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Nutrient Status of Rice (*Oryza sativa* L.) Growing Soils in Various Mandals of Nellore district in Andhra Pradesh

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ABSTRACT

A survey was undertaken to study the nutrient status of rice growing soils in various mandals of Nellore district in Andhra Pradesh. The analysis of the soils revealed that the texture of the soils varied from sandy clay loam to clay, neutral to strongly alkaline in reaction, non-saline, low to medium in organic carbon and available nitrogen and medium to high in available P and K. The available Ca, Mg, S, Fe, Mn and Cu were found to be above their respective critical limits in all the soils. However, 8.66 per cent samples were deficient in available Zn. Simple correlation studies revealed that N, P, K, Ca, Mg and S were positively and significantly correlated with organic carbon. Available K and Cu were positively and significantly correlated with soil pH while available P and Ca were negatively and significantly correlated with soil pH. However, available P was negatively and significantly correlated with clay content.

Key words : Rice soils, Macronutrients, Micronutrients.

Mineral nutrition has been recognized as an important constraint in crop production. Systematic and periodic identification of current nutrient deficiencies and sufficiencies is a prerequisite for sustaining the productivity and fertility of soils. Rice (*Oryza sativa* L.) is the most important and staple food crop for more than two thirds of the population. India has the largest area under rice (about 42.4 m.ha.) and with a production of about 90 million tonnes. In Andhra Pradesh rice occupies an area of 43.87 lakh hectares with the production of 142.10 lakh metric tones. Andhra Pradesh is surplus in rice grain production and can comfortably claim to be the granary of southern India. Rice-rice sequential cropping is an important cropping system in the rice growing areas of Nellore district.

As this system needs large amounts of nutrients to achieve high productivity, use of inorganic fertilizers and scarce use of organic manures year after year, has resulted in reduced crop yields. It is well recognized that inorganic fertilizers are not a complete substitute for organic manures and vice versa and their role is complementary (Swarup and Wanjari 2000). Keeping the above facts in view, the present investigation was taken up.

MATERIAL AND METHODS

The study area lies in between 13° 30' and 15° 60' of northern latitude and 70° 50' and 80° 15' of Eastern longitude comprising major rice growing mandals in Nellore district *viz.,* Buchireddypalem, Kovur, Indukurpet, Nellore rural and Alluru mandals.

Soil samples were collected from 60 rice-growing fields in the above mandals of Nellore district. From each field three soil samples were collected from a depth of 0-30 cm and the samples in each field were composited so as to obtain one composite sample from each field totaling to 60 samples. All the 60 soil samples were analysed for pH, Electrical Conductive , organic carbon and available K as per the standard procedures (Jackson, 1973). Available N was determined by alkaline permanganate method. The available P was extracted with 0.5M $NaHCO_3$ extractant and was determined by using ascorbic acid as reducing agent and the available K in the soils was extracted by employing neutral normal ammonium acetate and determined by aspirating the extract into the flame photometer (Jackson, 1973). Available Ca and Mg were determined by Versenate method (Chopra and Kanwar 1991) whereas available S was determined turbidimetrically using 0.15% $CaCl_2$ extractant (Cottenie *et al.,* 1979). DTPA exctractable Fe, Mn, Zn and Cu were determined as per Lindsay and Norvell (1978).

Soil samples were rated as low, medium and high categories as per the limit suggested by Muhr *et al.* (1965) for organic carbon, available N, P and K. Available Ca and Mg were classified based on the critical limits proposed by Tandon (1989) while available S was rated as per the critical limits

Table 1. Soil test summary - soil texture, pH, E. C and organic carbon (mean values) in rice grown soils.

Sl. No.	Mandal	Number of samples	Soil texture	PH (1:2.5)	E.C (dSm^{-1})	Organic carbon (%)
1.	Buchireddypalem	12	scl-sc	7.70	0.50	0.27
2.	Kovur	12	scl-c	7.83	0.52	0.50
3.	Nellore rural	12	scl-c	7.80	0.64	0.46
4.	Indukurpet	12	scl-c	7.60	0.50	0.38
5.	Alluru	12	scl-c	7.20	0.40	0.53

scl: sandy clay loam, sc: sandy clay, c: clay.

Table 2. Soil test summary for available N, P and K in rice grown soils.

Sl. No.	Mandal	Number of samples	Available N			Available P			Available K		
			Mean ($kg\ ha^{-1}$)	Nutrient index	Fertility status	Mean ($kg\ ha^{-1}$)	Nutrient Index	Fertility status	Mean ($kg\ ha^{-1}$)	Nutrient Index	Fertility status
1.	Buchireddypalem	12	165.94	1.00	L	30.76	2.75	H	223.98	2.25	H
2.	Kovur	12	312.29	1.58	L	28.65	3.00	H	396.13	2.83	H
3.	Nellore rural	12	317.52	1.67	M	27.14	2.58	H	506.58	.00	H
4.	Indukurpet	12	246.95	1.33	L	34.90	2.92	H	370.73	2.83	H
5.	Alluru	12	261.34	1.33	L	32.28	2.75	H	348.13	2.58	H

L : Low, M : Medium, H : High

Table 3. Soil test summary for available Ca, Mg, S, Fe, Mn, Zn and Cu.

