Current Journal of Applied Science and Technology

39(48): 189-194, 2020; Article no.CJAST.65211
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Distribution of DTPA Extractable Micronutrients in Soils of Central Telangana Region of Telangana

M. Ram Prasad[1*], P. Ravi[1] and K. Surekha[2]

[1]Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, India.
[2]Principal Scientist, Indian Institute of Rice Research, Hyderabad-5000 30, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author MRP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PR and KS managed the analyses of the study. Author PR managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i4831220
Editor(s):
(1) Dr. Nhamo Nhamo, Zimbabwe Open University, Zimbabwe.
Reviewers:
(1) Nooruldeen Shawqi Ali, University of Baghdad, Iraq.
(2) Abdulrahman Maina Zubairu, University of Maiduguri, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/65211

Original Research Article

Received 25 October 2020
Accepted 30 December 2020
Published 31 December 2020

ABSTRACT

Forty soil samples from ten pedons of the Central Telangana region, Telangana were studied for the vertical distribution of DTPA extractable. Zn, Cu, Fe and Mn and their relationship with some soil properties. Soil pH, $CaCO_{3,}$, organic carbon and particle-size distribution had a strong influence on the distribution of these micronutrients. The content of the micronutrient increased with the an increase in organic carbon and decreased with an increase in pH and $CaCO_3$. There was a decreasing trend for the distribution of these micronutrients with respect to depth. As per the critical limit prescribed for Zn, and Fe, 55 and 12% of the soil could be rated as deficient in available zinc and iron, respectively. Copper and manganese were found to be adequate.

Keywords: Available micronutrients; alkaline soil; soil horizons; critical limit.

1. INTODUCTION

The knowledge of the vertical distribution of micronutrient cations in soils provides an idea of the inherent capacity of soils to supply micronutrients from lower horizons. Studies conducted by other researchers [1-4] to understand the content and distribution of the

**Corresponding author: E-mail: mullapudiramprasad2020@gmail.com;*

nutrient cations in different soils and their relationship with soil properties were for other soils and information in this regard for the soils of central Telangana is scanty. Therefore, an attempt has been made to assess the micronutrient status in these soils and their relationship with some important soil properties.

2. MATERIALS AND METHODS

The Central Telangana region is located between 17°14′ to 18°21′ N latitude and 78°5′ to 81°6′ longitude in the south India. Climatically, the Central Telangana zone falls under semi-arid (wet) tropics with mean annual rainfall is 1167.7 mm, 74 per cent of which is received during monsoon (mid-June to mid-September). Ten representative pedons (P1 to P10) from Madhira, Aswaraopeta, Pinapaka, Sanga Reddy, Siddipeta, Gajwel, Warangal, Malyal, Eturnagaram and Ghanpur were exposed where all horizons were visible. The study area is covered by igneous and metamorphic rocks. Northwestern plateau and interior rugged plains from the Telangana. The moisture regime in the study area is ustic and soil temperature is iso-hyperthermic. The major crops grown in the study area are rice, maize, sorghum, cotton, black gram, green gram, and red gram.

Horizon-wise soil samples were collected from the studied pedons. All the samples were analyzed for pH, Soil organic carbon (SOC), carbonate minerals ($CaCO_3$), and particle-size distribution following standard procedures. The micronutrient cations were extracted with Diethylene Triamine Penta Acetic acid (DTPA) solution (to represent available forms) and determined with Atomic Absorption Spectrophotometer (AAS) as described by Lindsay and Norvell [5]. Simple correlations were calculated between DTPA-extractable micronutrient cations and soil properties [6,7].

3. RESULTS AND DISCUSSION

In general, soil reactions were neutral to alkaline with pH ranged from 6.5 to 8.7. Soil organic carbon content was very low to low (2.0-11.4 g kg^{-1} soil) and decreased with depth. Soils are slightly calcareous and calcium carbonate content varied from 0.13 to 3.9% in different horizons Table 1. The soils were sandy clay loam to clay in texture with clay content ranging from 19.7 to 68.6% (197-686 g kg^{-1} soil). Higher content of micronutrients was found in surface layers which might be due to their regular addition through plant residues, organic manures, and fertilizers [4]. There was no definite trend of distribution for micronutrients through depth Table 1.

