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Effect of management practices on soil acidity component in tea soil of Assam

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Abstract
The present study was carried out to evaluate the effect of management practices on soil acidity components in tea cultivation of Assam. Sixty numbers of soil samples were collected from two tea gardens of Golaghat district of Assam. Soil sample were analyzed for important soil chemical properties and different forms of acidity components using standard procedures. Conventional system was found to be more acidic than organic system although the pH was maintained at a favorable range for tea production. The Organic system was found to maintain higher levels of organic carbon than conventional system. The Total potential acidity was higher in both the management system. The value of total acidity was lower as compared to total potential acidity. Irrespective of depth all the acidity component were higher in conventional management system as compared to organic management, except pH dependent acidity which was higher in organic management. All the acidity components were found to decrease with depth and increase with age of plantations. Exchangeable acidity showed highly significant positive correlation with exchangeable Al both in organic (r=0.983**) and conventional (r=0.990). Highly significant positive correlation was found in between total potential acidity and pH dependant acidity under organic (r= 0.856**) and conventional (r=0.730**) management. The study showed that variation of acidity components were higher under conventional management which may be due to the dominant role of Al in these soils.

Keywords: Conventional system, organic system, total potential acidity, total acidity, exchangeable al

Introduction
The most recognizable term "soil acidity" which exert an adverse effect on crop growth, through its effect on maintenance of soil quality. The measurement of soil pH is the not only true representation of the soil acidity, which is subjected to change due to number of factors. The some amount of soil acidity is resides in the soil solid phase / interlayer spaces/and functional group of organic material. The major cash crop of Assam known as Tea (*Cammelia sinensis*) plays a very important role in the economic development state. Plantation of tea continuously on the same soil decreases the soil pH (Song and Liu, 1990 and Han *et al*., 2007) [15, 7]. In spite of increased overall productivity of tea plantations worldwide, there are concerns on the declining yields in the last two decades in the older plantations (40 years old and above). These plantations although established with sufficient gaps (more than 25%) no longer respond positively to known agronomic practices (Dutta *et al.*, 2010) [3] probably due to decline in soil quality. Intensive use of chemical fertilizers can jeopardise the conservation of soil and invite new problem which may create potential health hazards (Pradhan, 1992) [11]. Conventional farming system is more acidic as compared to organic farming system. Studies showed that nitrogenous fertilizer used in conventional tea cultivation such as ammonium sulphate, ammonium nitrate, urea etc. leads to soil acidity (Ma *et al.*, 1990) [8]. Use of nitrogenous fertilizers especially ammonium sulphate produces soil acidity by replacing K on the exchange sites. The replaced bases are leached out and the NH_4^+ on the soil particle is nitrified producing soil acidity. In addition to direct uptake of NH_4^+ by the tea plant, only a small fraction (30-40%) is utilized by plants and about 10-20 per cent is leached beyond the rooting zone along with an equivalent amount of bases leaving the soil acidic (Ranganathan and Natesan, 1987) [12].

Materials and Methods
The present investigation entitled, "Effect of management practices on soil acidity component in tea soil of Assam" was carried out at, Department of Soil Science, Assam Agricultural University, Jorhat.

The soil sample were collected from two Tea Estate of Assam of Golaghat district *viz.*, Hatikhuli tea estate (Organic) and Diffloo tea estate (conventional). Four composite samples from three depth and five age groups of tea plantations *viz.*, <15, 15-30, 30-45, 45-60 and >60 years were collected from each tea gardens. Samples were taken at three depths each (0-20cm and 20-40 cm and 40-60cm) from each of the two tea gardens. Altogether sixty numbers of soil samples were collected from each tea gardens. The soil chemical properties and acidity components were determined by standard procedure as described by Baruah and Barthakur (1997) [1]. Factorial RBD over location was undertaken to examine the effects of depth, age and management practices (location) and their interaction on acidity components. Simple correlation between different forms of acidity and were computed following standard statistical methods.

Results and Discussion

Soil Chemical characteristics

The results on chemical properties under organic and conventional management systems are presented in Table 1.

