JSR Publications

Available Online

J. Sci. Res. **3** (3), 683-688 (2011)

JOURNAL OF SCIENTIFIC RESEARCH

www.banglajol.info/index.php/JSR

Short Communication

Physico-chemical Properties of Soil of Rangapani Tea Estate of Bangladesh

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Received 20 April 2011, accepted in final revised form 17 August, 2011

Abstract

Bangladesh is one of the tea producing countries of the world. It has 163 tea estates. Rangapani is a low yielding tea estate relative to other neighboring tea estates of Chittagong district in Bangladesh. A total 54 soil samples were collected from six different hills and three topographic positions having different depths of Rnagapanni Tea-Estate. Physico-Chemical properties of soils such as active acidity, reserve acidity, cation exchange capacity and clay content of the collected soil samples were determined. The measured parameters of the soil samples were plotted and analyzed with reference to site and topography. The parameters have been found to vary with sampling sites, depths and topography. Active acidity and reserve acidity were very low, with some exceptions compared to the optimum range for tea cultivation. Sand, silt, clay and cation exchange capacity (CEC) were found in reasonable range

Keywords: Soil; Active acidity; Reserve acidity; Cation exchange capacity; Clay content.

doi: 10.3329/jsr.v3i3.7503 J. Sci. Res. 3 (3), 683-688 (2011)

1. Introduction

Tea (*Camellia sinensis*) is the most popular nonalcoholic drink all over the world. There are about 30 tea-producing countries in the world of which 12 are major tea producer and Bangladesh is one of them. There are about 163 tea estates in Bangladesh [1]. The average yield of tea in Bangladesh is about 835 lbs acre^{-1}, which is quite low, compared to other major tea producing countries (1200-1350 lbs acre^{-1}) of the world. Rangapani is a low yielding tea estate (848 lbs acre^{-1}) in the Chittagong district. Physico-chemical properties and nutrient status of soil [2, 3] are important for the cultivation of plants. Solubility of nutrients [4] and availability of microorganisms [5] depend mostly on active acidity,

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reserve acidity, buffer capacity and cation exchange capacity (CEC) of the soil [6]. All these parameters significantly influence the growth of plant and production rate of crop [7]. A significant amount of works on primary nutrient status, active acidity, CEC and other properties of the tea soils of Sylhet division were found [8-12] but no work on tea estates of Chittagong region was reported. With this point in view soil samples were collected from Rangapani tea estate located in Chittagong district, Bangladesh and physico-chemical properties of the soil like active acidity, reserve acidity, CEC and soil texture (% of sand, silt and clay content) were determined.

2. Experimental

Soil collection

Fifty four representative soil samples were collected from different sites of the Tea-Estate, Chittagong, Bangladesh in the month of March, 2009. The samples included top-soil (0 – 23 cm), sub-soil (23 – 46 cm) and the substratum-soil (46 – 91 cm) of three different topographic positions (hill-top, hill-slope and hill-base). The samples were dried in the air at room temperature, crushed to pass through 2 mm sieve and then analyzed.

Methods

The active acidity, *i.e.*, pH in water of the soil samples was determined with the pH meter (model HI 8424, HANNA Instruments, Romania) at the soil: water ratio of 1: 2.5 [13, 14]; the reserve acidity, *i.e.*, pH in 0.1M $CaCl_2$ was measured at the the soil : 0.1M $CaCl_2$ ratio of 1:2.5 [15] by using the same pH meter. Soil texture (percentage of sand, silt and clay content) and CEC were measured by the hydrometer (Model ERTCO 544416, ASTM, USA) method [16] and ammonium acetate method [17], respectively.

Statistical analyses

Values of different parameters were reported as the mean ± standard deviation. Statistical analyses of the measured parameters were performed by using Origin Pro 7.0 version at the level of $p < 0.05$, to evaluate the significance of differences.

