

Studies on the Status of Available Micronutrients for Plant Growth in Different Soil Series of Tiruchirapalli Region (Tamil Nadu)

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In the ten soil series of paddy cultivation in Tiruchirapalli District of Tamil Nadu, the salinity, sodicity level and the available micronutrients have been studied. Some soil series are classified as sodic and they are free from salinity hazard. Most of the soil series contain lesser available micronutrients other than copper. The ratio between iron and other micronutrients has been worked out.

INTRODUCTION

Among the essential requirements for plant growth, minerals assume greater significance. Plant physiology has recognised sixteen elements as essential for plant growth. They are grouped into macro and micronutrients. A knowledge of the available nutrients becomes essential for identifying the need otherwise for supplementing as fertilizers carrying the concerned nutrients. The deficiency or the excess presence of the micronutrients such as iron, manganese, zinc and copper may produce synergetic and antagonistic effects in the plants.^{1,2} The heterogeneous soil is classified based on the physical, chemical and biological properties. In Tiruchirapalli district nearly 34 soils have been identified and among them paddy is cultivated in nearly 10 soil series. The present study deals with the measurements of the pH, electrical conductance and the estimation of the available iron, zinc, manganese and copper in different soil types.

EXPERIMENTAL

Samples were collected from the major soil series of Tiruchirappalli region. The name of the series and the total area of distribution are presented in Table-1. The pH and the electrical conductivity of the soil were determined with 1 : 2 soil-water suspension (Instruments, Elico Pvt. Ltd., PE-132). The diethylene triamine pentaacetic acid (DTPA) extract was prepared and the available micronutrients, iron, manganese, zinc and copper were estimated for different soils using atomic absorption spectrophotometer (Varian Techtron).³ The DTPA extract was fed into the atomic absorption spectrophotometer and estimated at the following wavelength regions:

Iron: 248.3 nm; Manganese: 279.5 nm
 Zinc: 213.8 nm; Copper: 324.7 nm

TABLE-1
 NAME OF THE SOIL SERIES AND THE AREA OF DISTRIBUTION

S. No.	Series name	Total area (ha)
1.	Mangaripatti	8654
2.	Padalur	11036
3.	Puvalur	11460
4.	Thulukkanur	17246
5.	Palaviduthi	34302
6.	Pilamedu	7571
7.	Irugur	83454
8.	Madukkur	21547
9.	Omandur	803
10.	Alluvial	28605

All the chemicals used were of AnalaR Grade. Triple distilled water was used for solution preparation.

RESULTS AND DISCUSSION

The experimental results are presented in Table-2. Soils with pH greater than 8.5 are generally called as sodic soils. The decrease in pH (< 6.0) may lead to the dissolution of carbonates and hydroxides and to an increased desorption of metal cations. For the analysed samples, the pH is found to vary from 7.00 to 8.35 and hence all the soil series may be considered as free from sodicity hazard. However, Mangaraipatti and Alluvial series are associated with relatively higher pH. The increase in pH could be due to the increased amount of carbonates and biocarbonates.

Conductivity is a measure of the total concentration of the ionized substances. The mobility of ions, their valencies and their actual and relative concentrations affect conductivity.⁴ The electrical conductances are in the range of 0.39 to 1.49 mMho per cm as against the critical limit of 4 mMho per cm for saline salts. Thus all the soil series can be considered as free from salinity hazard.

Iron is one of the most important micronutrients for plants and it is present as complexes in plant tissues.⁵ The soil containing 7% of CaCO₃ is generally poor in iron content. The black soils of Tamil Nadu are rich in total iron and the available forms of iron have a decreasing tendency with depth. The status of available iron varies from 0.38 to 7.62 ppm (critical limit 2.00 ppm). Thus six of the ten series can be grouped as iron-deficient soils and iron fertilization is warranted for good growth of crops.

