Micronutrients and their Relationship with Soil Properties of Natural Disaster Proned Coastal Soils

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Abstract

Ninety six surface soil samples representing twenty villages of the recently tsunami affected areas of Nagapattinam taluk of Tamilnadu in India were analyzed for the basic soil parameters viz., pH, EC, OC and OM. The available micronutrients (DTPA extractable) viz., Fe, Mn, Cu and Zn were investigated by using Atomic Absorption Spectrophotometer (ECIL, AAS-4129). The availability of micronutrients and their relationship with soil properties were also studied. The result showed that the available micronutrients, Fe was found to be sufficient by 97% and Mn deficient by 100%, Zn was found to be sufficient by 53% and Cu deficient by 45% respectively. Further, Fe showed positive correlation with OC but negative correlation with pH. Mn also followed the same trend as that of Fe with OC, EC and pH. Cu showed positive correlation with EC and negative correlation with pH and OC. Zn showed negative correlation with OC and positive correlation with EC and pH.
Key words: DTPA-extractable, pH, micronutrients, soil properties, tsunami.

Introduction

Soil fertility is one of the important factors controlling yields of the crops. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. Introduction of high yielding varieties (HYV) in Indian Agriculture in mid- sixties compelled the farmers to use high doses of NPK fertilizers along with micronutrient fertilizers.

Micronutrient plays a vital role in maintaining soil health and also productivity of crops. These are needed in very small amounts. The soil must supply micronutrients for desired growth of plants and synthesis of human food. Increased removal of micronutrients as a consequence of adaption of HYVs and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil to below normal at which productivity of crops cannot be sustained. The deficiencies of micronutrients have become major constraints to productivity, stability and sustainability of soils. Soils with finer particles and with higher organic matter can generally provide a greater reserve of these elements whereas, coarse textured soils such as, sand have fewer reserves and tend to get depleted rather quickly.

The widespread need for the micronutrients observed in recent years can be accounted for in three ways viz. i) Naturally deficient in some soil types ii) their deficiency has been brought out by crop removal and iii) widespread erosion together with destruction of soil organic matter has also brought about their removal from the soil. Considering all the above facts a study was made in Nagapattinam taluk in Nagapattinam district of Tamil nadu which was recently affected by the tsunami of December 2004 in India. Further Nagapattinam district is often affected by natural

disasters like cyclones, floods, storm etc. It is well known that the soil series of Nagapattinam taluk are characterized by light in texture, moderate to high pH and low to medium in organic content. Hence an attempt has been made to analyze the basic soil parameters, macronutrients and the micronutrients of Nagapattinam taluk of Nagapattinam district.

Soil series and Characteristics: It was found that there are 8 soil series in Nagapattinam taluk. The name of the 8 soil series and its characteristics are mentioned below:

1. Adhanur(And) - Adhanur series comprises of dark grey brown to dark yellowish brown, loamy textured soils derived from Cauvery alluvium. The soils are very deep, non-calcareous, having sand layer within 100 cm.

2. Kalathur(Klt) - Dark grey (10 YR 4/1m); clay; strong coarse sub angular blocky; very hard firm sticky and plastic; brownish yellow root hair mottling; many fine to medium roots; slow permeability; gradual smooth boundary; pH 7.4;

3. Kohur(khr) - Very dark grey brown (10 YR 4/3 m); silty loam; medium moderate angular blocky; hard firm slightly sticky and plastic; slow permeability; cracks present; common fine brown mottlings; slightly saline; many fine roots; few fine pores; clear smooth boundary; pH 7.1;

4. Kivalur(kvr) - Dark yellowish brown (10 YR 4/4 m); silty clay; coarse strong sub angular blocky; hard firm sticky and slightly plastic; many fine to medium roots; many very fine tubular pores; slow permeability; deep crack; clear smooth boundary; pH 6.9;

5. Sikar(Skr) - Very dark greyish brown (10 YR 3/2 m); silty clay, coarse strong sub angular blocky; very hard firm sticky and plastic; few fine pores; many fine roots; moderately slow permeability; clear smooth boundary; pH 7.8;

6. Padugai(Pdg) - Brown (10 YR 4/3 m); sandy clay loam; moderate sub angular blocky; friable slightly sticky and nonplastic; faint common medium black mottling; many fine to medium

roots; common very fine random tubular pores; moderate permeability; abrupt smooth boundary; pH 6.8;

7. Sethi(Sth) - Grey(10 YR 6/1m); sand; structure less single grained; loose very friable nonsticky nonplastic; very rapid permeability; common fine roots; diffused smooth boundary; pH 7.7;

8. Nagapattinam(Ngp) - Very dark grey brown (10 YR 3/2 m); clay; coarse strong angular blocky; hard firm sticky and plastic; very slow permeability; deep crack; many fine roots; fine few pores; slightly saline; few fine yellow and brown mottling; clear irregular boundary; pH 7.1.

