Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

International Journal of Current Research
Vol. 11, Issue, 08, pp.6292-6294, August, 2019

DOI: https://doi.org/10.24941/ijcr.36029.08.2019

ISSN: 0975-833X

RESEARCH ARTICLE

DISTRIBUTION OF DIFFERENT FORMS OF IRON (Fe) AND ALUMINIUM (Al) UNDER DIFFERENT LAND USE SYSTEM IN ACID SOIL

***Linthoi Watham, Indira Sarangthem, Devarishi Sharma, L. and Punil Kumar Singh, L.**

Department of Soil Science and Agricultural Chemistry, College of Agriculture, CAU, Imphal, India

ARTICLE INFO

Article History:
Received 19th May, 2019
Received in revised form
24th June, 2019
Accepted 10th July, 2019
Published online 31st August, 2019

Key Words:

Different forms of iron and aluminium, Jhum, Valley, Terrace, Manipur.

**Corresponding author:*
Linthoi Watham

ABSTRACT

Soil samples were collected from three different districts of Manipur under different land use system viz. Churachandpur (Jhum), Imphal east (Valley) and Senapati (Terrace) following the method of stratified multistage sampling. The aim of the work described here has been to assess the distribution of different forms of iron and aluminium in different land use system of Manipur. The value of KCl extractable Fe and Al was found to be highest In Jhum cultivation than Valley and Terrace cultivation. In Jhum cultivation the value of NH4OAc extractable Fe and Al observed the highest than in valley and terrace. Similarly in Jhum cultivation, the Pyrophosphate extractable Fe and Al showed higher value than the valley and terrace cultivation. Acid ammonium oxalate extractable Fe and Al showed higher values in Jhum cultivation in comparison with Valley and terrace cultivation. The value of Dithionite citrate bicarbonate extractable Fe in terrace cultivation was found to be the highest. On the other hand, the value of Dithionite citrate bicarbonate extractable Al was observed highest in Jhum cultivation.

***Citation: Linthoi Watham, Indira Sarangthem, Devarishi Sharma, L. and Punil Kumar Singh, L.*, 2019.** "Distribution of different forms of iron (Fe) and aluminium (Al) under different land use system in acid soil", *International Journal of Current Research*, 11, (08), 6292-6294.

INTRODUCTION

Soils of the tropical region are dominantly alfisols, ultisols and oxisols and the dynamics of sesquioxides (iron and aluminum oxides) are progressively the determining factor for release of nutrient to planted crops. Iron (Fe) and Aluminum (Al) found in soils are released during soil weathering and soil development; they are re-precipitated as amorphous or crystalline oxides, hydroxides or oxhydroxides. The crystalline form of Al-oxides is thought to be substituted into crystalline Fe-oxides such as geothites and heamatite. However, it can be concluded that the nature, amount and distribution of Iron (Fe) and Aluminum (Al) oxides in soil affect its ionic charge, chemical characteristics, and ion adsorption especially, phosphorus (P) sorption, surface charge and specific surface area. Swelling and aggregate formation may be significantly modified by the presence of amorphous Fe and Al oxides. Profile distribution of different forms of Fe and Al oxides particularly dithionite and oxalate extractable Fe and Al serve as useful indicators to identify the horizon of accumulation of secondary oxides (Bera *et al.*, 2005) and depth of argillic horizon (Dolui and Chakraborty, 1998; Dolui and Chattopadhyay, 1997). The Fe and Al are released during the weathering of Fe and Al bearing parent materials. They are re-precipitated in the soils as oxides or hydroxide and oxyhydroxide of iron and aluminium. The quantity of these alternation products generally increased with soil age (Dolui and Bera, 2001). Thus, this work was carried out to investigate the distribution of different forms of iron and aluminium in different land use system of Manipur

MATERIALS AND METHOD

Soil samples were collected from three different districts of Manipur under different land use system *viz*. Churachandpur (Jhum), Imphal east (Valley) and Senapati (Terrace) district of Manipur by method of stratified multistage sampling.