TABLE-2
pH, ELECTRICAL CONDUCTIVITY AND THE STATUS OF AVAILABLE
MICRONUTRIENTS IN SOME SOIL SERIES OF TIRUCHIRAPALLI REGION

S. No.	Name of soil series	pH	EC (mMho)	Available micronutrients (ppm)			
				Iron	Zinc	Manganese	Copper
1.	Mangaripatti	8.35	0.66	4.36	1.10	4.52	9.98
2.	Padalur	8.20	0.68	1.96	1.12	1.56	1.76
3.	Thulukkanur	8.25	0.39	1.30	0.54	1.78	1.92
4.	Puvalur	7.30	1.49	3.68	0.80	1.66	4.18
5.	Palaviduthi	8.05	1.00	1.02	0.76	1.84	5.08
6.	Pilamedu	7.95	0.68	0.38	0.76	2.58	1.02
7.	Irugur	8.00	0.59	1.96	0.76	3.68	3.62
8.	Madukkur	7.00	1.10	6.68	0.98	1.30	4.82
9.	Ommandur	8.15	0.95	0.64	0.92	2.14	4.10
10.	Alluvial	8.30	0.71	7.62	1.60	2.22	5.38

Zinc deficiency leads to widespread nutritional disorder in various crops. The available zinc supply to the plant may be diluted by the increased concentration of phosphorus.⁶ The available zinc for the plants is found to vary from 0.54 to 1.60 ppm (critical limit 0.80 to 1.00 ppm). The soils of Mangaripatti, Padalur and Alluvial series are found to contain excess zinc. It must be diluted by adding phosphatic fertilizer for the increased uptake by the plant roots.⁷ Since the other soil series have low zinc content, they need zinc fertilization for the growth of crops and better yield. Application of zinc significantly decreases the available iron content and *vice versa*.⁸ Available potassium is more at low levels of zinc and at higher levels, zinc has an antagonistic effect on potassium availability.

Manganese is essential to all organisms. Its deficiency leads to infertility. It is responsible for the production of molecular oxygen in plants during photosynthesis.⁹ Increased amount of manganese in the soil increases the concentration of calcium, magnesium and potassium in the saturation extract of podzol soil under low pH. However, application of manganese is not influencing the availability of the macronutrients nitrogen, phosphorus, potassium, calcium and magnesium in the black, red and laterite soil groups. The water soluble and exchangeable manganese in soils are directly proportional to the level of applied manganese. By experiment, it is observed that the available manganese varies from 1.30 and 4.32 ppm for different soil series (critical limit 2.00 ppm). The soils of Mangaripatti, Pilamedu, Irugur, Ommandur and Alluvial series are richer in manganese. For other five series manganese fertilization is essential. Application of ferrous salts to the soil increases the exchangeable and water-soluble manganese. Similarly application of zinc increases the availability of manganese to the plant from the soil.

The status of available copper for different soil samples are in the range 1.02 to 9.98 ppm (critical limit 1.0 ppm). The result shows that all the samples are rich in available copper. Since it is very toxic to the plants it may produce

synergetic and antagonistic effects. The germination percentage of the seeds gradually decreases with the increase of copper concentration.¹⁰ The morphological parameters also show a decreasing trend with increase of copper content in soil. The low critical value (1.0 ppm) for copper may be due to its incorporation in living systems when the atmosphere shifts from reducing to oxidising state.¹¹

Excess concentration of heavy metals is lethal to the plants.¹² In the physiology of plants the relative amounts of iron, manganese and zinc present are essential for photosynthesis and biochemical reactions. Hence the relative availability of the micronutrients is examined (Table-3). The Fe/Zn ratio varies from 0.500 to as high a value as 6.816. While the lower ratio affects the availability of iron to the plants, the higher ratio produces the mutual antagonistic effect of iron and zinc. The Fe/Mn ratio varies from 0.964 to 5.138. If the ratio is greater than 2.00 severe antagonistic effect will be observed and it is the case for the Puvalur, Madukkur and Alluvial soil series.

TABLE-3
RELATION OF IRON TO OTHER MICRONUTRIENTS

S. No.	Name of soil series	Iron : Zinc	Iron : Manganese	Iron : Copper
1.	Mangaripatti	3.964	0.964	0.437
2.	Padalur	1.750	1.256	1.114
3.	Thulukkanur	2.407	0.730	0.677
4.	Puvalur	4.600	2.216	0.880
5.	Palaviduthi	1.342	0.554	0.201
6.	Pilamedu	0.500	0.148	0.373
7.	Irugur	2.578	0.532	0.541
8.	Madukkur	6.816	5.138	1.386
9.	Ommandur	0.965	0.299	0.156
10.	Alluvial	4.762	3.432	1.416

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