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Effect of Crops and Cropping Systems on Sulphur and Micronutrient Availability of Geo Referenced Soils of Ramanathapuram District in Tamil Nadu, India

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A B S T R A C T

The DTPA extractable cationic micronutrients, sulphur and some important soil physico-chemical properties were investigated in two cropping system of Ramanathapuram district of Tamil Nadu using GPS technique. Considering the critical limits of soil micronutrients, all soil associations were not adequately supplied with DTPA extractable micronutrients in rainfed chillies and rice cropping systems. Irrespective of cropping systems, the DTPA extractable cationic micronutrients were positively related with organic carbon content and negatively related to calcium carbonate content. Deficient soil samples were found in both cropping systems.

Introduction

Micronutrients deficiencies are often noticed in the soils under intensive cropping system of many agriculturally progressive states in India. The imbalanced use of fertilizer nutrients, increased demand of high yielding varieties, intensive cropping, decrease in recycling of organic manures and micronutrient free high input agricultural activities leads to continuous mining of micronutrients in soils leading to declined crop productivity and soil heath. The deficiency may either be primarily due to their low contents or secondarily by soil factor that reduce the availability (Sharma and Chaudhary, 2007). The extent of micronutrient deficiency varies not only in different states and districts but also in different blocks within the district. Micronutrient deficiencies are the one of the main causes for low yield or crop yield decline in irrigated (Katyal and Rattan, 2003) and rainfed cropping system in agriculture (Rego *et al.*, 2007). On the basis of computation of exhaustion period of micronutrient reserve under different cropping system soil zinc is the most limiting micronutrients followed by copper (Rattan *et al.*, 2009). Besides soil characteristics, land

use pattern also plays a vital role in governing the nutrient dynamics and fertility of soils (Venkatesh *et al.,* 2003). Assessing and mapping the fertility status of soils precisely using GPS techniques provides a great opportunity to plan for sustaining the productivity of crops and improving the economy of the country. Hence, the study was conducted to assess the micronutrient availability of soils in Ramanathapuram district of Tamil Nadu in different cropping system. Basic details on the system of cultivation, crops cultivated and cropping system followed in the study area were also collected to understand the relationship between soil nutrient availability and management strategies adopted. The relationship between soil physicochemical properties and available micronutrients status was worked out by constructing correlation studies to know the major factor that governs the nutrient availability. Due to continuous cultivation, soils under a particular land use system may affect physico-chemical properties which may modify DTPA – extractable micronutrients content and their availability to crops. So, analysis of these properties along with micronutrient status of different land use systems may have significant importance. Scanty information is available on status of cationic micronutrients and sulphur under different cropping system in the Ramanathapuram district of Tamil Nadu. An attempt has, therefore, been made to generate information regarding the DTPA-extractable Fe, Zn, Mn, Cu and sulphur status under two dominant cropping system, *viz*. rainfed rice and chillies of Ramanathapuram district of Tamil Nadu using GPS.

Materials and Methods

One hundred and eighty three samples were collected from rainfed rice growing areas of Ramanathapuram district in eleven blocks. Two hundred and twenty four samples were collected from rainfed chillies growing areas of Ramanathapuram district. The surface geo referenced soil samples were processed and analysed for pH, organic carbon, CEC, and available nitrogen, phosphorus and potassium following standard methods. The DTPA – extractable Fe, Zn, Mn and Cu were extracted with di-ethylene tri- amine penta-acetic acid (DTPA) solution (Lindsay and Norwell 1978) and subsequently analysed with the help of atomic absorption spectrophotometer (Chemito-203)

Results and Discussion

The pH, electrical conductivity, organic carbon status of the rainfed rice growing soils in different blocks of Ramanathapuram district ranged from 6.78 to 8.74, 0.10 to 0.42 dS m^{-1} and 0.14 to 0.42 per cent with mean of 7.96, 0.23 dS m^{-1} and 0.25 per cent. The free $CaCO_3$ values varied from 0.94 to 12.54 per cent with a mean of 8.74 per cent (Table 1) indicating that the soils were non to slightly calcareous in nature. Among the blocks, the part of the soils of from all the blocks were moderately calcareous in nature except Mandabam block.

