International Journal of Research in Agronomy 2024; SP-7(8): 252-255

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(8): 252-255
Received: 11-06-2024
Accepted: 17-07-2024

Vekaria LC
Assistant Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Vaghani JJ
Associate Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Mota Bhandariya (Amreli), Rajasthan, India

Vasoya Mansi J
M.Sc. (Agri.) Student, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Jadeja AS
Assistant Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Parakhia DV
Agriculture Officer, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Ponkia HP
Assistant Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Corresponding Author:
Vekaria LC
Assistant Professor, Department of Soil Science & Agricultural Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh, Rajasthan, India

Dynamics of iron fractions in calcareous *Vertic ustochrepts* under AICRP-LTFE soils

Vekaria LC, Vaghani JJ, Vasoya Mansi J, Jadeja AS, Parkhia DV and Ponkia HP

DOI: https://doi.org/10.33545/2618060X.2024.v7.i8Sd.1281

Abstract
The dynamics of Fe fractions in the selective treatments were studied by collecting the surface soil samples (0-15 cm) from the LTFE's conducted on groundnut-wheat-fodder at Instructional Farm, Junagadh Agricultural University, Junagadh during the year 1999 – (Initial soil), 2002-03 (4th year), 2006-07 (8th year) after completion of crop cycle. In a long run after 8th year the significant values were recorded in T_9 followed by T_4, T_{10} and T_{11}. Exchangeable Fe content did not showed any significant differences either through treatments or through years. The DTPA available and reducible Fe was significant when pooled over year and also Y x T interaction was significant. Total and residual-Fe content showed significant change, when pooled over the year and Y x T interaction was also significant. Highest value was recorded under application of FYM @ 25 t/ha to G'nut. Overall mean value was depleted on long term basis. The percentage availability and available total-Fe were also exhibited more or less same trend but in available total Y x T interaction was not significant.

Keywords: LTFE's soil, Fe fraction, water soluble-Fe, exchangeable-Fe, DTPA available- Fe, total-Fe, per cent available-Fe

Introduction
Inspite of high total iron in soils, its availability to crops is a major problem in many soils. The various forms of iron in soil are the immediately available, the available pool, available on decomposition and potential medium long term sources of available iron (Katyal and Deb, 1982) [5]. The DTPA available iron in Indian soils is greatly varies from traces to 982 ppm (Kanwar and Randhawa, 1974) [4]. This variation is mainly attributed to the soil types and their characteristics nature of chemical extractants used and agro-ecological condition (Sangwan and Singh, 1993) [8]. Considering this fact, there is a urgent need to study the dynamics of different forms of iron under intensive agricultural system and hence, the present investigation was planned.

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), 2002-03 (4th year, after wheat) and 2006-07 (8th year, after wheat). The treatments were T_1- 50% NPK 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^{-1} 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 + FYM @ 10 t ha^{-1} to G'nut and 100% N P K to Wheat, T_9 - Only FYM @ 25 t ha^{-1} to G'nut only, T_{10} - 50% N P K of recommended doses + 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 SSP) and T_{12} – Control. These soil samples were sequentially extracted for different Fe fractions as per the procedure described by Jackson

(1973) [1] as water soluble, exchangeable, DTPA available, and reducible form. Total Fe status was determined by digesting the soil using HF: $HClO_4$ (5:1). These extracts were analyzed for their Fe content on Atomic Absorption Spectrophotometer. Residual form of Fe was calculated by deducting water soluble + exchangeable + DTPA available + reducible (i.e available total) from the total Fe status of the soil. The per cent available Fe status was calculated as available total of the total Fe status of the soil.

Result and Discussion

Fe – Water Soluble

Pooled differences were not significant but Y x T interaction was significant. In a long run after 8th year the significant values were recorded in T_9 followed by T_4, T_{10} and T_{11}. The results are indicative of enhancing water soluble iron utilization by the application of fertilizers in a long run. Overall there was a numerical decrease in the water soluble iron content over a period of time (Table 1). The amount of water soluble ferrous iron was practically nil in almost all cases (Joshi and Dhir, 1982) [2].

