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DISTRIBUTION OF DTPA EXTRACTABLE MICRONUTRIENT CATIONS IN SOILS OF NALGONDA DISTRICT OF ANDHRA PRADESH

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ABSTRACT

Distribution of DTPA extractable micronutrients and their relationship with soil properties were studied in soils of Nalgonda district of Andhra Pradesh. The DTPA- Zn, Cu, Fe and Mn ranged from 0.06 to 1.30, 0.23 to 7.90, 1.80 to 14.60 and 2.13 to 22.00 mg kg^{-1} with mean values of 0.57, 1.59, 6.26 and 9.22 mg kg^{-1} respectively. Soil pH, calcium carbonate, organic carbon and particle-size fractions had strong influence on the distribution of these micronutrients. The content of micronutrient increased with the increase in organic carbon and decreased with increase in pH and $CaCO_3$. There was a decreasing trend for the distribution of these micronutrients with respect to depth. About 58 % and 29% of the soils could be rated as deficient in available zinc and iron respectively. Copper and manganese were found to be adequate in these soils.

Key words: DTPA extractable micronutrients, Soil properties, Nalgonda, Andhra Pradesh

INTRODUCTION

Micronutrients are important for maintaining soil health and also increasing productivity of crops as they play the vital roles in plant metabolism. These are needed in very small amounts. The deficiencies of micronutrients have become major constraints to productivity, stability and sustainability of soils. Availability of micronutrients is influenced by their distribution in soil and other physio-chemical properties of soil. 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 (Bhanwaria *et al.* 2011). The knowledge of vertical distribution of micronutrient cations in soils provides an idea of the inherent capacity of soils to supply the nutrients from lower horizons. Studies were conducted by different researchers (Thakur *et al*., 2011) on the distribution of the micronutrient cations in different soils and their relationship with soil properties. However, information in this regard for the soils of Nalgonda district, Andhra Pradesh is scanty and therefore, an attempt has been made to assess the micronutrient status in these soils and their relationship with some important soil properties.

MATERIALS AND METHODS

The study area is covered by igneous and metamorphic rocks. North western plateau and interior rugged plains form the Telangana region in Andhra Pradesh. Climatically, Nalgonda district falls under semi-arid tropics with an annual rainfall of around 789 mm. The moisture regime in the study area is Ustic and soil temperature class is isohyperthermic. The crops grown in the study area are rice, maize, sorghum, cotton, black gram, green gram and red gram. Forty five soil samples from ten pedons were collected from Nalgonda district of Andhra Pradesh. The processed soil samples were analyzed for pH, organic carbon (Walkley and Black, 1934), calcium carbonate (Piper, 1966) and particle-size distribution (Piper, 1966). The available micronutrient cations were extracted with DTPA extractant (Lindsay and Norvell 1978) and determined with atomic absorption spectrophotometer. Simple correlations were calculated between DTPA-extractable micronutrient cations and soil properties.

RESULTS AND DISCUSSION

In general, the soils were slightly acidic to slightly alkaline and pH ranged from 6.1 to 8.2. Organic carbon content was low to high (0.4 - 9.3 g kg^{-1}) with a mean of 4.5 g kg^{-1} and decreased with depth. Some soils are calcareous and calcium carbonate content varied from 1.0 to 259.0 g kg^{-1} in different horizons (Table 1) with a mean of 70.1 g kg^{-1}. The soils were loamy sand to clay in texture with clay content ranging from 8.7 to 60.3 %.

Available zinc

DTPA-extractable zinc in soils of Nalgonda district varied from 0.06 to 1.30 mg kg^{-1} with a mean value of 0.57 mg kg^{-1}, highest was present in surface horizon of Nandipadu pedon and lowest in bottom layer of Kukadam pedon (Table 1). Twenty six samples are deficient in zinc, as per critical limit of 0.6 mg kg^{-1} (Katyal, 1985). Zinc deficiency was not

Table1: Some physico-chemical properties of the soils and DTPA-extractable micronutrient cations (mg kg^{-1}) in soils of Nalgonda district