The available sulphur content in the rainfed rice growing soils of Ramanathapuram district ranged from 6.82 to 51.81 with a mean of 22.99 mg kg^{-1} indicating high in soil available sulphur status. The highest mean soil available sulphur content noticed in Mandabam (39.26 mg kg^{-1}) and the lowest in Kamudiblock (12.28 mg kg^{-1}).

The DTPA-extractable Zn status of the soils ranged from deficient too high in availability (0.12 to 6.22) with a mean of 0.75 mg kg^{-1} (Table 2). All the block mean values of Zn were deficient in Ramanathapuram district except Rajasingamangalam block. The available Fe content in rainfed rice soils ranged from 3.51 to 43.54 mg kg^{-1} with a

mean of 13.75 mg kg^{-1} (Table 2). The average mean values indicated that, rainfed rice soils of all the blocks were found sufficient in DTPA-Fe status except Mandabam (4.95) and Kadaladi blocks (7.16). The soil samples of Rajasingamangalam block registered the highest mean available Fe status (19.72 mg kg^{-1}) under the rainfed system of rice cultivation.

Deficient to sufficient Cu status (0.15 to 3.81 mg kg^{-1}) with a mean of 1.27mg kg^{-1} noticed in rainfed rice soils (Table 2). The average mean Cu status of the blocks revealed that, almost all the blocks were sufficient in Cu status except in Rajasingamangalam, Tirupullani, Mudukulathur, Kadaladi, Thiruvadanai and Mandapam blocks.

The DTPA-Mn content in rainfed rice growing soils of Ramanathapuram district ranged from 1.52 to 48.56 mg kg^{-1} with a mean of 11.74 mg kg^{-1} indicating sufficient in availability of Mn in all the blocks (Table 2).

The highest DTPA-Mn availability was noticed in all block soil samples under the rainfed system of rice cultivation.

The pH of the rainfed chillies growing soils in different blocks of Ramanathapuram district ranged from 6.74 to 8.14 with a mean of 7.93. The electrical conductivity (EC) of the soils varied from 0.04 to 0.63 dS m^{-1} with a mean of 0.23 dS m^{-1} indicating that the soils are low in salt concentration. (Table 3)

Table.1 Soil properties of rainfed rice growing soils in different blocks of Ramanathapuram district (n=183)

S. No	Name of the block	No. of Samples	pH		EC(ds/m)		OC (g/Kg)		CaCO3 (percent)	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	27	6.78-8.48	7.84	0.10-0.37	0.20	1.7-3.9	2.5	0.94-11.14	7.61
2	Nainarkoil	18	7.28-8.44	7.97	0.14-0.34	0.26	1.9-4.1	2.7	3.14-12.54	8.95
3	Bogalur	12	8.08-8.49	8.28	0.16-0.32	0.23	1.9-3.4	2.6	10.41-12.72	11.46
4	Paramakudi	32	7.12-8.74	8.24	0.12-0.42	0.23	1.5-2.9	2.2	1.13-12.50	11.30
5	Ramanathapuram	11	6.94-8.44	7.76	0.12-0.26	0.18	1.4-3.1	2.3	2.56-11.98	8.10
6	Tiruppullani	5	7.68-8.34	8.01	0.18-0.42	0.27	2.1-3.2	2.6	10.24-11.21	10.65
7	Mudukulathur	26	7.14-8.41	7.81	0.12-0.32	0.22	2.1-3.1	2.5	2.13-12.50	7.69
8	Kamudi	4	8.28-8.44	8.37	0.20-0.38	0.26	2.6-3.9	3.1	10.54-11.78	11.01
9	Kadadi	19	6.93-8.34	7.78	0.12-0.26	0.18	1.4-2.9	2.3	2.25-12.13	8.79
10	Thiruvadanai	26	6.98-8.54	7.80	0.12-0.42	0.22	1.8-4.2	2.8	1.50-12.25	7.29
11	Mandapam	3	6.88-8.14	7.60	0.18-0.38	0.28	1.7-3.7	2.5	2.25-4.75	3.38
	District	183	6.78-8.74	7.96	0.10-0.42	0.23	1.4-4.2	2.5	0.94-12.54	8.96

Table.2 Micronutrient and sulphur availability in rainfed rice growing soils in different blocks of Ramanathapuram district (n=183)

