ISSN-1680-9955

Pak. J. Anal. Chem. Vol. 6, No. 2, (2005) 59 – 64

Organic Carbon, Nitrogen and Phosphorus Contents of Some Soils of Kaliti Tea-Estate, Bangladesh

M. Shamsuddin Ahmed*, M. M. Hasan Shahin and A. F. M. Sanaullah
Department of Chemistry, University of Chittagong, Chittagong-4331, Bangladesh
E-mail : mshamsuuddin786@yahoo.com

Received: 15-08-2006, Revised: 02-10-2006, Accepted: 28-10-2006

Abstract

Some soil samples were collected from Kaliti Tea-Estate of Moulvibazar district, Bangladesh. Total nitrogen, organic carbon, organic matter, carbon-nitrogen ratio and available phosphorus content of the collected soil samples of different depths and of different topographic positions have been determined. Total nitrogen was found 0.07 to 0.12 %. Organic carbon and organic matter content found to vary from 0.79 to 1.25 and 1.36 to 2.15 % respectively. Carbon-nitrogen ratio of these soils varied from 9.84 to 10.69, while available phosphorus content varied from 2.11 to 4.13 ppm.

Keywords: Soil; total nitrogen; organic carbon; organic matter; carbon nitrogen ratio; available phosphorus.

Introduction

There exists about 162 tea gardens in Bangladesh which is one of the tea exporting countries of the world. Recently, we have reported the physico-chemical properties as well as the nutrient status of the soils of Rungicherra tea - estate of Moulvibazar district, Bangladesh [1, 2]. As a continuation of our work on soil properties of the tea estates, we are now reporting on the organic carbon, organic matter, total nitrogen and available phosphorus content of soils of Kaliti tea estate, a neighboring tea garden of our previous tea – estate Rungicherra.

The growth of plants, like tea, jute, coffee etc. largely depends on the availability of nutrients. Literature survey indicates that works on both primary and secondary nutrient status of soils of different parts of Bangladesh, such as forest [3-5], mangrove [6], flood affected areas [7,8], off-shore islands [9] and Madhupur tract area soils [10-12] are available. But, works on the nutrient status of tea soils of Bangladesh is very scarce. Notably the works of Chaudhury and coworkers [13-17] on the fertility status of some tea estates of Bangladesh are important. Unfortunately, there is no report available on the soil properties of Kaliti Tea-Estate of Moulvibazar district Bangladesh.

*Corresponding author

Experimental

Chemicals

The chemicals have been used for the investigation are: HCl (sp. Gravity 1.180), NaOH (99.99%), Na_2CO_3 (99.5%), H_3BO_3 (99.99%), $FeSO_4$ (99+%), $K_2Cr_2O_7$ (99%), ammonium molybdate (99.98), $SnCl_2$ (99.99%) , KH_2PO_4 (99+%). All the chemicals were from Aldrich. Ammonia free double distilled water was used during the experiments.

Apparatus

An analytical balance of accuracy $\pm$ 0.0001g was used for weighing. Kjeldahl digestion and distillation apparatus were used for the purpose of determination of total nitrogen. A Shimadzu (Model-160) double beam UV- visible spectrophotometer was used for estimating the available phosphorus content.

Collection of soil samples

Soil samples were collected from different sites of Kaliti Tea- Estate, Kulaura, Moulvibazar, Bangladesh. The top-soils (0-9 inches), sub-soils (9-18 inches) and the substratum (18-36 inches) of three different topographic positions (T_1 = hill-top, T_2 = hill-slope and T_3 = hill-base) were collected in the month of December. The collected soil samples from each sampling sites were dried in the air at room temperature, crushed to pass through 2 mm sieve and analyzed.

Methods

Soil organic carbon content was determined by wet oxidation method as described elsewhere [18]. Organic matter content of the soil samples was calculated by multiplying the percent of organic carbon by Van Bemmelon factor of 1.73. [19]. Total nitrogen was estimated by using micro-Kjeldahl digestion and distillation procedure [18]. Available phosphorus was extracted from the soil by using Bray and Kurtz No. 2 solution (0.1N HCL and 0.03N NH_4F) [20]. Phosphorus in the extract was determined by the chlorostannous reduced molybdophosphoric blue color method in a sulphuric acid medium [18].

