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Studies on micronutrient status in soils of Kavali revenue division of Nellore district, Andhra Pradesh, India

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ABSTRACT

The DTPA-extractable micronutrient cations Zn, Fe, Cu, Mn and their relationship with different soil properties were studied in 100 surface (0-20 cm) and 100 sub-surface (20-40 cm) soil samples of Kavali revenue division of Nellore district, Andhra Pradesh, India. Zn, Fe, Cu and Mn showed a decreased trend with depth and micronutrients showed positive relationship with organic carbon but inversely correlated with soil reaction.

Key words: DTPA- extractable micronutrients, correlation, soil properties

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INTRODUCTION

The stagnation in crop productivity has been found due to deficiency of some micro and secondary nutrients. Hence, micronutrients have assumed increasing importance in crop production under modern agricultural technology. Enhanced removal of micronutrients as a consequence of adoption of high yielding varieties and intensive cropping together with a shift towards high analysis NPK fertilizers and limited use of organic manures as well as recycling of crop residues are some important factors having contributed towards accelerated exhaustion of micronutrients from soil. The availability of micronutrients to plants is influenced by their distribution within the soil profile and other soil characteristics. Knowledge of vertical distribution of micronutrient cations in soil is helpful to understand the inherent capacity of soil to supply these nutrients to plants and their downward movement in soil.

EXPERIMENTAL SECTION

A total of 200 soil samples at two different depths (0-20 and 20-40 cm) were collected from 18 mandals of Kavali revenue division of Nellore district. The study area comprises 41.2 ha with and located in between $14^0$55'- $14^0$92' N latitude and $79^0$59'- $79^0$98' E longitude. The coordinates of the sampling locations were recorded using GPS (Global Positioning System).The soils of Nellore district belong to varied textural classes ranging from sandy to sandy clay loams and majority being red soils. Fig 1 shows IRS-P6 LISS III image of Kavali revenue division. The soil samples were analyzed for pH, ECe, organic carbon using standard procedures [2]. The available Zn, Fe, Cu and Mn were extracted with DTPA solution [3] were determined using Atomic Absorption Spectrophotometer (AAS). Simple correlation coefficients were computed relating micronutrient content with different soil properties of the experimental soils by adopting standard statistical procedures.

RESULTS AND DISCUSSION

The soils were strongly acidic to strongly alkaline in (4.81 to10.41) reaction. The ECe of samples ranged from 0.15 to 37.20 dS m^{-1} indicating the soils varied from non-saline to very strongly saline. The $CaCO_3$ content increased with depth, which indicates the process of leaching of calcium and subsequent precipitation as carbonates at a lower depth. In this paper, the results and discussion were performed for available iron, available zinc, available manganese, and available copper.

