ASSESSMENT OF SOIL PHYSICO-CHEMICAL PROPERTIES, AVAILABLE SULPHUR AND MICRONUTRIENTS STATUS IN SOUTHERN VILLUPURAM DISTRICT OF TAMIL NADU USING GIS TECHNIQUES

G. Yoganathan and S. Meena

G. YOGANATHAN* AND S. MEENA

Department of Soil Science and Agricultural Chemistry,
Tamil Nadu Agricultural University, Coimbatore - 641 003
e-mail: yogasac@gmail.com

ABSTRACT

Delineation of available sulphur and micronutrients was carried out by randomly collecting georeferenced surface 0-15 cm soil samples representing different soil units as per the soil map preparedon 1:50,000 scale from 1639 sites in southern Villupuram district, Tamil Nadu using Global Positioning System (GPS). The soil samples were analyzed for available sulphur and micronutrients. The delineation study clearly indicated that, available sulphur content in soils, it was observed that 4.21, 8.66 and 87.11 per cent of the surface soils of southern Villupuram district are low (<10 mg kg^{-1}), medium (10-15 mg kg^{-1}) and high (> 15 mg kg^{-1}), respectively. The available micronutrient status of DTPA-Zn was found to be deficient in 72.88 per cent of soils of southern Villupuram district followed by DTPA-Cu and Fe with 44.80 and 16.77 per cent deficiency respectively. The deficiency of DTPA-Mn, available sulphur and HWSB was low to the tune of 15.08 and 4.21 and 1.65 per cent, respectively.Locations of soil sampling sites of southern Villupuram district were marked on base map on 1:50,000 scale prepared from State Revenue Maps and digitized using Arc-info GIS 9.

*Corresponding author

INTRODUCTION

One of the biggest success stories of independent India is the rapid strides made in the field of agriculture. In the past sixty years, India has emerged from famine ridden colonial times, to a famine free Republic. Green revolution has triggered to achieve higher production and nutritional security in the country. However, intensive cultivation of high yielding varieties, increased use of NPK fertilizers free from secondary and micronutrients, decreased use of organic manures and lack of crop residue recycling have led to depletion of native nutrient fertility and resulted in wide spread deficiencies of secondary and micronutrients. The deficiency may either be primarily due to their low contents or secondarily by soil factor that reduce the availability (Sharma and Chaudhary, 2007). Sulphur deficiency in soils of Indian states varies from 5 to 83 per cent with an overall mean of 41 per cent (Singh, 2001). In Tamil Nadu, sulphur deficiency ranged between 7- 40 per cent and has been reported mostly in red soils (Alfisol), low level laterite soils and alluvial soils with low organic matter (Sankaran, 1989).Global Positioning System (GPS) and Geographical Information System (GIS) helps in collecting a systematic set of georeferenced samples and generating spatial data about the distribution of nutrients (Sharma, 2004). Estimation on characterization and incorporation of spatial variation of micronutrients are important in the site specific management, precision farming and sustainable agriculture (Nayak *et al.*, 2006).The land resource inventory and mapping ofshrink-swell soils (1:50000scale) was carriedout to evaluate soil site suitability for cottonbased cropping systems. The soil map wasgenerated with 48 mapping units as soil seriesassociations and interpreted for agriculturalland use. The land capability analysis showedthat the arable land is only 34.4 per cent (4.21 lakh hectares), out of which 17.9 percent of land was evaluated as suitable for cotton (Bhaskar *et al.*, 2011). Micronutrients status of Tamil Nadu soils is generally poor as a result of intensive cropping without proper substitution of nutrient elements (Velu *et al.*, 2008). It has been estimated that the overall deficiency of zinc, iron, manganese and copper was 58, 17, 6 and 6 per cent respectively in soils of Tamil Nadu. Increasing cropping intensity in marginal lands and lower use of micronutrients has further escalated the magnitude of zinc deficiency in Tamil Nadu **(**Singh, 2009). The GIS provides scientists, planners, managers and decision makers an efficient way of combining and analyzing georeferenced and descriptive data from different sources (soils, vegetation, geology, land covers and others) for better understanding and management of natural resources (Fernandaz *et al.*, 1993). With ever increasing demandfor agricultural land and afforestation programmes, there is an urgent need to makelarge bulk of this wasteland productive andfertile. This is only feasible through sustainablescientific methods of reclamation. Reclamationis the process by which derelict or highlydegraded lands are returned to productivityand by which some measure of biotic function and productivity is restored (Mishra and Monalisa Rath, 2013). Soil nutrient maps covering large areas improve our understanding of the nature and extent of nutrient problems, and aid in determining their relationships with climate, soil properties, and soil genetic characteristics determined at similar scales. Intermediate scale maps can be useful in delineating specific areas where deficiencies or toxicities are likely for agriculture,

