Delineation of soil available Sulphur status in Madurai district of Tamil Nadu – a GIS approach

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Abstract- *The study was conducted in Madurai district with a view to assess the soil available sulphur status at block level. A total of 1724 geo referenced surface soil samples have been manually collected from 13 blocks. The soil samples were analyzed and it is observed that 95and 5 % of the samples of the study area are deficient and sufficient in available sulphur content. The overall results portray that: barring Kottampatti block, the remaining blocks are severely deficient in available sulphur irrespective of the type of cropping systems and hence an intelligent application of sulphur fertilizers and organic manures are right away recommended.*

Key words- Available sulphur, GIS, Soil physico-chemical properties, correlations.

1, INTRODUCTION

Sulphur (S) is the fourth major nutrient for the crop plants after nitrogen, phosphorous and potassium to the crop plants. It is an essential constituent of S-containing amino acids, viz. cysteine, cystine and methionine. It is a constituent of ferrodoxin-containing nitrogenase which takes part in biological nitrogen fixation and other electron transfer reactions.

Lack of knowledge and importance about sulphur, exhaustive and high yielding cultivars and neglected usage of farm yard manures seems to have terminated to a wide occurrence of sulphur deficiency. As intensive farming practices are followed and use of sulphur free phosphatic fertilizers and pesticides became popular (Navneet Pareek, 2007), the areas which are presumed to contain adequate amount of sulphur may also begin to show sulphur deficiency [2].

It is supplied to the soil from weathering of rocks and minerals, mineralized from organic matter or from added fertilizers. In countries like India, sulphur is one element that must not be ignored. Sulphur deficiencies in Indian soils vary from 5 to 83 % with an overall mean of 41 % [5]. The availability of sulphur in soil depends up on the soil physic-chemical properties *viz*. pH, EC, free $CaCO_3$ (lime) content and native extractable sulphur are the most important. Both positive and negative interactions have been reported between sulphur and soil properties. Hence the present study was carried out to build data bank on site specific soil fertility for the promotion of balanced use of sulphur fertilizer.

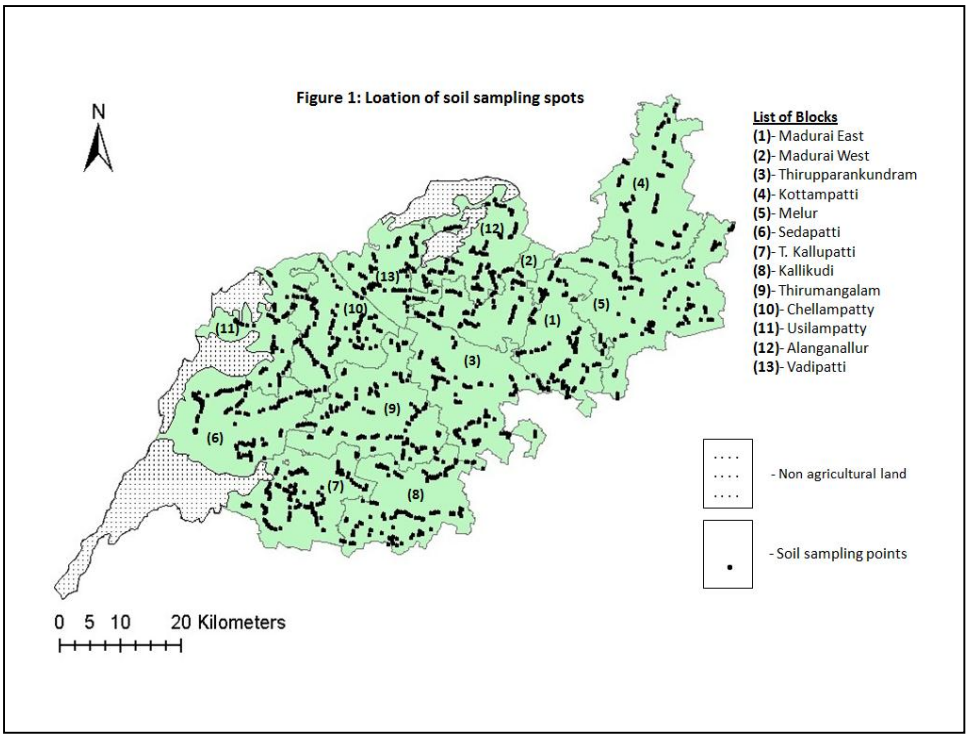

Figure.1 Location of Soil sampling spots

2, Materials and Methods

2.1 Soil sampling, Processing and Analysis:

The study was a representative of entire agricultural soils of Madurai district of Tamil Nadu, conducted during 2012. It geographically bounded between 9.93° N latitude and 78.12° E longitude. The climate of this region is semi-arid with an annual rainfall of 832 mm. A total of 1724 geo-referenced surface soil samples (0 – 0.15 m) were collected from the fields of each panchayat village @ 4 samples per village. The processed soil samples were analyzed for physico-chemical properties using standard procedures pH and EC [1], organic carbon [7], free $CaCO_3$ [4] and available sulphur content was determined turbidmetrically by $CaCl_2$ (0.15 %) solution as an extractant and the absorbance is read in a spectro photometer at 420 nm [8] and grouped the soils in to sufficient (>10 mg kg^{-1}) and deficient (<10 mg kg^{-1}) categories [6].