3.1 Zinc

DTPA-extractable zinc varied from 0.17 to 1.92 mg kg^{-1} soil. Out of 40 soil samples, 22 samples are deficient in zinc, according to the critical limit (0.6 mg kg^{-1} soil) [8]. Zinc deficiency was not observed in soil samples of pedon, 2, 7 and 9, whereas pedon 3, 4, 5, 6, and 10 appeared to be deficient in zinc. Zinc deficiency was noticed after 54 cm and 66 cm in pedon 1 and 8, respectively. Lower zinc content in black soils is due to its sorption (exchange and chemical sorption) by clay [9] or due to high pH values, which have resulted in the formation of insoluble compounds of zinc [10]. Available Zn content was significantly and a negatively correlated (r=-0.33**) with calcium carbonate. Soil sand and silt also had a negative correlation but soil organic carbon and clay a 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. [7].

3.2 Copper

DTPA extractable Cu content in soils ranged from 0.30 to 10.10 mg kg^{-1} soil with a value of 2.17 mg kg^{-1} soil . Considering the critical limit of 0.20 mg kg^{-1} for Cu for normal plant growth [11], the soils are rated adequate in available Cu. Soil pH and $CaCO_3$ content had a significant negative correlation (r=-0.56**and -0.31** respectively) with Cu, but soil organic carbon and clay had a significant positive relation with *Cu.* These findings are in agreement with Satyavathi and Reddy [2], Pati and Mukhopadhyay [12] and Thakur et al. [4].

3.3 Iron

DTPA extractable Fe content in these soils varied between 4.2 and 42.3 mg kg^{-1}. Considering the critical limit of 4.5 mg kg^{-1} for Fe [5], 11 samples, which represent 12 % of soil samples were deficient in iron. The Fe was deficient in pedons 6, 8, and 10 due to high pH and medium in $CaCO_3$ [13,14]. Soil organic carbon had a significant positive relation ($r=0.37^{**}$) with Fe Table 2.

Table 1. Some physical and chemical properties of the soils and DTPA-extractable cations

Location	Horizon	Depth (cm)	pH (1:2.5)	OC (g kg^{-1})	$CaCO_3$ (%)	Particle size distribution			Zn	Cu	Fe	Mn
						Sand	Silt	Clay				
						(%)			mg kg^{-1} soil			
Pedon 1: Fine, smectitic, iso-hyperthermic Vertic Haplustepts												
Madhira	Ap	0-18	7.8	8.8	1.8	36.0	18.2	45.8	0.87	3.90	10.90	14.80
Dist: Khammam	Bwg_1	18-54	8.0	6.1	2.4	31.3	20.1	48.6	0.63	2.80	9.80	12.30
	Bwg_2	54-100	7.9	5.2	3.1	28.7	19.8	51.4	0.48	2.80	8.20	9.80
	Bw	100-140	7.9	4.1	3.6	27.3	22.3	60.3	0.41	2.10	7.10	8.20
Pedon 2: Fine-loamy, mixed, iso-hyperthermic Typic Haplustepts												
Aswaraopeta	Ap	0-12	6.6	8.2	0.0	52.2	21.8	25.9	0.65	0.33	6.78	5.35
Dist: Khammam	Bw_1	12-26	7.3	5.6	0.1	51.6	20.3	28.1	0.76	0.39	7.15	4.87
	Bw_2	26-60	6.9	3.1	0.1	63.9	16.3	19.7	0.87	0.34	7.20	5.45
	Bw_3	60-95	7.0	3.2	0.2	59.5	18.6	21.8	0.93	0.46	8.34	6.52
Pedon 3: Fine, smectitic, iso-hyperthermic Chromic Haplusterts												
Pinapaka	Ap	0-24	7.8	8.1	1.6	29.2	18.9	51.9	0.44	0.72	5.20	9.40
Dist: Khammam	Bw	24-42	7.9	7.6	1.8	28.3	19.2	52.5	0.36	0.56	4.60	6.50
	Bss_1	42-89	8.0	6.1	1.8	29.4	17.7	52.9	0.35	0.42	6.20	9.20
	Bss_2	89-120	8.1	5.6	2.8	27.8	15.2	57.0	0.36	0.30	4.50	7.40
Pedon 4: Fine-loamy, mixed, iso-hyperthermic Udic Paleustalfs												
Sangareddy	Ap	0-14	6.8	11.4	1.4	53.4	21.0	26.6	0.38	10.10	42.30	18.24
Dist: Medak	Bw	14-28	6.6	9.0	4.6	50.7	17.0	32.3	0.36	8.61	30.25	12.81
	Bt_1	28-60	6.3	6.0	3.7	35.2	11.6	54.8	0.27	8.42	30.61	12.23
	Bt_2	60-95	6.2	4.1	1.8	32.8	12.4	54.8	0.21	8.04	22.18	8.63
	Bw	95-120	6.1	2.0	2.3	34.7	13.2	52.1	0.21	7.21	21.06	8.22
Pedon 5: Fine, smectitic, iso-hyperthermic Typic Haplusterts												
Siddipeta	Ap	0-16	8.2	7.0	2.0	20.0	23.3	56.7	0.49	0.91	11.60	25.60
Dist: Medak	Bss_1	16-35	8.4	5.2	2.3	16.5	24.2	59.3	0.46	0.86	10.40	24.20
	Bss_2	35-74	8.3	5.0	3.2	13.3	21.0	65.7	0.39	0.72	8.20	15.60
	Bss_3	74-100+	8.4	4.6	3.6	14.0	17.4	68.6	0.31	0.46	6.40	14.20
Pedon 6: Fine-loamy, mixed, iso-hyperthermic Udic Ustorthents												
Gajwel	A	0-25	7.3	7.6	3.9	58.7	12.4	29.0	0.32	0.49	4.20	14.80
Dist: Medak	AC	25-75+	7.7	5.0	3.6	66.2	9.4	24.4	0.26	0.44	3.80	12.14