Results and Discussions

Table 1 lists the organic carbon (OC), organic matter (OM), total nitrogen (TN), carbon nitrogen ratio (C/N) and available phosphorus (AP) contents of the soils along with the standard deviations for each parameter. Each data is the mean of six measurements. Organic carbon contents of the soils are found to be medium and ranged from 0.79 to 1.25 %. This poor status of organic carbon content is thought to be due to its rapid decomposition caused by high rainfall and temperature. However, the OC content for hill-top soils of all depths are higher than that of the critical value (1%) for the cultivation of tea [21], while maximum soils of the other topography have the lower values. Almost similar type of variations for OC content was observed as earlier [2] for Rungicherra tea estate, a neighboring tea estate of the present studied area.

Organic matters (OM) are counted as the life of the soil. OM plays a key role in the maintenance of soil fertility. It affects the physical as well as biological properties of the soil largely. The observed OM content of the studied soil varied with the topographic positions and soil depths. OM content was found to range from 1.36 to 2.15 % (Table 1). Like the soils of rungicherra tea estate [2], hill-top soils of all depths of present tea estate contain higher percentage of OM than those observed for the other topographic positions. The maximum value of OM content was recorded 2.15%. For Rungicherra, the highest value was recorded 2.14%. Some other reported [14, 22] maximum values of organic matter content were 2.73% for Sathgaon, 2.71% for Kurmah 2.58 % for Udnacherra, 1.94 % for Baraoora and 1.40 % for Amrail Tea Estates of the same district.

Table 1. Organic carbon (OC), organic matter (OM), total nitrogen (TN), carbon nitrogen ratio (C/N) and available phosphorus (AP) content of soils of Kaliti Tea-estate.

Depth	Topography	OC	OM	TN	C/N	AP
	Hill top	1.25±0.14	2.15±0.25	0.12±0.01	10.08±0.26	4.13±0.75
0-9″	Hill slope	1.08±0.15	1.87±0.25	0.11±0.01	9.84±0.32	3.16±0.64
	Hill base	0.95±0.12	1.63±0.20	0.09±0.01	10.14±0.47	2.51±0.39
	Hill top	1.15±0.11	1.99±0.20	0.11±0.01	10.01±0.16	3.94±0.80
9-18″	Hill slope	1±0.18	1.72±0.30	0.1±0.01	9.96±0.98	3.02±0.71
	Hill base	0.86±0.12	1.48±0.18	0.08±0.01	10.48±0.47	2.28±0.45
	Hill top	1.09±0.10	1.88±0.17	0.11±0.01	10.11±0.27	3.82±0.77
18-36″	Hill slope	0.93±0.17	1.61±0.29	0.09±0.02	10.27±0.46	2.8±0.63
	Hill base	0.79±0.13	1.36±0.22	0.07±0.01	10.69±0.66	2.11±0.42