and in determining localized soil characteristics that may be associated with such problems. Highly detailed maps of soil micronutrient contents and their availability at field level are being developed for site-specific precision agriculture. Soil micronutrients maps have fostered the discovery of relationship between soil micronutrients contents and their availability and some human and livestock health problems such as goiter, Keshan and Kaschin-Beck diseases, and cancer. Georeferenced maps also help in monitoring changes in micronutrient status over a period of time by revisiting with help of GPS, which is otherwise not possible in the random sampling. The district of Villupuram, extending over an area of 8,204.63 sq.km, is situated in the North eastern part of Tamil Nadu. It is bounded on the North by Tiruvannamali and Kancheepuram districts, on the East by the Bay of Bengal, on the South by Cuddalore and on the West by Salem and a part of Dharmapuri districts. The district lies between 11º 59¢ and 12º48¢ north latitude and 78º60¢and 79º to 80¢ east longitude. Villupuram district comprises of 7 taluks, 22 blocks, 1104 Panchayats and 1490 Villages. The present study covered the southern part of Villupuram district comprising of four taluks, eleven blocks and 509 revenue villages. With this background the present investigation on soil available sulphur and micronutrients status at block level in the southern Villupuram district of Tamil Nadu was carried out to assess the availability and deficiency of sulphur and micronutrient status in soils of southern Villupuramand to derive nutrient index and fertility rating for sulphur and micronutrients of soils and to prepare thematic maps for depicting the available sulphur and micronutrients status at block level.

MATERIALS AND METHODS

Mapping of soil micronutrient status of southern Villupuram district

The southern Villupuram districtmap (1:50,000) was vectorised by using Raster to Vector software (R_2V), and then exported into Arc-GIS 9 software. Database on soil available sulphur and micronutrients status of the study area was developed using Microsoft Excel package. The database was
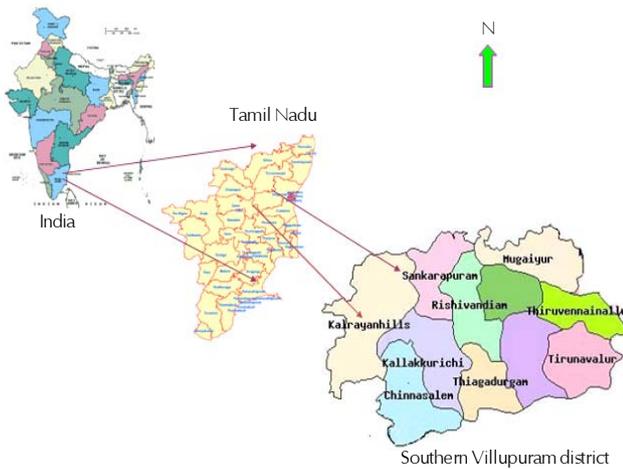

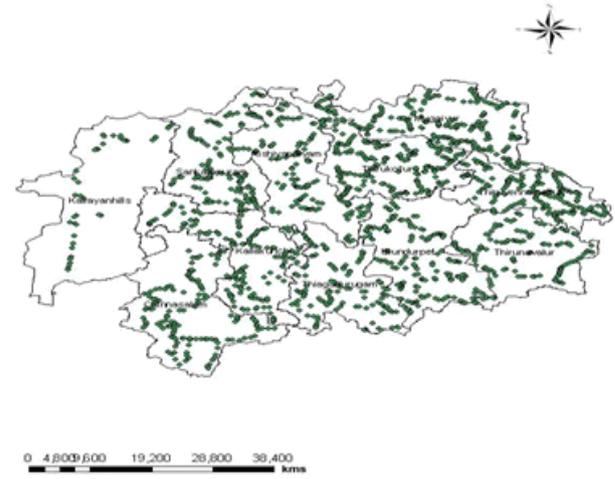
Figure 1: Location map of southern Villupuram District