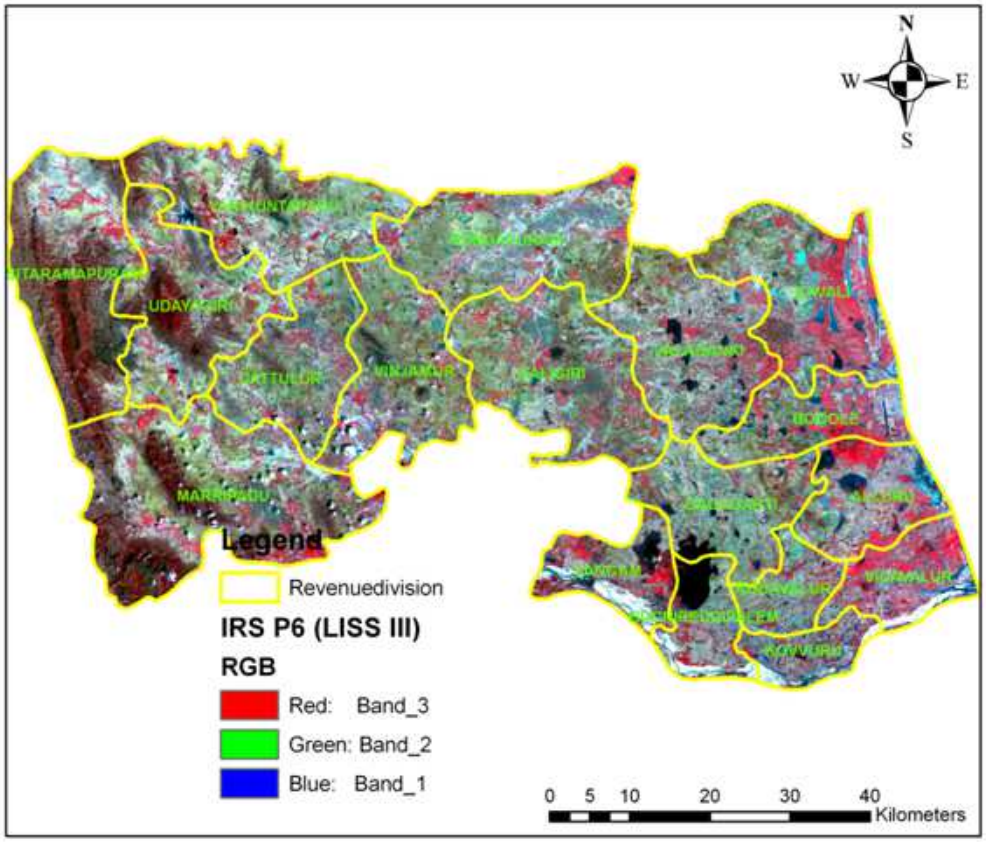

Fig. 1: IRS-P6 LISS III FCC image of Kavali revenue division

3.1. AVAILABLE IRON

Most of the soils of Kavali division were found to be sufficient in available iron content. The data pertaining to the available iron content of the soil samples (surface and subsurface) of each mandal along with mean, range and their distribution were presented in Table 1.

The available iron content of surface soil samples varied from 1.86 to 466.4 ppm with a mean value of 49.14 ppm. As per the critical limit 4.5 ppm suggested by Lindsay and Norvell, 97 % of samples were found above critical limit (>4.5 ppm) and only 3 % samples were below critical limit (>4.5 ppm).

The available iron content of sub-surface soil samples ranged from 3.73 to 343.4 ppm with a mean value of 42.71 ppm. Out of 100 sub-surface samples analyzed, 96 samples were above critical limit and only 4 samples were below critical limit. The surface soil samples have high available iron content compared to sub-surface soil samples. 97 and 96 % of surface and sub-surface samples were above critical limit in available iron content, respectively.

The variation in the available iron content among soils was found to be related to the variation in the soil reaction. The present study had shown significant negative correlation between available iron content and soil reaction (r = -0.616**) (Table 5). The relative low available iron in sub-surface might be due to the precipitation of iron in the

form of insoluble iron compounds caused by increasing alkalinity [10, 11]. The available iron content was decreased with increase in depth. This behavior was similar to the distribution pattern of organic carbon at various depths and showed significant correlation (r = 0.548**). The availability of metal ions increased with increase in organic matter content because organic matter may supply chelating agents [4].

3.2. AVAILABLE ZINC

The surface soils of Kavali division were found to be sufficient in zinc but relatively deficient in the sub-surface soils. The minimum and maximum available zinc content of soil samples (surface and subsurface) of each mandal along with mean, range and their distribution were presented in Table 2.

The average available zinc content of surface soil samples ranged from 0.14 to 5.77 ppm with a mean value of 1.16 ppm. 48 % of surface samples were found below critical limit, while 52 % of samples were found above critical limit. As per the suggestion given by Lindsay and Norvell, the distribution of the soils with regard to the critical limit of zinc was 0.8 ppm.

