004) <sup>[4]</sup>. This will also help in monitoring changes in micronutrient status over a period of time. It can be revisited with help of GPS, which is otherwise not possible in the random sampling.

With this background, a study was conducted with revolutionary effort to examine hot water soluble boron status and delineate the hot water soluble boron status scrupulously at block level in the Tirunelveli district of Tamil Nadu.

**Study area**

Tirunelveli district in Tamil Nadu is bounded by Virudhunagar district in the North, Western Ghats in the West, Kanyakumari district in the South and Thoothukudi district in the East. Tirunelveli district is comprised of 11 taluks, 19 blocks and 628 Revenue villages covering an

area of 6, 81,065 ha of land. The Tirunelveli district lies between 8°.08' and 9°.25' of the Northern latitude and 77°.09' and 77°.59' of Eastern longitude. Major portion of the district is covered by plain topography. Red loam is the predominant soil type in the district accounting for 48.21 per cent followed by the black soil of 30.09 per cent.

## 2. Material and methods

### Collection of soil samples

Totally 1798 geo-referenced surface soil samples covering the entire village in nineteen blocks of Tirunelveli district were

collected randomly at 0-15 cm depth by adopting the standard procedures of soil sample collection. The GPS data (Latitude °N and Longitude °E) were collected from each sampling sites distributed over the entire Tirunelveli district by using Garmin GPS 76CS model (Fig. 1). The collected soil samples were dried, gently bound, sieved (2 mm sieve) and preserved in polythene bags. Locations of soil sampling sites of Tirunelveli district were marked on base map on 1: 50,000 scales prepared from State Revenue Maps and digitized using Arc-info GIS (9.2).