Figure 2: Soil sampling point Latitude ^{0}N and Longitude ^{0}E of southern Villupuram district
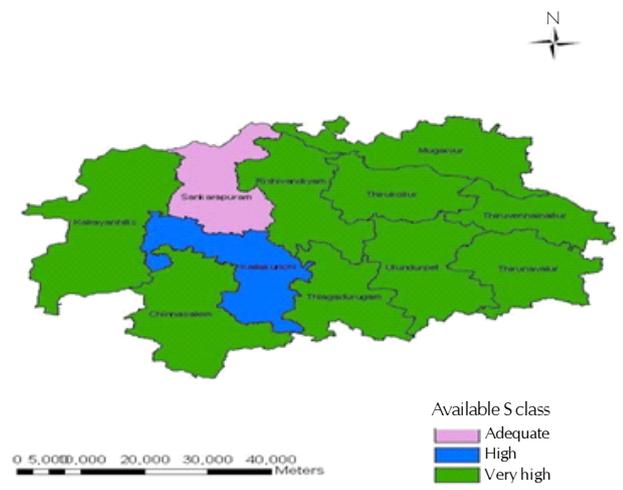

Figure 3: Nutrient index rating class for available sulphur in surface soils of southern Villupuram district at block level
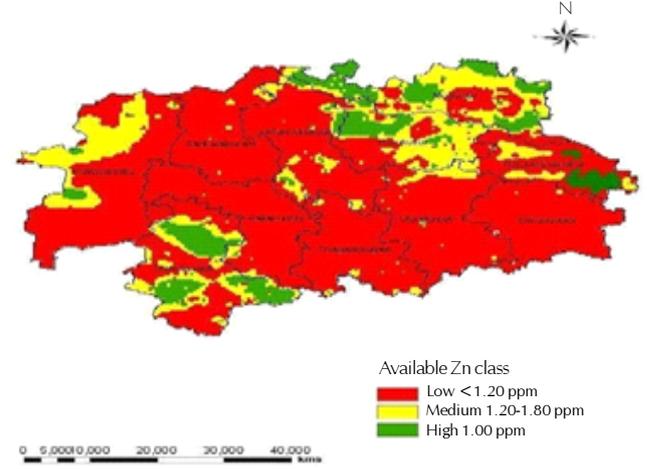

Figure 4: Nutrient index rating class for available zinc in surface soils of southern Villupuram district at block level

exported to Arc GIS 9 software and the thematic maps on available sulphur and micronutrients status were generated. The thematic maps at block level were generated for showing status of available sulphur and micronutrients based on block mean and nutrient index values.

Collection of Soil Samples

Totally 1639 georeferenced surface soil samples covering all the villages in eleven blocks of southern Villupuram district were collected randomly at 0-15 cm depth by adopting the standard procedures of soil sample collection. The Global Positioning System (GPS) data (Latitude ºN and Longitude ºE) were collected from each sampling sites distributed over the entire southern Villupuram district by using Garmin GPS (76CS model). The collected soil samples were air dried, gently bound, sieved (2 mm sieve) and preserved in polythene bags for further analysis. Locations of soil sampling sites of southern Villupuram district were marked on base map on 1:50,000 scales prepared from State Revenue Maps and digitized using Arc-info GIS 9 (Fig.1).

RESULTS AND DISCUSSION

Available sulphur and micronutrients

The surface soil samples were classified deficient on the basis of $CaCl_2$ extractable critical limit of 10 mg kg^{-1} for sulphur and DTPA extractable critical limit of less than 1.2 mg k^{-1} for Zn, less than 3.7 mg kg^{-1} for Fe, less than 2.0 mg kg^{-1} for Mn and less than 1.2 mg kg^{-1} for Cu. For HWSB, the critical limit for classification was 0.46 mg kg^{-1}. The perusal of data in Table 1clearly showed that out of the 1639 samples analyzed, Zn deficiency was found to be more prevalent in 72.88 per cent samples followed by Cu (44.80%), Fe (16.77%) and Mn (15.08%), Sulphur was deficient to the extent of 4.21percent Only 1.65 per cent samples studied exhibited boron deficiency.