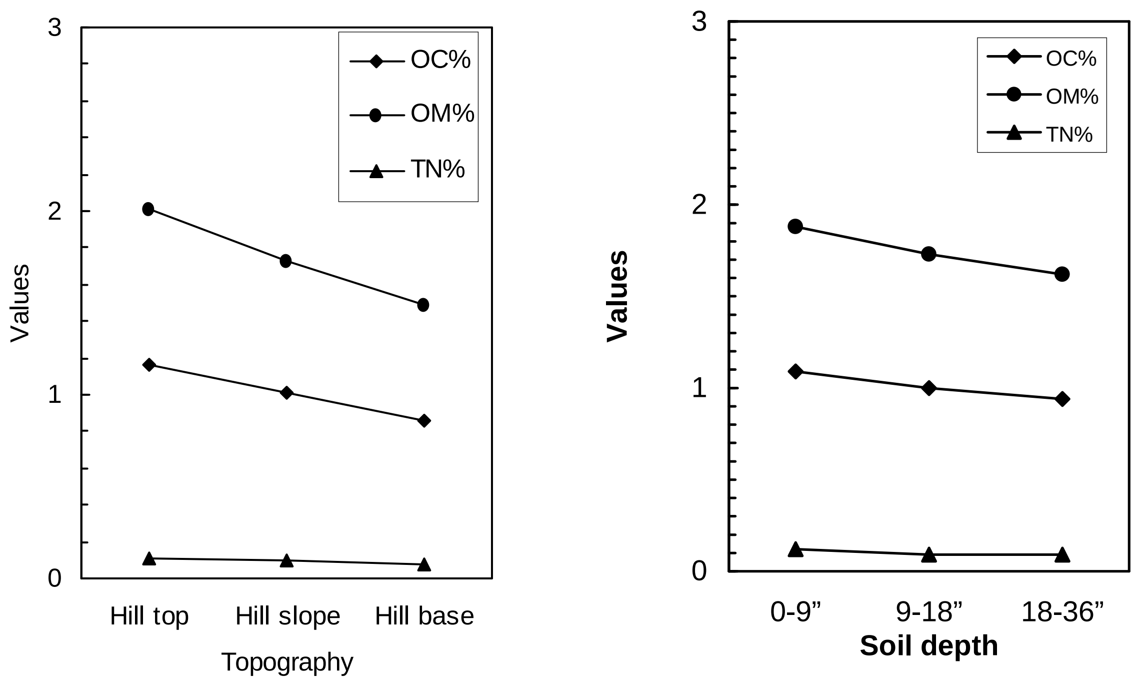

Fig.1. Organic carbon (OC), organic matter (OM) and total nitrogen (TN) influenced by topography and depth of the soils of Kaliti Tea-estate.

Nitrogen, amongst the plant nutrients, plays an important role in increasing the yield of tea. Total nitrogen (TN) of the studied soils was found to range from 0.07 to 0.12 percent (Table 1). TN content has found to decrease gradually with soil depth maintaining the order, top-soil> sub-soil> substratum soil. Most of our soil samples contain slightly higher values of TN than that of the critical value (0.1%) for tea cultivation [21]. Chaudhury and Ahsan [16] observed 0.09 to 0.12% TN for Bilashcherra experimental farm of Bangladesh Tea Research Institute. Recently, Ahmed *et al*. [2] reported 0.095 to 0.13% TN for the soils of Rungicherra Tea –Estate. Chaudhury and Kibria reported [23] some average values of TN for the soils of Jagcherra (0.1%) and Modhupur (0.08%) Tea Estates of the country.

The influence of variations of topography and soil depth on OC, OM and TN are shown graphically in Fig.1. Examination of this Figure reveals the following:

(a) OC and OM are found to vary significantly with topographic position and soil depth. These variations may be due to difference in washing, air oxidation and decay of plant residues etc.

(b) The variation of TN with topography as well as depths is not so remarkable as those observed for OC and OM.

(c) OC, OM, and TN values are found to follow the following sequences amongst the topographic positions and soil depths irrespective of their magnitudes of variations: (i) Hill top > Hill slope > Hill base and (ii) Top soil (0-9″) > Sub soil (9-18″) > Substratum soil (18-36″).

C/N ratio of the soil is important for soil-microorganisms. It plays an important role in the synthesis of new microbial cells, which in turn die and are decomposed by other. The C/N ratio of the studied soils ranges from 9.84 to 10.69 (Table 1). This observed range of C/N ratio is higher than those (8.25- 9.38) reported [2] for the soils of an adjacent Tea-Estate of the present studied area. Maximum soil samples of present tea - estate have a higher value of C/N ratio than that of the critical