Study area: Nagapattinam soil series comes under Agro climatic zone, Sub-zone IV – Cauvery Delta zone. Coastal eco system – Eastern coastal plain hot sub humid to semi-arid eco system with a growing period 90 – 210+ days. Nagapattinam taluk is one of the 8 taluks of Nagapattinam District of Tamilnadu that lies between Lat. 110 3' N; Long 790 50'E, surrounded by Karaikal, Nannilum, Thiruvarur, Kivelur and Bay of Bengal. It covers an extant of 31181 ha land area. The sites from where soil samples were collected are depicted in Map 1, for which an inventory survey of the area was conducted.

Materials and Methods

Soil samples (0-15 cm) were collected from 96 sites (map.1) covering 20 revenue villages, keeping in view the physiographic characteristic in different cross sections of the area as well as variation in soil texture. Soils were completely air-dried and passed through 2mm sieve and stored in properly labeled plastic bags for analysis. The list of villages of sampling sites of Nagapattinam Taluk soils are highlighted in the given Map1and the names of the sampling stations are given in table 1.

The processed soil samples were analyzed for basic soil parameters (pH, EC, OC and OM) and the available Fe, Mn, Cu and Zn in soil samples were extracted with a DTPA solution (0.005M DTPA + 0.01 M CaCl2 + 0.1M triethanolamine, pH 7.3 as outlined by Lindsay and Norvell[11]. The

concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (ECIL, AAS-4129).

Results and Discussion

The results of all the relevant soil characteristics are described in table2.

The soils are neutral to alkaline in reaction, pH 7.32 – 8.75 with the mean value of pH 7.9. The relative high pH of the soils might be due to the presence of high degree of base saturation. The electrical conductivity (EC), organic carbon (OC), organic mineral (OM) of the soil varied from 0.09 – 0.62 dsm-1, 0.20 – 0.42% and 0.41- 0.84% with a mean value of 0.331dsm-1, 0.29% and 0.60% respectively (Table .2). It showed a considerable variation with types and topography of soils. On the basis of the limits suggested by Muhr[3] for judging salt problems of soils, all samples (100%) were found normal (< 1.0) in EC.

The organic carbon was very low (<0.50%) in 100% soil samples (table.2). The very low OC content of these soils may be attributed to the poor vegetation and high rate of organic matter decomposition under hyper-thermic temperature regime which leads to extremely high oxidizing conditions[7]. The results of the present investigation are in close proximity with the findings of singh *et al* [1].

Data on available Fe in soil samples indicated that 3% soil samples were deficient in DTPA-Fe content and 97% of the soil samples were sufficient (Table 2) with 4.5mg kg^{-1} as the critical limit proposed by Lindsay and Norvell[11]. The content of DTPA- Fe in soils varied from 4.1 to 6.72mg kg-1 with an average value of 5.72mg kg-1 (Table . 2). The available of Fe increased significantly with an increase in EC (r = 0.66), organic carbon (r = 0.42) whereas the same decreased with increase in pH (r = -1.10) (Table. 3).

The DTPA-Mn in the soil samples varied from 2.04 to 2.72mg kg-1 with the mean value of 2.36 (Table .2), considering 3.00 mg kg-1 as critical limit for Mn deficiency[6], here all the 100% samples were deficient in availability (Table.2).

The available Mn in these soil samples was positively correlated with EC (r = 0.02), remaining same with organic carbon and inversely proportional to pH by -0.17 (Table. 3).

Available Cu content of the soil samples varied from 0.20 – 1.15mg.kg^{-1} with the mean value of 0.708mg.kg-1 (Table. 2). The data indicated that 45% of the soil samples[9] were deficient in availability of Cu and 55% were sufficient (Table.2) considering 0.66 mg kg-1. The available Cu inversely proportional to pH (r = - 0.47), OC (r = - 0.06) and directly proportional to EC (r=0.24), (Table. 3).