Fe – Exchangeable

Exchangeable iron content did not showed any significant differences either through treatments or through years (Table 1). Exchangeable Fe ranged between 2 -8 ppm observed by Joshi *et al*. (1988) [3].

Fe – DTPA Available

The DTPA available iron was significant when pooled over year and also Y x T interaction was significant (Table 1). Most of the treatments have higher significant value as compared to control in pooled results. Overall mean value was increased over a long period. The DTPA extractable Fe varied from 1.0 to 21.4 ppm with a mean value of 7.2 ppm (Randhawa and Singh, 1996) [7].

Fe – Reducible

Although reducible iron was significant when pooled over year and also Y x T interaction was significant. The highest value was recorded under application of 100% N P K of recommended doses in G'nut -Wheat sequence (T_2) followed by T_1, T_{11}, T_3 and T_{10} (Table 1) with the least value in all chemical fertilizer treatments. In the chemical fertilizer application resulted in unutilization of reducible iron. Overall mean value is depleted on long term basis. The addition organic matter showed a positive balance reducible Fe fractions but their values were lower than the values without added organic matter observed by Nirupama *et al.* (1999) [6].

Fe – Total

Total iron content showed significant change, when pooled over the year and Y x T interaction was also significant. Highest value was recorded under application of FYM @ 25 t/ha to G'nut. Overall mean value was depleted on long term basis (Table 2). The chemical fertilizer application resulted in enhancement of the utilization of total iron or conversion of total to available form by the soil reaction and under utilization by the plants.

Fe – Residual

Like wise total form, residual iron also showed significant differences when pooled over the year and Y x T interaction was also significant. Highest value was recorded under application of FYM @ 25 t/ha to G'nut (Table 2).

Fe – Percentage Availability

It was significant when pooled over the year and interaction was also significant (Table 2). The application of 50% NPK (T_1) and 100% NPK as P in SSP (T_{11}) of recommended doses in G'nut-Wheat sequence showed the significantly higher values as compared to Control.

Fe – Available Total

Total available form of iron also exhibited more or less same trend. Pooled effect was significant but Y x T interaction was not significant. Highest value was recorded in T_2 followed by T_1 and T_{10}. Overall mean value was same over the time. After 8th year chemical fertilizers in general showed declining trend of Fe available total. While in FYM and control treatment it was maintain. Accumulation in soil was observed by virtue of conversion to available form (Table 2).

Table 1: Status of different forms of available iron in soils of LTFE experiment in 1st, 4th and 8th year

Treat.	Iron water soluble from in soil (ppm)				Iron exchangeable form in soil (ppm)			
	1st year	4th year	8th year	pooled	1st year	4th year	8th year	pooled
T_1	0.035	0.036	0.024	0.032	0.030	0.031	0.035	0.032
T_2	0.035	0.032	0.018	0.028	0.032	0.028	0.027	0.029
T_3	0.035	0.031	0.015	0.027	0.035	0.033	0.027	0.032
T_4	0.035	0.033	0.029	0.032	0.031	0.030	0.032	0.031
T_5	0.030	0.022	0.025	0.025	0.031	0.027	0.034	0.031
T_6	0.029	0.026	0.031	0.029	0.031	0.027	0.040	0.032
T_7	0.035	0.031	0.026	0.030	0.030	0.023	0.032	0.028
T_8	0.032	0.033	0.020	0.028	0.032	0.027	0.040	0.033
T_9	0.034	0.030	0.034	0.033	0.029	0.024	0.038	0.031
T_{10}	0.030	0.038	0.027	0.032	0.032	0.028	0.032	0.031
T_{11}	0.035	0.036	0.027	0.032	0.033	0.030	0.034	0.032
T_{12}	0.035	0.037	0.021	0.031	0.028	0.022	0.031	0.027
SEm±	0.002	0.003	0.003	0.003	0.002	0.003	0.003	0.002
CD at 5%	NS	0.009	0.007	NS	NS	NS	NS	NS
C.V.%	11.300	18.480	20.160	16.560	10.780	24.930	17.600	18.130
Mean	0.033	0.032	0.025	0.030	0.031	0.027	0.034	0.031
Y * T	S.Em.±	0.002	C.D. at 5%	0.007	S.Em.±	0.003	C.D. at 5%	NS