The pH of the soils varied from highly acidic to acidic in reaction ranging from 4.1 to 5.4 with a mean value of 5.2 under organic management whereas under conventional management pH values ranged from 3.6 to 5.1 with a mean value of 4.7. The increase in the soil acidity in conventional tea cultivation was due to the fact of high application of nitrogenous fertilizer such as NH_4SO_4, urea, (Tee *et al*., 1987; Ma *et al.*, 1990) [8] & continuous use of these acidifying fertilizers without the use of lime reduces the soil pH below 4 i.e. to a level which is unsuitable for the economic production of crops (Tisdale and Nelson, 1975). The EC ranged from 0.01 to 0.04 (dS $^{m-1}$), with mean value of 0.015 (dS $^{m-1}$) under organic management whereas under conventional management it ranged from 0.01 to 0.04 (dS $^{m-1}$) with mean value of 0.021 (dS $^{m-1}$).

The organic carbon content of the soils ranged from 0.46 to 1.81 per cent with mean value of 0.76 per cent under organic management, whereas under conventional management it ranged from 0.27 to 0.85 per cent with an average value of 0.57 per cent. The increase in organic carbon in organic management is due to microbial biomass contained in the organic amendment (Glover *et al.* (2000) [5].

The soil varied in CEC ranging from 4.1 to 14.7 cmol(p^+) kg^{-1} with mean value of 7.9 cmol(p^+) kg^{-1} under organic management, whereas under conventional management it ranged from 4.6 to 10.9 cmol(p^+) kg^{-1} with mean value of 7.7 cmol(p^+) kg^{-1}. The higher CEC in organic management is due to presence of more organic matter (Hallsworth, 1958 and Chan, 1992) [6].

Table 1: Soil chemical properties under organic and conventional management system

Parameters	Organic				Conventional			
	Mean	Range	Standard dev	Variance	Mean	Range	Standard dev	Variance
pH (1:2.5)	5.2	4.1-5. 4	0.34	0.11	4.7	3.6-5.1	0.489	0.24
EC (dS $^{m-1}$)	0.015	0.01-0.04	0.007	4.91	0.021	0.01-0.04	0.0065	4.37
Organic carbon (%)	0.76	0.46-1.81	0.28	0.083	0.57	0.27-0.85	0.137	0.018
Cation exch. Capacity [cmol (p^+) kg^{-1}]	7.9	4.1-14.7	2.38	0.728	7.7	4.6-10.9	1.54	2.40

Soil acidity components

The soil acidity components of soils under organic management and conventional management are presented in Table 2. The results showed that total acidity ranged from 1.20 to 2 cmol(p^+) kg^{-1} with a mean value of 2.47 cmol(p^+) kg^{-1} in organic management whereas in conventional total acidity ranges from 1.47 to 4.10 cmol(p^+) kg^{-1}, with a mean value of 2.78 cmol(p^+) kg^{-1}. The exchangeable H^+ ranges from 0.10 to 0.75 cmol(p^+) kg^{-1}, with a mean value of 0.29 cmol(p^+) kg^{-1} in organic management whereas in conventional the exchangeable H^+ ranges from 0.22to 0.60 cmol(p^+) kg^{-1}, with a mean value of 0.35 cmol(p^+) kg^{-1}. The exchangeable Al ranges from 1.25 to 4.25 cmol(p^+) kg^{-1}, with a mean value of 2.32 cmol(p^+) kg^{-1} in organic management whereas in conventional the value ranges from 0.75 to 4.75 cmol(p^+) kg^{-1}, with a mean value of 3.39 cmol(p^+) kg^{-1}. The exchange acidity ranges from 1.37 to 4.45 cmol(p^+) kg^{-1} with a mean value of 2.60 cmol(p^+) kg^{-1} in organic management whereas in conventional, the value ranges from 1.00 to 5.30 cmol(p^+) kg^{-1} with a mean value of 3.75 cmol(p^+) kg^{-1}. The non exchangeable Al ranges from 0.05 to 0.98 cmol(p^+) kg^{-1} with a mean value of 0.39 cmol(p^+) kg^{-1} in organic management whereas in conventional the value ranges from 0.02 to 1.08 cmol(p^+) kg^{-1} with a mean value of 0.34 cmol(p^+) kg^{-1}. The total potential acidity ranges from 4.80 to 10.60 cmol(p^+) kg^{-1} with a mean value of 6.89 cmol(p^+) kg^{-1} in organic management whereas in conventional the total potential acidity ranges from 4.90 to 10.40 cmol(p^+) kg^{-1} with a mean value of 7.10 cmol(p^+) kg^{-1}. The pH dependent acidity ranges from 1.56 to 4.50 cmol(p^+) kg^{-1} with a mean value of 4.25 cmol(p^+) kg^{-1} in organic whereas in conventional the value ranges from 1.38 to 6.7 cmol(p^+) kg^{-1} with a mean value of 3.36 cmol(p^+) kg^{-1}. The extractable acidity ranges from 1.56 to 4.50 cmol(p^+) kg^{-1} with a mean value of 2.93 cmol(p^+) kg^{-1} in organic management whereas in conventional management the value ranges from 1.25 to 5.42 cmol(p^+) kg^{-1} with a mean value of 4.08 cmol(p^+) kg^{-1}. In Compared to organic tea cultivation the value all the acidity components were higher in conventional tea cultivation which may be due to application of more nitrogenous fertilizer except pH dependent acidity which was higher in organic management. This may be due to high content of Fe and Al oxides and organic matter in the soils (Misra *et al.*, 1987) [9], and dissociation of proton from the functional groups like -COOH and phenol (Sanyal, 1991) [13].

