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

International Journal of Current Research
Vol. 6, Issue, 12, pp.10851-10854, December, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

ASSESSMENT OF SOIL FERTILITY STATUS IN SILCOORIE TEA ESTATE, ASSAM, NORTH EAST INDIA

[1]Nandakumar Singh Haorongbam, [1,*]Jayashree Rout and [2]Laxmi Narayan Sethi

[1]Department of Ecology and Environmental Science, Assam University, Silchar 788011
[2]Department of Agricultural Engineering, Assam University, Silchar 788011, Assam, India

ARTICLE INFO

Article History:
Received 07th September, 2014
Received in revised form
18th October, 2014
Accepted 07th November, 2014
Published online 30th December, 2014

Key words:
Soil Fertility, Tea,
Total nitrogen,
Active acidity,
Bio-fertilizer.

ABSTRACT

A short term pre-monsoon field study has been conducted to determine the soil fertility status in Silcoorie Tea Estate of Cachar district, Assam, North East India. Soil samples were collected from six different sections of the tea estate. Physico-chemical properties of the soil, i.e., texture, moisture content, bulk density, water holding capacity, total nitrogen (N), total phosphorus (P), total potassium (K), soil organic carbon (SOC), soil organic matter (SOM), pH, electrical conductivity, C:N ratios from four different depths were analyzed. The soil of the tea garden is sandy clay and silt loam in texture with acidic pH (~4.2). The average SOC, SOM content, total N, K and P contents of the soil were found to be quite lower than the critical value considered ideal for tea cultivation. Lime treatment and/or organic base fertilizer for maintaining the active acidity level, proper nutrient management practices like retention of pruning litters, shade tree droppings and weed mass, use of bio-fertilizers are recommended to achieve sustainable productivity.

INTRODUCTION

Tea (*Camellia sinensis* L.) is a perennial evergreen shrub growing in a wide range of soil types derived from diverse parent material in tropical, subtropical and temperate climate (Eden, 1976). Apart from the temperature and precipitation, soil is the most limiting factor, which influences growth and ultimate yield of the tea plants. At present around 579.35 thousand hectares and is under tea cultivation in India with 1095.46 million kilogram of tea production during the year 2011 (Anonymous, 2012). India contributes about 27% of the world's tea demand in terms of domestic and international requirements. One of the most popular perennial crops, tea is extensively cultivated in North East India since the beginning of the 19th century. The Cachar district in southern Assam shares about 10% of both total areas under tea production as well as productivity in Assam (Anonymous, 2012). Soil nutrient plays a vital role in tea cultivation. Long-term cultivation of the tea crop are known to lead to a decline in soil quality (Dang, 2000). The desired yield has sharply fallen in recent years. Nutrient management of plantation crops has greater importance particularly to sustain and improve soil health. In a given locality, however, soil characteristics as well as nutrient parameters play a significant role for sustainable tea production (Hamid *et al.,* 2004; Sarwar *et al.,* 2011).

***Corresponding author: Jayashree Rout,**
Department of Ecology and Environmental Science, Assam University, Silchar 788011

Nutrient requirements for commercial tea production are particularly high because the harvestable portions of tea are succulent shoots, which contain the largest percentage of nutrients in the plant (Do *et al.,* 1980). Thus, nutrient recycling and mineral balance are important factors affecting nutrient budgets in tea garden soil. Fertilization is known to balance nutrient cycling and improve plant growth and crop yield. Nitrogen, phosphorous and potassium are the three major nutrients of the soil which plants use in large amounts for their growth and survival. Intensive application of nitrogen fertilizers causes the pH of the soil of the tea cultivation area to be acidic (Amir *et al.,* 2010). Evaluation of soil fertility status in tea garden is necessary for proper management including fertilizer applications. Accordingly, we report here in assessment of the soil fertility status in a tea estate of Cachar district, Assam, North East India.