Nutrient index rating

Table 2. Considering the southern Villupuram district as a whole, available sulphur and boron status was very high and manganese was found to be in high category. Adequate and marginal fertility rating was noticed for iron and copper. Available zinc status based on nutrient index value was low

Thematic maps

The vectorized southern Villupuram district map and database on soil available sulphur and micronutrients were exported into Arc-GIS software. The thematic maps on available sulphur and micronutrients (Zn, Fe, Mn, Cu and B) were generated at block level for depicting the available nutrient status based on

Table 1: Per cent samples deficient for available sulphur and micronutrients in surface soils of different blocks of southern Villupuram district

S. No.	Name of Block	No of soil samples	Per cent of samples deficient for available sulphur and micronutrients					
			Sulphur	DTPA-Zn	DTPA-Fe	DTPA-Mn	DTPA-Cu	HWSB
1	Chinnasalem	153	0.00	51.63	14.38	7.19	16.34	0.00
2	Kalrayan Hills	45	0.00	80.00	13.33	0.00	15.55	2.22
3	Kallakurichi	135	8.89	94.07	9.63	0.00	21.48	2.22
4	Mugaiyur	238	0.84	35.71	16.39	22.69	41.18	2.94
5	Rishivandiyam	144	1.39	81.94	12.50	15.28	71.53	1.39
6	Sankarapuram	129	25.58	89.92	24.03	20.16	62.79	0.00
7	Thirukkoilur	203	0.00	40.39	5.91	38.42	38.92	5.42
8	Thiruvennainallur	179	1.68	54.19	15.64	30.73	45.81	3.35
9	Thiagadurgam	120	0.00	85.83	29.75	25.00	43.33	0.00
10	Thirunavalur	135	2.22	95.56	31.85	0.74	85.19	0.00
11	Ulundurpet	158	5.70	92.41	10.76	5.70	50.63	0.63
	District average	1639	4.21	72.88	16.77	15.08	44.80	1.65

Available Fe class
Low < 9.70 ppm
Medium 9.70-8.00 ppm
High 0.00 ppm

Figure 5: Nutrient index rating class for available iron in surface soils of southern Villupuram district at block level

Available Mn class
Low < 2.00 ppm
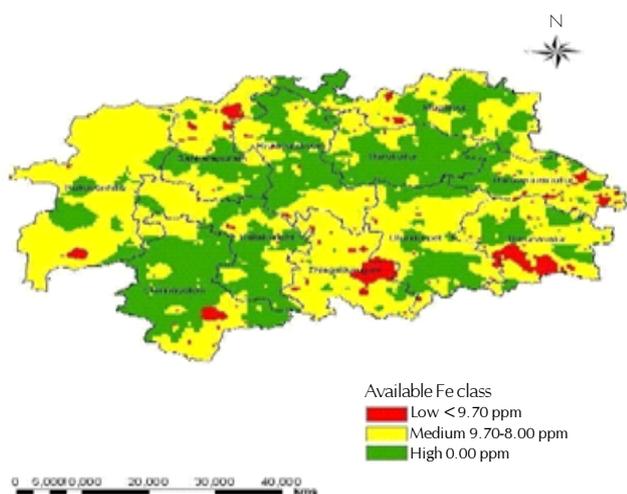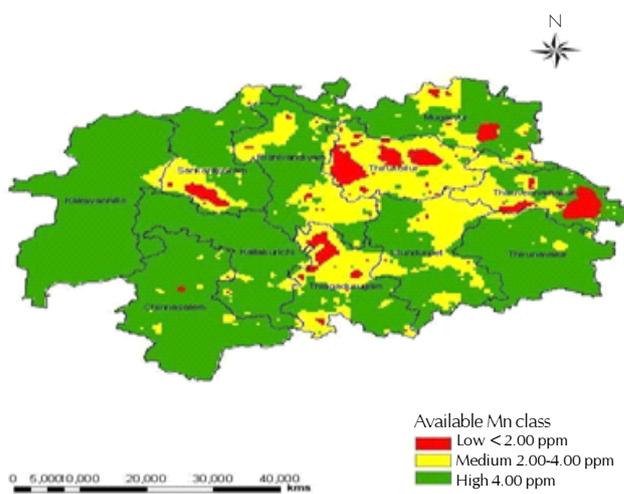Medium 2.00-4.00 ppm
High 4.00 ppm