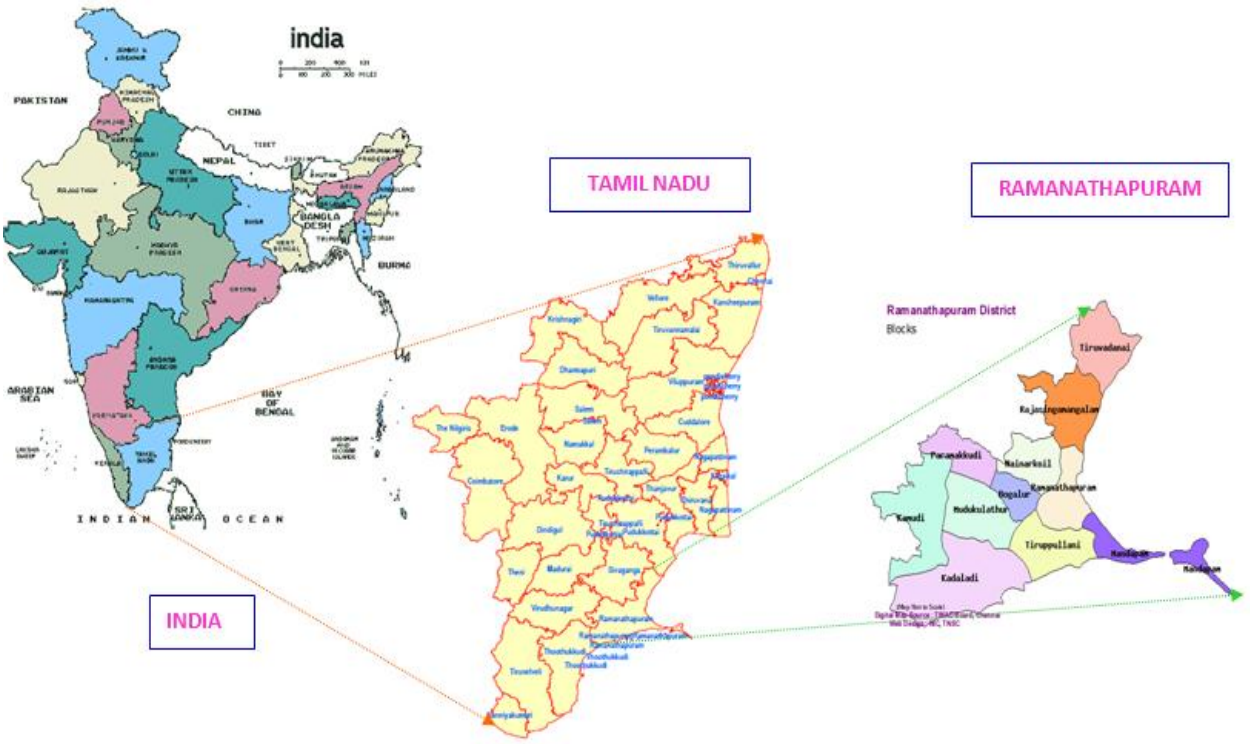
S no	Name of block	No of sample	Fe		Mn		Zn		Cu		S	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	27	7.46-43.54	19.72	6.10-40.29	15.98	0.27-6.22	1.72	0.15-1.62	0.99	8.50-31.30	19.29
2	Nainarkoil	18	6.94-22.73	13.81	1.52-29.29	15.09	0.12-1.14	0.31	1.06-3.21	2.26	17.14-49.52	31.13
3	Bogalur	12	10.40-16.87	12.90	4.21-14.20	7.90	0.46-3.92	1.07	0.74-2.92	2.01	9.37-39.50	17.90
4	Paramakudi	32	6.62-24.82	13.69	2.61-25.72	10.49	0.12-6.04	0.68	0.55-2.65	1.35	12.21-70.69	29.55
5	Ramanathapuram	11	8.44-23.16	17.94	3.45-28.74	17.56	0.31-2.18	0.70	0.45-3.81	1.87	12.58-32.76	23.04
6	Tiruppullani	5	6.68-38.51	19.52	3.20-7.19	5.07	0.46-1.07	0.85	0.32-0.52	0.37	15.66-35.62	22.40
7	Mudukulathur	26	4.24-22.48	12.46	2.71-19.89	11.60	0.40-2.12	0.72	0.65-1.75	0.99	9.46-39.22	18.83
8	Kamudi	4	6.72-21.74	14.42	11.69-24.01	16.03	0.49-1.28	0.80	0.97-1.87	1.42	6.82-14.50	12.28
9	Kadadi	19	3.51-24.48	7.16	2.27-12.75	4.97	0.29-1.56	0.57	0.84-1.92	1.04	11.38-38.02	21.28
10	Thiruvadanai	26	5.43-18.44	14.77	7.01-48.56	21.06	0.21-1.26	0.61	0.45-1.29	0.84	8.53-36.73	17.93
11	Mandapam	3	3.68-7.10	4.95	2.95-4.99	3.48	0.23-0.45	0.32	0.61-1.16	0.83	27.97-51.81	39.26
	District	183	3.51-43.54	13.75	1.52-48.56	11.74	0.12-6.22	0.75	0.15-3.81	1.27	6.82-51.81	22.99

