The Andhra Agric. J 55(6):59-62, 2009

Micro Nutrient Status of Some Rice Soils of Andhra Pradesh in Relation to Soil Properties

K Laxminarayana and V Rajagopal
Department of Soil Science and Agricultural Chemistry, College Agriculture,Rajendranagar, Hyderabad-30, Andhra Pradesh, India

ABSTRACT

The physicochemical properties and status of micro nutrients in the intensively rice growing soils representing from eight districts of Andhra Pradesh under Krishna-Godavari zone, Nagarjuna Sagar project area and Telangana region were assessed. The relationship between various soil properties and available micro nutrients was studied for better manipulation and to obtain sustainable crop yields of rice. The results of the study revealed that the soils varied widely in texture (scl to c), neutral to slightly alkaline (pH 6.35 - 8.22), non saline (EC 0.14 - 2.23 dS m^{-1}) having low to high in org. C (0.46-1.17%), 220-418, 8.38-18.68 and 114-373 kg/ha of available N, P and K, respectively. It was observed that Zn deficiency is severe in all the districts of the study, whereas other micro nutrients (Fe, Mn and Cu) were above the critical limits. The available micro nutrients showed significantly negative relationship with pH and sand fraction and significantly positive relationship with clay, organic carbon content of the soil. It was found that the soil pH and organic carbon were the major contributing factors towards the availability of various micronutrients and hence, maintenance of organic matter and pH of the soil is essential to sustain the soil fertility and to enhance the crop productivity.

Key words : Micro nutrients, Rice, Soil properties

Rice is the major staple food crop in Andhra Pradesh, occupies 2/3 of the cultivated area with a production of >10.0 Mt, ranks second in total fertilizer consumption (2.174 Mt) and consumption per unit gross cropped area (179 kg ha^{-1}), according to the estimates of 2000-01 (FAI, 2001). It is extensively cultivated in the *Krishna - Godavari* Zone, *Nagarjuna Sagar* Project area and other coastal districts under rice-rice cropping sequence. Imbalanced use of fertilizers and intensive cropping led to deficiency of micro nutrients, which limits the crop productivity. In the present investigation, status of micro nutrients in rice soils of Andhra Pradesh was assessed and their relationship with soil physico-chemical properties was established for sustenance of soil quality.

MATERIAL AND METHODS

A total of thirty two bulk soil samples (0.3 m depth) were collected from intensively rice growing soils (rice-rice cropping sequence) representing from eight districts of Andhra Pradesh *viz.,* West Godavari (6), East Godavari (5), Krishna (3), Guntur (3), Srikakulam (5), Rangareddy (3), Nalgonda (4) and Nellore (3). The soils were shade dried, processed and analyzed for physico-chemical properties by following standard methods as outlined by Jackson (1973). The available micro nutrients (Zn, Fe, Mn and Cu) were estimated in the DTPA extract using Varian Techtran model of Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978). Simple linear correlation coefficients between available micro nutrients and soil properties were computed. Stepwise regression equations were computed to establish the relationship between micro nutrients and soil properties.

RESULTS AND DISCUSSION

Physico-chemical properties

The soils had wide variation in texture from sandy clay loam to clay and belong to Vertisols, Entisols, Alfisols and Inceptisols and the soils classified into clayey (13), clay loam (14), loam (3), silty clay loam (1) and sandy clay loam (1). The clay content in these soils varied from 17.5-47.5 percent, while the silt content varied from 7.5-27.5 percent. The soils from East Godavari, West Godavari, Krishna, Guntur and Rangareddy were heavy in texture and the soils from Srikakulam, Nalgonda and Nellore were found to be light textured. These results are in accordance with the findings of Adinarayana *et al.* (1984). The pH of the soils varied from 6.4 - 8.2. Majority of the soils were neutral in reaction and only one soil had a pH of > 8.0.

Table 1. Available micronutrient status of rice soils of Andhra Pradesh

Zone & No. of soils	District(s)	pH	EC (dS m^{-1})	Org. C (%)	Available micro nutrient (mg kg^{-1})			
					Zn	Fe	Mn	Cu
1 Krishna-Godavari Zone - 17	East Godavari West Godavari Krishna Guntur	6.5-7.7 (7.1)	0.19-2.23	0.67-1.17 (0.98)	0.39-1.84 (0.75)	4.7-62.8 (21.9)	6.3-47.8 (19.4)	1.32-2.86 (2.08)
2 Nagarjuna Sagar Project area - 4	Nalgonda	7.3-7.8 (7.6)	0.20-0.62 (0.31)	0.46-0.87 (0.69)	0.27-0.79 (0.46)	3.4-10.0 (8.0)	2.8-5.6 (4.2)	0.44-0.74 (0.54)
3 Coastal - 8	Srikakulam Nellore	6.4-7.8 (7.2)	0.14-1.03 (0.38)	0.53-1.05 (0.74)	0.39-2.32 (1.00)	9.3-62.9 (30.9)	5.1-14.7 (9.2)	0.64-1.59 (1.09)
4 Telangana - 3	Rangareddy	7.7-8.2 (7.9)	0.30-1.34 (0.71)	0.71-0.98 (0.80)	0.55-1.71 (1.32)	8.4-12.4 (10.8)	5.3-6.2 (5.7)	0.94-1.74 (1.23)

