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RESEARCH ARTICLE

STATUS OF DTPA-EXTRACTABLE CATIONIC MICRONUTRIENTS AND PHYSIO CHEMICAL PROPERTIES OF GEO REFERENCED SOILS UNDER IRRIGATED AND RAINFED ECOSYSTEMS OF RAMANATHAPURAM DISTRICT IN TAMILNADU

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ABSTRACT

The DTPA extractable cationic micronutrient and some important soil physic-chemical properties were investigated in two ecosystem 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 both ecosystems. Irrespective of land use, the DTPA extractable cationic micronutrients were positively related with organic carbon content and negatively related to calcium carbonate content. The soils under rainfed condition possessed lesser values of all the nutrient availability than irrigated soil environment. Deficient soil samples were found in all the blocks, for Fe, Zn, Cu and B in district and none of the samples from all the blocks had deficient in range of Mn except Nainarkovil block

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INTRODUCTION

Indian agriculture during the past 50 years has achieved a fourfold growth in food production by adopting modern agricultural practices. However, intensive cultivation of higher 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). Micronutrients are as essential as macronutrients but required in smaller quantities by plants. The extent of micronutrient deficiency varies not only in different states and districts but also in different blocks within the district. Micronutrient deficiencies is 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).

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Besides soil charectersitics, land use pattern also plays a vital role in governing the nutrient dynamics and fertility of soils (Venkatesh *et al*. 2003). Due to continous cultivation, soils under a particular land use system may affect physic-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 under different ecosystems in the Ramanathapuram district of Tamil Nadu. An attempt has, therefore, been made to generate information regarding the DTPA- extractable Fe, Zn, Mn and Cu status under two dominant land use systems, *viz*. irrigated and rainfed ecosystem of Ramanathapuram district of Tamil Nadu using GPS.

MATERIALS AND METHODS

Eight hundred and eighty seven samples representing rainfed ecosysytem were collected. The major crops cultivated under rainfed conditions were chillies, rice, sorghum, cotton and gingelly. Seven hundred and fifty seven samples representing irrigated ecosystem were collected and major crops grown under irrigated situation were rice, cotton, gingelly and coconut. The rainfed and irrigated ecosystem spread all over the blocks in Ramanathapuram district.