Analytical procedure: The processed soil samples (< 2 mm size fractions) were analysed to study important physicochemical properties. The pH of the soils were estimated by using soil suspension (1:2.5) (Jackson 1973); organic carbon by the method of Walkley and Black; cation exchange capacity (CEC) by ammonium saturation method (Jackson 1973); clay content by hydrometer method Buoyoucous, 1962.

Distribution of different forms of iron (Fe) and aluminium (Al)

KCl extractable Fe and Al: In Jhum cultivation the value of kcl extractable Fe and Al ranges from 3.67-8.40 $mgkg^{-1}$ and 42.67-96.90 $mgkg^{-1}$ with a mean value of 6.34 and 68.75 $mgkg^{-1}$ (Table 1). In Valley cultivation the value ranges from 3.00-6.64 $mgkg^{-1}$ and 23.55-55.89 $mgkg^{-1}$ with a mean value of

Different extractants used:

Sl. No.	Forms	Extractant	Reference
1.	KCl extractable Fe and Al	1 M KCl (1 hour extraction)	Black (1965)
2.	NH4OAc extractable Fe and Al	NH4OAc (1 hour extraction at pH 4.8)	Olson and Carlson (1950)
3.	Pyrophosphate extractable Fe and Al	Sodium pyrophosphate (over night extraction at pH 10)	Agriculture Canada (1984)
4.	Acid ammonium oxalate extractable Fe and Al	0.2 M acid ammonium oxalate (four hour extraction at pH 3.0)	Agriculture Canada (1984)
5.	Dithionite citrate bicarbonate extractable Fe and Al	Dithionite citrate bicarbonate (20 minutes extraction twice)	CSSC Sub-committee on Methods of Analysis (1978)

Table 1. Forms of iron and aluminium (mg/kg) under Jhum cultivation at 0-20 cm

Soil no.	$\mathrm{Fe_{KCl}}$	$\mathrm{Al_{KCl}}$	$\mathrm{Fe_a}$	$\mathrm{Al_a}$	$\mathrm{Fe_p}$	$\mathrm{Al_p}$	$\mathrm{Fe_o}$	$\mathrm{Al_o}$	$\mathrm{Fe_d}$	$\mathrm{Al_d}$
1.	6.38	96.90	18.20	63.66	730.00	280.00	3543.00	3109.00	6706.00	3918.00
2.	5.45	67.00	13.80	70.55	629.00	261.00	3131.00	2213.00	6157.00	6818.00
3.	7.71	50.00	22.25	57.90	608.00	286.00	3971.00	2464.00	6814.00	4243.00
4.	5.99	70.43	18.40	76.56	667.00	194.00	2998.00	3342.00	6323.00	4218.00
5.	3.67	59.00	17.11	53.14	716.00	307.00	4248.00	2813.00	7065.00	3887.00
6.	4.00	42.67	20.20	78.67	758.00	248.00	3018.00	2173.00	5476.00	2308.00
7.	6.05	71.84	14.38	50.11	575.00	196.00	3153.00	3692.00	5612.00	3844.00
8.	7.05	63.19	20.05	52.89	583.00	266.00	4142.00	2940.00	8596.00	4172.00
9.	4.55	91.40	14.62	47.58	503.00	201.00	3988.00	3936.00	6296.00	5053.00
10.	8.40	75.84	13.62	75.90	587.00	285.00	4085.00	3554.00	5216.00	3261.00
11.	6.64	64.70	11.47	41.43	576.00	261.00	3258.00	3455.00	8762.00	6646.00
12.	5.89	90.43	12.50	58.75	617.00	286.00	4551.00	2771.00	7826.00	5518.00
13.	7.34	80.79	17.00	66.88	556.00	280.00	4173.00	3574.00	5716.00	6127.00
14.	8.11	61.20	15.49	46.14	587.00	303.00	4083.00	3896.00	6885.00	3994.00
15.	7.81	45.90	15.05	60.00	627.00	249.00	3444.00	2183.00	7996.00	6014.00
Mean	6.34	68.75	16.28	60.01	621.27	260.20	3719.07	3074.33	6763.07	4668.07
S.D.	1.46	16.34	3.09	11.77	69.76	36.91	517.96	620.84	1113.80	1304.67

