International Journal of Agricultural Sciences
Volume **10** | Issue 1| January, 2014 | 348-350

RESEARCH PAPER

Dynamics of manganese fractions in a calcareous under AICRP-LTFE soils

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Abstract : Surfaces soil samples (0-15 cm) were collected to study the dynamics of Mn fractions in the selective treatments of the LTFE's conducted on groundnut-wheat crop sequence at Instructional Farm, Junagadh Agricultural University, Junagadh, during the year 1999 (Initial year) and 2010-2011 (12th year) after completion of crop cycle. The selected treatments were T_1- 50 % NPK of RD in G'nut-Wheat sequence, T_2 - 100 % N P K of RD in groundnut -Wheat sequence, T_3 -150 % N P K of RD in groundnut -Wheat sequence, T_4 - 100 % N P K of RD in groundnut -Wheat sequence + $ZnSO_4$ @ 50 kg/ha once in three year to groundnut only (*i.e.* '99, 02, 05 etc), T_5 - N P K as per Soil Test, T_6 - 100 % N P of RD in groundnut -Wheat sequence, T_7 - 100 % N of RD in groundnut -Wheat sequence, T_8 - 50 % N P K of RD in groundnut -Wheat sequence + FYM @ 10 t/ha groundnut and 100 % N P K to Wheat, T_9 - Only FYM @ 25 t/ha to groundnut only, T_{10} - 50 % N P K of RD in groundnut -Wheat sequence + Rhizobium + PSM to groundnut and 100 % N P K to Wheat, T_{11} - 100 % N P K of RD in groundnut -Wheat sequence (P as S S P) and T_{12} - Control. The water soluble Mn was found very trace. The FYM application recorded the highest values of DTPA-Mn at 12th year. Overall decline in reducible form of Mn were found, but it was found significant only at 12th year. Overall mean registered decrease in total Mn content on the long run basis. After 12th year residual Mn increase in T_9 whereas in other treatments. Per cent available and exchangeable of Mn found non significant after 12th year. There were overall decreased in total available form of Mn after a long run.

Key Words : Mn fraction, Water soluble-Mn, Exchangeable-Mn, DTPA-Mn, Total available-Mn, LTFE'S soil

View Point Article : Meena, Sukh Ram, Solanki, M.S. and Deshraj (2014). Dynamics of manganese fractions in a calcareous under AICRP-LTFE soils. *Internat. J. agric. Sci.*, **10** (1): 348-350.

Article History : Received : 02.02.2013**; Revised :** 06.11.2013**; Accepted :** 01.12.2013

INTRODUCTION

Manganese play an important role in photosynthesis and detoxification of superoxide free radicals. It is an integral component of water splitting enzyme associated with photosynthesis-II. Medium black soils of Saurashtra region derived from trap basalt, sand stone and lime stone under semi-arid climate have unique properties of calcareousness which affect the physico-chemical properties, nutrient availability and plant growth. Very little or no work was done on Mn nutrition, status and different forms in soils of Saurashtra region so far. Hence, there is a need for depth study of dynamics of different forms of Mn under intensive agriculture, present investigation was carried out.

MATERIAL AND METHODS

Surface soil samples (0-15 cm) were collected from the selective treatments of the LTFE's conducted on groundnut-wheat crop in Randomized Block Design replicated four time at Instructional Farm, Junagadh Agricultural University, Junagadh during the year 1999 (Initial year) and 2010-2011 (12th year) after completion of crop cycle. The treatment selected were T_1- 50 % NPK of recommended doses in groundnut-Wheat sequence, T_2 - 100 % N P K of recommended doses in groundnut -Wheat sequence, T_3 -150 % N P K of recommended doses in groundnut -Wheat sequence, T_4 - 100 % N P K of recommended doses in groundnut -Wheat sequence + $ZnSO_4$ @ 50 kg/ha once in three year to groundnut only (*i.e.* '99,

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Table 1 : Status of different forms of Manganese in soils of LTFE experiment in Initial and 12th year

Treatments	Mn-Water soluble		Mn-Exchangeable		Mn-DTPA-available	
	Initial year	12th year	Initial year	12th year	Initial year	12th year
T_1	0.480	0.488	2.31	1.71	5.17	5.36
T_2	0.460	0.463	2.53	1.83	5.98	5.55
T_3	0.499	0.483	2.64	1.84	5.82	5.16
T_4	0.459	0.484	2.42	1.62	5.80	5.18
T_5	0.496	0.509	2.40	1.60	5.51	5.39
T_6	0.466	0.463	2.35	1.54	5.71	5.37
T_7	0.494	0.512	2.71	1.60	6.33	5.94
T_8	0.482	0.590	2.02	1.89	6.40	6.50
T_9	0.446	0.634	2.51	2.11	6.80	6.93
T_{10}	0.456	0.464	2.03	1.65	5.57	5.70
T_{11}	0.452	0.493	2.13	1.51	6.16	5.71
T_{12}	0.458	0.453	2.15	1.46	5.66	5.10
S.E.±	0.025	0.027	0.23	0.15	0.39	0.29
C.D. (P=0.05)	NS	0.079	NS	NS	NS	0.85
C.V.%	10.5	10.8	19.5	17.4	13.4	10.4
Mean	0.471	0.503	2.35	1.70	5.91	5.66
Y * T	S.E.± = 0.038	C.D. (P=0.05) = NS	S.E.± = 0.24	C.D. (P=0.05) = NS	S.E.± = 0.49	C.D. (P=0.05) = NS

Table 1 contd....