Table.3 Soil properties of rainfed chillies growing soils in different blocks of Ramanathapuram district (n=224)

S. No	Name of the block	No. of Samples	pH		EC(ds/m)		OC (g/Kg)		CaCO3 (per cent)	
			Range	Mea	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	12	7.29-8.41	8.02	0.04-0.31	0.18	1.7-4.1	2.6	1.31-10.78	8.25
2	Nainarkoil	12	7.18-8.32	7.97	0.15-0.39	0.27	1.7-4.2	2.7	2.94-11.59	7.64
3	Bogalur	19	7.14-8.48	8.18	0.12-0.32	0.21	1.4-3.1	2.2	1.18-12.48	10.73
4	Paramakudi	27	7.14-8.54	8.16	0.11-0.46	0.25	1.5-3.5	2.3	1.25-12.38	10.73
5	Ramanathapuram	5	6.94-8.31	7.84	0.08-0.52	0.25	1.4-3.7	2.4	5.21-11.78	9.85
6	Tiruppullani	5	7.59-8.2	7.95	0.12-0.61	0.40	2.2-3.9	3.0	5.64-10.98	9.72
7	Mudukulathur	35	6.86-8.46	8.11	0.16-0.34-	0.23	2.0-3.2	2.5	2.12-12.37	10.38
8	Kamudi	77	6.78-8.68	8.06	0.04-0.48	0.20	1.3-4.8	2.7	1.78-11.44	9.37
9	Kadadi	13	6.82-8.41	7.41	0.11-0.28	0.20	1.5-2.8	2.2	1.12-12.51	6.53
10	Thiruvadanai	1	8.14-8.14	8.14	0.14-0.14	0.14	2.1	2.1	10.50-10.50	10.50
11	Mandapam	18	6.74-8.34	7.49	0.11-0.63	0.26	1.4-4.4	2.7	2.38-12.75	6.27
	District	224	6.74-8.14	7.93	0.04-0.63	0.23	1.3-4.8	2.4	1.12-12.48	9.08

Table.4 Micronutrient and sulphur availability in rainfed chillies growing soils in different blocks of Ramanathapuram district (n=224)

S no	Name of block	No of sample	Fe		Mn		Zn		Cu		S	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	12	6.87-14.86	11.72	13.11-36.18	21.58	0.64-2.31	1.21	0.13-2.13	1.21	7.78-32.02	20.89
2	Nainarkoil	12	10.92-16.69	13.32	6.52-19.73	10.97	0.21-2.65	1.02	0.15-2.65	1.02	11.38-26.98	21.34
3	Bogalur	19	4.16-17.30	11.83	4.49-18.46	9.89	0.37-1.25	0.64	0.76-1.25	0.64	8.32-42.80	18.86
4	Paramakudi	27	4.41-47.19	18.15	3.07-27.96	11.54	0.12-0.75	0.34	0.11-0.75	0.34	12.51-37.25	25.29
5	Ramanathapuram	5	8.35-20.12	12.73	4.63-23.45	10.77	0.33-0.59	0.44	0.52-0.59	0.44	11.46-28.50	17.5
6	Tiruppullani	5	12.57-21.60	18.59	6.58-30.48	19.90	0.68-2.07	1.18	0.36-2.07	1.18	12.34-38.15	23.57
7	Mudukulathur	35	4.08-19.93	13.07	3.84-21.44	13.98	0.22-1.66	0.72	0.16-1.66	0.72	10.18-86.70	29.7
8	Kamudi	77	3.00-29.73	7.81	4.41-59.31	13.87	0.29-6.32	1.27	0.23-6.23	1.27	15.77-39.64	21.29
9	Kadadi	13	5.76-33.81	14.39	3.62-21.73	8.23	0.15-0.87	0.38	0.47-0.87	0.38	8.02-35.14	20.33
10	Thiruvadanai	1	15.58-15.58	15.58	15.62-15.62	15.62	0.63-0.63	0.63	0.92-0.63	0.63	8.53-8.53	8.53
11	Mandapam	18	3.06-20.06	8.76	2.15-14.11	6.23	0.13-2.28	0.50	0.57-2.28	0.50	26.35-75.74	47.16
	District	224	3.06-47.19	13.26	2.15-59.31	12.96	0.12-6.32	0.75	0.11-6.32	0.75	7.78-86.70	23.13



