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Fractions of zinc in calcareous *Vertic haplustepts* as influenced by sixteen years of fertilization and manuring in ltfe soils

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Abstract
A field study entitled "Fractions of Zinc in Calcareous *Vertic Haplustepts* as Influenced by Sixteen Years of Fertilization and Manuring in LTFE Soils" at Junagadh. The effect of integrated nutrient management (INM) on fractions of zinc under groundnut-wheat cropping sequence of a *Haplustepts* soil was studies in a long-term field experiment initiated during *kharif* 1999 at Junagadh, Gujarat. Effect of varying dose of N, NP, NPK with FYM, Zn, S and *Rhizobium* on fractions of zinc. The soil of the experimental site was clay loam in texture, alkaline in reaction, low in available nitrogen and phosphorus, while high in potassium, sulphur and zinc. The study was aimed to find out the effect of continuous application of inorganic fertilizers and organic manure on the distribution of Zn fractions. There was an increase in soil DTPA available Zn status of LTFE soils, while some important forms of Zn such as reducible Zn, total Zn and residual Zn was recorded decline. Conversion of exchangeable to DTPA-Zn was evident. In light of this, overall mean DTPA available Zn was recorded high values (1.43 ppm) as compared to the critical values. Further the internal turnover of Zn along with other fertilizers could also help avoid the deficiencies of Zn even on a long run. The whole spectrum warranted a need to supply Zn nutrient through suitable sources to stabilize Zn status in the soil. The total form was a predominant component followed by DTPA available Zn. There were inter-conversions from DTPA available as well as total form to the reducible forms in a long run.

Keywords: integrated nutrient management, fractions of Zn, groundnut-wheat cropping sequence, rhizobium and DTPA available Zn

Introduction
Micronutrient cations are usually held very strongly by the organic legends and exist in the soils in different pools. Viet (1962) [2] postulated existence of five distinct pools of micronutrient cations in soil viz., (i) soil solution or water soluble, (ii) exchangeable, (iii) adsorbed, complexed and chelated, (iv) associated with secondary minerals and as insoluble metal oxides and hydroxides, and (v) associated with primary minerals. First three pools exist in a state of dynamic equilibrium and constitute the labile pool from which the plants draw micronutrients. Consequently, a number of sequential fraction procedures have been developed for studying the relative abundance of different fractions in the soils and their relative importance in supplying micronutrients to the growing crops (Saviour and Stalin (2014) [4]. Long-term experiments (LTE) offer a better platform to visualize the status of micronutrients in soil under intensive cropping and their contribution to sustained production. In India, intensive cropping with nutrient exhaustive high-yielding varieties coupled with the use of high analysis fertilizers for enhancing food grain production have catalyzed the rapid depletion of available micronutrients in soil in general (Singh, 2009) [3] and available zinc (Zn) in some areas in particular (Nayyar *et al*., 1990) [5]. Organic matter redistribution the forms of applied Zn into the exchangeable and organic matter fractions. Micronutrients are important for maintaining soil health and also increasing productivity. They are being made available to plant through their various fractions like water soluble, exchangeable, available, reducible, soluble and residual. The availability of the micronutrients in soil is also influenced by the soil properties like soil pH, soil EC, content of organic matter, free lime, soil, moisture, proportion of clay and silt fractions, type of clay, concentrations of interacting ions, *etc.*

Materials and Methods
Surface soil samples (0-15 cm) were collected from the AICRP-LTFE soils conducted on groundnut-wheat sequence in RBD, replicated four times, at Instructional Farm, Junagadh Agricultural University, Junagadh during the year 1999 (initial) and 2014-15 (16th year, after wheat). Initial soil properties of LTFE soil was soil pH 8.2, soil EC 0.37 dS/m. $CaCO_3$ 32.2

g/kg, CEC 36.8 c mol (P^+)/kg, soil OC 8.9 g/kg, soil Av. N 161 kg/ha, soil Av. P_2O_5 9.48 kg/ha, soil Av. K_2O 184 kg/ha, soil Av. S 17.4 mg/kg, Fe 13.7 mg/kg, Mn 10.01 mg/kg, Zn 1.47 mg/kg and Cu 3.24 mg/kg, respectively.

