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Studies on Soil Fertility Status under Different Land Use Systems in Nagaland

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Abstract
A research investigation was undertaken during 2014 to evaluate the fertility status of soils under forest and jhum land use system from twelve different locations covering three districts of Nagaland. The investigation results revealed that the soils of are strongly acidic to moderately acidic with high soil organic carbon, medium to high in available N, low to medium in available K, deficient in available P and adequate in available S. The soils of forest land use system are generally high in nutrient availability than those under jhum land use system. The available P under forest land use system showed positively correlated with the organic carbon (r= 0.695*) and available N (r= 0.602*) while under jhum land use system the available N showed positively correlated with the organic carbon (r= 0.873**).

Keywords: Fertility, forest, jhum, land use system, correlation

Introduction
Intensification in agricultural landscapes and land use change has resulted in widespread soil degradation and loss in soil-based ecosystem services and biodiversity. Land use pattern play an important role in governing the nutrient dynamics and fertility of soil. A particular land use system may directly or indirectly affects the physicochemical properties of soils which may modify the fertility status and nutrient availability to plants. Understanding the fertility status of a soil is vital for maintaining soil health and sustainable agricultural production. Therefore the present investigation was undertaken to generate information regarding the fertility status of soils under different land use system from twelve different locations covering three districts of Nagaland.

Materials and Methods
The bulk surface soils (0-15cm) under forest and jhum land use system were collected from twelve villages of three selected districts of Nagaland namely, Rusoma, Kohima, Meriema and Kidima under Kohima district, Kangching, Tamlu town, Tamlu and Namsang under Tuensang district and Wansoi, Maksha, Panso and Keshai under Longleng district. Soil samples were crushed and passed through 2 mm sieve.
The soil pH was determined in 1:2 soil:water suspension using glass electrode pH meter (Richards, 1954). Electrical conductivity was determined in 1:2 soil:water suspension using conductivity bridge and expressed as dSm^{-1} (Richards, 1954). The sand, silt and clay fractions of soil samples were determined by the International Pipette method using 1N sodium hydroxide (NaOH) as a dispersing agent (Piper, 1966). The organic carbon of the soil sample was determined by rapid titration method advocated by Walkely and Black method and expressed in percentage as described by Jackson (1973). The cation exchange capacity (CEC) of the soil was determined by leaching the soil with neutral normal ammonium acetate solution (1 N NH_4OAc) at pH 7.0 (Chapman, 1965).
The available nitrogen was determined by using alkaline potassium permanganate method (Subbiah and Asija, 1956). The available phosphorous was determined by Bray and Kurtz No-1 method (Bray and Kurtz, 1945) as described by Baruah and Barthakur (1997). The available potassium was determined flame photometrically after extracting the soil with neutral normal ammonium acetate (NH_4OAc) at pH 7.0 (Jackson, 1973). The available sulphur was extracted from the soil using 0.15% $CaCl_2$ as extractantsin a ratio of 1:5 soil:extractant (Chesnin and Yien, 1950). The sulphur in the extract was determined by Turbidimetric method and the intensity of the turbidity formed was measured using UV spectrophotometer at a wavelength of 440 nm. The soluble and adsorbed sulphate S from the soil were extracted by 0.01M $Ca(H_2PO_4)_2$ and determined turbidimetrically by using spectrophotometer at wavelength 420μm (Chesnin and Yien, 1950).

Exchangeable Ca and Mg were determined in 1N ammonium acetate extracts of soil by titration against EDTA (Black 1965).

Results and Discussion

Physico-chemical properties of soil under jhum and forest land use systems

The present investigation showed that the soils in all the three districts namely Kohima, Longleng and Tuensang falls under sandy clay and sandy clay loam textural class. It was observed that the percentage of sand, silt and clay ranges from 45.20-60.60%, 10.00-21.00% and 27.80-39.80% respectively. The findings are in conformity with Zende (1987) who reported that the percentage sand, silt and clay of soils of Nagaland ranges from 17-91%, 4-48% and 4-35% respectively.

In general, the pH of soils both under jhum and forest land use system varied from strongly acidic to moderately acidic in reaction. Acidic nature of parent material and leaching of exchangeable bases and soluble salts under high rainfall are the causes of acidic reaction of the soils. The soils of jhum land use system was found to varied from 5.10 to 5.90 while the forest land use system were found to varied from 4.60 to 5.66. The lower pH value forest land use system in may be due to higher Al and Fe content and low base saturation Saha *et al.* (1999). Patton *et al.* (2005) also reported that the soils of Nagaland were acidic in nature with a pH range of 4.6 to 5.9 and 4.6 to 5.7 in cultivated and forest soils respectively. Sen *et al* (1997) also reported that the soils of North East region were acidic in reaction (4.0 to 5.6). The soil pH shows positive correlation with clay (0.597*) which may be due to the presence of H^+ ions on the exchange site of clay.