Sl. No.	Mandal	Number of samples	Available secondary nutrients			Available micronutrients ($mg\ kg^{-1}$)			
			Ca (cmol (p+) kg^{-1})	Mg (cmol (p+) kg^{-1})	S ($mg\ kg^{-1}$)	Fe	Mn	Zn	Cu
1.	Buchireddypalem	12	6.82	1.94	23.75	24.65	10.18	0.89	1.58
2.	Kovur	12	8.02	2.09	29.16	23.87	12.24	1.07	1.56
3.	Nellore rural	12	8.15	2.48	32.10	22.98	7.95	0.99	1.68
4.	Indukurpet	12	9.13	2.36	24.95	20.09	10.60	0.96	1.42
5.	Alluru	12	9.36	2.22	33.64	21.87	8.21	1.00	1.51

Table 4. Correlation coefficients (r) between physical and physico-chemical characteristics of soil and available soil nutrients

	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu
Clay	0.082	-0.226*	0.478**	-0.032	0.084	0.180	0.105	-0.083	0.053	0.027
pH	-0.082	-0.295*	0.369**	-0.275*	-0.156	-0.006	0.023	0.005	-0.106	0.265*
E.C	0.128	-0.094	0.072	-0.044	0.025	0.258*	-0.159	0.006	-0.036	0.038
O.C	0.310*	0.303*	0.448**	0.325*	0.241*	0.332**	-0.114	-0.107	0.137	-0.005

** At 1% level of significance

* At 5% level of significance

established by Tandon (1991). In respect of available Fe, Mn, Zn and Cu, the ratings given by Lindsay and Norvell (1978) were followed. Nutrient Indices (N.I) for available N, P and K were worked out as per the formula given by Parkar *et al.* (1951). Simple correlation analysis was also carried out between soil physical and physico-chemical characteristics and available soil nutrients by adopting standard procedures.

RESULTS AND DISCUSSION

The soil texture in the rice growing soils varied from sandy clay loam to sandy clay in Buchireddypalem mandal where as texture ranged from sandy clay loam to clay in Kovur, Nellore rural , Indukurpet and Alluru mandals (Table 1). This variation in soil texture might be due to the variation in topographic position, nature of parent material, *in situ* weathering of clay and age of soils. Similar results were reported by Sampath Kumar and Sankar Reddy (2010) in rice grown soils of Nellore district. pH of the rice growing soils was varied from 7.20 to 7.83. The variation in pH might be attributed to the variation in nature of parent material and degree of weathering. Similar findings were reported by Leelavathi *et al.*, (2009). The soils were non-saline with EC values varying between 0.40 and 0.64 dSm^{-1}. The organic carbon content in these soils ranged from 0.27 to 0.53 per cent. The low organic carbon content in these soils might be due to rapid oxidation of organic matter, as the climate of the area is tropical. These findings were in good agreement with the findings of Laxminarayana (2009).

Available N, P, K, Ca, Mg and S

The rice growing soils were low to medium in available N with overall nutrient index values ranging from 1.00 to 1.67 while available P and K were medium to high with overall nutrient index values varying from 2.58 to 3.00 and 2.25 to 3.00, respectively (Table 2). The low available nitrogen status of these soils might be attributed to low organic carbon content. Further, the semi-arid conditions of the area might have favoured the rapid oxidation and less accumulation of organic matter releasing more NO_3-N which could have been last by leaching (Finck and Venkateswarlu, 1982). Medium to high availability of P in these soils may be due to the continuous use of phosphatic fertilizers like single super phosphate by the farmers in these areas. The higher values of K could be attributed to more intense weathering, release of K from organic residues, application of K fertilizers and upward translocation of potassium from lower depth along the capillary raise of ground water. These findings were in agreement with the findings of Vara Prasad Rao *et al.,* (2008).

Available Ca (6.82 to 9.36 cmol (p+) kg^{-1} soil), Mg (1.94 to 2.48 cmol (p+) kg^{-1} soil) and S (23.75 to 33.64 mg kg^{-1}) in these rice growing soils were found to be above their respective critical limits (Table 3). The higher sulphur content in these soils might be due to the continuous application of fertilizers like single super phosphate. Similar findings were reported by Suda and Chandini (2005).

Available Fe, Mn, Zn and Cu

DTPA extractable Fe, Mn, Zn and Cu in rice growing soils ranged from 20.09 to 24.65, 7.95 to 12.24, 0.89 to 1.07 and 1.42 to 1.68 mg kg^{-1} soil, respectively (Table 3). All the available micronutrients except Zn were above their respective critical limits. However, 8.66 percent of the samples were deficient in available Zn. The lower Zn values obtained in the study area might be due to the presence of medium to heavy textured soils like sandy clay loams and clays in which fixation of Zn occurred in the octahedral layers substituting for magnesium (Elgabaly, 1950). Similar observations were in agreement with findings of Lakshminarayana and Rajagopal (2004) in rice growing soils of Andhra Pradesh.

Correlation studies

Simple correlations were worked out between various soil characteristics and available soil nutrients and the correlation coefficients were presented in Table 4. Available N, P, K, Ca, Mg and S were positively and significantly correlated with organic carbon while available P was negatively and significantly correlated, with clay content of the soil (Table 4). The positive association of most of the available nutrients with organic carbon might be due to the fact that the latter was the primary reservoirs of the former. However, the negative relation between available P and clay content might be due to the fixation of applied P (Baljit Sing *et al.,*2001). Available K and Cu were positively and significantly correlated with soil pH while available P and Ca were negatively and significantly correlated with soil pH (Table 4). Available S were positively and significantly correlated with EC of the soil (Table 4). Similar findings were reported by Yadav and Alok Kumar (2009).

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