MATERIALS AND METHODS

Study area: The present study was conducted in Silcoorie Tea Estate that covers about 900 hectares tea plantation area in Cachar district of Assam, North East India. The district lies between 92° 24' E and 93° 15' E longitude and 24°22' N and 25° 8' N latitude and situated at 36.5 (MSL). The geographical area covered by Cachar district is 3,786 Sq. Km. The map showing study sites is given in Figure 1. The area of experiences subtropical, warm and humid during summer where humidity ranges from 53.67 to 94.59 % in winter and

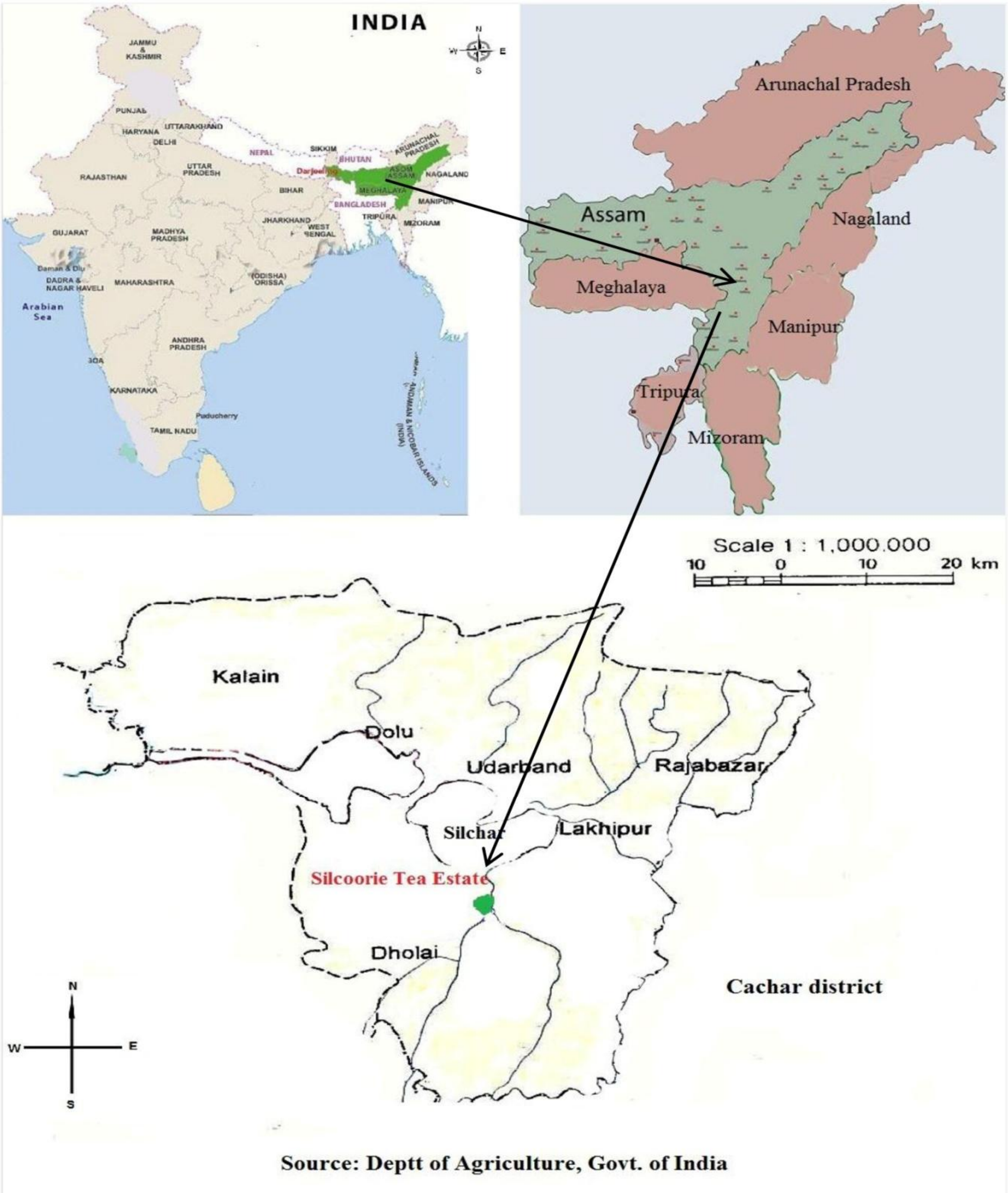

Figure 1. Map showing study sites at Cachar district, Assam North East India

64.04 to 94.60 % in summer and received about 3200-3500 mm rainfall during the year.