Tr No.	Treatment Details
T_1	50% N P K of recommended doses in G'nut -Wheat sequence
T_2	100 % N P K of recommended doses in G'nut -Wheat sequence
T_3	150 % N P K of recommended doses in G'nut -Wheat sequence
T_4	100 % N P K of recommended doses in G'nut -Wheat sequence + $ZnSO_4$ @ 50 kg/ha once in three year to G'nut only (i.e. '99, 02, 05 etc)
T_5	N P K as per Soil Test
T_6	100 % N P of recommended doses in G'nut -Wheat sequence
T_7	100 % N of recommended doses in G'nut -Wheat sequence
T_8	50 % N P K of recommended doses in G'nut -Wheat sequence + FYM @ 10 t/ha G'nut and 100 % N P K to Wheat
T_9	Only FYM @ 25 t/ha to G'nut only
T_{10}	50 % N P K of recommended doses in G'nut -Wheat sequence + Rhizobium + PSM to G'nut and 100 % N P K to Wheat
T_{11}	100 % N P K of recommended doses in G'nut -Wheat sequence (P as S S P)
T_{12}	Control

Zinc Fractionation method

The sequential extraction technique employed to separate the various forms of manganese was Tessier's procedure by Jackson (1973) and Viets (1962) [2] as water soluble, exchangeable, DTPA available, and reducible form. Total Zn status was determined by digesting the soil using HF: HClO4 (5:1). These extracts were analyzed for their Zn content on Atomic Absorption Spectrophotometer. Residual form of Zn was calculated by deducting water soluble + exchangeable + DTPA available + reducible (i.e available total) from the total Zn status of the soil. The per cent available Zn status was calculated as available total of the total Zn status of the soil.

Results and Discussion

Zn - Water Soluble

Water soluble form of Zn differed significantly when years pooled but in Y x T interaction was non-significant. The highest value was recorded in T_4 treatment (0.10 ppm) followed by T_3, T_5 and T_9 treatment (Table 1). The fraction of Zn in soil samples showed that zinc in water soluble pools were virtually non-existent (Shinghal and Rattan, 1995) [6].

Zn – Exchangeable

Exchangeable form of Zn differed significantly at 1st, 16th year while when pooled over years were found non-significant (Table 2). The highest value was recorded in T_3 followed by T_{10}, T_{12} and T_2 after 16 years. The Y x T interaction was also significant. Mean values were no significant difference observed over time of 16 years.

Zn – DTPA Available

This forms did not differed significantly when pooled over years and also Y x T interaction was found non-significant and the highest values was recorded in application of 100 % N P K of recommended doses in G'nut -Wheat sequence + $ZnSO_4$ @ 50 kg/ha once in three year to G'nut only (T_4) followed by T_1, T_{11} and T_{10} treatment in 1st year and also higher value observed under application of 50 % N P K of recommended doses in G'nut -Wheat sequence + Rhizobium + PSM to G'nut and 100 % N P K to Wheat (T_{10}) followed T_4, T_7, and T_{11} treatment after 16th year. Overall mean value increased with time span (Table 3).

Zn – Reducible

Although the pooled differences were not significant due to treatment, also Y x T was found non-significant (Table 4). The highest values were recorded under application of 50% N P K of recommended doses in G'nut -Wheat sequence (T_1) followed by T_9 treatment in 1st year. The mean value was declined after 16th year. The residual Zn which contributed the major fraction in soil and apparently associated with soil minerals, showed a higher mean value of 24.6 ppm (Gowrisankar and Murrigappan, 1998) [7].

Zn– Total

The total forms of Zn differed significantly when pooled over years and also Y x T interaction was significant (Table 5). The highest value was recorded under application of FYM @ 25 t/ha to G'nut (T_9) in mostly all the years and pooled result. In a long run only slightly decline was observed in the mean value. In general, total Zn converted into available Zn under its depletion status of soil, which might utilized by crop. The total soil zinc concentration ranged from 38.1 to 113.8 ppm (Chaudhary *et al.*, 1997) [8].

Zn – Residual

Likewise total, the residual form of Zn also differed significantly when pooled over years and also in Y x T interaction was significant (Table 6). The highest value was recorded under application of FYM @ 25 t/ha to G'nut (T_9). In a long run depletion was observed in all the treatment. The residual zinc fraction constituted higher percentage of total zinc fraction observed by Shinghal and Rattan (1995) [6].

Zn – Percentage Availability

Pooled differences were not significant, also Y x T interaction was not significant. In long run in 16th year the per cent available Zn increased to the highest level under application of 100 % N P of recommended doses in G'nut -Wheat sequence (T_6) followed by application of 100 % N P K of recommended doses in G'nut -Wheat sequence + $ZnSO_4$ @ 50 kg/ha once in three year to G'nut only (T_4) and 100 % N of recommended doses in G'nut -Wheat sequence (T_7) (Table 7).