3. Results and Discussions

Active acidity (pH in water), reserve acidity (pH in $CaCl_2$), clay content and CEC of the soil samples are shown in Table 1 as mean value and standard deviations, *F*-statistics with LSD0.05 of the cited parameters are given in the Tables 2 and 3 respectively. The active acidity represents the number of hydrogen ions which dissociate from the adsorptive complex and exist in the solution [18]. Active acidity of the studied soil was found to vary from 3.85 to 5.13 with the mean value of 4.37 (Table 1). Most of the soil samples have active acidity values (Table 2) lower than the optimum range (4.5–5.8) [19] for tea cultivation. These values are quite similar to those of Sathgaon tea estate [12] and slightly

higher than those of Rungicherra tea estate [11] both of Moulvibazar district. Each data in Table 1 is the average of six samples. The data showed that the top soil and subsoil of hill base contained the lowest and the highest active hydrogen ion concentration respectively.

Reserve acidity is all titratable acidity associated with the soil phase. It is equal to the sum of exchangeable and non-exchangeable acidity and represents the buffer capacity of a soil. The observed reserve acidity of the soil ranged from 3.73 – 4.31 with the mean value of 3.90 (Table 1). In an acid soil, most of the hydrogen ions (H^+) present are absorbed by the soil (reserve acidity). The observed reserve acidity is slightly higher than those of Sathgaon [12] and Rungicherra [11] tea estate of Moulvibazar district, Bangladesh.

Table 1. Active acidity (pH in water), reserve acidity (pH in $CaCl_2$), soil texture (% of sand, silt, and clay) and CEC of soils of Rangapani tea estate.

Depth (cm)	Topography	pH in water	pH in $CaCl_2$	Sand %	Silt%	Clay%	CEC (meq/100g)
	Hill top	4.39±0.17	3.98±0.14	51.0±15.57	26.25±9.84	22.25±5.86	10.63±3.8919
0-23	Hill slope	4.43±0.19	3.96±0.14	62.33±7.69	20.85±6.26	16.8±2.11	28.40±5.7841
	Hill base	4.47±0.37	3.95±0.20	66.5±5.0	21.25±5.42	12.25±1.37	8.43±1.4556
	Hill top	4.43±0.16	3.90±0.06	49.0±17.32	20.83±5.16	28.5±8.66	13.32±4.1243
23-46	Hill slope	4.42±0.18	3.87±0.04	56.08±10.05	21.67±4.9	22.67±4.91	14.53±1.686
	Hill base	4.21±0.21	3.82±0.06	6.0±8.51	18.75±8.48	17.25±2.62	27.3±4.4853
	Hill top	4.39±0.16	3.89±0.13	49.83±13.93	20.83±5.16	29.33±9.83	13.8±5.4259
46-91	Hill slope	4.27±0.22	3.89±0.07	55.67±9.31	20.00±5.48	24.33±4.92	11.6±2.5892
	Hill base	4.33±0.22	3.84±0.07	64.0±9.62	16.25±6.47	19.75±4.68	23.2±5.4007
Over all mean value		4.37	3.90	57.7	20.70	21.5	15.04

The clay content of the soil samples is calculated by determining the soil texture (Table 1). Soil texture (% of sand, silt and clay) is found to vary with topographic positions and soil depths. Silt and clay content follows a trend for topographic variations, *i.e.,* hill-top > hill-slope > hill-base but sand follows a reverse trend. The clay content ranged from 11.0 to 43.5% with the mean value of 21.5%. Recently Sanaullah *et al*. [12] reported the variation of clay content of the soils of Sathgaon tea estate from 15.27 % to 19.66 %. The nature of most of the soils of Rangapani tea estate are found to be sandy clay loam, fine loamy loam and sandy loam. Generally, tea is found to grow on soils of various textural types but sandy-loam and sandy clay loam are considered to be the best [8, 9].