Location	Horizon	Depth (cm)	pH (1:2.5)	OC (g kg^{-1})	$CaCO_3$ (%)	Particle size distribution			Zn	Cu	Fe	Mn
						Sand	Silt	Clay				
						(%)			mg kg^{-1} soil			
Pedon 7: Fine, smectitic, iso-hyperthermic Typic Haplusterts												
Warangal	Ap	0-16	7.9	7.9	2.3	44.0	14.6	41.4	1.92	2.30	6.94	12.04
Dist: Warangal	Bg_1	16-50	7.8	5.8	2.6	40.0	14.8	45.2	1.57	1.86	6.69	5.31
	Bg_2	50-75	7.8	4.6	3.3	39.0	15.8	45.2	0.97	1.53	6.32	5.16
	Bw	75-110+	7.3	4.4	3.7	42.6	13.0	44.6	0.92	1.16	5.81	4.75
Pedon 8: Fine-loamy, mixed, iso-hyperthermic Udic Haplustepts												
Malyal	Ap	0-18	7.6	7.9	1.6	56.2	14.2	29.5	1.29	3.90	10.90	10.06
Dist: Warangal	Bw_1	18-30	7.9	6.6	2.5	52.3	17.1	30.6	1.10	2.15	10.21	10.23
	Bw_2	30-66	7.9	5.6	3.1	56.4	12.3	31.2	0.70	1.65	4.20	9.87
	C	66-150+	8.0	3.1	3.8	60.2	13.5	26.2	0.34	1.55	3.65	6.91
Pedon 9: Fine-loamy, mixed, iso-hyperthermic Typic Rhodustalfs												
Eturnagaram	Ap	0-12	6.7	9.6	1.2	67.6	7.9	24.5	1.66	1.95	23.27	12.09
Dist: Warangal	AB	12 to 50	6.5	8.1	1.8	68.1	8.3	23.6	1.60	1.87	19.21	11.80
	Bt_1	50-86	6.4	6.1	1.6	63.0	8.0	28.9	1.50	1.40	17.31	8.60
	Bt_2	86-98+	6.7	3.2	2.1	61.5	9.8	28.6	1.25	1.23	12.85	9.20
Pedon 10: Fine, mixed, iso-hyperthermic Typic Haplustalfs												
Ghanpur	Ap	0-15	8.0	8.0	1.8	54.6	15.0	30.3	0.56	0.88	8.80	10.60
Dist: Warangal	Btg	15-40	8.2	7.6	2.5	47.8	15.2	36.9	0.49	0.68	6.80	9.20
	Bwg	40-80	8.4	6.1	3.6	49.6	14.1	36.2	0.38	0.45	3.20	8.40
	Bg	80-110	8.7	5.6	2.8	48.2	12.5	39.2	0.41	0.66	6.60	8.20
	Bt	110+	8.5	4.9	2.6	40.6	17.0	42.6	0.32	0.58	5.80	7.90

Table 2. Correlations between soil properties and soil available micronutrients

Micronutrients	Soil Zn	Soil Cu	Soil Fe	Soil Mn
Soil properties				
Soil pH	-0.27	-0.56*	0.17	-0.5
OC (g kg-1)	0.29	0.25	0.37 *	0.44*
$CaCO_3$ (%)	-0.33*	-0.31*	-0.04	0.09
Clay Content	0.14	0.05	0.04	0.27

** Significant*

3.4 Manganese

DTPA extractable Mn content was varied from 4.7 and 42.3 mg kg^{-1} soil in different horizons which are above the critical limit of 3 mg kg^{-1} for Mn as suggested by Takkar et al. [15]. Available Mn content was significantly and positively correlated with organic carbon and clay.