2.2 Statistical and Spatial Analysis

The Pearson correlation coefficients were estimated for all possible paired combinations of the response variables to generate a correlation coefficient matrix. These statistical parameters were calculated with SPSS 16.0® software (SPSS Inc., Chicago, III., USA). In this research, the study area is wrested from the base map, the GPS points and values (chemically analysis results) are coupled. The location of sampling sites was fed into the GIS environment and digitized using

ArcGIS-10 software, they are validated for digitization errors, polygonized and finally transformed in to thematic map by spatial interpolation method of kriging [3]. Spherical, exponential and Gaussaian models were fitted to the empirical semivariograms. Best-fit model with smallest nugget values with minimum root mean square error (RMSE) were selected for each soil property.

3, Results and Discussion

3.1 Soil physico-chemicals properties

The prominent soils in the district are red, red loam and black cotton soils. The data on the physico-chemical properties indicate that the soil pH is slightly acidic to slightly alkaline in reaction (5.50 and 9.11). The Electrical conductivity of the soils ranged from 0.10 and 1.06 dS m^{-1}, a characteristic of a normal soil. The status of organic carbon in the soils is low, as the OC content ranged from 0.30 and 5.00 g kg^{-1}. The free $CaCO_3$ content was ranged between 0.75 and 8.00 %.

3.2 Available sulphur

The critical level of available sulphur in soil is 10 mg kg^{-1}. The range and mean values of soil sulphur for all the blocks are listed in Table 1. The block wise, Madurai West block recorded a mean of 5.05 mg kg^{-1}, Melur block: 5.18 mg kg^{-1}, Sedapatti block: 5.21 mg kg^{-1}, T. Kallupatti block: 4.96 mg kg^{-1}, Kallikudi block: 5.27 mg kg^{-1}, Chellampatty block: 5.20 mg kg^{-1}, Usilampatty block: 5.21 mg kg^{-1}, Alanganallur block: 5.12 mg kg^{-1}, Vadipatti: 5.17 mg kg^{-1}, Madurai East block: 5.14 mg kg^{-1}, Thirupparankundram block recorded: 5.34 mg kg^{-1}. Kottampatti block: 7.55 mg $kg^{-1}$and Thirumangalam block: 5.01 mg kg^{-1}. About 99 % of the samples are found to be in deficient category. As a whole the sulphur deficiency is found to be around 95 % in the soils of Madurai district.

3.3 Inter-relationship with other soil properties

The soil physico chemical properties moderate the availability of nutrients. To assess the effects of pH, EC, OC and free $CaCO_3$ levels on available sulphur, correlation coefficients among these parameters have been worked out in Table 2. The correlation studies revealed that the sulphur content in the soil was negatively correlated with the soil parameters viz. pH (r = -0.084**), EC (r = -0.050*), free lime (r = -0.064**) and positively with OC (r = 0.025).

3.4 Thematic maps

The thematic maps were generated at block levels to depict the available Sulphur status based on soil analytical results. The available soil sulphur status of Madurai district is given in Figure. 2.

Table 1: Block wise Range and Mean values of Soil properties and available sulphur of Madurai district.

Block Name	pH (1:2.5)	EC (dS m^{-1})	O C (g kg^{-1})	Free lime (%)	Available S (mg kg^{-1})	Fertility rating
Madurai East	5.57-9.11	0.10-0.86	0.30-4.90 (2.50)	0.75-5.00 (2.76)	2.30-10.55 (5.14)	Very low
Madurai West	5.55-8.88	0.10-0.90	0.50-4.40 (2.40)	1.00-4.00 (2.88)	2.64-7.85 (5.05)	Very low
Thirupparankundram	6.31-8.53	0.10-1.00	0.30-4.50 (2.00)	1.00-6.00 (2.61)	2.30-10.55 (5.34)	Very low
Kottampatti	5.52-8.90	0.10-0.90	0.30-5.00 (2.60)	1.00-4.00 (2.15)	2.30-22.95 (7.55)	Low
Melur	5.51-8.76	0.10-1.00	0.50-4.40 (2.20)	0.75-6.00 (3.80)	2.32-8.05 (5.18)	Very low
Sedapatti	6.01-8.35	0.10-0.98	0.30-4.40 (2.30)	0.75-4.00 (2.54)	2.70-8.05 (5.21)	Very low
T. Kallupatti	5.65-8.10	0.10-1.06	0.30-4.50 (2.60)	1.00-8.00 (3.86)	2.70-8.10 (4.96)	Very low
Kallikudi	5.94-8.40	0.10-0.93	0.30-4.50 (2.00)	0.75-5.00 (2.81)	2.40-8.05 (5.27)	Very low
Thirumangalam	5.82-8.40	0.10-0.84	0.30-4.50 (2.30)	1.00-6.00 (3.23)	1.00-15.00 (5.01)	Very low
Chellampatty	5.66-8.88	0.10-0.90	0.30-4.40 (1.90)	1.00-5.00 (3.23)	2.30-7.60 (5.20)	Very low
Usilampatty	6.23-8.82	0.10-0.84	0.30-4.50 (2.00)	1.00-5.00 (2.75)	2.80-8.05 (5.21)	Very low
Alanganallur	5.50-8.73	0.10-0.73	0.30-4.40 (2.80)	1.00-4.00 (3.38)	2.65-9.95 (5.12)	Very low