The organic carbon (OC) in the soil was found to be high irrespective of the land use system ranging from 0.98 to 2.55% and 0.96 to 2.55% under forest land use system and jhum land use system respectively. Datta *et al* (1983) reported that the organic carbon content of the soils of Nagaland ranges from 0.55 to 3.09%. On an average, higher percentage of organic carbon was found in soils of forest land use system (2.00%) conditions as compared to jhum land use system (1.71%) which can be attributed to higher root residues and forest litter (Khera and Kahlon 2005).

The concentration of salts in the soil is estimated from the electrical conductivity (EC). On an average, the electrical conductivity of the soils of forest land use system and jhum land use system varied from 0.16 dSm^{-1} to 0.35 dSm^{-1}. Kire (1992) also reported that the electrical conductivity of the soils of Kohima district of Nagaland varied from 0.15 to 0.69 mmhos cm^{-1}.

Irrespective of the land use system the cation exchange capacity (CEC) of soils was low in all the three districts of Nagaland. On an average, the forest land use systems have higher CEC value13.22 cmol (p^+) kg^{-1} than the jhum land use system (11.43 cmol (p^+) kg^{-1}). The higher CEC value of forest soils can be attributed to higher organic carbon content in the soil of forest land use system (Kumar *et al.* 2002). The cation exchange capacity (CEC) of the soils of forest land use system and jhum land use system vary from 8.40 to 21.20 cmol (p^+) kg^{-1} and 6.20 to 19.80 cmol (p^+) kg^{-1} respectively. Sharma *et al.* (2012) also reported that the CEC of Nagaland soils vary from10.3 to 15.3 cmol (p^+) kg^{-1}.

Soil fertility status under forest land use system and jhum land use system

The available N status of the soils varies from medium to high both forest and jhum land use system. However, the available N was observed to be higher in the forest land use system with an average of 601.21 kg ha^{-1} as compared with the soils of jhum land use system foothill (567.54 kg ha^{-1}). This may be due to the fact that organic carbon is higher in the forest land use system which contributes to the available nitrogen content in the soil. Chenithung *et al.* (2014) reported that the N status of forest soils was higher in comparison to cultivated land of Nagaland. The available N shows positive correlation with organic carbon (0.873**) of soil under jhum land use system which indicates soil organic matter is a major source of nitrogen.

The soils of forest land use system and jhum land use system in all the three districts of Nagaland was found to be low in available P status. Sharma and Shukla (2001) also reported that over 50% of the soils in Nagaland were deficient in available P. The low content of available P in these soils might be due to higher fixation of phosphorus by Fe^{2+}, Mn^{2+} and Al^{3+} (Laskar *et al.* 1983). The available P of soils under forest and jhum land use system varied from 6.27 to 9.12 kg ha^{-1} and 6.27 to 8.40 kg ha^{-1} respectively. The available P shows positive correlation with organic carbon (0.695*) under forest land use system indicating that organic matter is a source of available P in soil (Chenithung *et al.* 2014).

The available K status of the soils varied from 56 to 184.80 kg ha^{-1} and 78.40 to 184.80 kg ha^{-1} under forest and jhum land use system respectively which was found to be low to medium in available K status. Kire (1992) also reported low to medium available K content in soils of Nagaland. On an average, the jhum land use system (134.63 kg ha^{-1}) contained higher amount of available K content than the soils of forest land use system (122.95 kg ha^{-1}). Positive correlation was found between available K and clay (0.623*) which could be due to the presence of K on the exchange sites of clay.

On an average the exchangeable $Ca^{2+}+Mg^{2+}$ in soils of forest land use system and jhum land use system was 4.05 cmol (p^+) kg^{-1} and 10.15 cmol (p^+) kg^{-1} respectively. Similar finding has been reported Kumar and Rao (1990) in soils of Manipur. The exchangeable $Ca^{2+}+Mg^{2+}$ shows negative correlation with clay (-0.619*).