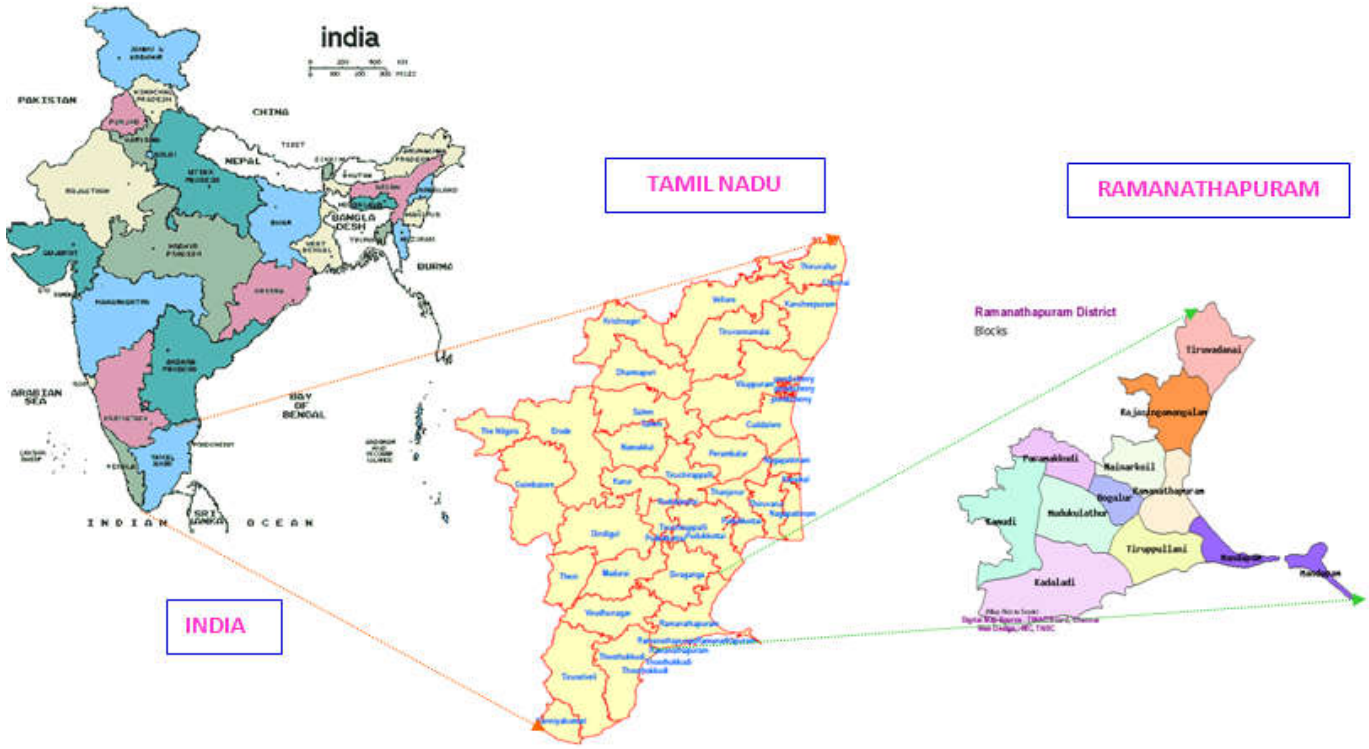

Table 1. Details of geo referenced soil samples

S. No	Taluk name	Black name		No. of samples
1	Thiruvadanai	1.	Rajasingamangalam	152
		2.	Thiruvadanai	196
2	Paramakudi	3.	Nainarkoil	152
		4.	Bogalur	104
		5.	Paramakudi	164
3	Mudukulathur	6.	Mudukulathur	208
4	Kamudi	7.	Kamudi	220
5	Kadaladi	8.	Kadaladi	248
6	Ramanathapuram	9.	Ramanathapuram	112
		10.	Tiruppullani	144
7	Ramanathapuram& Rameswaram	11.	Mandapam	120
		TOTAL		1820

Table 2. The data soil properties and micronutrient status

Parameter	Irrigated		Rainfed	
	Range	Mean	Range	Mean
No. of samples	757		887	
pH	6.58-8.64	7.94	6.29-8.74	7.89
EC (dS m^{-1})	0.01-0.69	0.23	0.04-0.63	0.43
OC (%)	0.10-0.54	0.25	0.11-0.48	0.25
$CaCO_3$ (%)	0.88-14.48	8.84	0.94-12.79	8.62
Micronutrient status (mg kg^{-1})				
DTPA-Zn	0.1-8.3	1.00	0.11-6.64	0.80
DTPA-Fe	6.1-90.3	31.9	2.20-47.19	13.67
DTPA-Cu	0.1-5.8	1.50	0.11-5.70	1.27
DTPA-Mn	2.7-61.8	21.1	0.69-59.31	13.27

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-ethelene 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 of the soils in irrigated system ranged from 6.58 to 8.64 with a mean of 7.94 (Table 2). The highest mean soil pH was found in Bogalur (8.24) followed by Nainarkovil (8.16) block (Table 3). Almost all soils in irrigated condition were neutral to slightly alkaline in soil reaction. Generally the soils under rainfed condition had neutral to alkaline soil pH (7.89) with a range of 6.29 to 8.74 (Table 2). The overall mean electrical conductivity in the soils of Ramanathapuram district in irrigated environment showed low salt content (0.23 dS m^{-1}) (Table 2). The highest electrical conductivity of the soils under irrigated system was recorded in Mandapam (0.38 dS m^{-1}) block while the lowest in Kamudi (0.17 dS m^{-1} block) (Table 3).