Treatments	Mn-Reducible		Mn-Total		Mn-Residual	
	Initial year	12th year	Initial year	12th year	Initial year	12th year
T_1	44.95	44.50	242.8	221.6	189.9	169.5
T_2	44.77	43.90	242.0	219.0	188.3	167.3
T_3	44.85	44.56	241.2	212.7	187.4	160.7
T_4	45.38	44.56	250.0	216.1	195.9	164.3
T_5	44.92	45.66	246.3	225.1	193.0	171.9
T_6	46.55	45.32	248.2	219.6	193.1	166.9
T_7	45.36	45.49	256.9	219.5	202.0	165.9
T_8	45.42	46.39	260.0	237.7	205.7	182.4
T_9	45.29	46.99	258.8	241.2	203.8	184.5
T_{10}	45.50	45.76	250.6	226.6	197.1	173.0
T_{11}	45.01	44.21	247.8	216.4	194.1	164.5
T_{12}	44.52	43.85	243.6	207.0	190.8	156.2
S.E.±	0.61	0.68	4.46	4.04	4.52	4.10
C.D. (P=0.05)	NS	1.95	12.8	11.6	NS	11.8
C.V.%	2.7	3.0	3.6	3.6	4.6	4.9
Mean	45.21	45.10	249.0	221.9	195.1	168.9
Y * T	S.E.± = 0.65	C.D. (P=0.05)= NS	S.E.± = 3.99	C.D. (P=0.05)= NS	S.E.± = 4.09	C.D. (P=0.05)= NS

Table 1 contd....

Treatments	Mn-per cent available		Mn-total available	
	Initial year	12th year	Initial year	12th year
T_1	21.84	23.50	52.91	52.06
T_2	22.22	23.64	53.74	51.74
T_3	22.32	24.49	53.81	52.04
T_4	21.64	24.11	54.06	51.84
T_5	21.67	23.63	53.33	53.16
T_6	22.22	24.00	55.08	52.69
T_7	21.39	24.44	54.90	53.54
T_8	20.90	23.29	54.32	55.37
T_9	21.27	23.52	55.04	56.66
T_{10}	21.38	23.66	53.55	53.57
T_{11}	21.70	24.01	53.75	51.94
T_{12}	21.62	24.57	52.79	50.85
S.E.±	0.49	0.55	0.76	0.66
C.D. (P=0.05)	NS	NS	NS	1.89
C.V.%	4.5	4.6	2.8	2.5
Mean	21.68	23.90	53.94	52.96
Y * T	S.E.± = 0.52	C.D. (P=0.05)= NS	S.E.± = 0.76	C.D. (P=0.05)= NS

NS=Non-significant

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 - 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) and T_{12} - Control. These soil samples were sequentially extracted for different Mn fractions as per the procedure described by Jackson (1979) and Viets (1962) as water soluble, exchangeable, DTPA available, and reducible form. Total Mn status was determined by digesting the soil using HF: $HClO_4$ (5:1). These extracts were analyzed for their Mn content on Atomic Absorption Spectrophotometer. Residual form of Mn was calculated by deducting water soluble + exchangeable + DTPA available + reducible (i.e available total) from the total Mn status of the soil. The per cent available Mn status was calculated as available total of the total Mn status of the soil.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Mn-Water soluble:

The water soluble Mn was found in very trace quantity and found significant variation due to treatments over time (Table 1). Similarly, Mehra and Baser (1982) and Sharma *et al*. (1997) also reported stress amount of water soluble Mn.

Mn–exchangeable :

Exchangeable Mn content was not affected by different treatments over time and Y x T interaction also found non-significant (Table 1).

Mn-DTPA available:

The DTPA-available form of Mn found significant after 12^{th} year under the application of FYM (Table 1). The overall mean value of DTPA available-Mn decreased after 12 year. Similarly, Dangarwala *et al*. (1996) reported that after harvesting of 26^{th} crops Mn availability was reduced.

Mn-reducible :

The reducible form of Mn showed significant difference due to treatments over time (Table 1). The mean value of the reducible after 12 year slightly decline and found lowest in the chemical fertilizer treatments suggesting enhanced utilization of reducible Mn.

Mn-total :

The Mn-Total form found significant at initial and 12^{th} year under the application of organic fertilizer (Table 1). The highest value found under the application of T_8 at initial year and T_9 at 12^{th} year. Overall mean registered decrease in the total Mn content on the long run basis. There is a possibility of replenishing Mn in the soil by fertilizer application. These finding support the earlier work Bhardwaj and Omanwar (1994).

Mn-residual :

The differences due to treatment with respect to residual Mn content was significant only after a long run of at 12^{th} year. The mean value of residual increased after 12^{th} year of experiment.

Mn-per cent available :

The per cent available form of Mn found non-significant due to treatment after long run in experiment (Table 1) but numerical mean value was increased after 12^{th} year.

Mn-available total :

The Mn-available total form found significant at 12^{th} year under the application of organic fertilizer (Table 1). The highest value was under the organic fertilizer as compared to chemical fertilizer treatments indicating faster utilization of available total-Mn by the application of chemical fertilizers.

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