Treat.	Iron DTPA available form in soil (ppm)				Iron reducible form in soil (ppm)			
	1st year	4th year	8th year	pooled	1st year	4th year	8th year	pooled
T_1	4.086	5.234	9.135	6.152	8.51	9.24	7.72	8.49
T_2	4.418	5.477	8.257	6.051	9.13	10.47	7.31	8.97
T_3	4.312	4.466	7.964	5.581	9.16	8.11	6.59	7.95
T_4	4.944	4.873	8.619	6.145	8.01	6.49	6.74	7.08
T_5	4.466	5.232	8.638	6.112	7.18	5.40	6.48	6.36
T_6	4.764	5.365	8.757	6.295	7.20	5.57	7.93	6.90
T_7	4.114	4.864	8.156	5.711	7.44	6.24	6.42	6.70
T_8	4.612	6.176	9.853	6.880	7.93	6.84	6.50	7.09
T_9	4.628	6.320	7.849	6.265	7.20	4.90	5.41	5.84
T_{10}	4.954	5.439	9.052	6.481	8.46	7.90	7.19	7.85
T_{11}	4.735	5.463	10.492	6.897	8.22	7.88	8.28	8.12
T_{12}	4.483	5.018	8.577	6.026	7.81	5.59	6.18	6.53
SEm±	0.228	0.316	0.483	0.284	0.62	0.71	0.54	0.48
CD at 5%	NS	0.910	1.391	0.833	NS	2.05	1.55	1.39
C.V.%	10.040	11.860	11.000	11.530	15.44	20.23	15.65	17.16
Mean	4.543	5.327	8.779	6.216	8.02	7.05	6.90	7.32
Y * T	S.Em.±	0.358	C.D. at 5%	1.007	S.Em.±	0.63	C.D. at 5%	1.77

Table 2: Status of total, residual, per cent available and available total form of iron in 1st, 4th and 8th year in the LTFE soils

Treat.	Iron total form in soil (ppm)				Iron residual form in soil (ppm)			
	1st year	4th year	8th year	pooled	1st year	4th year	8th year	pooled
T_1	28057	27310	25557	26975	28044	27296	25540	26960
T_2	29255	27550	27921	28242	29241	27533	27905	28227
T_3	29548	27313	24852	27237	29534	27300	24837	27224
T_4	29390	27634	25050	27358	29376	27623	25034	27344
T_5	28229	26908	26369	27169	28218	26897	26353	27156
T_6	30598	28217	26282	28366	30586	28206	26265	28352
T_7	28655	27711	26604	27657	28643	27700	26589	27644
T_8	30238	30644	26693	29192	30225	30631	26677	29177
T_9	30504	33200	30091	31265	30492	33189	30078	31253
T_{10}	29495	27900	28352	28582	29482	27886	28336	28568
T_{11}	29457	27399	26438	27765	29444	27386	26419	27750
T_{12}	29647	25319	24619	26528	29635	25308	24604	26516
SEm±	566.12	731.98	857.43	626.58	566.14	731.78	857.34	626.58
CD at 5%	NS	2107.63	2468.84	1837.8	NS	2107.04	2468.58	1837.8
C.V.%	3.85	5.21	6.45	5.2	3.85	5.21	6.46	5.2
Mean	29423	28092	26569	28028	29410	28080	26553	28014
Y * T	S.Em.±	728.35	C.D. at 5%	2046.69	S.Em.±	728.25	C.D. at 5%	2046.42