The EC of the rainfed soils ranged from 0.04 to 0.63 dS m^{-1} with a mean of 0.43 indicating low in salt concentration (Table 2). The organic carbon content of the soils under irrigated system ranged from 0.10 to 0.54 per cent with a mean of 0.25 per cent revealing low in organic carbon status of the soils (Table 2). The highest mean organic carbon content was recorded in Mandabam block (0.29 per cent) while the lowest in Bogalur (0.20 per cent) block (Table 3). The mean organic carbon content of the soils under rainfed situation was low in fertility and ranged from 0.11 to 0.48 per cent (Table 2). The soil of Kamudi block was higher in organic carbon status (0.28 per cent) and the lowest in Kadaladi (0.22 per cent) (Table 5). The free $CaCO_3$ (per cent) content of the soils in irrigated system showed a mean of 8.84 per cent indicating slightly calcareous nature of soils (Table 2). The highest mean free $CaCO_3$ content was noted in the soils of Bogalur (11.33 per cent) block and the lowest in Mandabam (6.75 per cent) block (Table 2). The mean free $CaCO_3$ content of the soils in rainfed cultivation system was slightly calcareous in nature and ranged from 0.94 to 12.79 per cent with a mean of 8.62 per cent (Table 2). The highest mean free $CaCO_3$ registered in the soils of Bogalur block (11.24 per cent) while the lowest in Tiruppullani (6.20 per cent) block soils (Table 5).

Table 3. Chemical properties of soil under irrigated condition in different blocks of Ramanathapuram district (n=757)

S.No	Name of the block	No. of Samples	Crops grown	pH		EC(ds/m)		OC (g/Kg)		CaCO3 (percent)	
				Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	109	Rice, Cotton	6.59-8.64	7.96	0.06-0.51	0.20	1.2-4.4	2.6	1.03-11.31	8.41
2	Nainarkoil	66	Rice, Gingelly, Cotton	7.28-8.63	8.16	0.12-0.36	0.22	1.4-5.4	2.5	1.94-12.98	10.54
3	Bogalur	17	Rice, Gingelly	7.94-8.38	8.24	0.14-0.29	0.20	1.1-2.4	2.0	10.48-12.34	11.33
4	Paramakudi	44	Rice, Gingelly, Cotton	6.78-8.44	7.92	0.01-0.68	0.23	1.1-4.5	2.3	2.12-12.22	9.49
5	Ramanathapuram	85	Rice, Cotton	6.72-8.44	7.83	0.08-0.63	0.27	1.7-4.4	2.6	2.28-12.48	8.19
6	Tiruppullani	61	Rice, Cotton, Gingelly	6.78-8.44	7.80	0.08-0.63	0.28	1.7-4.4	2.7	2.28-14.48	7.67
7	Mudukulathur	83	Rice, Cotton, Pulses	7.12-8.46	8.15	0.11-0.34	0.24	1.8-4.3	2.5	2.13-12.50	10.71
8	Kamudi	19	Rice, Cotton, Gingelly	6.78-8.41	7.84	0.02-0.29	0.17	1.9-4.2	2.8	1.48-11.38	7.55
9	Kadadi	103	Rice, Cotton	6.78-8.44	7.70	0.08-0.34	0.19	1.1-3.2	2.2	1.38-12.50	7.68
10	Thiruvadanai	165	Rice, Gingelly	6.58-8.64	7.79	0.07-0.57	0.24	1.0-4.4	2.8	0.88-12.38	8.92
11	Mandapam	5	Rice, Coconut	7.14-8.12	7.82	0.14-0.69	0.38	2.0-4.1	2.9	1.88-12.50	6.75

Table 4. Micronutrient availability in the soil under irrigated condition in different blocks of Ramanathapuram district (n=757)