Vadipatti	6.51-9.00	0.10-0.90	0.30-4.40 (2.40)	1.00-6.00 (3.98)	2.80-8.10 (5.17)	Very low
Overall for the district					1.00-22.95 (5.34)	Very low

Values within parenthesis are average values.

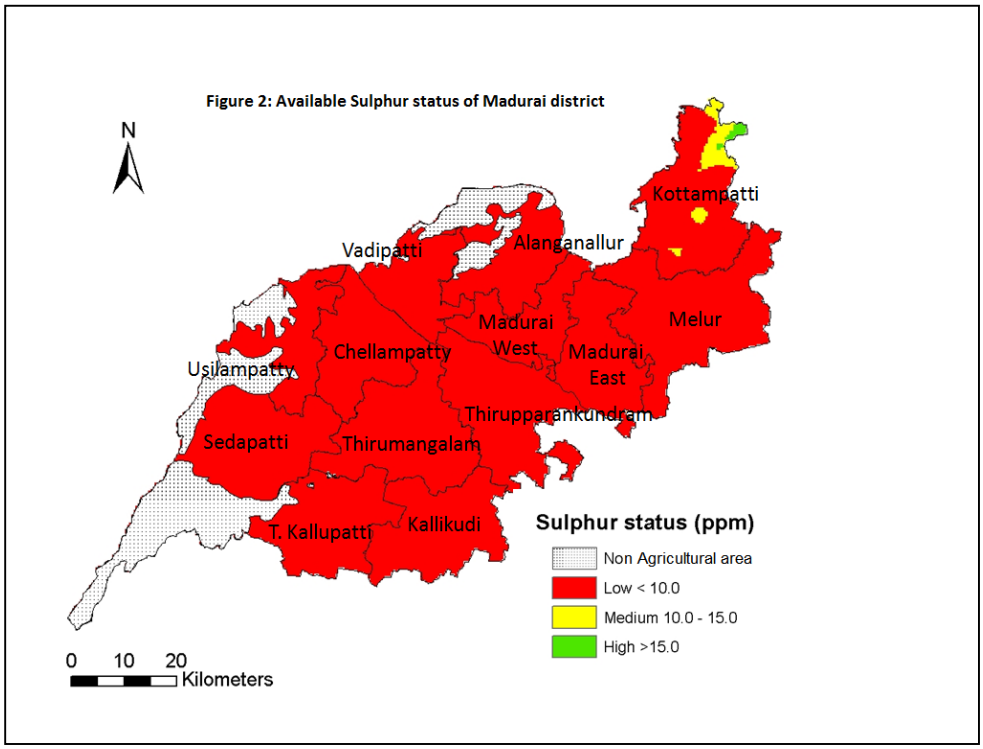

Table 2: Correlation between the soil physico chemical properties and soil available sulphur

Soil properties	**EC**	**OC**	**Free $CaCO_3$**	**Available Sulphur**
pH	0.002	-0.039	0.012	-0.084**
EC	1	-0.026	0.062*	-0.050*
OC		1	-0.030	0.025
Free $CaCO_3$			1	-0.064**

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

IV Conclusion and Future work

The present study reveals that the soils are highly deficient in available sulphur content. From this study, it is clear that the availability of sulphur decreases significantly with increase in the *viz*. pH, EC, free $CaCO_3$ content and increases with increase inorganic content. So in order to supply sulphur to the crop plants the usual sulphur free fertilizers have to be replaced with the sulphur containing fertilizers such as single super phosphate, ammonium sulphate, gypsum, thio and poly sulphates. A regular use of organic manures is also recommended as the soils are deficient in the soil organic carbon. The purpose of exploiting GIS is to note the exact sampling places, so a reassessment after some time or even a decade is certainly possible even at the same sampling spots or agricultural field.

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BIOGRAPHY

The author got his under graduate degree from Agricultural College & Research Institute, Madurai in 2010. He did his post graduate degree in Soil Science & Agricultural Chemistry Tamil Nadu Agricultural University, Coimbatore in 2012. The research topic assigned to him was: "Delineation of Soil available Sulphur and Micronutrient status of Madurai district of Tamil Nadu using GIS techniques". Currently he is working as a Research Scholar in Agro Climate Research Centre, Tamil Nadu Agricultural University - Coimbatore, India.