Table 2: Soil acidity components under organic and conventional management

Parameters	Organic				Conventional			
Unit: cmol (p^+) kg^{-1})	Mean	Range	Standard dev	Variance	Mean	Range	Standard dev	Variance
Total acidity	2.47	1.20-2.00	0.23	0.05	2.78	1.47-4.10	0.53	0.28
Exch H^+	0.29	0.10-0.75	0.10	0.01	0.35	0.22-0.60	0.09	0.01
Exch Al^+	2.32	1.25-4.25	0.66	0.43	3.39	0.75-4.7	0.85	0.72
Exch acidity	2.60	1.37-4.45	0.66	0.44	3.75	1.00-5.30	0.90	0.82
Non exch Al	0.39	0.05-0.98	0.24	0.06	0.34	0.02-1.08	0.30	0.09
Total potential acidity	6.89	4.80-10.60	1.33	1.76	7.10	4.90-10.40	1.24	1.54
pH dep acidity	4.25	1.56-4.50	0.71	0.50	3.36	1.38-6.73	1.18	1.40
Extractable acidity	2.93	1.56-4.50	0.71	0.50	4.08	1.25-5.42	0.84	0.70

Variation of acidity components with depth and management system

The variation of acidity components with depth and management systems is shown in Table 3. The exchangeable Al was found to increase significantly with depth under conventional tea cultivation. Relatively low exchangeable Al in the surface horizons appears to be due to mobilization of Al by its complexes with organic acids produced by the decomposition of leaf litter in the surface horizons and subsequent downward movement and adsorption of these complexes by clay minerals in the sub-surface horizons (Schnitzer and Skinner, 1963) [14]. The exchange acidity was relatively higher in the lower depths, which is probably due to higher exchangeable Al in the lower depths. Exchangeable Al plays a dominant role in exchange acidity soils (Gangopadhay *et al.*, 2016) [4]. The total potential acidity and pH dependant acidity was found highest at the surface under organic systems of tea cultivation. This is mainly due to higher content of organic matter under organic system Pati and Mukhopadhyay (2011) [10] reported that pH-dependent acidity is the main form of acidity and it increases 1.85 meq for each percentage rise in organic matter.

Table 3: Variation of acidity components with depth and management systems

Depth	Management	Acidity components cmol(p^+)kg^{-1}							
		TA	EH	E Al	Exch A	NExch Al	TPA	PDA	Ext A
0-20	Organic	2.535	0.312	2.402	2.713	0.377	7.170	4.537	2.960
(D_1)	Conventional	3.110	0.364	3.035	3.399	0.183	5.980	3.581	3.583
20-40	Organic	2.350	0.276	2.302	2.579	0.349	6.892	4.394	2.798
(D_2)	Conventional	2.630	0.352	3.497	3.848	0.383	5.190	3.342	4.231
40-60	Organic	2.115	0.271	2.263	2.534	0.446	6.610	4.076	3.042
(D_3)	Conventional	2.629	0.349	3.654	4.003	0.439	5.148	3.145	4.442
S.Ed(±)		0.111	0.028	0.200	0.208	0.071	0.355	0.318	0.197
CD (P=0.05)		0.242	NS	0.435	0.455	NS	0.544	0.431	0.445

NS = Non-significant

Variation of acidity components with age and management systems

Higher value of exchangeable Al, exchangeable acidity, total potential acidity and pH-dependant acidity under conventional tea cultivation with increasing age of plantations indicated that acidity components are significantly altered by long term fertilization (Table 4). Similarly, Wang *et al.* (2010) [18] also observed that continuous cultivation of tea caused soil acidification leading to decrease in basic cations. Organic tea cultivation decreased exchangeable Al but under conventional system, reducing the concentration of exchangeable Al could reduce soil acidification. Significant difference in acidity components was found among organic and conventional system of tea cultivation. Highest acidity was recorded in conventional system which is significantly higher than organic system except pH dependant acidity which was found to be significantly higher under organic which is being contributed from organic matter.