`S no	Name of block	No of sample	Fe		Mn		Zn		Cu	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	109	18.5-46.3	29.4	4.4-39.0	23.2	0.2-8.3	1.7	0.1-2.8	1.1
2	Nainarkoil	66	16.3-48.2	30.2	8.9-29.4	22.1	0.1-2.6	0.7	0.9-3.7	2.1
3	Bogalur	17	6.1-63.9	38.9	13.1-59.1	25.7	0.3-3.9	1.3	0.9-3.4	1.8
4	Paramakudi	44	11.9-59.9	28.1	5.6-43.1	15.6	0.2-3.9	0.7	0.4-5.6	1.6
5	Ramanathapuram	85	23.5-60.8	31.8	13.1-55.4	27.9	0.2-4.6	0.8	0.3-4.7	1.7
6	Tiruppullani	61	22.5-55.6	36.7	15.1-61.4	30.8	0.4-7.6	1.4	0.3-4.7	0.9
7	Mudukulathur	83	20.1-43.2	27.2	8.1-21.4	17.0	0.3-2.4	0.8	0.2-2.3	1.2
8	Kamudi	19	9.9-59.9	34.5	5.4-61.8	27.7	0.2-4.9	1.4	1.0-5.3	2.1
9	Kadadi	103	8.1-67.9	33.8	3.1-41.6	17.6	0.2-1.7	0.5	0.5-5.8	1.8
10	Thiruvadanai	165	18.5-90.3	45.1	5.1-53.5	19.6	0.2-6.7	0.9	0.2-3.1	0.9
11	Mandapam	5	7.9-18.8	14.9	2.7-8.6	5.2	0.2-1.9	0.8	1.2-1.5	1.4

Table 5. Chemical properties of soil under rainfed condition in different blocks of Ramanathapuram district (n=887)

S.No	Name of block	No of Sample	Crops Grown	pH		EC (ds/m)		OC (g/Kg)		CaCO3(per cent)	
				Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	40	Rice, Chillies, Gingelly, Sorghum	6.78-8.48	7.90	0.04-0.37	0.20	1.7-4.1	2.2	0.94-11.14	7.87
2	Nainarkoil	57	Rice, Chillies, Gingelly, Sorghum, Groundnut	7.18-8.64	8.04	0.12-0.39	0.24	1.3-4.2	2.6	2.04-12.78	9.01
3	Bogalur	61	Rice, Chillies, Gingelly, Sorghum, Groundnut, pulses10.27	7.14-8.58	8.25	0.08-0.31	0.21	1.3-3.4	2.3	1.18-12.79	11.26
4	Paramakudi	86	Rice, Chill9.10ies, Gingelly,6.20 Sorghum, 9.70Groundnut,cott8.84on	6.78-8.74	8.12	0.08-0.42	0.60	1.5-3.5	2.3	1.13-12.50	10.27
5	Ramanathapuram	22	Rice, Chillies, Gingelly, Sorghum, coconut	6.94-8.44	7.79	0.09-0.63	2.10	1.3-3.9	2.4	2.56-12.22	9.10
6	Tiruppullani	68	Rice, Chillies, Gingelly, Sorghum, Groundnut,coconut	6.72-8.44	7.48	0.11-0.34	0.27	1.4-4.2	2.7	2.34-11.72	6.20
7	Mudukulathur	106	Rice, Chillies, Gingelly, Sorghum, Groundnut, pulses	6.86-8.46	8.04	0.04-0.53	0.23	2.1-3.4	2.5	2.13-12.50	9.70
8	Kamudi	161	Rice, Chillies, Gingelly, Sorghum	6.29-8.68	8.00	0.10-0.34	0.20	1.3-4.8	2.8	1.14-12.24	8.84
9	Kadadi	129	Rice, Chillies, Gingelly, Sorghum, Groundnut, pulses	6.72-8.44	7.84	0.12-0.42	0.19	1.1-3.6	2.2	1.23-12.50	8.81
10	Thiruvadanai	27	Rice, Chillies, Gingelly, Sorghum, Groundnut,coconut	6.98-8.54	7.82	0.08-0.63	0.22	1.8-3.2	2.7	1.50-12.50	7.40
11	Mandapam	80	Rice, Chillies, Gingelly, Sorghum, Groundnut	6.54-8.44	7.51	0.08-0.63	0.23	1.4-4.4	2.6	1.88-12.75	6.37