Table 2. Forms of iron and aluminium (mg/kg) under valley cultivation at 0-20 cm

Soil no.	$\mathrm{Fe_{KCl}}$	$\mathrm{Al_{KCl}}$	$\mathrm{Fe_a}$	$\mathrm{Al_a}$	$\mathrm{Fe_p}$	$\mathrm{Al_p}$	$\mathrm{Fe_o}$	$\mathrm{Al_o}$	$\mathrm{Fe_d}$	$\mathrm{Al_d}$
1	4.97	23.55	12.67	33.45	355	155	3035	1452	3780	1970
2	6.44	55.89	9.99	22.87	361	270	4189	2241	4590	4079
3	5.23	56.70	15.55	30.18	291	201	2045	1900	5190	4178
4	4.18	43.22	13.70	57.44	425	175	2178	1500	5255	3520
5	6.64	50.19	11.88	25.10	269	205	4295	1761	3154	4410
6	4.88	38.12	15.00	49.00	310	169	2200	2519	4519	3270
7	3.76	41.93	6.93	35.53	220	130	3018	2134	5400	4100
8	3.00	40.00	10.12	25.66	255	180	1571	2261	4510	1795
9	4.80	45.21	8.4	30.15	200	210	2590	2069	6189	2189
10	5.61	37.29	10.34	37.34	380	190	2451	2142	4619	1860
Mean	4.95	43.21	11.46	34.67	306.6	188.5	2757.2	1997.9	4720.6	3137.1
S.D.	1.13	9.75	2.81	10.98	72.96	37.59	897.03	342.51	854.73	1073.71

Table 3. Forms of iron and aluminium (mg/kg) under terrace cultivation at 0-20 cm

Soil no.	$\mathrm{Fe_{KCl}}$	$\mathrm{Al_{KCl}}$	$\mathrm{Fe_a}$	$\mathrm{Al_a}$	$\mathrm{Fe_p}$	$\mathrm{Al_p}$	$\mathrm{Fe_o}$	$\mathrm{Al_o}$	$\mathrm{Fe_d}$	$\mathrm{Al_d}$
1.	5.89	79.64	20.15	66.26	519	200	3622	3130	5702	3349
2.	4.50	56.47	11.87	55.06	380	217	2982	3439	3903	2330
3.	4.23	52.14	15.94	53.66	412	136	3502	2424	4197	4471
4.	4.97	54.53	17.60	51.33	379	217	2936	1731	6251	4296
5.	4.64	49.73	14.70	55.46	560	212	3081	2040	4980	2664
6.	5.98	35.96	9.37	61.24	421	229	2692	2563	5370	3958
7.	4.41	60.55	9.00	56.47	391	195	2828	3005	6026	4713
8.	3.05	44.66	15.06	66.76	308	123	3670	3390	5123	3321
9.	4.61	59.83	14.44	51.33	391	190	2796	2040	5630	3553
10.	5.28	63.92	17.78	53.35	515	212	3525	3239	5823	2912
11.	4.31	59.36	10.46	59.43	360	185	3679	2770	4511	3954
12.	5.20	46.21	14.56	60.72	387	143	3710	2487	5159	4274
13.	4.79	68.09	9.91	51.73	470	232	3784	1720	6840	4296
14.	4.78	66.03	18.74	57.56	433	195	3620	2955	5596	3950
15.	5.33	48.68	13.00	55.46	431	184	4087	2931	4611	2120
Mean	4.80	56.39	14.17	57.05	424	191	3367	2657	5315	3611
S.D.	0.72	10.85	3.53	4.96	67.22	33.28	435.83	573.08	795.32	805.81

4.95 and 43.21 mgkg^{-1} (Table 2) whereas under Terrace cultivation the value ranges from 3.05-5.98 mgkg^{-1} and 35.96-79.64 mgkg^{-1} with a mean value of 4.80 and 56.39 mgkg^{-1} (Table 3). KCl extractable Fe and Al extracted more or less exchangeable Fe and Al which are held on the charged surfaces. The release of Fe and Al depends on pH and organic matter in soil. Both Fe and Al were high in surface soil possibly because of difference in their clay content, organic matter and pH. The release of Fe and Al increases with decreasing pH due to dissolution of some amorphous Fe and Al (Cabrerra and Talibudeen, 1977). The KCl extractable Fe and Al were highest under jhum cultivation followed by terrace and valley in surface soil.