Zn – Available Total

Total available Zn showed significant differences when pooled over year but Y x T interaction was not significant (Table 8). The highest value was observed in T_4 treatment followed by T_{10}, T_{11}, T_7 and T_1. Overall mean value was increasing over the years. This gives an indication of supplementation and faster utilization of available Zn by the application of chemical fertilizers. Thus in a long run after

16th year in T_{10} and T_4 treatment the values remained higher by virtue of conversion of total to available form by the soil reaction.

Table 1: Status of water soluble form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc water soluble from in soil (ppm)			
	Initial year	16th year		pooled
T_1	0.12	0.03		0.07
T_2	0.12	0.03		0.07
T_3	0.13	0.04		0.09
T_4	0.17	0.03		0.10
T_5	0.13	0.04		0.09
T_6	0.11	0.02		0.06
T_7	0.11	0.02		0.06
T_8	0.12	0.02		0.07
T_9	0.14	0.03		0.09
T_{10}	0.13	0.02		0.08
T_{11}	0.13	0.03		0.08
T_{12}	0.12	0.05		0.08
SEm±	0.01	0.01		0.01
CD at 5%	0.03	0.02		0.02
C.V.%	15.85	50.71		22.59
Mean	0.13	0.03		0.08
Y * T	S.Em.±	0.01	C.D. at 5 %	NS

Table 2: Status of exchangeable form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc exchangeable form in soil (ppm)			
	Initial year	16th year		pooled
T_1	0.22	0.16		0.19
T_2	0.14	0.17		0.16
T_3	0.15	0.27		0.21
T_4	0.20	0.16		0.18
T_5	0.12	0.14		0.13
T_6	0.15	0.12		0.14
T_7	0.15	0.16		0.16
T_8	0.17	0.16		0.17
T_9	0.17	0.13		0.15
T_{10}	0.12	0.19		0.15
T_{11}	0.14	0.14		0.14
T_{12}	0.18	0.18		0.18
SEm±	0.02	0.02		0.01
CD at 5%	0.05	0.05		NS
C.V.%	21.40	22.65		22.06
Mean	0.16	0.16		0.16
Y * T	S.Em.±	0.02	C.D. at 5 %	0.05

Table 3: Status of DTPA available form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc DTPA available form in soil (ppm)			
	Initial year	16th year		pooled
T_1	0.98	1.80		1.39
T_2	0.82	1.34		1.08
T_3	0.83	1.60		1.21
T_4	1.56	2.63		2.09
T_5	0.76	1.72		1.24
T_6	0.73	1.88		1.31
T_7	0.75	2.44		1.60
T_8	0.66	1.60		1.13
T_9	0.83	1.89		1.36
T_{10}	0.87	2.86		1.87
T_{11}	0.90	2.39		1.64
T_{12}	0.86	1.69		1.27
SEm±	0.10	0.63		0.32
CD at 5%	0.29	0.49		NS
C.V.%	22.95	63.13		62.69
Mean	0.88	1.99		1.43
Y * T	S.Em.±	0.45	C.D. at 5 %	NS

Table 4: Status of reducible form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc reducible form in soil (ppm)			
	Initial year	16th year		pooled
T_1	0.69	0.32		0.51
T_2	0.46	0.23		0.34
T_3	0.48	0.28		0.38
T_4	0.29	0.48		0.38
T_5	0.48	0.31		0.40
T_6	0.40	0.37		0.39
T_7	0.47	0.43		0.45
T_8	0.28	0.28		0.28
T_9	0.50	0.35		0.43
T_{10}	0.31	0.55		0.43
T_{11}	0.43	0.39		0.41
T_{12}	0.33	0.29		0.31
SEm±	0.05	0.12		0.06
CD at 5%	0.15	NS		NS
C.V.%	23.95	65.13		45.93
Mean	0.43	\0.36		0.39
Y * T	S.Em.±	0.09	C.D. at 5 %	NS

Table 5: Status of total form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc total form in soil (ppm)			
	Initial year	16th year		pooled
T_1	32.23	27.01		29.62
T_2	34.25	25.97		30.11
T_3	34.55	24.79		29.67
T_4	32.82	32.07		32.44
T_5	33.23	26.42		29.82
T_6	36.35	20.66		28.50
T_7	32.91	30.40		31.65
T_8	36.49	31.78		34.13
T_9	38.77	39.92		38.89
T_{10}	35.00	39.47		37.23
T_{11}	34.46	39.56		37.01
T_{12}	31.56	32.80		32.18
SEm±	0.90	2.97		1.55
CD at 5%	2.59	8.54		4.21
C.V.%	5.23	19.25		13.45
Mean	34.38	30.83		32.61
Y * T	S.Em.±	2.19	C.D. at 5 %	6.19