Soil sampling and analysis: Fifty four representative soil samples were collected from six different sections up to a depth of 80cm with an interval of 20cm i.e., 0-20, 20-40, 40-60 and 60-80cmfromSilcoorieTea Estate, Cachar district, Assam in the month of March, 2012. Soil texture was analysed by Hydrometer method (Black, 1965). The moisture content of the soil samples was determined by using standard method given by Anderson and Ingram (1993). Electrical conductivity of soil was determined in the soil: water suspension (1:2.5) (Jackson, 1967). Soil pH was determined from 1:2.5 soil-water suspensions using a digital pH meter (GeNei pH meter). Soil organic carbon, total nitrogen, total phosphorus and total potassium were determined following standard protocol (Okalebo *et al.,* 1993). The factor of 1.724 was used to convert the organic carbon percentage into soil organic matter (%). Statistical analysis was carried out for each set of data using the software SPSS (Version 20.0) at the level of $p < 0.05$, to evaluate the significance of differences.

RESULTS

Physical properties of tea soil

The summary of the observed soil physical properties in relation to different sections of the study site and soil depths of the tea garden are presented in Table 1. The soil texture of the study area was found silty loam, and sandy clay in nature. The soil bulk density was found to be higher with increasing depth at all the sections (ranged from 1.30±0.87gm/cm^3 to 1.32±0.21gm/cm^3). The moisture content and water holding capacity were ranged from (26.43±0.02 to 27.15±0.14) and (54.30±2.14 to 56.98±2.94) percentage. The maximum value was found in the upper horizons and it decreases with an increase in depth of all the sections.

highest potassium content being recorded in the lower layers. Table 3. Shows the correlation of chemical properties (pH, conductivity, soil organic carbon, soil organic matter, total nitrogen, and total phosphorous and total potassium) of soil in relation to different sections and soil depths of the study site of the tea garden. The soil pH had a strong and positive correlation with soil organic carbon (r= *0.954).

Table 1. Physical properties of soil in relation to different study sites and soil depth (Assam. India)

Location	Depth(cm)	Sand (%)	Silt (%)	Clay (%)	Moisture content (%)	Bulk density(gm /cm^3)	Water holding capacity (%)
Silcoorie Tea Estate	0-20	30±2.04	27±2.71	43±2.72	27.15 ±0.14	1.30±0.87	56.98±2.94
	20-40	27±1.84	25±2.26	49±2.33	25.65±0.12	1.32±0.06	54.22±2.54
	40-60	25±2.19	24±2.90	44±2.21	23.45±0.19	1.36±0.12	52.18±2.65
	60-80	23±3.84	21±2.82	41±2.89	22.55±0.22	1.38±0.98	50.27±2.76

Table 2. Chemical properties of soil in relation to different study sites and soil depth (Assam. India)

Location	Depth(cm)	pH	Conductivity (mS)	Soil organic Carbon %	Soil Organic matter %	Total N %	Total P (*g kg*$^{-1}$)	Total K (*g kg*$^{-1}$)	C:N
Silcoorie Tea Estate	0-20	4.47±0.08	1.60±0.05	1.61±0.06	2.77±0.02	0.78±0.01	1.22±0.11	11.00±1.04	2.06
	20-40	4.39±0.20	1.00±0.12	1.41±0.02	2.43±0.07	0.67±0.02	1.17±0.32	13.60±1.09	2.10
	40-60	4.06±0.22	0.90±0.08	1.20±0.08	2.06±0.09	0.67±0.01	0.66±0.42	14.00±1.07	1.79
	60-80	4.03±0.12	0.90±0.06	1.13±0.07	1.94±0.01	0.50±0.02	0.37±0.12	15.30±1.02	2.26

Table 3. Correlations matrix among various soil parameter in Silcoorie Tea Estate

Variable	pH	Conductivity mS	Organic carbon %	Total N%	Total P(g/Kg^{-1})	Total K(g/Kg^{-1})	C:N
pH	1.00						
Conductivity mS	0.783	1.00					
Organic carbon %	*0.954	0.903	1.00				
Total N%	0.714	0.762	0.866	1.00			
Total P(g/Kg^{-1})	0.936	0.692	0.934	0.861	1.00		
Total K(g/Kg^{-1})	-0.737	-0.923	-0.778	-0.469	-0.520	1.00	
C:N	0.202	0.051	-0.012	-0.509	-0.132	-0.423	1.00

* Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed).