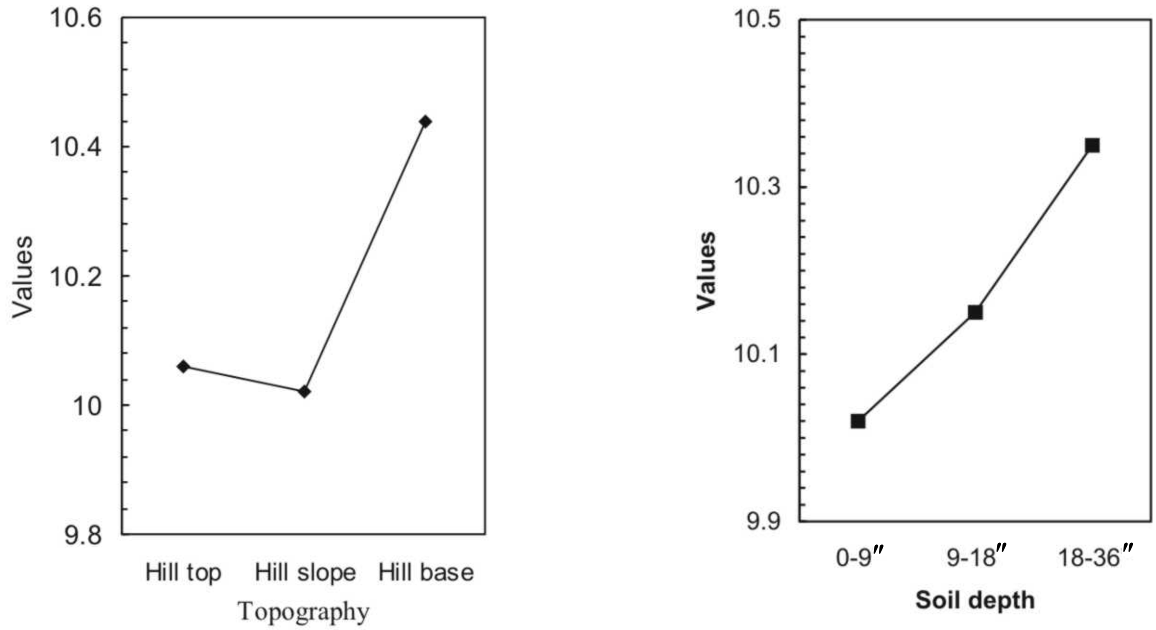

Fig. 2. Carbon/nitrogen (C/N) influenced by topography and depth of soils of Kaliti Tea-estate

value, 10, for tea cultivations [21]. The distribution pattern of C/N ratio amongst different topographic positions and depths is irregular. Similar irregular trend for C/N ratio with topography and depths were observed earlier for some tea soils [2] and rubber plantation areas [4, 5] of Bangladesh.

The influence of variations of topography and soil depth on C/N is shown graphically in Fig. 2. An analysis of the Figure reveals that the variation of C/N with topographic position is irregular whereas in the case of soil depth the parameter increases gradually with soil depth.

Phosphorus is an important plant nutrient. It plays a decisive role in the normal growth of tea and also stimulates the development of roots. It was found that the available phosphorus (AP) content of Kaliti tea- estate soils is ranged from 2.11 to 4.13 ppm (Table 1). The measured data indicate that the soils are deficient in AP. These values are significantly lower than that of the critical value (10 ppm) for the cultivation of tea [21]. Soils of Rungicherra Tea- Estate [2] were also deficient in AP. These low contents of AP may be due to the conversion of AP into unavailable form by microorganisms and / or phosphate fixation by aluminum in the prevailing acidic conditions (pH = ~ 4.60). Moreover, AP content of soil may be varied due to the difference in formation of organic phosphorus compounds by decomposition of organic matter and other vegetations.

The values of AP have been plotted against topographic positions and soil depth in Fig. 3. The Figure reveals that AP is found to vary with topographic position as well as with soil depth and follow the following sequences:

(i) Hill top > Hill slope > Hill base and
(ii) Top soil (0-9″) > Sub soil (9-18″) > Substratum soil (18-36″).

Similar trend for AP were observed earlier [2] in the case of Rungicherra tea – estate soils.