Table 6: Status of residual form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Zinc residual form in soil (ppm)			
	Initial year	16th year		pooled
T_1	30.23	24.71		27.47
T_2	32.72	24.21		28.46
T_3	32.96	22.60		27.78
T_4	30.60	28.77		29.69
T_5	31.75	24.20		27.97
T_6	34.96	18.26		26.61
T_7	31.42	27.34		29.38
T_8	35.26	29.72		32.49
T_9	37.12	36.61		36.86
T_{10}	33.57	35.85		34.71
T_{11}	32.85	36.61		34.73
T_{12}	30.07	30.59		30.33
SEm±	0.91	2.83		1.48
CD at 5%	2.61	8.13		3.88
C.V.%	5.54	19.97		13.74
Mean	32.79	28.29		30.54
Y * T	S.Em.±	2.10	C.D. at 5 %	5.93

Table 7: Status of percentage available form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Percentage available of Zinc in soil			
	Initial year	16th year		pooled
T_1	6.25	8.37		7.31
T_2	4.48	6.86		5.67
T_3	4.60	8.84		6.72
T_4	6.76	9.98		8.37
T_5	4.48	8.46		6.47
T_6	3.82	11.61		7.72
T_7	4.54	9.12		6.83
T_8	3.37	6.49		4.93
T_9	4.26	6.40		5.33
T_{10}	4.10	9.05		6.58
T_{11}	4.68	8.05		6.37
T_{12}	4.73	6.88		5.80
SEm±	0.35	2.09		1.06
CD at 5%	0.99	1.54		NS
C.V.%	14.77	50.17		46.09
Mean	4.67	8.34		6.51
Y * T	S.Em.±	1.50	C.D. at 5 %	NS

Table 8: Status of total available form of zinc in soils of LTFE experiment in Initial and 16th year

Treat.	Total available forms of Zinc in soil (ppm)			
	Initial year	16th year		pooled
T_1	2.00	2.31		2.15
T_2	1.53	1.76		1.65
T_3	1.58	2.18		1.88
T_4	2.21	3.30		2.76
T_5	1.48	2.22		1.85
T_6	1.39	2.40		1.89
T_7	1.49	3.06		2.27
T_8	1.23	2.06		1.64
T_9	1.65	2.41		2.03
T_{10}	1.43	3.62		2.52
T_{11}	1.61	2.95		2.28
T_{12}	1.49	2.21		1.85
SEm±	0.10	0.74		0.38
CD at 5%	0.30	0.56		0.41
C.V.%	13.15	58.67		51.51
Mean	1.59	2.54		2.07
Y * T	S.Em.±	0.53	C.D. at 5 %	NS

References

1. Jackson ML. Soil chemical analysis. Prentice Hall of Indian Pvt. Ltd., New Delhi. 1973, 388-415.
2. Viet FG, Jr Chemistry. Availability of micronutrient in soils. J Agric. Food chem. 1962; 10:165-178.
3. Singh MV. Effect of trace element deficiencies in soil on human and animal health. Bulletin of the Indian Society of Soil Science. 2009; 27:75-101.
4. Saviour MN, Stalin P. Release behavior of zinc fractions for varying levels of added Zn in sandy loam soils, The Bioscan. 2014; 8(3, 4):235-240.
5. Nayyar VK, Takkar PN, Bansal RL, Singh SP, Kaur NP, Sadana US. Status of micronutrients in Soils of Punjab. Research Bulletin, Department of soils, Punjab Agricultural University, Ludhiana. 1990, 146.
6. Shingal SK, Rattan RK. Soil zinc fraction and their availability in some Inceptisols and Engisols. J Indian Soc. Soil Sci. 1995; 43(1):80.
7. Gowrisankar D, Murrigappan V. Zinc fraction studies in the soils of Amarawathy River Command Area of Tamilnadu. J Indian Soc. Soil Sci. 1998; 46(1):140-142.
8. Chaudhary AK, Mc Laren RG, Cameron KC, Swift RS Fractionation of zinc in some New Zealand soils. Communication in Soil Science and Plant Analysis, 1997; 28(3, 5):301-312.