P.No. and location	Horizon	Depth (cm)	pH (1:2.5)	Organic carbon (g kg^{-1})	$CaCO_3$ (g kg^{-1})	Texture	Zn	Cu	F e	M n
Thummada	Ap	0-8	6.10	3.70	1.0	LS	1.02	1.74	7.20	9.10
	Cr	8-45+	6.60	2.80	1.0	LS	0.81	1.48	6.10	7.10
Nandipadu	Ap	0-10	7.70	5.70	259.0	C	1.30	7.90	5.20	5.94
	Cr	10-55+	7.68	3.80	243.0	C	0.90	6.80	4.10	3.84
Dugapalli	A	0-25	7.38	5.60	59.0	SCL	0.32	0.49	6.20	14.80
	AC	25-75+	7.78	3.00	66.0	SCL	0.26	0.44	5.80	12.14
Kukadam	Ap	0-11	7.00	2.40	1.0	SL	0.38	1.58	6.10	14.64
	AB	11-19	7.10	1.65	1.0	SL	0.24	1.38	5.22	16.64
	Bw1	19-45	7.10	1.65	2.5	SCL	0.18	1.37	4.74	12.90
	Bt1	45-70	7.20	1.65	1.2	SCL	0.12	1.33	4.28	10.72
	Bt2	70-90	7.20	1.25	5.0	SCL	0.08	1.30	4.26	7.26
	C	90+	7.70	1.09	4.0	SL	0.06	1.27	3.96	6.57
Topcherla	Ap	0-23	6.31	5.20	1.2	SL	0.99	0.54	5.54	9.30
	AB	23-51	6.38	3.30	1.3	SL	0.96	0.45	5.38	8.70
	Bt1	51-66	6.41	2.90	1.1	SCL	0.82	0.36	4.98	7.17
	Bt2	66-110	7.42	2.70	1.4	SCL	0.71	0.23	4.66	7.82
Regulagada	Ap	0-20	7.50	7.00	70.0	C	0.46	1.28	4.00	22.00
	Bw1	20-64	7.50	4.10	84.0	C	0.42	1.24	4.00	19.00
	Bw2	64-90	7.60	3.70	138.0	C	0.27	0.81	3.10	12.10
	Ck	90+	8.00	1.90	249.0	C	0.19	0.64	1.80	8.70
J. P. Gudam	Ap	0-10	7.80	7.80	237.5	Cl	0.68	0.57	3.42	2.87
	Bw	10-28	8.10	4.50	241.3	C	0.30	0.46	3.11	2.84
	BCk	28+	8.20	0.40	243.8	C	0.23	0.20	1.88	2.13
Vemulapalli	Ap	0-12	7.18	7.90	38.0	SC	1.28	3.90	10.90	10.06
	Bw1	12-40	7.40	6.00	42.0	SC	1.23	2.60	9.62	9.22
	Bw2	40-66	7.42	2.80	52.0	SC	0.86	1.76	7.21	7.18
	BC	66-87	7.61	1.40	63.0	SC	0.79	1.72	6.08	7.05
	C	87-110	7.64	1.50	33.0	SC	0.48	0.98	2.00	3.20
T. R. Gudam	Ap	0-20	7.50	6.20	59.0	SCL	0.53	2.30	14.60	8.92
	Bw1	20-45	7.40	5.80	66.0	SCL	0.52	1.86	14.00	8.80
	Bw2	45-80	7.48	5.00	85.0	SCL	0.47	0.62	11.20	8.40
	BC	80-100	7.12	4.10	90.0	SCL	0.33	0.45	11.80	8.10
	C	100+	7.40	3.80	112.0	SCL	0.2	0.31	7.60	6.20
Molkacherla	Ap	0-18	6.66	9.30	6.2	C	1.10	3.50	9.10	15.90
	Bw	18-36	6.89	8.30	7.4	C	0.90	3.20	8.10	13.70
	Bwss1	36-51	7.32	6.80	8.0	C	1.00	2.00	6.20	8.10
	Bwss2	51-85+	7.67	5.60	8.0	C	0.60	1.30	8.80	5.40
Wadapalli	Ap	0-24	7.80	9.10	16.0	C	0.44	0.72	5.20	9.40
	Bw	24-42	7.91	7.60	18.0	C	0.36	0.56	4.60	6.50
	Bss	42-89	8.00	6.10	18.0	C	0.35	0.42	6.20	9.20
	C	89-120	8.10	5.60	28.0	C	0.36	0.30	4.50	7.40
Devulapalli	Ap	0-18	7.80	8.80	88.0	C	0.87	3.90	10.90	14.80
	Bw1	18-54	8.00	6.10	104.0	C	0.63	2.80	9.80	12.30
	Bw2	54-100	8.00	5.20	141.0	C	0.35	1.80	6.20	7.80
	BCk	100-140	7.90	2.10	161.0	C	0.25	0.90	2.10	3.10

observed in soil samples of pedons Thummadam, Nandipadu, Topcherla, Vemulapalli and Molkacherla, whereas the pedons Dugapalli, Kukadam, Regulagada, T R gudam and Wadapalli showed deficiency of zinc. Decrease in Zn content from upper layer to bottom layer except in Wadapalli and Molkacherla. Lower content of zinc in black soils is due to its fixation by clay or due to high pH values which have resulted in the formation of insoluble compounds of zinc (Tandon, 1995). Available Zn content was significantly and negatively correlated (r = -0.0864) with calcium carbonate. Sand had negative correlation (r = -0.04) but organic carbon (r = 0.45), silt (r = 0.15) and clay (r = 0.01) had positive influence on DTPA-Zn (Table 2). The results of the present investigation were in close agreement with the findings of Bhanwari *et al.* (2011) who reported that the available Zn increased significantly with increase in clay, organic carbon, silt and availability of Zn decreases significantly with an increase in calcium carbonate, pH and sand content.