The measured OC, OM, TN, C/N and AP data have been analyzed by using Two-way ANOVA to see the effect of topography as well as soil depth on the measured parameters. The values of F statistics, probability (applicability of null hypothesis) and least significant difference at 95% confidence level (LSD 0.05) are tabulated in Table 2 and Table 3. F values for OC, OM, TN and AP due to topographic variations are found to be 22.9213, 23.1519, 42.9004 and 33.6515 respectively (Table 2) and are significant at

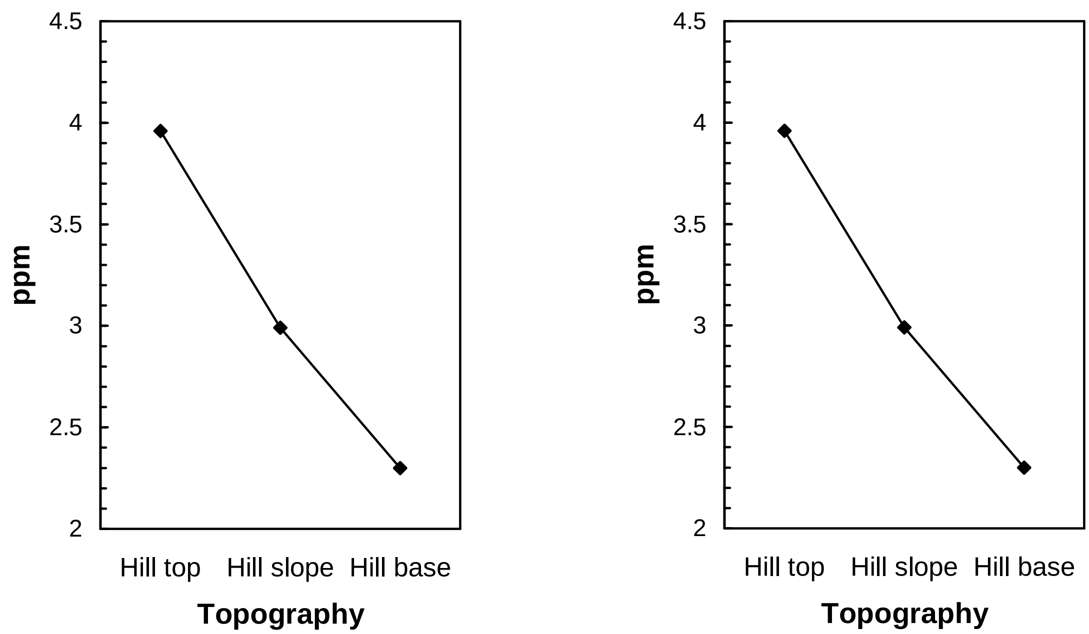

Fig. 3. Available phosphorus (AP) influenced by topography and depth of soils of Kaliti Tea-estate

0.0000 levels. These values of F and the given probability values (Table 2) indicate that topographic variations have a significant effect on OC, OM, TN and AP content of the studied soils. On the other hand, value of F (3.7811) with a probability value (0.0346) indicating that the variation of topography on C/N is significant at less than 3.46% level. While working for varying the soil depths it has been found that F values for OC, OM and TN are 6.0874, 6.1631 and 5.4896 respectively (Table 3). These values of F are significant at less than 0.00 level *i.e.*, OC, OM and TN values also vary significantly with soil depths. F statistics for C/N is 2.0908 and is not significant at more than 14.63% level. On the other hand F statistics for AP is 1.5252 and is not significant at more than 25.64% level. These values of F with cited probability values indicate that both C/N and AP content do not vary significantly with soil depths *i.e.* null hypothesis is valid incase of the effect of soil depths on C/N and AP content.

Table 2. Effect of topography on organic carbon (OC), organic matter (OM), total nitrogen (TN), carbon nitrogen ratio (C/N) and available phosphorus (AP) content of soils of Kaliti Tea - estate.

Parameter	Topography			F-statistics @ df=2	LSD 0.05	Probability
	Hill top	***Hill slope***	***Hill base***			
OC%	1.16a	1.01b	0.86c	22.9213	0.0881	0.0000
OM%	2.01a	1.73b	1.49c	23.1519	0.1520	0.0000
TN%	0.11a	0.10b	0.08c	42.9004	0.0707	0.0000
C/N	10.06a	10.02a	10.44b	3.7811	0.3342	0.0346
AP (ppm)	3.96a	2.99b	2.30c	33.6515	0.4094	0.0000

Note: Values followed by same letter is not significant at 0.05 LSD

Table 3. Effect of depth on organic carbon (OC), organic matter (OM), total nitrogen (TN), carbon nitrogen ratio (C/N) and available phosphorus (AP) content of soils of Kaliti Tea - estate.