The available zinc content of sub-surface soil samples ranged from 0.02 to 4.91 ppm with a mean value of 0.80 ppm. 67 % of samples were found below critical limit and 33 % of samples were found above critical limit. Surface soil samples have higher (mean 1.16 ppm) concentration of available zinc as compared with sub-surface soil samples (mean 0.80 ppm). On the whole, 48 % of surface and 67 % of sub-surface soil samples were below critical limit. Zn metal ions have tendency to precipitate as hydroxides and carbonates under alkaline pH range. Therefore, their solubility and mobility will decrease resulting in reduced availability of zinc [8, 9].

A decreasing trend with depth was observed due to decrease in organic content and increase in $CaCO_3$ and pH [6]. The decreasing trend with depth might be due to the low organic matter in the sub-surface which showed a positive correlation (r = 0.200**) (Table 5) with organic carbon and negative correlation with pH (r = -0.237*). The availability of metal ions increased with increase in organic matter content because organic matter might have supplied chelating agents [4, 11, 12].

3.3. AVAILABLE MANGANESE

The available manganese content of soils of Kavali division were found to be sufficient (>1.0 ppm) in both surface and sub-surface in all the locations. The available manganese content of soil samples (surface and subsurface) of each mandal along with mean, range and their distribution was presented in Table 3.

The available manganese content of surface and sub-surface soil samples ranged from 0.60 to 45.29 ppm and 0.16 to 58.51 ppm with mean values of 12.88 and 11.88 ppm, respectively. The lowest and highest mean values of surface (3.71 and 36.91 ppm) and sub-surface (3.25 and 29.71 ppm) soil samples were observed in Dattulur mandal and Bogole mandals, respectively.

All most all of surface (99 %) and sub-surface (98 %) samples were found to be above critical limit. Whereas only 1 % of the surface and 2 % of sub-surface samples were below critical limit of available manganese were based on the critical limit 1.0 ppm suggested by Lindsay and Norvell. All the soil samples were found to be above critical limit. Surface soil samples have high (mean 12.88ppm) concentration of available manganese as compared with subsurface soil samples (mean 11.88 ppm).

The irrigated cropping system, heavy nature of the soils and less mobility of Mn^{2+} in the soils might have contributed for the accumulation of reducible and soluble forms of manganese in the surface layers and so, higher amounts were found in the surface soil samples [5]. Positive correlation with organic carbon (0.357**) (Table 5) was observed. With increase in pH, divalent form (Mn^{+2}) might be converted to trivalent (Mn^{+3}) or polyvalent (Mn^{+7}) forms [11]. There was a negative correlation (-0.353**) between pH and available manganese.

3.4. AVAILABLE COPPER

The available copper content of Kavali division were found to be sufficient (>0.2 ppm) in both surface and in sub-surface soils. The available copper content of soil samples (surface and subsurface) of each mandal along with mean, range and their distribution was presented in Table 4. The available copper content of surface and sub-surface soil samples ranged from 0.31 to 6.51 and 0.04 to 5.21 ppm with mean values of 3.94 and 2.69 ppm, respectively.