Figures in parentheses indicate the mean values

Electrical conductivity of the soils varied from 0.14 - 2.23 dS m^{-1}. The org. C content varied from 0.46 - 1.17 percent with a mean of 0.86 percent. The soils of West Godavari contain higher amount of org. C (1.02-1.17%), while it was lowest in the soils of Nalgonda. As per the ratings, 63 per cent soils of the study were high in org. C (> 0.75%), 34 percent soils were medium (0.5 - 0.75%) and the rest of the soils were low in org C. Similar findings for rice soils of Andhra Pradesh were reported by Hoang and Prasada Rao (1991). Total N content of the soils varied from 0.04 to 0.12 percent with a mean of 0.08 percent. The alluvial soils of *Krishna - Godavari* Zone contained highest total N, which was influenced by organic matter and clay content of the soils. The alluvial soils of *Krishna-Godavari* zone contained highest total N, which were influenced by organic matter and clay content of the soils (Venkatesu, 1993).

The initial NH_4-N ranged from 18 to 68 kg ha^{-1} with a mean of 41 kg ha^{-1}. The available N extracted by alkaline $KMnO_4$ ranged from 220 - 418 kg ha^{-1} with a mean of 317 kg ha^{-1}. Of all the soils, 84 percent recorded medium and the rest were low in available N content (< 250 kg ha^{-1}). The Olsen's extractable P in the soils ranged from 8.38 - 18.69 kg ha^{-1} with a mean of 12.79 kg P ha^{-1}. Of all the locations, 22 percent were found lower values of available P and the rest had medium in available P. The available K in the soils of the study ranged from 114 to 373 kg ha^{-1} with a mean of 208 kg K ha^{-1}. It was found that 40 percent soils had higher status and the rest were medium in available K.

Available micro nutrients

The DTPA-Zn content varied from 0.27 - 2.32 mg kg^{-1}, with a mean of 0.83 mg kg^{-1} (Table 1). Of all the soils, majority (72 % soils) were found deficient in available Zn and only nine locations showed higher than the critical limit of 0.80 mg kg^{-1}. The Zn deficiency in the soils of various regions was in the order of *Krishna Godavari* zone > *Nagarjuna Project* area > coastal area > Telangana region. In some of the soils the Zn level is as low as 0.27 mg kg^{-1} (*Nagarjuna Project* area), whereas in coastal districts it was found to be as high as 2.32 mg kg^{-1}. The available Fe content of these soils ranged from 3.4 - 62.9 mg kg^{-1} with a mean value of 21.4 mg kg^{-1}. Almost all the soils were found to be higher than the critical limit of 4.0 mg kg^{-1}. The available Mn content in these rice soils varied from 2.8 - 47.8 mg kg^{-1}, with a mean of 13.7 mg kg^{-1}. None of the soils found deficient in DTPA-Mn (< 2.0 mg kg^{-1}). The available Cu in these rice soils ranged from 0.44 - 2.86 mg kg^{-1} with a mean of 1.56 mg kg^{-1}. All the rice soils under the study were found to be higher than the critical limit of 0.2 mg kg^{-1}.

Relationship between available micronutrients and soil properties

The results in Table 2 revealed that the available Fe, Mn and Cu had significantly positive

Table 2. Linear correlation matrix (r) between available micro nutrients and soil properties

Micro nutrient	Sand	Silt	Clay	pH	Org. C	Eh
Zinc	0.05	-0.18	0.03	0.20	0.18	0.11
Iron	-0.01	-0.14	0.11	-0.41*	0.34*	0.25
Manganese	-0.47**	0.32*	0.45**	-0.67**	0.48**	0.41*
Copper	-0.78**	0.51**	0.77**	-0.36*	0.81**	0.73**

* and ** Significant at 5.0 and 1.0 per cent level, respectively

Table 3. Multiple regression equations indicating the relationship between available micro nutrients and soil properties