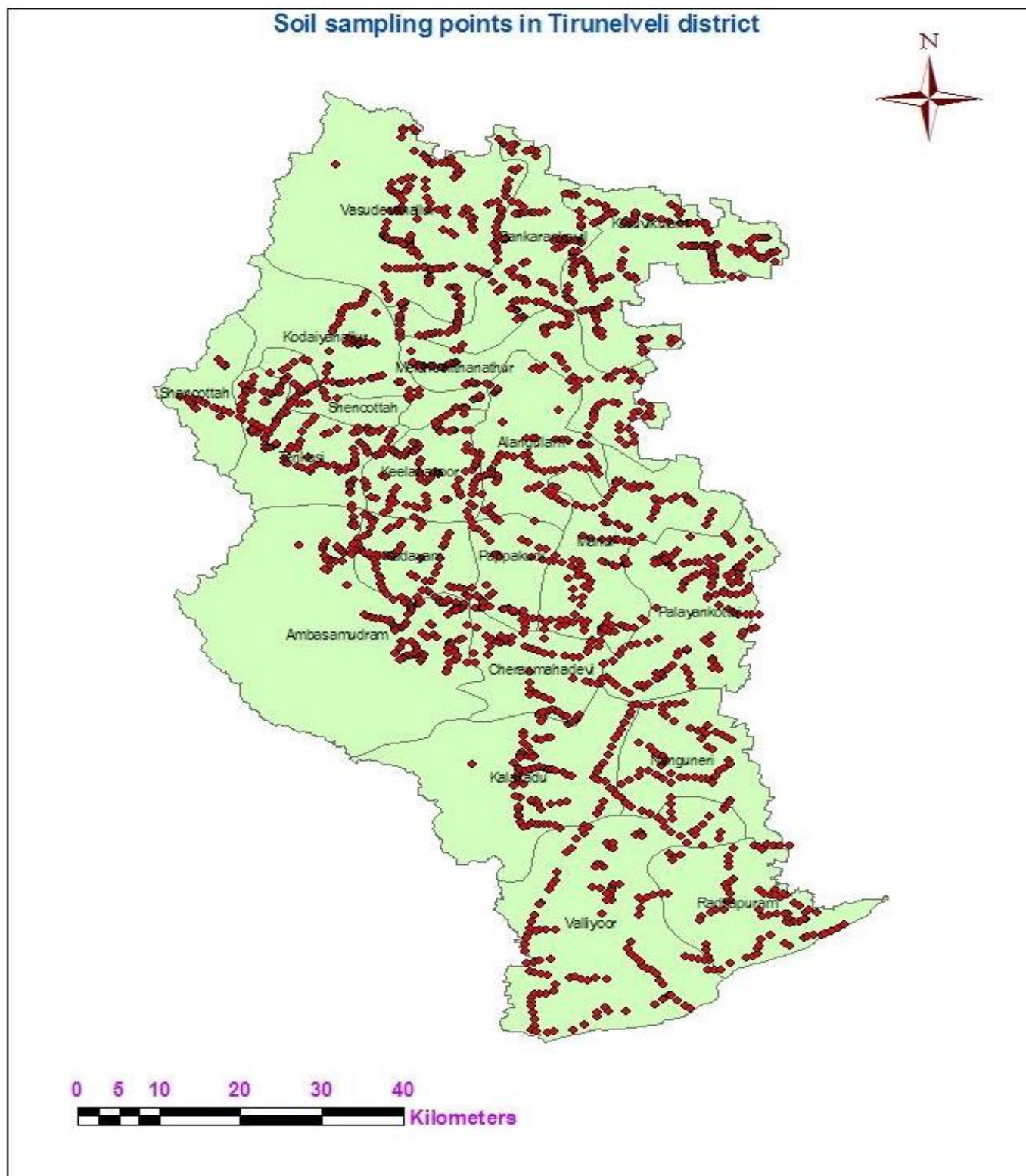


Fig 1: Soil sampling points of Tirunelveli district

**Table 1:** Range, mean values and percent sample category of hot water soluble boron status for different blocks of Tirunelveli district

S. No.	Block name	Range and mean values	Percentage sample category		
		Hot water-soluble boron (mg kg <sup>-1</sup> )	Hot water-soluble boron		
			L	M	H
1.	Alangulam	0.62 – 1.00 (0.74)	0.0	100.0	0.0
2.	Ambasamudram	0.84 -1.90 (1.30)	0.0	5.2	94.8
3.	Cheranmahadevi	0.01 – 0.47 (0.09)	94.3	5.7	0.0
4.	Kadayanallur	0.35 -2.02 (0.56)	20.9	76.1	3.0
5.	Kadayam	1.80 - 3.12 (2.20)	0.0	0.0	100.0
6.	Kalakadu	0.13 - 0.94 (0.61)	11.5	88.5	0.0
7.	Keelapavoor	0.13 - 0.94 (0.59)	15.3	84.7	0.0
8.	Kuruvikulam	0.76 - 5.52 (2.01)	0.0	2.3	97.7
9.	Manur	0.45 - 2.63 (1.89)	0.0	3.3	96.7
10.	Melaneelithanallur	0.45 - 1.92 (0.76)	0.0	97.0	3.0
11.	Nanguneri	0.20 - 2.58 (0.59)	18.1	79.3	2.6
12.	Pappakudi	0.01 - 0.60 (0.09)	96.8	1.6	1.6
13.	Palayamkottai	0.45 - 2.63 (1.97)	0.0	1.6	98.4
14.	Radhapuram	0.64 - 1.00 (0.76)	0.0	100.0	0.0
15.	Sankarankovil	0.20 - 2.58 (0.58)	19.0	79.3	1.7
16.	Senkottai	0.58 - 2.19 (1.41)	0.0	6.4	93.6
17.	Tenkasi	0.43 - 1.57 (0.80)	1.3	87.0	11.7
18.	Valliyoor	0.07 - 2.22 (0.85)	5.3	81.3	13.3
19.	Vasudevanallur	1.86 - 2.83 (2.19)	0.0	0.0	100.0
Overall for District			11.7	46.4	41.9

### Generation of map

The Tirunelveli district map (1:50,000) was vectorised by using Raster to Vector software (R2V), and then exported into Arc-GIS software. Database on hot water-soluble boron status of the study area was developed using Microsoft Excel package. The database was exported to Arc GIS software and the thematic map on hot water-soluble boron was generated.

### 3. Results and discussion

In Tirunelveli district, the two major soil groups exists are the red and black soils. Red loam is the predominant soil type accounting for 48.21 per cent followed by the black soil of 30.09 per cent. The other types of soils are lateritic soil, sandy coastal alluvium, red sandy soil and others.

#### 3.1. Hot water extractable boron

The hot water-soluble boron varied from 0.01 to 5.52 mg kg<sup>-1</sup> with an overall mean value of 1.15 mg kg<sup>-1</sup> soil in Tirunelveli district. The highest value (5.52 mg kg<sup>-1</sup>) was recorded in Ilayarajanendal village of Kuruvikulam block whereas the lowest value of HWSB (0.01 mg kg<sup>-1</sup>) was recorded in Cheranmahadevi and Pappakudi block. With increasing

concentration of available boron content in soils indicated that onset of salinization is accompanied by an increase in the available form of boron (Chaudhary and Shukla 2004)<sup>[5]</sup>.

The low B concentrations in these blocks are apparently due to continuous cropping and intensive applications of fertilizers without adequate supply of micronutrients. By considering 0.44 mg kg<sup>-1</sup> available boron in soils as critical limit (Berger and Trough 1940)<sup>[6]</sup> about 11.7 per cent of the samples are found to be low in boron status.

#### 3.2. Thematic map

The hot water soluble boron of different blocks of Tirunelveli district was grouped into three categories based on the critical limits followed for availability of micronutrient in India and Tamil Nadu. The thematic map clearly identifies the blocks that are extremely deficient in hot water soluble boron status which require utmost attention to sustain the soil productivity. Based on the critical limits for available boron (0.44 mg kg<sup>-1</sup>), the different blocks of Tirunelveli district was depicted (Fig.2). The hot water soluble boron was found to be low in Pappakudi and Cheranmahadevi blocks and in rest of the blocks it exhibited medium to high status.