Table 1: Available Iron content of soils of Kavali revenue division

S.No	Mandal	No. of samples	Surface				Subsurface			
			Fe (ppm)		Number of samples		Fe (ppm)		Number of samples	
			Range	Mean	Deficient	Sufficient	Range	Mean	Deficient	Sufficient
1	Sitaramapuram	5	7.07-13.89	9.66	-	5	9.53-120.02	34.42	-	5
2	Udayagiri	4	6.66-93.88	45.57	-	4	8.31-64.49	37.99	-	4
3	Varikuntapadu	4	3.43-97.27	33.02	1	3	3.93-127.23	78.60	1	3
4	Dattulur	3	4.80-7.68	6.16	-	3	4.19-5.78	5.09	1	2
5	Marripadu	3	3.12-24.10	11.08	1	2	3.73-12.86	7.80	1	2
6	Vinjamur	4	6.48-16.78	9.44	-	4	5.59-13.81	9.11	-	4
7	Kaligiri	5	5.41-16.46	9.68	-	5	6.70-20.73	10.89	-	5
8	Kondapuram	5	7.33-32.68	14.15	-	5	5.44-31.64	13.01	-	5
9	Kavali	5	7.31-177.55	43.88	-	5	5.90-74.11	21.92	-	5
10	Bogole	3	156.34-466.4	278.14	-	3	98.92-343.4	211.39	-	3
11	Jaladanki	9	6.61-41.48	15.09	-	9	4.25-13.59	8.87	1	8
12	Koovuru	7	1.86-101.37	40.58	1	6	7.50-99.05	30.51	-	7
13	Kodavalur	4	53.22-180.37	94.93	-	4	27.44-67.14	40.81	-	4
14	Alluru	3	153.97-249.56	206.24	-	3	191.80-222.7	202.61	-	3
15	Vidavalur	6	10.31-89.70	41.69	-	6	15.17-101.18	51.41	-	6
16	Buchireddipalem	9	5.36-47.73	32.41	-	9	6.91-41.79	17.43	-	9
17	Dagadarti	14	19.53-191.78	78.71	-	14	28.57-147.96	72.95	-	14
18	Sangam	7	14.01-46.39	30.97	-	7	10.28-37.50	21.38	-	7
		100	1.86-466.40	49.14	3	97	3.73-343.40	42.71	4	96

Table 2: Available Zinc content of soils of Kavali revenue division

S.No	Mandal	No. of samples	Surface				Subsurface			
			Zn (ppm)		Number of samples		Zn (ppm)		Number of samples	
			Range	Mean	Deficient	Sufficient	Range	Mean	Deficient	Sufficient
1	Sitaramapuram	5	0.17-0.87	0.49	4	1	0.15-4.70	1.24	4	1
2	Udayagiri	4	0.24-2.60	1.25	3	2	0.32-2.80	1.08	3	1
3	Varikuntapadu	4	0.28-2.02	1.03	1	3	0.31-1.03	0.62	2	2
4	Dattulur	3	0.16-0.65	0.43	3	-	0.33-0.51	0.40	3	-
5	Marripadu	3	0.21-0.38	0.30	3	-	0.36-0.70	0.53	3	-
6	Vinjamur	4	0.34-1.26	0.80	2	2	0.29-0.50	0.41	4	-
7	Kaligiri	5	0.46-0.63	0.54	5	-	0.32-0.88	0.49	4	1
8	Kondapuram	5	0.31-1.23	0.79	3	2	0.02-0.14	0.054	5	-
9	Kavali	5	0.44-3.24	1.39	2	3	0.41-2.71	1.14	2	3
10	Bogole	3	1.04-2.70	1.77	-	3	0.31-0.42	0.35	3	-
11	Jaladanki	9	0.54-3.24	1.46	2	7	0.35-1.99	1.06	4	5
12	Koovuru	7	0.18-4.77	1.13	5	2	0.06-2.63	0.69	5	2
13	Kodavalur	4	0.48-4.77	1.65	3	1	0.06-1.98	0.68	3	1
14	Alluru	3	0.89-5.77	3.81	-	3	0.73-4.91	2.74	1	2
15	Vidavalur	6	0.33-1.78	0.81	4	2	0.04-0.44	0.16	6	-
16	Buchireddipalem	9	0.72-2.16	1.46	1	8	0.28-1.97	0.93	5	4
17	Dagadarti	14	0.14-1.84	0.90	6	8	0.48-2.28	0.97	5	9
18	Sangam	7	0.53-1.69	0.94	2	5	0.31-1.13	0.63	5	2
		100	0.14-5.77	1.16	48	52	0.02-4.91	0.80	67	33

All the surface soil samples were found to be above critical limit (0.2 ppm) regarding the available copper content indicating that these soils were adequately supplied with copper. The higher (3.36 ppm) and lower (0.64) mean values of available copper content were found in surface soils of Alluru and Jaladanki mandals, respectively. Whereas in sub-surface samples, 97 % were above critical limit and the lowest mean value was found in Vinjamur mandal (0.69 ppm) and the highest was found in Kondapuram (3.92 ppm) mandal. Available copper content of surface soil samples had high (3.94 ppm) concentration as compared with sub-surface soil samples (2.69 ppm).