Treat.	Percentage available of Iron in soil				Total available forms of Iron in soil (ppm)			
	1st year	4th year	8th year	pooled	1st year	4th year	8th year	pooled
T_1	0.045	0.053	0.066	0.055	13.91	14.54	12.66	13.71
T_2	0.046	0.058	0.056	0.054	14.38	16.01	13.62	14.67
T_3	0.046	0.046	0.059	0.050	13.55	12.64	13.54	13.24
T_4	0.044	0.041	0.062	0.049	13.75	11.43	13.02	12.73
T_5	0.042	0.040	0.058	0.046	10.70	10.68	11.71	11.03
T_6	0.039	0.039	0.064	0.048	12.27	10.99	12.03	11.76
T_7	0.041	0.040	0.055	0.045	11.11	11.15	11.62	11.29
T_8	0.042	0.043	0.062	0.049	12.85	13.08	12.60	12.84
T_9	0.039	0.034	0.044	0.039	12.15	11.28	11.89	11.77
T_{10}	0.046	0.048	0.058	0.051	13.90	13.41	13.47	13.59
T_{11}	0.044	0.049	0.071	0.055	13.01	13.40	13.02	13.14
T_{12}	0.042	0.042	0.060	0.048	11.86	10.67	12.36	11.63
SEm±	0.002	0.003	0.003	0.003	0.79	0.78	0.65	0.43
CD at 5%	NS	0.008	0.009	0.007	2.29	2.23	NS	1.21
C.V.%	11.220	11.950	10.890	11.400	12.43	12.47	10.32	11.78
Mean	0.043	0.044	0.060	0.049	12.79	12.44	12.63	12.62
Y * T	S.Em.±	0.003	C.D. at 5%	0.008	S.Em.±	0.74	C.D. at 5%	NS

Conclusion
In conclusion, the study highlights the complex dynamics of iron forms in soil over time and under various treatments. Water soluble iron showed significant changes only in specific treatments after eight years, indicating that fertilizer applications can enhance its utilization in the long run. However, a general decrease in water soluble iron was observed. Exchangeable iron remained stable across treatments and years. DTPA extractable iron and reducible iron showed significant changes, with higher values under specific treatments but overall depletion over time, especially under chemical fertilizer use. Total and residual iron content also demonstrated significant changes, with the highest values associated with organic amendments. Percentage availability and total available iron trends similarly indicated significant impacts from specific treatments, with chemical fertilizers leading to a declining trend over time. Overall, while chemical fertilizers initially enhance iron availability, long-term use tends to reduce overall iron content, suggesting a potential benefit of incorporating organic matter to maintain iron levels.

References
1. Jackson ML. Soil chemical analysis. Prentice Hall of Indian Pvt. Ltd., New Delhi, c1973.
2. Joshi DC, Dhir RP. Distribution of different forms of manganese and iron in the soil of extremely air parts of Western Rajasthan. Annals of Arid Zone. 1982;21(1):1-8.
3. Joshi DC, Singh N, Kolarkar AS. Forms of iron and manganese and their availability in the salt affected soils of the Guhiga catchment of the Upper Luni Basin of Rajasthan. Tropical Agriculture. 1988;65(1):41-48.
4. Kanwar JS, Randhawa HS. “Micronutrient Research in Soil and Plants”. A Review of ICAR, New Delhi. c1974.
5. Katyal JC, Deb DL. In: Review of Soil Research in India, Part-I, Journal of Indian Society of Soil Science. c1982. p. 146-159.
6. Nirupama Gogal, Das M, Bora DK. Effect of organic matter on the transformation of different fractions of iron in some Alfisols of Assam under submergence. Journal of Indian Society of Soil Science. 1999;47(1):149-151.
7. Randhawa HS, Singh SP. Distribution of zinc fractions in alluvium derived soils of Punjab. Journal of Indian Society of Soil Science. 1996;43(1):124.
8. Sangwan BS, Singh K. Vertic distribution of Zinc, manganese, copper and iron in the semi-arid soils of Haryana and their relationship with soil proprperties. Journal of Indian Society of Soil Science. 1993;31(3):467.
9. Viet FG. Chemistry and availability of micronutrient in soils. J Agric. Food chem. 1962;10:165-178.