Table 6. Micronutrient availability in the soil under rainfed condition in different blocks of Ramanathapuram district (n=887)

`S no	Name of block	No of Sample	Fe		Mn		Zn		Cu	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
1	Rajasingamangalam	40	6.78-43.54	17.15	6.10-40.29	17.56	0.27-6.22	1.55	0.13-1.62	0.93
2	Nainarkoil	57	6.94-22.73	13.30	0.69-29.29	14.90	0.20-2.65	0.73	0.12-3.53	1.87
3	Bogalur	61	4.16-19.12	13.52	4.21-24.22	11.17	0.60-3.92	0.77	0.13-3.40	1.62
4	Paramakudi	86	4.41-47.19	15.91	2.61-30.38	11.44	0.12-6.04	0.48	0.11-2.65	1.10
5	Ramanathapuram	22	8.35-23.16	16.64	3.45-29.93	16.04	0.31-2.18	0.58	0.42-3.81	1.50
6	Tiruppullani	68	6.17-38.51	15.86	2.25-30.48	7.79	0.19-6.64	1.29	0.29-4.13	0.61
7	Mudukulathur	106	4.08-27.48	13.35	4.08-27.48	13.35	0.22-2.12	0.73	0.16-3.14	1.22
8	Kamudi	161	3.00-32.90	10.33	4.33-59.31	14.67	0.40-6.32	1.09	0.23-5.70	1.55
9	Kadadi	129	2.20-42.63	8.71	2.20-27.84	7.06	0.12-2.36	0.45	0.47-5.61	1.37
10	Thiruvadanai	27	5.43-18.44	14.80	7.01-48.56	20.86	0.21-1.26	0.61	0.45-1.29	0.84
11	Mandapam	80	2.69-29.62	10.90	1.89-20.83	7.38	0.11-2.58	0.55	0.14-3.08	1.36

Micronutrient availability in the soils of Ramanathapuram district under irrigated situation was observed with mean of 31.9, 21.1, 1.0, 1.5 mg kg^{-1} for Fe, Mn, Zn and Cu respectively (Table 2). Considering the critical limits of 4.5 mg/kg, proposed by Lindsay and Norvell (1978), the deficient range of Zn noticed under irrigated condition in all the blocks of Ramanathapuram district except in Rajasingamangalam, Bogalur, Thiruppullani and Kamudi blocks (Table 4). The DTPA-Zn content in the soils of irrigated system ranged from 0.10 to 8.3 mg kg^{-1} and the highest mean Zn content was found in Rajasingamangalam block (1.7 mg kg^{-1}) (Table 4). All the blocks had higher DTPA-Fe content and values ranged from 6.1 to 90.3 mg kg^{-1} (Table 4). The soils of Thiruvadanai block recorded the highest mean Fe availability (45.1 mg kg^{-1}) while the lowest Fe status in Mandabam block (14.9 mg kg^{-1}) under irrigated condition. (Table 4). Considering the critical limits of 0.2 mg/kg, proposed by Lindsay and Norvell (1978), the sufficient range of Cu noticed in all the blocks of Ramanathapuram district except in Rajasingamangalam (Table 4) under irrigated system. The DTPA-Cu content in the soils of irrigated system ranged from 0.10 to 5.8 mg kg^{-1} with overall mean of 1.5 mg kg^{-1} (Table 4). The highest mean Cu content in the soils was found in Nainarkovil and Kamudi blocks (2.1 mg kg^{-1}) and the lowest in Thiruvadanai and Tirupullani (0.9 mg kg^{-1}) blocks (Table 4). The DTPA-Mn content in the soils ranged from 2.7 to 61.8 mg kg^{-1} and the highest mean Mn availability was noted in the soils of Tirupullani block (30.8 mg kg^{-1}) whereas the lowest mean Mn content was in Mandabam block (5.2 mg kg^{-1}) (Table 4). Considering the critical limits of 1 mg kg^{-1}, proposed by Lindsay and Norvell (1978), the sufficient range of Mn noticed in all the blocks of Ramanathapuram district.