100 % of surface and 97 % of sub-surface soil samples were sufficient in available copper. The high copper content of soils might be due to manuring, application of copper fungicides and release from weathering minerals [1, 7, 13].

Table 3: Available Manganese content of soils of Kavali revenue division

S.No	Mandal	No. of samples	Surface				Subsurface			
			Mn (ppm)		Number of samples		Mn (ppm)		Number of samples	
			Range	Mean	Deficient	Sufficient	Range	Mean	Deficient	Sufficient
1	Sitaramapuram	5	2.24-6.05	4.54	-	5	7.46-13.29	9.26	-	5
2	Udayagiri	4	4.90-15.06	9.64	-	4	4.92-12.04	7.35	-	4
3	Varikuntapadu	4	2.42-8.36	6.46	-	4	6.39-11.96	8.18	-	4
4	Dattulur	3	1.25-7.57	3.71	-	3	1.85-4.61	3.25	-	3
5	Marripadu	3	1.55-6.05	4.27	-	3	1.63-14.65	8.77	-	3
6	Vinjamur	4	5.97-13.87	10.73	-	4	10.30-17.99	13.73	-	4
7	Kaligiri	5	4.32-13.87	8.83	-	5	7.78-15.25	11.58	-	5
8	Kondapuram	5	0.60-7.80	4.65	1	4	6.06-11.44	8.05	-	5
9	Kavali	5	5.62-24.60	10.69	-	5	8.73-23.38	12.59	-	5
10	Bogole	3	29.82-43.92	36.91	-	3	7.79-58.51	29.71	-	3
11	Jaladanki	9	5.21-19.76	9.14	-	9	2.01-14.69	8.75	-	9
12	Koovuru	7	3.59-14.31	10.71	-	7	5.06-30.04	10.37	-	7
13	Kodavalur	4	1.93-24.43	9.79	-	4	4.21-8.23	5.78	-	4
14	Alluru	3	15.72-18.31	17.33	-	3	5.46-14.86	12.24	-	3
15	Vidavalur	6	1.81-34.01	11.79	-	6	0.16-11.47	4.98	2	4
16	Buchireddipalem	9	6.16-16.93	10.46	-	9	4.92-12.04	7.56	-	9
17	Dagadarti	14	6.63-45.29	28.19	-	14	17.14-42.29	24.22	-	14
18	Sangam	7	7.25-18.72	11.10	-	7	8.99-16.93	12.53	-	7
		100	0.60-45.29	12.87	1	99	0.16-58.51	11.88	2	98

Table 4: Available Copper content of soils of Kavali revenue division

S.No	Mandal	No. of samples	Surface				Subsurface			
			Cu (ppm)		Number of samples		Cu (ppm)		Number of samples	
			Range	Mean	Deficient	Sufficient	Range	Mean	Deficient	Sufficient
1	Sitaramapuram	5	0.88-1.47	1.19	-	5	0.47-1.53	0.80	-	5
2	Udayagiri	4	1.00-3.70	2.78	-	4	0.84-4.22	2.28	-	4
3	Varikuntapadu	4	1.07-2.86	2.24	-	4	0.59-2.46	1.46	-	4
4	Dattulur	3	0.46-1.83	1.26	-	3	0.52-1.00	0.75	-	3
5	Marripadu	3	1.23-1.89	1.80	-	3	0.11-2.35	1.09	-	3
6	Vinjamur	4	1.26-1.80	1.64	-	4	0.09-1.38	0.69	1	3
7	Kaligiri	5	1.01-2.24	1.67	-	5	0.55-1.45	0.88	-	5
8	Kondapuram	5	2.45-3.44	3.02	-	5	3.11-5.21	3.92	-	5
9	Kavali	5	0.44-1.99	1.29	-	5	0.34-2.77	1.48	-	5
10	Bogole	3	1.85-2.01	1.93	-	3	1.91-5.87	3.44	-	3
11	Jaladanki	9	0.31-1.38	0.64	-	9	0.61-1.22	0.90	-	9
12	Koovuru	7	0.96-4.70	2.46	-	7	0.50-4.37	2.32	-	7
13	Kodavalur	4	1.08-3.65	2.17	-	4	1.42-4.19	2.93	-	4
14	Alluru	3	2.80-4.03	3.36	-	3	1.97-3.17	2.49	-	3
15	Vidavalur	6	0.47-2.80	1.06	-	6	0.048-2.19	0.74	2	4
16	Buchireddipalem	9	0.54-4.25	2.13	-	9	0.86-2.35	1.54	-	9
17	Dagadarti	14	2.03-6.51	3.12	-	14	1.00-3.83	2.42	-	14
18	Sangam	7	1.88-5.47	3.11	-	7	1.43-4.53	3.03	-	7
		100	0.31-6.51	3.94	-	100	0.04-5.21	2.69	3	97