Available Zn in the soil samples varied from 0.28 to 0.90 mg kg-1 with the mean value of 0.58 mg.kg-1 (Table.2). On the basis of critical limit suggested by Takkar and Mann[6] 47% samples were deficient, 53% samples were marginal and none of the samples were sufficient (Table.2) in availability (< 0.6 mg.kg-1 for deficient, 0.6 to 1.2mg.kg-1 for marginal and > 1.2 mg.kg-1 for sufficient). The availability of Zn increased with increase in EC (r = 0.2), pH (r = 0.3) whereas reduced with increase in organic carbon (r = - 0.033), (Table. 3).

Conclusion

The study among micronutrients, Fe sufficient by 97%, Mn deficient by 100%, Zn sufficient by 53% and Cu deficient by 45%. The studied soils though contained adequate amounts of available micronutrients deficiencies also recorded. The results indicated that the soil properties pH, EC and OC as the main characteristics playing major role in controlling the availability of micronutrients. These factors could be manipulated in order to combat any present or future deficiencies of micronutrients in these soils.

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Table-1: Name of the villages and number on the map.

S.No	Name of the Village	No. on the Map	S.No	Name of the Village	No. on the Map
1.	Ervadi	53	11	Therkupoigainallur	20
2.	Marungur	117	12	Thirukkanapuram	92
3.	Nagapattinam	5	13	Uthamacholapuram	123
4.	Thuraiyur	119	14	Vazhakudi	106
5.	Vadakarai	87	15	Kattumavadi	63
6.	Oratthur	17	16	Kurichi	22
7.	Puducheri	15	17	Palaiyur	6
8.	Sembiyanmadevi	27	18	Pappakoil	11
9.	Sikkal	12	19	Thenkarai	94
10.	Themangalam	1	20	Vadugacheery	25

MAP:1, Location of soil samples of Nagapattinam taluk

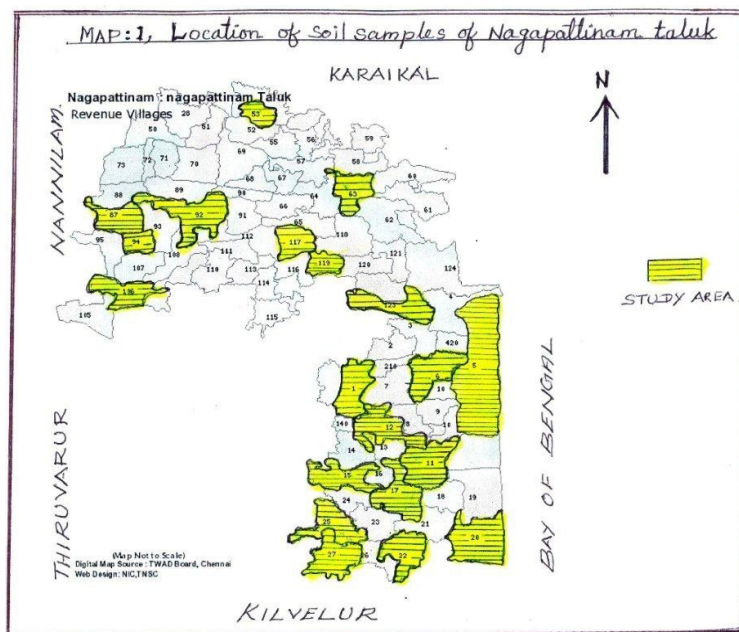**Table-2: Physico – chemical properties and nutrient status of soil characteristics**

Soil Characteristics	Range	Mean
pH	7.32 -8.75	7.9
EC	0.09-0.62dsm-1	0.331dsm-1
OC	0.20-0.42%	0.29%
OM	0.41-0.84%	0.60%

Available Micronutrients'	Range (mg.kg-1)	Mean (mg.kg-1)	Deficient (%)	Marginal (%)	Sufficient (%)
Fe	4.1-6.72	5.72	3	nil	97
Mn	2.04-2.72	2.36	100	nil	nil
Cu	0.20-1.15	0.708	45	nil	55
Zn	0.28- 0.90	0.58	47	53	nil

Table-3: Correlation matrix between soil properties and available nutrients

Soil Characteristics	Available Micronutrients			
	Fe	Mn	Cu	Zn
OC	0.42	same	-0.06	-0.033
pH	-1.10	-0.17	-0.47	0.3
EC	0.66	0.02	0.24	0.2