Chemical properties of the soil

The observed chemical properties (pH, conductivity, soil organic carbon, soil organic matter, total nitrogen, total phosphorous and total potassium) of soil in relation to different sections and soil depths of the study site of the tea garden were shown in Table 2. The soil pH of the study area was observed in the ranges from 4.03±0.22 to 4.47±0.08. The electrical conductivity of the soil in the study site was found in the ranged from 0.90±0.06 mS to 1.60±0.05mS. Both the pH and conductivity values showed a decreasing trend with the increase in depth of soil in all the sections. The soil organic carbon and soil organic matter of the study sites were found higher in the upper horizons and decreased subsequently with an increase in depth. The soil organic carbon and soil organic matter ranged from 1.13±0.07 to 1.61±0.06 % and 1.94±0.01 to 2.77±0.02 %, respectively. The organic carbon and organic matter content was found to be highest in top surface that progressively decreased with greater depth. The total nitrogen contents of the soil was found in the ranged from 0.50± 0.02% to 0.78±0.01 %. The C: N of the soil was found in the range of 1.79 to 2.26. The total phosphorus content of soil were found in the range of 0.37 ±0.12 to 1.22 ±0.11 gkg^{-1}, respectively. The total phosphorus contents of the soil decrease with increasing depth. The total potassium content of the soil was obtained in the range of 11.00 ±1.04 to 15.30 ±1.02 gkg^{-1} with

DISCUSSION

Soil texture may effect productivity in a variety of way i.e. by affecting moisture availability, soil temperature, nutrient supply and the accessibility of soil organic matter to microbial decomposition (Schimel *et al.*, 1996). In the present findings, the soil texture of the study area was found to be silty loam, and sandy clay in nature, which might have favoured tea plantation. The texture of soil cannot be changed easily in such a way that there is a preferential migration of finer soil particles to the lower layers due to the changes brought by organic matter and root activities of plants under the plantation (Gupta, 1987; Gupta and Sharma, 2008). The water holding capacity increased with the increase in the clay content at all the sites and was low on the sites, where percent sand was higher. Sandy soils generally have less favorable moisture holding capacity and nutrient retention characteristics than non-sandy soils (Perry, 1994). The bulk density was found more with increasing depth at all the sites. This finding agree with that of (Haan, 1977) who reported that the bulk density increased with the increasing soil depths because the lower layers were more compact under the weight of upper portion of soil and also due to the lower amount of organic matter in deeper layers. The higher soil pH value was found at the top layers of soil in all the sections of tea garden. This indicates that disturbance may promote the alkalinity of the soil.

Ma *et al.* (1990) have reported that nitrogenous fertilizers used in conventional tea cultivation such as ammonium nitrate, ammonium sulphate, urea, calcium ammonium nitrate and ammonium chloride increase the acidity of the soil. In addition, continuous use of ammonium sulphate without the addition of lime (calcium carbonate) will reduce the soil pH to a level that is unsuitable for economic production of crops (Tisdale and Nelson, 1975). Therefore, these soils could be amended with lime and organic fertilizer to adjust the pH. The soil organic carbon, soil organic matter and were found higher in the upper horizons and decreased subsequently with an increase in depth. The highest content of organic matter in top soil may be due to the continuous agronomic practices and decomposition of pruning materials and leaf litter. So, management practices, including fertilizer application, pruning of tea trees, and soil tillage, might also have a substantial impact on TOC content (Zhu, 1983). The higher total nitrogen content in the top soil was consistent with the findings of Li *et al.* (2009), this might be due to the contribution of organic matter derived from tea plant litter (Li, 1997).

The low total nitrogen content in the lower depth of the soil might be due to intensive leaching of the soil nutrients. However as a whole total nitrogen observed in the study site was low, this might be due to vigorous growth of tea trees, which consume a large amount of soil nitrogen. Total phosphorous and potassium content of the study area were found less with increasing horizontal depth, which was similar with the findings of Liao (1996). This can be attributed to reduced top-dressing with inorganic fertilizers and substantial absorption by tea trees (Liao, 1996; Li *et al*., 2009), in addition to intensive soil erosion. However, the soil pH had a strong and positive correlation with soil organic carbon indicating that the soil organic carbon as influenced by the soil pH. The overall soil quality have been observed to have declined. Thus, a proper soil nutrient management is warranted for improving soil health and crop productivity. This study is expected to furnish valuable clues to enhance productivity through a balanced use of mineral fertilizers combined with organic and biological sources of plant nutrients and improve the stock of the plant nutrient in soil to sustain profitable production of tea.