On an average, the amount of soluble sulphate was found to be higher in jhum land use system (1.76 μg g^{-1}) than the forest land use system (1.51 μg g^{-1}). On the other hand, the amount of adsorbed sulphate was higher in forest land use system (4.36 μg g^{-1}) than the soils of jhum land use system (2.99 μg g^{-1}). This can be attributed to the fact that forest land use system being more acidic than the jhum land use system and adsorbed SO_4^{2-} in soil increases with decrease in pH (Guadalix *et al.* 1991 and Xue *et al.* 1991). The soluble sulphate shows negative correlation with clay (-0.638*) while the adsorbed sulphate shows negative correlation with CEC of the soil (761**) under forest land use system.

Table 1: Sand, silt and clay percentage and textural class of soils under forest land use system and jhum land use system

Soil Sample	Forest land use system				Jhum land use system			
	Sand (%)	Silt(%)	Clay(%)	Textural Class	Sand (%)	Silt(%)	Clay(%)	Textural Class
Kohima District								
Rusoma	50.20	12.00	37.80	sc	52.00	16.80	31.20	scl

Kohima	51.60	10.40	38.00	sc	51.80	19.20	29.00	scl
Meriema	51.00	14.00	35.00	sc	46.60	15.40	38.00	sc
Kidima	53.20	9.60	37.20	sc	48.20	14.20	37.60	sc
Longleng District								
Kangching	45.20	10.00	39.80	sc	46.00	14.80	39.20	sc
Tamlu Town	50.00	12.80	37.20	sc	53.40	12.00	34.60	scl
Tamlu	53.80	12.00	34.20	scl	54.00	15.40	30.20	scl
Namsang	57.80	11.60	30.60	scl	53.80	11.80	34.40	scl
Tuensang District								
Wansoi	60.40	11.80	27.80	scl	49.20	13.20	37.60	sc
Maksha	51.60	16.40	32.00	scl	46.00	21.00	33.00	scl
Panso	60.60	10.20	29.20	scl	59.40	11.20	29.40	scl
Keshai	49.20	13.00	37.80	sc	54.20	12.4	33.40	scl

Note: sc indicates sandy clay scl indicates sandy clay loam

Table 2: pH, organic carbon (OC), electrical conductivity (EC) and cation exchange capacity (CEC) of soils under forest land use system and jhum land use system

Soil Sample	pH		Organic carbon (%)		EC (dSm^{-1})		CEC (cmol (p^+) kg^{-1})	
	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system
Kohima District								
Rusoma	4.95	5.10	2.55	2.40	0.70	0.19	15.60	12.60
Kohima	4.71	5.21	2.40	1.73	0.22	0.20	17.20	19.40
Meriema	4.90	5.65	2.28	2.55	0.26	0.21	19.60	19.80
Kidima	5.45	5.40	2.18	1.46	0.24	0.16	21.20	14.00
Longleng District								
Kangching	5.20	5.90	1.95	1.26	0.16	0.11	9.20	6.20
Tamlu Town	4.60	5.40	0.98	0.96	0.23	0.23	11.80	10.20
Tamlu	5.30	5.50	1.65	1.13	0.24	0.24	12.10	8.40
Namsang	5.40	5.70	1.65	1.28	0.16	0.18	8.40	6.20
Tuensang District								
Wansoi	5.60	5.90	1.58	1.35	0.12	0.12	9.80	9.60
Maksha	5.41	5.70	2.10	2.19	0.20	0.11	9.80	10.20
Panso	5.09	5.60	2.55	2.36	0.49	0.29	11.80	7.60
Keshai	5.20	5.50	2.15	1.91	0.16	0.12	12.20	13.00

Table 3: Available N, P and K, exchangeable Ca^{2+}+Mg^{2+}, soluble and adsorbed SO_4^{2-}- S of soils under forest land use system and jhum land use system