Parameter	Depth			F-statistics @ df=2	LSD 0.05	Probability
	0-9″	*9-18″*	*18-36″*			
OC%	1.09a	1.00b	0.94c	6.0874	0.0881	0.0068
OM%	1.88a	1.73b	1.62c	6.1631	0.1520	0.0063
TN%	0.12a	0.09b	0.09c	5.4896	0.0707	0.0007
C/N	10.02a	10.15a	10.35a	2.0908	-------	0.1463
AP (ppm)	3.26a	3.08a	2.91a	1.5252	-------	0.2564

Note: Values followed by same letter is not significant at 0.05 LSD

References

1. M. Shamsuddin Ahmed, M. R. Zamir and A. F. M. Sanaullah, *International J. Agr. Biol*., 8 (2006) 89.
2. M. Shamsuddin Ahmed, M. R. Zamir and A. F. M. Sanaullah, *Pak. J. Anal. Chem.*, 6 (2005) 10.
3. M. M. Hassan and A. T. M. N. Islam, *Ind. J. For.*, 7 (1984) 217.
4. M. B. Zaman, A. R. Mazumder, N. Ahmed, M. S. Hussain and S. Rahman, *Bang. J. Soil Sci*., 20 (1984) 7.
5. K. Anam, S. M. I. Huq, A. Aziz and M. Ahmed, *Bang. J. Soil Sci*., 14 (1978)161.
6. M. M. Hassan and A. H. Mazumder, *Ind. J. For.*, 13 (1990) 281.
7. Z. H. Khan, A. R. Mazumder, M. S. Hussain and S. M. Saheed, *J. Ind. Soc. Soil Sci*., 45 (1997) 89.
8. Z. H. Khan, A. R. Mazumder, M. S. Hussain and S. M. Saheed, *J. Ind. Soc. Soil Sci*., 46 (1998) 485.
9. Z. H. Khan, M. S. Hussain and A. R. Mazumder, *Bang. J. For. Sci*, 27 (1998)114.
10. A. K. M. N. Islam, A. J. M. S. Karim, M. A. Rahman, M. M. Begum and K. M. Khalequzzaman, *Bang. J. Agr. Res*., 27 (2002) 553.
11. A. T. M. E. Hossain and Z. H. Khan, *Bang. J. For. Sci.*, 29 (2000)112.
12. M. A. Zaman, A. S. M. Mohiuddin, A. R. Mazumder and M. S. Hussain, *Bang. J. Soil Sci.*, 23 (1992) 15.
13. S. H. Chaudhury, *Tea J. Bang*., 14 (1978) 2.
14. S. H. Chaudhury and K. M. Shome, *Tea J. Bang.*, 14 (1978) 12.
15. S. H. Chaudhury, A. K. M. G. Kibria and K. A. Hasan, *Tea J. Bang*., 11 (1975) 20.
16. S. H. Chaudhury and Q. Ahsan, *Tea J. Bang.*, 15 (1979) 13.
17. S. H. Chaudhury, K. A. Hasan and M. Molla, *Tea J. Bang.*, 7 (1969) 9.
18. M. L. Jackson,. *Soil Chemical Analysis* (Prentice Hall of India, Pvt. Ltd., New Delhi) 1/e (1973) 498.
19. C. S. Piper, *Soil and Plant Analysis* (Interscience, New York) (1942) 221.
20. R. H. Bray and L. T. Kurtz, *Soil Sci*., 59 (1945) 39.
21. A. K. M. G. Kibria and M. A. Rashid, *Fertilizer Recommendation for matures Tea*, Bang. Tea Res. Inst. Pamphlet No. 21, Srimangal, Moulvibazar, (1994) 7.
22. M. F. Hossain, A. Islam, W. Islam and S. Rahaman, *Tea J. Bang*., 24 (1988) 8.
23. S. H. Chaudhury and A. K. M. G. Kibria, *Tea J. Bang*., 12 (1976) 3.