In general, calcium carbonate decreased the availabilities of micronutrients owing to their insoluble hydroxides at higher pH [16]. Contrary to it, organic carbon had a positive influence on DTPA-micronutrients due to complexation and chelation [12].

4. CONCLUSION

The soils of the Central Telangana region, Telangana were studied for the vertical distribution of DTPA extractable. Zn, Cu, Fe, and Mn and their relationship with some soil properties. DTPA-extractable zinc, copper, iron and manganese contents ranges from 0.17 to 1.92 mg kg^{-1} soil, 0.30 to 10.10 mg kg^{-1} soil, 4.2 to 42.3 mg kg^{-1} soil and 4.7 and 42.3 mg kg^{-1} soil, respectively. Out of 40 soil samples 22 samples are deficient in zinc and 11 samples were deficient in iron. Soil pH, calcium carbonate, organic carbon and particle-size fractions had strong influence on the distribution of these micronutrients. The content of the micronutrient increased with the increase in organic carbon and decreased with an increase in pH and $CaCO_3$.

ACKNOWLEDGEMENT

The First author gratefully acknowledges Dr. K. Sureekha and other authors for providing support and guidance during research work and assistance during preparation of manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sharma YM, Gupta GP. Distribution of total and available micronutrients in profiles of different soils of Madhya Pradesh. Annals of Agriculture Research. 2001;22:125-127.
2. Satyavathi PLA, Reddy MS. Distribution of DTPA extractable micronutrients in soils of Telangana. Andhra Pradesh Agropedology. 2004;14(1):32-37.
3. Mahesh Kumar M, Raina P, Sharma BK. Distribution of DTPA extractable micronutrients in arid soils of Churu district, Rajasthan. Agropedology. 2011;21(1):44-48.
4. Thakur R, Kauraw DL, Singh M. Profile distribution of micronutrient cations in a Vertisol as influenced by long-term application of manure and fertilizers. Journal of the Indian Society of Soil Science. 2011;59(3):239-244.
5. Lindsay WL, Novell WA. Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Journal. 1978;42:421-428.
6. Katyal JC, Sharma BD. DTPA-extractable and total Zn, Cu, Mn and Fe in Indian soil and their association with some soil properties. Geoderma. 1991:49:165–179.
7. Bhanwaria R, Kameriya PR, Yadav BL. Available micronutrient status and their relationship with soil properties of mokala soil series of rajasthan. Journal of the Indian Society of Soil Science. 2011;59:392-396.
8. Katyal JC. Research achievements of all India coordinated scheme of micronutrients in soils and plants. Fertilizer News. 1985;30:67-80.
9. Manohar C. Zinc fixation by some black and red soils of Andhra Pradesh. M.Sc. (Ag.) thesis, Andhra Pradesh Agric. Univ., Hyderabad (unpublished). 1974;1-185.
10. Tandon HLS. Micronutrient in search and agricultural production (Fertilizer Development and Consultation Organization, New Delhi, India); 1995.

11. Katyal JC, Randhawa NS. Micronutrients, FAO fertilizer and plant nutrition bulletin No. 1983;5:92.
12. Pati R, Mukhopadhyay D, Distribution of cationic micronutrients in some acid soils of West Bengal. Journal of the Indian Society of Soil Science. 2011;59(2):125-133.
13. Thampatti KCM, Jose AI. Vertical distribution and dynamics of iron, manganese and aluminium in rice soils of Kuttand, Kerala. Agropedology. 2006;16(1):26-31.
14. Reddy KG, Govardhan V, Kumar YSS. Distribution of DTPA extractable micronutrient cations in soils of Nalgonda district of Andhra Pradesh. Annals of Plant and Soil Research. 2014;16(2):121-124.
15. Takkar PN, Chhibba IM, Meht SK. Twenty years of co-ordinated research on micronutrient in soils and plants. Indian Society of Soil Science. Bulletin. No. 1989;1:76.
16. Sahoo AK, Chattopadhyay T, Singh RS, Shyampura RL. Available micronutrient status in the soils of Malwa plateau (Rajasthan). Journal of the Indian Society of Soil Science. 1995;43:698-700.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/65211