Table 4: Variation of acidity components with age and management systems

Age (Yrs)	Management	TA	EH	E Al	Exch A	NExch Al	TPA	PDA	Ext A
<15	Organic	2.467	0.254	2.711	2.965	0.341	6.492	3.527	3.306
	Conventional	2.550	0.310	3.129	3.469	0.357	7.333	3.864	3.826
15-30	Organic	2.525	0.333	2.454	2.787	0.239	6.450	3.662	3.068
	Conventional	2.835	0.319	3.497	3.816	0.187	6.908	3.093	4.003
30-45	Organic	2.458	0.263	2.425	2.687	0.389	7.542	4.854	3.077
	Conventional	2.600	0.318	2.771	3.088	0.507	6.767	3.678	3.596
45-60	Organic	2.475	0.292	1.956	2.247	0.613	6.604	4.540	2.572
	Conventional	3.149	0.462	4.102	4.563	0.250	7.680	3.117	4.813
>60	Organic	2.408	0.291	2.065	2.356	0.372	7.367	5.094	2.643
	Conventional	2.814	0.435	3.478	3.913	0.374	6.842	3.028	4.118
S.Ed(±)		0.157	0.041	0.282	0.295	0.101	0.502	0.450	0.278
CD (P=0.05)		0.312	0.081	0.252	0.387	0.200	0.999	0.896	0.555

Correlation among soil acidity components with Irrespective of depth

A significant positive correlation of exchange H^+ with exchangeable Al was observed under conventional system (r=0.610**) compared to organic system (r=0.284*). pH-dependent and total potential acidity are in a dynamic equilibrium, they are related to each other. The pH-dependent acidity and total potential acidity showed significant correlations with organic(r=0.856**) and (r=0.730**) under conventional management. Exchange acidity showed higher positive correlation with exchangeable Al (r=0.999**) under conventional management then organic management (r=0.983**) (Table 5 and Fig. 1).

Table 5: Correlation coefficient among acidity components

	Organic								Conventional							
	TA	**EH⁺**	**EAl**	**EXA**	**NA**	**TP**	**PDA**	**EXTA**	**TA**	**EH⁺**	**EAl**	**EXA**	**NA**	**TP**	**PDA**	**EXTA**
TA		0.164	0.0114	0.149	-0.147	-0.003	-0.086	0.094		0.252*	0.096	0.11	-0.260*	-0.110	-0.200	0.031
EH⁺	0.164		0.284*	-0.108	-0.038	-0.140	-0.086	-0.091	0.252*		0.530**	0.610**	-0.250*	0.510**	-0.066	0.560**
EAl	0.114	-0.284*		-0.983**	-0.328**	0.358**	-0.166	0.891**	0.095	0.53**		0.990**	-0.380**	0.390**	-0.330	0.930**
Ex A	0.149	-0.108	0.983**		-0.348**	0.345**	-0.188	0.907**	0.11	0.61**	0.990**		-0.390**	0.420**	-0.300**	0.940**
NA	-0.148	-0.038	-0.328*	-0.348**		0.345**	0.220	-0.016	-0.26*	-0.250*	-0.380**	-0.390**		-0.340**	-0.890**	-0.590**
TP	-0.003	-0.140	0.358*	0.345**	0.027		0.856**	-0.353	-0.11	0.510**	0.390**	0.420**	-0.340**		0.730**	-0.330**
PDA	-0.086	-0.086	-0.166	-0.188	0.220	0.856**		-0.129	-0.200	-0.060	-0.330**	-0.300*	-0.890**	0.730**		-0.360**
EXT	0.094	-0.091	0.891**	0.907**	-0.016	0.353**	-0.129		0.03	0.59**	0.934**	0.938**	-0.230	0.350**	-0.470**	