Soil sample	Available N ($kg\ ha^{-1}$)		Available P ($kg\ ha^{-1}$)		Available K ($kg\ ha^{-1}$)		Exchangeable Ca^{2+} + Mg^{2+}(mel^{-1})		Soluble SO_4^{2-}-S ($\mu g\ g^{-1}$)		Adsorbed SO_4^{2-}-S ($\mu g\ g^{-1}$)	
	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system	Forest land use system	Jhum land use system
Kohima District												
Rusoma	675.53	612.46	9.12	8.30	123.30	156.60	3.60	5.60	1.13	1.00	2.25	2.50
Kohima	539.04	515.01	8.81	7.58	67.20	78.40	3.40	6.40	1.38	1.50	3.50	2.75
Meriema	602.46	651.94	6.48	7.59	162.40	167.20	3.40	6.00	1.50	1.25	3.50	2.50
Kidima	551.58	498.86	7.82	8.06	184.00	184.80	6.60	15.00	1.00	1.50	2.25	3.25
Longleng District												
Kangching	652.29	514.76	8.93	6.27	107.50	110.20	3.40	3.60	1.00	1.63	5.88	2.13
Tamlu Town	526.85	476.02	6.70	7.62	131.04	134.40	2.80	2.80	1.25	1.13	3.50	2.75
Tamlu	551.94	502.30	6.27	6.70	67.20	84.00	5.20	5.80	1.50	1.88	3.50	2.63
Namsang	541.94	576.67	6.38	8.06	123.20	134.40	4.80	9.00	2.38	1.63	5.63	4.00
Tuensang District												
Wansoi	602.82	562.64	7.17	6.50	184.80	179.20	7.60	7.00	2.38	1.88	4.63	7.75
Maksha	665.18	627.55	8.60	8.10	156.80	173.60	6.40	8.00	1.50	3.50	6.13	2.25
Panso	614.30	677.55	9.50	8.40	56.00	89.60	16.60	20.40	1.25	2.00	6.13	1.63
Keshai	690.62	594.66	8.50	7.17	112.00	123.20	6.40	5.20	1.88	2.25	5.53	2.25

Table 4: Correlation coefficient under forest land use system

Soil properties	Clay	pH	Organic carbon (%)	EC (dSm^{-1})	CEC (cmol (p^+) kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Exchangeable Ca^{2+} + Mg^{2+}(mel^{-1})	Soluble SO_4^{2-}-S (μg g^{-1})
pH	-0.517									
Organic carbon (%)	0.121	-0.046								
EC (dSm^{-1})	0.079	-0.337	0.548							
CEC (cmol (p^+) kg^{-1})	0.417	-0.322	0.465	0.278						
Available N (kg ha^{-1})	0.104	0.197	0.482	0.281	-0.202					
Available P (kg ha^{-1})	0.225	-0.108	0.695*	0.454	0.014	0.602*				
Available K (kg ha^{-1})	-0.122	0.397	-0.218	-0.267	0.200	0.079	-0.313			
Exchangeable Ca^{2+} + Mg^{2+}(mel^{-1})	-0.619*	0.305	0.334	0.247	-0.164	0.152	0.384	-0.256		
Soluble SO_4^{2-}-S (μg g^{-1})	-0.638*	0.459	-0.339	-0.460	-0.468	-0.072	-0.462	0.213	0.045	
Adsorbed SO_4^{2-}- S (μg g^{-1})	-0.424	0.333	-0.034	-0.353	-0.761**	0.370	0.244	-0.215	0.443	0.361

Note: *, ** indicates significant at 5% and 1% level of significance respectively.

Table 5: Correlation coefficient under jhum land use system

Soil properties	Clay	pH	Organic carbon (%)	EC (dSm^{-1})	CEC (cmol (p^+) kg^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Exchangeable Ca^{2+} + Mg^{2+}(mel^{-1})	Soluble SO_4^{2-}-S (μg g^{-1})
pH	0.591*									
Organic carbon (%)	-0.243	-0.204								
EC (dSm^{-1})	-0.554	-0.402	0.126							
CEC (cmol (p^+) kg^{-1})	-0.042	-0.497	0.451	0.060						
Available N (kg ha^{-1})	-0.173	0.154	0.873**	0.120	0.078					
Available P (kg ha^{-1})	-0.406	-0.503	0.533	0.396	0.184	0.461				
Available K (kg ha^{-1})	0.623*	0.180	0.173	-0.490	0.150	0.169	0.187			
Exchangeable Ca^{2+} + Mg^{2+}(mel^{-1})	-0.226	0.021	0.309	0.392	-0.133	0.404	0.552	-0.013		
Soluble SO_4^{2-}-S (μg g^{-1})	-0.148	0.410	0.168	-0.405	-0.262	0.319	0.014	0.081	0.176	
Adsorbed SO_4^{2-}- S (μg g^{-1})	0.372	0.379	-0.369	-0.335	-0.113	-0.176	-0.365	0.434	-0.094	-0.061

Note: *, ** indicates significant at 5% and 1% level of significance respectively.

Conclusion

From the investigation, it has been revealed that the soils of Nagaland are strongly acidic to moderately acid with high organic carbon content, medium to high available N, low to medium available K and adequate available S and deficient in available P. The soils of forest land use system have higher soil organic carbon and available nutrients than those under jhum land use system.