The organic content in the soils ranged from 0.13 to 0.48 with a mean of 0.24 per cent indicating that the soils were mostly low in organic carbon status (Table 3). All the rainfed chillies growing blocks were found to contain low in organic carbon content. All the soils were falls under non to moderately in calcareous nature and values varied from 1.12 to 12.48 per cent with the mean of 9.08 (Table 3). Part of the soils under all the rainfed chillies growing blocks fall under moderately calcareous nature and the mean free $CaCO_3$ value revealed that the blocks soils of Bogalur, Paramakudi, Mudukulathur and Thiruadanai were showed the high $CaCO_3$ value of > 10.0 per cent.

The available sulphur content in the rainfed chillies growing soils of Ramanathapuram district ranged from 7.78 to 86.70 mg kg^{-1} with a mean of 23.13 mg kg^{-1} indicating high in soil available sulphur status (Table 4).

The DTPA-extractable Zn status of the soils ranged from deficient to sufficient in availability (0.12 to 6.32) with a mean of 0.75 mg kg^{-1} (Table 4). Almost all the block soils were deficient in Zn status except in Rajasingamangalam and Kamudi. Low Zn status noticed in the soils of Paramakudi (0.12 mg kg^{-1}) while the highest Zn observed in Kamudi (6.32 mg kg^{-1}) blocks (Table 4).

The available Fe content in the rainfed chillies growing soils of Ramanathapuram district ranged from 3.00 to 47.19 mg kg^{-1} with a mean of 13.26 mg kg^{-1} (Table 4). The average mean values indicated that chillies grown soils of all the blocks were observed that sufficient in DTPA-Fe status. The highest mean available Fe status noticed in soil samples Tirupullani (18.59 mg kg^{-1}) block while the lowest in Kamudi (7.81 mg kg^{-1}) block. Deficient to sufficient Cu status (0.11 to 6.32 mg kg^{-1}) with a mean of 0.75 mg kg^{-1} noticed in rainfed chillies soils (Table 4).

Soil properties and nutrient availability varied with crops and cropping system. A slight increase in soil pH and salinity was noted in chillies growing soils than rice grown soils. The increase in pH of soils could be due to increased calcium carbonate content which produces more OH ions upon hydrolysis and created an alkaline effect (Verma *et al.*, 2007). The soils under rainfed chillies showed deficient Zn status. But the very low organic carbon content of the soils indicates that corrective measures would be required to avoid Zn deficiency in near future and similar observations have been made by Katyal and Datta (2004) and Sood *et al.,* (2009). The Cu availability in sole crop of rice was might be due to increase in finer fractions of the soil leads to increased surface area for ion exchange thus contributing to higher Cu availability. Deficient Cu availability was specifically recorded in the soils under chillies based cropping systems could be ascribed to the low organic content in the soils (Sood *et al.,* 2009). Hence to conclude, that the soils of rice cultivation possessed the highest amount of available sulphur and micronutrients than chilly crops grown in the Ramanathapuram district. Among the cultivation of chilies and rice crops under rainfed condition, the chillies crop registered the highest amount of mean free $CaCO_3$, available sulphur and Mn as compared to rice system which registered the highest amount of available Fe, Zn, Cu, B and organic carbon. Similarly the mean nutrient content of sulphur, available micronutrients and all other soil properties were higher in rice based cropping system than chillies based cropping system.

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