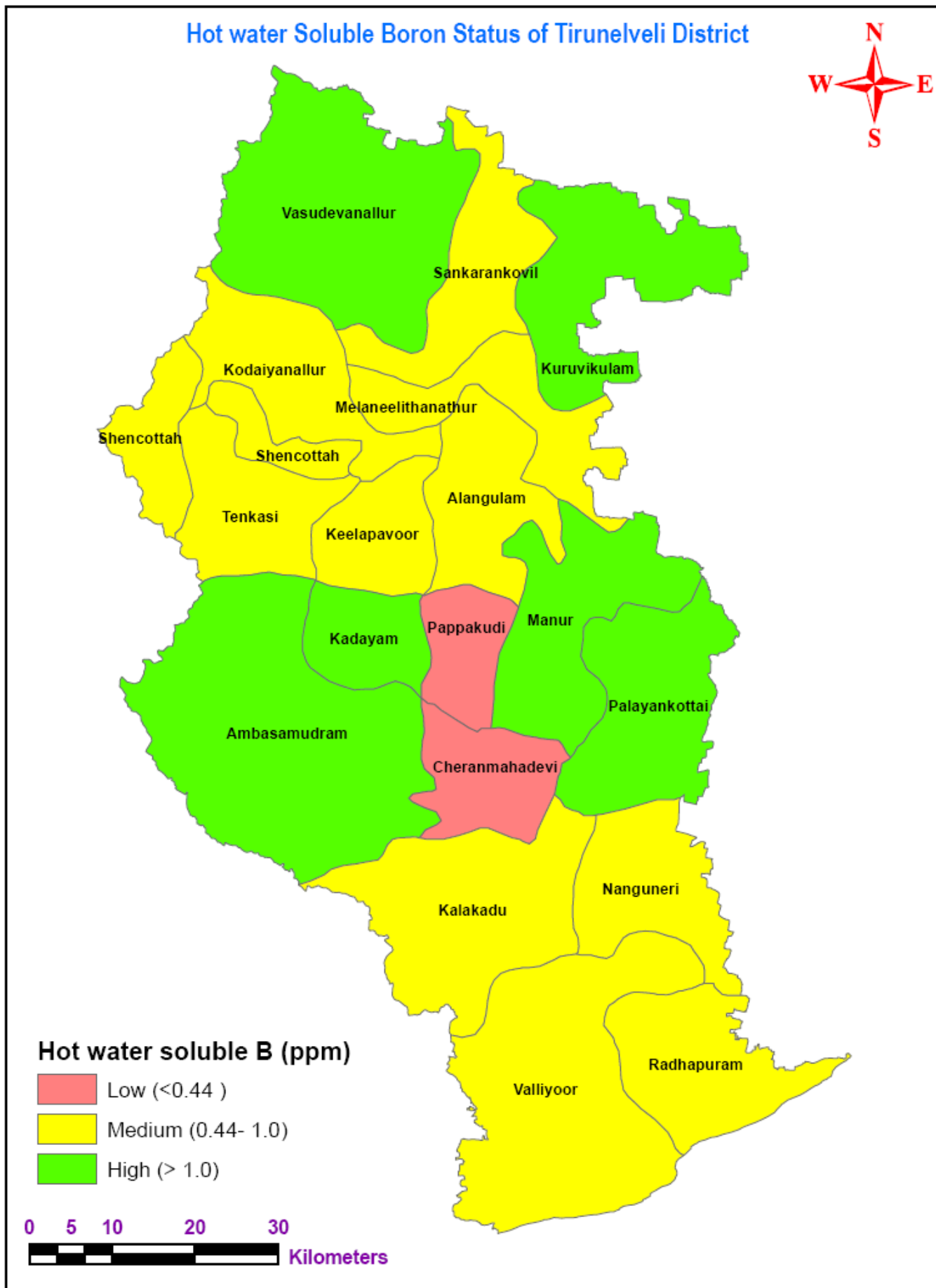


Fig 2: Hot Water soluble boron status of Tirunelveli district

Thus, from the above investigation it is very clear that in the soils of Tirunelveli district, the availability of Boron is

sufficient in general and required to be applied in specific situations as per the need. Besides, the edaphic factors such as

organic carbon content and free lime status are widely believed to be circumventing the availability of micronutrients, which also needs to be addressed to develop strategies for alleviation of micronutrient deficiencies in Tirunelveli district of Tamil Nadu. Micronutrient status plays a major role in increasing crop yields and soil productivity in general and hence, it is essential to adopt an integrated way of adding organic amendments with micronutrients, which will sustain the soil fertility and crop productivity.

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