***significant at 0.05 per cent level
**Significant at 0.01 per cent level

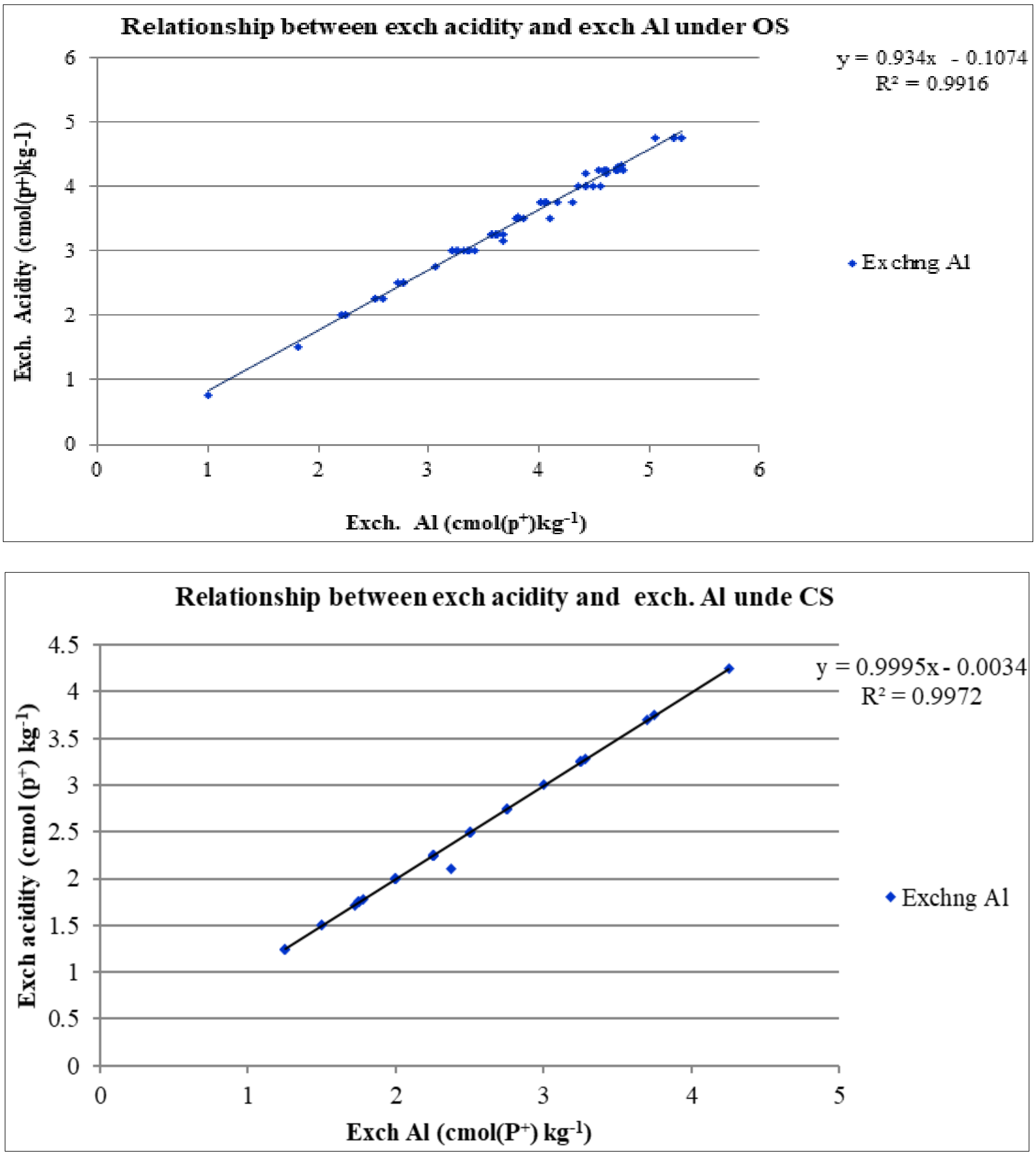

Fig 1: Relationship between exchange acidity and exchangeable Al under both the management system

Correlation coefficient among soil acidity components with depth

Correlation among acidity components with depth is given in Table 6. Highly significant negative correlation was found between exch H^+ and exch Al at all the three depths, under conventional management compared to organic management the highest being at the surface. Exch Al and exch acidity were highly significantly correlated at all the depths both under organic and conventional management, the highest correlation being under conventional management. pH dependant acidity was highly significantly correlated with total potential acidity the highest correlation being under organic management.