NH$_4$OAc extractable Fe and Al: In Jhum cultivation the value of NH$_4$OAc extractable Fe and Al ranges from 11.47-

20.05 $mgkg^{-1}$ and 41.43-78.67 $mgkg^{-1}$ with a mean value of 16.28 and 60.01 $mgkg^{-1}$ (Table 1). In Valley cultivation the value ranges from 6.93-15.55 $mgkg^{-1}$ and 22.87-57.44 $mgkg^{-1}$ with a mean value of 11.46 and 34.67 $mgkg^{-1}$ (Table 2). Whereas in Terrace cultivation the value ranges from 9.00-20.15 $mgkg^{-1}$ and 51.33-66.76 $mgkg^{-1}$ with a mean value of 14.17 and 57.05 $mgkg^{-1}$ (Table 3). NH_4OAc extractable Fe and Al extract higher amount of Fe and Al than KCl extractable Fe and Al. It was found to higher in jhum followed by terrace and valley under surface soil.

Pyrophosphate extractable Fe and Al: In Jhum cultivation the value of Pyrophosphate extractable Fe and Al ranges from 503-758 $mgkg^{-1}$ and 194-307 $mgkg^{-1}$ with a mean value of 621.27 $mgkg^{-1}$ and 260.20 $mgkg^{-1}$(Table 1). In Valley cultivation the value ranges from 200.00-425.00 $mgkg^{-1}$ and 130.00-270.00 $mgkg^{-1}$ with a mean value of 306.00 and 188.50 $mgkg^{-1}$ (Table 2). Whereas in Terrace cultivation the value ranges from 308.00-560.00 $mgkg^{-1}$ and 123.00-229.00 $mgkg^{-1}$ with a mean value of 424.00 and 191.00 $mgkg^{-1}$ (Table 3). The Pyrophosphate extractable Fe and Al extract the fractions of Fe and Al which are bound to organic matter (Loveland and Digby, 1984). Pyrophosphate extractable Fe and Al were highest in the surface horizon which might be due to being intimately related with organic matter content in the soil profile. Similar results were reported by Dolui *et al.,* (1988).

Acid ammonium oxalate extractable Fe and Al: In Jhum cultivation the value of Acid ammonium oxalate extractable Fe and Al ranges from 2998-4551 $mgkg^{-1}$ and 2173-3936 $mgkg^{-1}$ with a mean value of 3719.07 $mgkg^{-1}$ and 3074.33 $mgkg^{-1}$(Table 1). In Valley cultivation the value ranges from 1571.00-4295.00 $mgkg^{-1}$ and 1452.00-2519.00 $mgkg^{-1}$ with a mean value of 752.00 and 1997.90 $mgkg^{-1}$ (Table 2). Whereas in Terrace cultivation the value ranges from 3903.00-6840.00 $mgkg^{-1}$ and 2120.00-4713.00 $mgkg^{-1}$ with a mean value of 3367.00 and 2657.00 $mgkg^{-1}$ (Table 3). Acid ammonium oxalate extracts Fe and Al from amorphous inorganic substances as well as organic matter complexes, but did not dissolve crystalline oxide (Parfitt and Child, 1988). The data shows that the Acid ammonium oxalate extracts Fe and Al were highest in Jhum cultivation followed by Terrace and Valley.

Dithionite citrate bicarbonate extractable Fe and Al: In Jhum cultivation the value of Dithionite citrate bicarbonate extractable Fe and Al ranges from 5216.00-7996.00 $mgkg^{-1}$ and 2308.00-6646.00 $mgkg^{-1}$ with a mean value of 6763.00 $mgkg^{-1}$ and 4668.07 $mgkg^{-1}$(Table 1). In Valley cultivation the value ranges from 3154.00-6189 $mgkg^{-1}$ and 1795.00-4410.00 $mgkg^{-1}$ with a mean value of 4720.60 and 3137.00 $mgkg^{-1}$(Table 2).Whereas in Terrace cultivation the value ranges from 3903.00-6840.00 $mgkg^{-1}$ and 2120.00-4713.00 $mgkg^{-1}$ with a mean value of 5315.00 and 3611.00 $mgkg^{-1}$ (Table 3). Dithionite citrate bicarbonate Fe and Al extractant removes finely crystalline Fe and Al in addition to the oxalate solution fraction (Borggaard 1998). The data revealed that the Dithionite citrate bicarbonate extractable Fe and Al were highest in jhum cultivation followed by terrace and valley cultivation system.