Dependable variable	Regression equation	R^2
1. DTPA-Zn	Y = –2.284 – 0.017 Clay + 0.307 pH + 0.717 Org. C + 0.002 Eh	0.366*
	Y = –1.924 – 0.012 Clay + 0.267 pH + 0.797 Org. C	0.359*
	Y = –1.640 + 0.269 pH + Org. C	0.290
	Y = 0.395 + 0.504 Org. C	0.181
2. DTPA-Fe	Y = 148.511** – 0.183 Clay – 22.420** pH + 50.631** Org. C + 0.173 Eh	0.512**
	Y = 151.778** – 22.856** pH + 48.672** Org. C + 0.158 Eh	0.510**
	Y = 107.539* – 15.145* pH + 27.225* Org. C	0.245
	Y = –7.006 + 32.806* Org. C	0.112
3. DTPA-Mn	Y = 107.216** + 0.469* Clay – 14.632** pH + 17.471* Org. C – 0.071 Eh	0.644**
	Y = 87.351** + 0.243 Clay – 12.937** pH + 13.654* Org. C	0.609**
	Y = 91.735** – 13.144** pH + 19.807** Org. C	0.590**
	Y = 118.175** – 14.429** pH	0.446**
4. DTPA-Cu	Y = 0.475 + 0.029* Clay – 0.249* pH + 1.678** Org. C + 0.004 Eh	0.808**
	Y = 1.179 + 0.037** Clay – 0.339** pH + 1.836** Org. C	0.795**
	Y = 1.848 – 0.371** pH + 2.776** Org. C	0.705**
	Y = – 0.959** + 2.913** Org. C	0.647**

* and ** Significant at 5 and 1 per cent level, respectively; R^2-Coefficient of multiple determination

relationship with org. C (r = 0.34*, 0.48** and 0.81**, respectively), which was probably due to organic matter acts as a store house for retention and transformation of various essential nutrients and influences their availability in the soil system. Significantly positive relationship was observed between available Mn and Cu with clay and silt and significantly negative relationship with sand content of the soils. However, the available micro nutrients showed significantly negative relationship with pH, except available Zn, which showed non significant relationship with pH of the soil. The redox potential had significant relationship with available Cu (r = 0.73**) and available Mn (r = 0.41*).

Stepwise regression analyses were done to assess the relative contribution of various soil physico-chemical properties on DTPA extractable micro nutrients and presented in Table 3. The clay, org. C and pH have contributed 36 % variation to the available Zn, whereas the org. C alone showed a variation of 18 % to the DTPA-Zn. However, clay, pH, org. C and redox potential accounted 51.2, 64.4 and 80.8 % observed variation to the available Fe, Mn and Cu, respectively. Organic carbon alone accounted for 11.2 % of observed variation to the DTPA-Fe and inclusion of pH and redox potential increased the R^2 value by another 39.8 % to the regression. In case of DTPA-Mn, pH alone accounted

for 44.6 % variation and inclusion of org. C showed a further increase of 14.4% variation to the regression and the contribution of other variables like clay and redox potential is negligible. Organic C alone accounted for 64.7 % variation to the DTPA-Cu and inclusion of pH showed an increase of 5.8 % variation to the regression and clay has further increased another 9 % variation to the regression. Thus, the results indicated that org. C and pH were the major soil properties contributed to the available micro nutrients in these rice soils.

In conclusion, the Zn deficiency was severe in the rice soils of *Krishna - Godavari* zone, *Nagarjuna Sagar project* area and other coastal districts of Andhra Pradesh, which warrants the regular application of $ZnSO_4$ @ 25 kg ha^{-1} along with balanced NPK fertilizers in order to sustain the rice yields. However, the occurrence of other micro nutrients (Fe, Mn and Cu) is well above the critical limits in these rice soils. Maintenance of organic matter level and pH of the soils is utmost important for transformation as well as availability of macro and micro nutrients and to produce sustainable crop yields.

LITERATURE CITED

Adinarayana V, Balaguravaiah D, Sreerama Murthy K and Subba Rao I V 1984. Characteristics and classification of coastal sandy soils of Bapatla from Andhra Pradesh. The Andhra Agricultural Journal 31(3): 184-191.

FAI 2001. *Fertiliser Statistics 2000-2001*, The Fertiliser Association of India, New Delhi, pp. 91-118.

Hoang P J and Prasada Rao A 1991. Paper presented at the symposium on Soil Potassium organized by the Indian Potash Ltd. at NAARM, Hyderabad.

Jackson M L 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Lindsay W L and Norvell W A 1978. Development of a DTPA soil test for zinc, iron, manganese and copper. *S*oil Science Society of America Proceedings 42(3): 421-428.

Venkatesu T 1993. Distribution and availability of cationic micronutrients in groundnut grown on sandy soils of Nellore district. M.Sc. (Ag) Thesis, Acharya N.G. Ranga Agricultural University, Hyderabad.

(Received on 23.02.2006 and revised on 09.06.2008)