Table 5: Correlation coefficient (r) values of pH, organic carbon and calcium carbonate with micronutrients

Available Nutrients	Soil properties	
	pH	EC
Iron	-0.616**	0.183**
Zinc	-0.237**	0.200**
Manganese	-0.353**	0.140*
Copper	-	-

*Note: ** - significant at 5% level.*

CONCLUSION

200 surface and sub-surface soil soils were collected and analyzed in the laboratory. Location of soil samples was collected using GPS. This study reveals that, the soils were strongly acidic to strongly alkaline in (4.81 to10.41)

reaction. The surface soil samples have high available iron content compared to sub-surface soil samples. 67 % of the available zinc for sub-surface soil samples was below critical limit and 33 % of samples were found above critical limit (0.8 ppm). The available manganese was having positive correlation with organic carbon (0.357). It is also observed that, in Alluru and Jaladanki mandals higher (3.36 ppm) and lower values (0.64) of available copper were established for surface soils.

REFERENCES

[1] Chaudhary D R; Arup Ghosh; Patolia J S. *Current Science.*, **2006a**, 91 (1): 99-104.
[2] Jackson M L. *Soil Chemical Analysis*, Prentice Hall of India Private Ltd, New Delhi., **1973**,134-182
[3] Lindsay W L and Norvell W A. *Soil Science Society of American Journal.*, **1978**, 42, 421-428.
[4] Meena H.B; Sharma R P; Rawat U S. *Journal of the Indian Society of Soil Science.*, **2006**, 54 (4), 508-512.
[5] Mohapatra A R and Kibe M. *Journal of the Indian Society of Soil Science.*, **1972**.20, 67-77.
[6] Naresh Guptha; Trivedi S K; Bansal K N; Kaul R K. *Journal of the Indian Society of Soil Science.*, **2003**, 51(4), 517-522.
[7] Polara J V and Kabaria B D. *Journal of Indian Society of Coastal Agricultural Research.*, **2006**, 24 (1), 50-51.
[8] Pradeep R; Dasog G S; Kuligod V S. *Karnataka Journal of Agricultural Sciences,*. **2006**, 19 (1): 131-133.
[9] Ramprakash T. Characterization and classification of some soils of Gampalagudem mandal in Krishna district of Andhra Pradesh. *M.Sc. (Ag.) thesis*, Andhra Pradesh Agricultural University, Rajdendranagar, **1998**.
[10] Sakal R; Singh A P; Singh S P. *Journal of the Indian Society of Soil Science.*, **1988**, 36, 59-63.
[11] Sharma P P; Megh-Singh; Sharma J P. *Journal of the Indian Society of Soil Science.*, **2003**, 51 (4), 522-527.
[12] Sharma R B and Motiramani D P. *Journal of the Indian Society of Soil Science.*, **1969**, 17, 19-26.
[13] Vijayasekhar R; Vittal Kuligod B; Basavaraj P K; Dasog G S; Salimath S B. *The Andhra Agricultural Journal.*, **2000**, 47, 141-143.