Table 6: Correlation coefficient among acidity components with depth

	Organic			Conventional		
	Exch Al	Exch A	TPA	Exch Al	Exch A	TPA
Exch H^+						
D_1	-0.349**			-0.723**		
D_2	-0.254*			-0.307*		
D_3	-0.136			-0.714**		
Exch Al						
D_1		0.984**	0.602**		0.996**	0.488**
D_2		0.980**	0.088		0.994**	0.366**
D_3		0.991**	0.239*		0.997**	0.306*
Extr A						
D_1	0.955**	0.965**		0.992**	0.995**	
D_2	0.948**	0.958**		0.907**	0.924**	
D_3	0.663**	0.711**		0.937**	0.939**	
PDA						
D_1			0.803**			0.748**
D_2			0.848**			0.778**
D_3			0.926**			0.736**

*significant at 0.05 per cent level
**Significant at 0.01 per cent level

Conclusion

It can be concluded from the findings of the present investigation that the total potential acidity was higher in both the management system. all the acidity components were decreased with depth of soil in both the management systems, except exchangeable Al was found to increase significantly with depth under conventional tea cultivation.. The contribution of exchangeable aluminium towards the exchangeable acidity was more conspicuous under both the management systems. So under conventional system, reducing the concentration of exchangeable Al could help to reduce soil acidification creating a favorable soil condition for long term sustainability.

Reference

1. Baruah TC, Barthakur HP. A Text book of Soil analysis. Vikas Publishing House Pvt. Ltd., New Delhi. 1997, 94-103.
2. Chan KY, Roberts WP, Heenan DP. Organic carbon and associated soil properties of a red earth after 10 years of rotation under different stubble and tillage practices. Soil Res. 1992;30(1):71-83.
3. Dutta R, Stein A, Smaling EMA, Bhagat RM, Hazarika M. Effects of plant age and environmental and management factors on tea yield in Northeast India. Agron. J. 2010;102(4):1290-1301.
4. Gangopadhyay SK, Nayak DC, Singh SK. Characteristics of tea growing soils in relation to soil acidity in Upper Brahmaputra Valley of Assam. J. Indian Soc. Soil Sci. 2016;64(4):341-350.
5. Glover JD, Reganold JP, Andrews PK. Systematic method for rating soil quality of conventional, organic, and integrated apple orchards in Washington State. Agric. Ecosyst. Environ. 2000;80(1):29-45.
6. Hallsworth EG, Wilkinson GK. The contribution of clay and organic matter to the cation exchange capacity of the soil. J. Agril. Sci. 1958;51(1):1-3.
7. Han WY, Kemmitt SJ, Brookes PC. Soil microbial biomass and activity in Chinese tea gardens of varying stand age and productivity. Soil Biol. Biochem. 2007;39:1468-1478.
8. Ma WC, Brussaard L, Ridder JA. Long term effect of nitrogenous fertilizer on grassland earthworms (Oligochaeta: Lumbricidae): their relation to soil acidic fixation. Agril. Ecosyst. Environ. 1990;30(2):71-80.
9. Misra UK, Satapathy S, Panda N. Characterization of some acid soils of Orissa. I. Nature of Soil acidity. J Indian Soc. Soil Sci. 1987;37:22-28.
10. Pati R, Mukhopadhyay D. Distribution of cationic micronutrients in some acid soils of West Bengal. J Indian Soc. Soil Sci. 2011;59(2):125-133
11. Pradhan SB. Status of fertilizer use in organic farming. In: Nitrogen in crop production. Hauck, R.D. (ed). A.S.A.CSSA and SSA Madison W.I, 1992, 585-600.
12. Ranganathan V, Natesan S. Manuring of tea–recommendations for high yielding fields. Handbook of Tea Culture 1987;1:1983.
13. Sanyal SK, De Datta SK. Chemistry of phosphorus transformations in soil. In: Advances in soil science. Springer New York, 1991, 1-120.
14. Schnitzer M, Skinner SIM. Organo-metallic interactions in soils. 3. Properties of iron and aluminium-organic matter complexes prepared in the laboratory and extracted from a soil. Soil Sci. 1963;98:197-202.
15. Song M, Liu Y. Effect of biogeochemical cycle in tea garden on the soil acidification. J Tea Sci. 1990;10(2):19-26.
16. Tee BG, Dudas JM, Pawluk S, Harapiak JT. Physical,

chemical and micromorphological effects of nitrogen fertilizers on Chernozemic soils. *Geoderma* 1987;40(2):177.
17. Tisdale SL, Nelson WL. Soil Fertility and Fertilizers. 1975.
18. Wang H, Xu RK, Wang N, Li XH. Soil acidification of alfisols as influenced by tea cultivation in Eastern China. Pedosphere. 2010;20(6):799-806.