Available copper

DTPA extractable Cu content in these soils ranged from 0.23 to 7.90 mg kg^{-1} with a mean value of 1.67 mg kg^{-1}, highest was present in surface horizon of Nandipadu pedon and lowest in bottom layer of Topcherla pedon(Table 1). Decease in Cu content from upper layer to bottom layer in all the twelve pedons. The available copper was more in surface layers and decreased with depth, which might be due to its association with organic carbon affecting its availability in surface layers. Similar observations were made by Thakur *et al*. (2011). Considering the critical limit of 0.2 mg kg^{-1} for Cu for normal plant growth (Katyal and Randhawa 1983), the soils are rated adequate in available Cu. Soil pH and $CaCO_3$ content had negative correlation with copper but organic carbon and had significant and positive relation with Cu (Table 2). These findings are in agreement with Ram and Mukhopadhyay (2011).

Available iron

DTPA extractable Fe content in these soils varied between 1.80 to 14.60 mg kg^{-1} with a mean of 6.26 mg kg^{-1}. Highest values were recorded in surface horizon of T R gudam pedon (14.60 mg kg^{-1}) while lowest values were recorded in bottom layer of Regulagada pedon (1.80 mg kg^{-1}) (Table 1). All the pedons had shown decreasing trend with increasing depth. It might be due to accumulation of humic material in the surface layers besides prevalence of reduced conditions in sub-surface layers. The organic carbon due it its affinity to Fe, influences its solubility and availability by chelation which protects Fe from oxidation and precipitation which consequently increased the availability of iron (Kumar *et al*. 2011). Considering the critical limit of 4.5 mg kg^{-1} for Fe (Lindsay and Norvell 1978), the 29 per cent of the soils are rated deficient in available Fe. Available Fe content was significantly and positively correlated (r = 0.4680) with organic carbon, clay (r = 0.20) and silt (r = 0.05) and negatively correlated with pH (r = -0.20) and calcium carbonate (Table 2). These findings are in agreement with Satyavathi and Reddy (2004).

Table 2: Correlation between soil properties and available micronutrients

Soil characteristics	DTPA Zn	DTPA Cu	DTPA Fe	DTPA Mn
Sand	-0.04	-0.276	-0.144	-0.03
Silt	0.15	0.252	0.05	0.122
Clay	0.01	0.23	0.20	0.119
$CaCO_3$	-0.08	-0.27	-0.26	-0.374
Organic carbon	0.45	0.29	0.46	0.271
pH	-0.42	-0.003	-0.206	-0.265

Available manganese

DTPA extractable Mn content was varied from 2.13 to 22.00 mg kg^{-1} in different horizons with a mean of 9.2 mg kg^{-1}. Highest values were recorded in surface horizon of Regulagada pedon (22.00 mg kg^{-1}). While lowest value was recorded in bottom layer of Jappathiveerapagudam pedon (2.13 mg kg^{-1}) (Table 1). All the pedons had shown decreasing trend with depth except Kukadam, Topcherla and Wadapalli. Available Mn was decreased with depth was also reported by Kumar *et al*. (2011). Considering the critical limit of 1 mg kg^{-1} for manganese. All samples are deficient in Mn. Available Mn content was significantly and positively correlated with organic carbon (r= 0.2714) and clay (r= 0.119) and negatively correlated with calcium carbonate (r = -0.374), pH (r = - 0.265) (Table 2). The results of the present investigation were in close agreement with the findings of Ram and Mukhopadhyay (2011). In general, calcium carbonate decreased the availabilities of micronutrients owing to their insoluble hydroxides at higher pH (Sahoo *et al*., 1995). Contrary to it, organic carbon had positive influence on DTPA-micronutrients due to complexation (Thampatti and Jose 2006).

Conclusions

These observations point out those 58 and 29% soil samples of Nalgonda district of Andhra Pradesh are deficient in DTPA- Zn and Fe respectively and need zinc fertilization for sustainable crop production. Higher amounts of these micronutrient cations were found in surface layers. The soil properties had a definite influence on their availability.

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