In general, soils under irrigated system, deficient range of Zn noticed in all the blocks of Ramanathapuram district except in Rajasingamangalam, Bogalur, Tiruppullani and Kamudi. The Cu was sufficient in all the blocks except in Thiruvadanai and Tirupullani. The Fe and Mn was sufficient in all the blocks. The soils under rainfed condition possessed lesser values of all the nutrient availability than irrigated soil environment. Deficient soil samples were found in all the blocks, for Fe, Zn and Cu in district and none of the samples from all the blocks had deficient in range of Mn except Nainarkovil block (Table 6). The DTPA-Zn content in the soils varied from 0.11 to 6.64 mg kg^{-1} with a mean of 0.80 mg kg^{-1}. The highest mean DTPA Zn content noticed in the soils of Rajasingamangalam block (1.55 mg kg^{-1}) and the lowest Zn status in Kadaladi (0.45 mg kg^{-1}) block soils under rainfed system (Table 6). Considering the critical limit, all blocks have deficient range of Zn. The overall mean DTPA-Fe availability in the soils of rainfed system was 13.67 mg kg^{-1} with a range of 2.20 to 47.19 mg kg^{-1} revealing very high availability of Fe. The highest mean Fe availability recorded in Rajasingamangalam (17.15 mg kg^{-1}) block while the lowest was in Kadaladi (8.71 mg kg^{-1}) block under rainfed system (Table 6).

The DTPA Cu content in the soils of rainfed system varied from 0.11 to 5.70 mg kg^{-1} and the highest mean Cu content found in Nainarkovil (1.87 mg kg^{-1}). The lesser DTPA Cu status, noticed in Tiruppullani (0.61 mg kg^{-1}) block (Table 6). But soils from all blocks have sufficient range of Cu under rainfed system. None of the soils from all the blocks, had deficient in Mn status under rainfed system and the values ranged from 0.69 to 59.31 mg kg^{-1} except few samples in Nainarkovil block. The highest mean Mn status registered in Thiruvadanai block (20.86 mg kg^{-1}) whereas the lowest in Kadaladi (7.06 mg kg^{-1}) (Table 6). To conclude that, there is no wide variation in the soil properties under both irrigated and rainfed systems (Table 1). However the higher soil pH and Free $CaCO_3$ was noticed in Irrigated system. The rainfed system had higher amount of electrical conductivity than others. With regard to mean availability of sulphur and micronutrient, the irrigated environment registered the highest availability of all nutrients except Zn which was higher in garden land condition. Moisture plays an important role in soil nutrient availability by influencing the soil chemical characteristics. "Neutral to Alkaline" soil reaction was observed in both irrigated and rainfed situations and the neutral pH under irrigated situations might be due to reduced condition prevailing under wetting (Ponnamperuma, 1972). The overall mean values of the soils indicated neutral soil reaction, low salinity, low organic carbon and slightly calcareous nature. However the range values showed a variation in organic carbon, EC and free $CaCO_3$. The higher EC values were noticed in soils under irrigated system than rainfed system and this could be ascribed to inflow of soluble salts through irrigation water (Somasundaram *et al*. 2009). The soils under irrigated conditions had higher organic carbon which can be explained by increased C input through root biomass and similar results were reported by Singh *et al*. (2009). Lesser EC, OC, and $CaCO_3$ content was observed under rainfed situation which might be due to deficit moisture availability and faster decomposition and loss (Datta *et al*. 1989). Although the nutrient availability was lesser in soils under rainfed situation, the mean values indicated sufficient nutrients availability in the soils of Ramanathapuram district except Zn which showed deficient status. Comparing the irrigated and rainfed situations, more than 40 per cent reduction in Fe and Mn and 15 per cent reduction in Cu availability was noted in rainfed soils and the order of reduction was higher Cu > Mn > Fe. Poor organic matter content and reduced water availability under rainfed situation leads to reduced solubilisation of nutrients to the available pool thus leads to reduced nutrient availability. Similar results were reported by Paramasivam *et al.* (1994).

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