Conclusion

The KCl extractable Fe and Al were highest under jhum cultivation followed by terrace and valley in surface soil. It was found to higher in jhum followed by terrace and valley under surface soil. Pyrophosphate extractable Fe and Al were highest in the surface horizon which might be due to being intimately related with organic matter content in the soil profile. The data shows that the Acid ammonium oxalate extracts Fe and Al were highest in Jhum cultivation followed by Terrace and Valley. The data revealed that the Dithionite citrate bicarbonate extractable Fe and Al were highest in jhum cultivation followed by terrace and valley cultivation system.

REFERENCES

Agriculture Canada, 1984. Analytical Methods Manual (B. H. Sheldrick, ed.) Land Resource Institute, Ottawa, ON, LLRI Contribution. pp 84-90.

Bera, R., A. Seal, M. Banerjee and A.K. Dolui, 2005. Nature and profile distribution of iron and aluminum in relation to pedogenic processes in some soils developed under tropical environment in India. *Environ. Geol.,* 47: 241-245.

Black, C. A. 1965. Methods of Soil Analysis Part I and II, *American Society of Agronomy*, Inc., Madison, Wisconsin, USA.

Borggard, O.K. 1988. Phase identification by selective dissolution techniques. In: Iron in soil and clay minerals, *J. W. Stucki, B. A. Goodman and U. Schwertmann (eds). D. Reidel Publishing Company, Boston, M.A.* 93-98.

Buoyoucous, G.J. 1962. Hydrometer method improved for making particle size analysis of soils. *Agron. J.* 54: 464-465.

Cabrerra, F and Talibudeen, O. 1977. Effect of soil pH and organic matter on labile aluminium in soils under permanent grass. *J. Soil Sci.,* 28: 259-270.

Canada Soil Survey Committee, Subcommittee on Methods of Analysis, 1978. Manual on Soil Samplingand Method sof Analysis. In J. A. McKeague, ed. Canadian Society of Soil Science, Ottawa, Canada. Pp 98-106.

Dolui, A.K. and N. Chakraborty, 1998. Differentiation of forms of extractable aluminium in relation to pedogenic processes in two alfisols and an entisols. Int. J. Trop. Agric., 16: 257-266.

Dolui, A.K. and P.P. Chattopadhyay, 1997. Extraction of froms of iron from some soil series of West Bengal and Bihar. Agropedology, 7: 44-47.

Dolui, A.K. and R. Bera, 2001. Relation between iron forms and pedogenic processes in some alfisols of Orissa, India. Agrochimica, 45: 161-170.

Dolui, AK, Chandran, P. and Nayek, A K. 1988. Nature imd profile distribution of iron in some soil series of Jalpaiguri district, West Bengal. *Proc. Natn. Aca. Sci. India,* 58, (A) Part-J 1-6.

Jackson, M.L. 1973. Soil Chemical analysis, Pub.Prentice Hall of Indian pvt. Ltd., New Delhi

Loveland, P. J., and Digby, P. 1984. The extraction of Fe and A1 by 0.1 M pyrophosphate solutions: a comparison of some techniques. *J. Soil Sci.,* 35, 243-50.

Olson, R. V. and Carlson, C. W. 1950. Iron chlorosis of sorghum and trees as related to exchangeable soil iron and manganese. *Proceedings of the Soil Science Society of America,* 14: 109-112

Parfitt, R. L., Childs, C. W., and Eden, D. N. 1988. Ferrihydrite and allophane in four Andepts from Hawaii and implications for soil classification. *Geoderma,* 41.

Walkley A. and Black, L.A 1934. An experiment of the different method for determining soil organic matter & a proposed modification of the chromic acid titration method. *Soil Science*, 37: 29-38.

****