Figure 6: Nutrient index rating class for available manganese in surface soils of southern Villupuram district at block level

Table 2: Nutrient index value for available sulphur and micronutrients in different blocks of southern Villupuram district

S.No	Block Name	Number of soil samples	Nutrient Index Values					
			Available Sulphur	DTPA-Zn	DTPA-Fe	DTPA-Mn	DTPA-Cu	DTPA-B
1	Chinnasalem	153	2.99	1.86	2.40	2.70	2.50	2.81
2	Kalrayan Hills	45	2.87	1.20	2.13	3.00	2.44	2.91
3	Kallakurichi	135	2.62	1.07	2.41	2.85	2.12	2.79
4	Mugaiyur	238	2.97	1.97	2.23	2.34	1.99	2.72
5	Rishivandiyam	144	2.87	1.30	2.31	2.30	1.38	2.93
6	Sankarapuram	129	2.31	1.13	2.28	2.40	1.57	2.93
7	Thirukkoilur	203	2.99	1.86	2.62	1.69	2.05	2.58
8	Thiruvennainallur	179	2.94	1.68	2.37	2.03	1.88	2.74
9	Thiagadurgam	120	2.97	1.17	1.91	2.25	1.83	2.85
10	Thirunavalur	135	2.89	1.05	2.01	2.90	1.19	2.98
11	Ulundurpet	158	2.72	1.10	2.32	2.56	1.80	2.78
	District average	1639	2.83	1.40	2.27	2.46	1.88	2.82

< 1.33 – Very Low, 1.33 – 1.66 – Low, 1.66 – 2.00 – Marginal, 2.00 – 2.33 – Adequate, 2.33 – 2.66 – High, > 2.66 – Very High
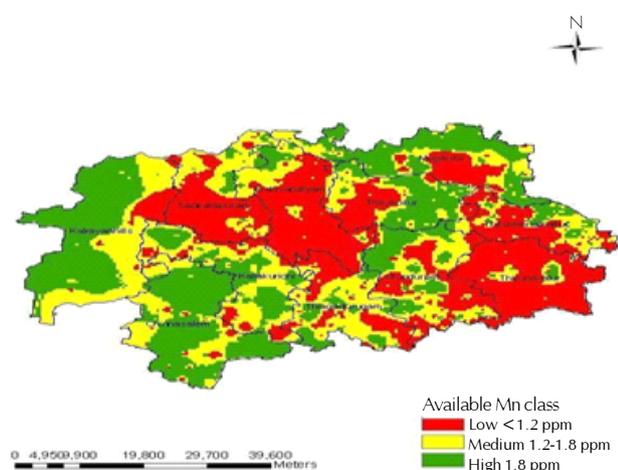

Available Mn class
- Low < 1.2 ppm
- Medium 1.2-1.8 ppm
- High 1.8 ppm

Figure 7: Nutrient index rating class for available copper in surface soils of southern Villupuram district at block level

Available B class
- Low < 0.46 ppm
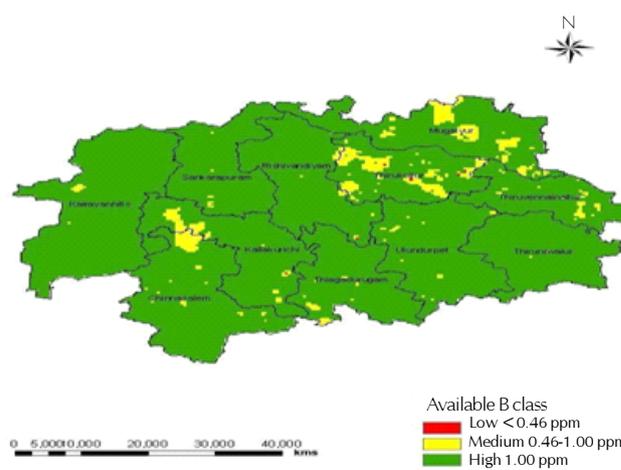- Medium 0.46-1.00 ppm
- High 1.00 ppm

Figure 8: Nutrient index rating class for available boron in surface soils of southern Villupuram district at block level

block mean values and nutrient index values (Fig1-8).

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