Acknowledgement

NSH thanks Assam University for UGC fellowship. Thanks are due to Silcoorie tea estate authority for permission to carry out the work.

REFERENCES

Amir, B., I. Emododin, M.R. Atashi and H.R. Bork. 2010. Land-Use Change and Soil. Degradation: A case study, North of Iran. *Agric. Biol. J. N. Am*., 1(4): 600-605.

Anderson, J. M. and Ingram, J. S. I. (Eds.). 1993. Tropical Soil Biology and Fertility – A Handbook of Methods. Second edition. United Kingdom: CAB International.

Anonymous. 2012. Tea statistics. Tea Board of India. Black, C.A. (Ed.). 1965. Methods of soil analysis. Part I and II. American society of Agronomy, Inc., Publishers, Madison, Wincosin USA.

Dang, V.M. and Anderson, D.W. 2000. Application of soil taxonomy classification into Northern Vietnam. *Vietnamese Soil Sci.,* 13: 15-23, Davidson DT.

Do, N.Q., Vo, T.T.N. and Vi, K.T., 1980. Results of experiment: chemical fertilizers (NPK) on tea crop in Phu Ho. In: Agricultural Research. *Agricultural Publishing House,* Hanoi, pp. 127–146.

Eden, I. 1976. Tea 3rd (Eds.). Longman, London, 816.

Gupta, M.K. and Sharma, S.D. 2008. Effect of tree plantation on soil properties, profile morphology and productivity index I. Poplar in Uttrakhand. *Ann. For*., 16 (2): 209-224.

Gupta, M.K. 1987. Physico-chemical studies of soil in silver fir and spruce forests of western Himalayas managed under different silvicultural systems. Ph.D. Thesis. Garhwal University, Srinagar, Garhwal.

Haan, S. 1977. Humus, its formation, its relation with the mineral part of the soil and its significance for the soil productivity. *Soil Organic Matter Studies (IAEA Vienna)* 1:21-30.

Hamid, T.A. 2004. Physico-Chemical studies of potential tea growing areas of Pakkhal valley in District Mansehra. Sarhad Journal of Agriculture, 20: 208-214.

Jackson, M.L. 1967. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Li, Z. 1997. Some biochemical properties of tea soils in subtropical region of China. *Trop. and Subtrop. Soil Sci*. 6:162-170.

Li, Siyue, Xiaoli Cheng, Zhifang Xu, Hongyin Han, and Quanfa Zhang. 2009 . Spatial and Temporal Patterns of the Water Quality in the Danjiangkou Reservoir, China. *Hydrological sciences journal* 54, no. 1: 124-134.

Liao, W. 1996. Soil nutrient dynamic characteristics and its regulation in tea garden. *Tea in Fujian,* 12:25-27.

Ma, W. Cl., Brussaard, L. and Ridder, J. A. 1990. Long-term effects of nitrogenous fertilizers on grassland earthworms (Oligochaeta: Lumbricidae): Their relation to soil acidification. *Agriculture Ecosystem and Environment*, 30(2): 71-80.

Okalebo, J.R., Gathua, K.W. and Woomer, P.L. 1993. Laboratory methods of soil and plant analysis: A working manual – Technical Bulletin no.1, Soil Science Society, East Africa.

Perry, D.A. 1994. Forest ecosystems. The Johns Hopkins University Press. Baltimore, Maryland, USA.

Sarwar, G, H Schmeisky, MA Tahir, Y Iftikhar, and NU Sabah. 2011. Application of Green Compost for the Improvement of Dry Matter Yield and Chemical Composition of Lolium Perenne (Grass). *J. Anim. Pl. Sci* 21, no. 4: 710-714.

Schimel, D.S., Barswell, B.H., Mckeown, R., Ojima, D.S., Parton, W.J. and Pulliam, W. 1996. Climate and nitrogen controls on the geography and time scales of terrestrial biogeochemical cycling. *Global Biogeochemical Cycles,* 10: 677-692.

Tisdale, S. L. and Nelson, W. L. 1975. Soil Fertility and Fertilizers. Second (Eds.). New York: Macmillan Publishing Co.

Zhu, Z. 1983. Soil science. Agriculture Press, Beijing, China Lao, J. and X. Chen. 1980. Study on continuous determination of soil total nitrogen and total phosphorus content. *Chin. J. Soil Sci.,* 11:45-46.

****