CEC is an important factor of nutrient holding capacity of soil [21]. The values for CEC were found to vary from 6.6 to 33.0 meq/100g with the mean value of 15.0 meq/100g. CEC is found to vary with sites and topography (Table 1) and even with profiles of same sampling site. Hossain *et al.* [22] reported a similar range of variation in CEC (5.15 to 33.25 meq $100g^{-1}$) of soils of Satgoan, Baraora and Kurmah tea estates. The variation of CEC occured due to the difference in nature and amount of clay content, pH and percentage of organic matter content present in the soil [23].

Table 2. Effect of topography on active acidity, reserve acidity, CEC, sand, silt and clay content of the soils of Rangapani tea estate.

Parameter	Topography			*F*-statistics	LSD0.05	Probability
	Hill top	Hill slope	Hill base			
pH in water	4.41	4.37	4.33	2.9870	0.0216	0.05970
pH in $CaCl_2$	3.62	3.91	3.87	2.8689	0.0218	0.06653
CEC (meq/100g)	12.6	18.8	13.7	3.2474	4.6571	0.04738
Sand (%)	50.7	58	64.8	8.2585	7.0082	0.0008
Silt (%)	22.6	20.7	18.8	0.1522	-	0.8592
Clay (%)	26.7	21.3	16.4	16.0739	3.6452	0.0000

The experimental data for active acidity, reserve acidity, CEC, sand, silt and clay content have been analyzed statistically 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 Tables 2 and 3. *F* values for active acidity, reserve acidity and CEC due to topographic variations are found to be 2.9870, 2.8689 and 3.2474, respectively (Table 2) and are significant at less than 4.73% level. Again, *F* values for sand and clay content are found to be 8.2585 and 16.0739, respectively (Table 2). These values of *F* are significant at 0.000 levels, i.e., topographic variations have a significant effect on sand and clay content of the studied soils. On the other hand, value of *F* (0.1522) for silt with a high probability value (0.8592) indicates that the variation of topography has almost no effect on silt, i.e., null hypothesis is valid for this parameter. While, working for different soil depths it has been found that *F* values for active acidity and reserve acidity are 4.1251 and 4.0196 respectively (Table 3).

These values of *F* are significant at less than 2.21% level. Again, *F* values for silt and clay have been found to be 100.6939 and 9.0594 respectively and are significant at 0.000

levels. These indicate that active acidity, reserve acidity, silt and clay vary significantly with soil depths. On the other hand, *F* statistics for CEC and sand content are 1.5587 and 0.6421 respectively and is not significant at more than 22.06% level. These values of *F* with cited probability values indicate that both CEC and sand content do not vary significantly with soil depths.

Table 3. Effect of depth on active acidity, reserve acidity, CEC, sand, silt and clay content of the soils of Rangapani tea estate.

Parameter	Depth (cm)			*F*-statistics	LSD0.05	Probability
	0-23	23-46	46-91			
pH in water	4.43	4.35	4.33	4.1251	0.0216	0.02209
pH in $CaCl_2$	3.96	3.86	3.87	4.0196	0.0218	0.02432
CEC (meq/100g)	15.8	12.5	16.2	1.5587	-	0.22064
Sand (%)	56.5	56.9	60.1	0.6421	-	0.5306
Silt (%)	19	20.3	22.8	100.6939	5.9135	0
Clay (%)	24.5	22.8	17.1	9.0594	3.6452	0.0005

4. Conclusion

Most of the soil samples are acidic in nature and the values are higher than the optimum range of tea cultivation. The tea estate authority is required to consider lime treatment for improving the active acidity level keeping in mind buffer capacity as well as reserve acidity of the soil. Clay content and the CEC of the soils are satisfactory. Textural class of the maximum soil samples are sandy loam and sandy clay loam which are considered to be best for tea cultivation. Proper drainage system, irrigation and shading should be maintained strictly to prevent soil erosion and to enhance the yield of tea.

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