References

1. Baruah TC, Barthakur HP. A Textbook of Soil Analysis, Vikas Publishing House Private Limited, New Delhi, 1997.
2. Black CA. Methods of Soil Analysis. American Society of Agronomy, Inc, Publisher, Madison, Wisconsin, USA, 1965, 171-175.
3. Bray RH, Kurtz LT. Determination of total organic and available forms of phosphorus in soils. Soil Science. 1945; 59:39-45.
4. Chapman HD. CEC by ammonium saturation. American Journal of Agronomy. 1965; 9:891-901.
5. Chenithung TT, Sharma YK, Sharma SK. Fertility status and soil acidity under different land use system in Wokha district of Nagaland. Journal of the Indian Society of Soil Science. 2014; 28(3):414-418.
6. Chesnin L, Yien CH. Turbimetric determination of available sulphates. Soil Science Society of America Proceedings. 1950; 28:149-151.
7. Datta M, Gupta RK, Prasad RN. Amelioretion and phosphate management of acid soils of Nagaland. Research Bulleting of ICAR for NEH Regoin, Shillong, 1983.
8. Guadalix ME, Pardo MT. Sulphate sorption by variable charge soils. Journal of Soil Science. 1991; 42:607-614.
9. Jackson ML. *Soil Chemical Analysis*, Prentice Hall of India Private Limited., New Delhi, 1973.
10. Khera KL, Kahlon MS. Impact of land use pattern on soil erosion in sub-montane Punjab. Indian Journal of Soil Conservation. 2005; 33:204-06.
11. Kire K. Fertility evaluation, nutrient fixation and effect of liming on rice in soils of Kohima district. *Ph.D thesis*, IARI, New Delhi, 1992.
12. Kumar K, Rao KVP. Fertility status of Manipur valley soils. Indian Journal of Hill Farming. 1990; 3(2):73-75.
13. Kumar S, Sharma JC, Sharma IP. Water retention characteristics and erodibility indices of some soils under different land uses in North-West Himalayas. Indian Journal of Soil Conservation. 2002; 30:29-35.
14. Laskar S, Dahwal KS, Prasad RN. Soils of Tripura and their fertility management. Research Bulleting of ICAR Research Complex for NEH Region, Shillong, (Tripura Centre). 1983; 23:31-36.
15. Patil SG, Veeramallappa P, Hebbara M. Sulphate retention as influenced by pH and soil constituents in some major soil groups of Karnataka. Journal of the Indian Society of Soil Science. 1997; 45:48-53.
16. Patton S, Sharma SK, Singh PK. Characterisation of acid soils of Nagaland. Annals of Plant and Soil Research 2005; 7:107-08.
17. Piper CS. Soil and Plant Analysis. Hans Publishers, Bombay, 1966.
18. Richards LA. Diagnosis and improvement of saline and

alkali soils. Agricultural Handbook No. 60, USDA, Washington, 1954.
19. Saha B, Samra JS, Singh K, Juneja ML. Physico-chemical properties of soils under different land use systems. Journal of the Indian Society of Soil Science. 1999; 47:133-40.
20. Sen TK, Nayak DC, Singh RS, Dubey PN, Maji AK, Chamuah GS, Sehgal J. Pedology and edaphology of benchmark acid soils of North-Eastern India. Journal of the Indian Society of Soil Science. 1997; 45:782-790.
21. Sharma YK, Sharma A, Sharma SK. Distribution of DTPA- Extractable micronutrient cations in soils of Zunheboto district of Nagaland in relation to soil characteristics. Journal of Interacademicia. 2012; 16:101-08.
22. Sharma,U.C. And Shukla, L.M. (2001) Nutrient mining in different agro-climatic zones of NERH. *Fertilizer News* 46, 115-119.
23. Shukla, B., Kherawat, L.M. And Lal, B.S.M. (2013) Kinetics of sulphate release in soils of Jharkhand. *International Journal of Agricultural Science* 9, 139-144.
24. Subbiah, B.V. and Asiji, A.L. (1965) A rapid procedure for the estimation of available nitrogen in soils. *Current Science* 25, 259-260.
25. Walkey, A. and Black, I.A. (1934) An examination of the Degtjareff method for determining soil organic carbon matter and a purposed modification of chronic acid titration method. *Soil Science* 37, 29-38.
26. Xue, D.S. and Harrison, R.B. (1991) Sulphate, aluminium, iron and pH relationships in four Pacific-Northwest forest subsoil horizon. *Soil Science Society of America Journal* 55, 837-840.
27. Zende, N.A. (1987) Soils of Nagaland in relation to their physiography, their characteristics and classification. *Journal of the Indian Society of Soil Science* 35, 706-711.