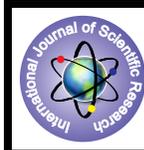


The Macronutrients Status of Long Term Tea Cultivated Soils in Dibrugarh and Sivasagar Districts of Assam, India



Environment

KEYWORDS : Macronutrients, organic matter, composite soil, texture

Dr. Tara Nath Nath

Associate Professor, Department of Chemistry, Moran College, P.O. Moranhat, Dist-Sivasagar, Assam-785670 India

ABSTRACT

In the present study macronutrients (NPK) were analyzed with some other physico-chemical properties of soils of tea estates. The study was carried out during the year 2007 to 2010. A total of 180 composite soil samples from soil depths of 0-15 cm (surface) and 15-30 cm (subsurface I) and 30-60 cm (subsurface II) were collected from 20 tea estates. The samples were analyzed for texture, pH, total organic matter, nitrogen, phosphorous, and potassium. Soils of tea estates were sandy loam in texture at the depth of 0-15cm with an acidic in nature having pH 4.48 to 5.62. At the depth of 0-15, 15-30 and 30-60 cm soils were sufficient in organic matter with ranged of 1.87 to 3.60, 1.19 to 2.81 and 0.88 to 2.46 % ; total nitrogen content were ranged of 0.167 to 0.340, 0.102 to 0.260 and 0.073 to 0.228 % ; Available P with ranged 44.00--213.00, 40.33--199.67 and 39.00--188.33 mg/kg and Extractable K with ranged of 2.13--2.97, 2.08--2.93 and 2.01--2.87 meq/kg respectively.

Introduction

Under highly weathered condition over long periods of time and continuous application of chemical fertilizers soil nutrients undergoes significant changes both in chemical forms and affect the soil properties. Among many agronomic measures, fertilization may be the most important way to maintain high crop productivity and soil quality (Suo and Wang, 2000; Shen, 2002; Thanki, J.D.). Nitrogen plays a key role in plant nutrition. It is the mineral element required in the greatest quantity by green plants and it is the nutrient most often deficit. Thus, increasing application of nitrogen fertilizer levels up to 120 or 150 kg N/ha led to significant increases in growth, yield and its components and quality characters of tea crops (Abou Keraisha and Farghaly, 2003 ; Darwish, 2003 ; Zohry and Farghaly, 2003 ; El-Aref et al., 2004 and Moser et al., 2006). In spite of mineral fertilizers have a good effect on plant productivity; nevertheless it's also having a pollutant effect on the environment especially dissolved ones like as nitrogen fertilizer. Whereas, it is more rapidly leaching to ground water, which affects human and animal health (Ramos and Varela, 1990). Also, excess application of nitrogen fertilizer could be accumulated in plant tissues in freely manner; this also affects human health and crop quality. However, judicious use of mineral nitrogen fertilizer should be promoted on improvement tea productivity (Wopereis et al., 2006). So, organic fertilizer could be accepted as a healthy fertilizer for different crops. The role of organic fertilizer is very important for plant growth and yield, because it provides stable supply of both macro- and micronutrients (Kabeerathumma et al., 1993 and Mowafy, 2002), and improves soil physical, chemical and biological properties (Kurul and Tripathi, 1990), and consequently supports the maximum yield (Youssef et al., 2001). Moreover, Nicholson et al., (1999) and Hati, et al. (2007) indicated that modest improvements in the nitrogen availability in organic fertilizers could be a result in a major cost saving for the farmer by reducing the requirement for mineral nitrogen fertilizer and reduce the risk of environmental pollution.

Integrated use of both organic manures and chemical fertilizers has emerged as a promising option not only for maintaining higher productivity of tea, but also for providing maximum stability to tea production in intensive farming systems (Swarup, 1998 ; Vats et al., 2001 and Wang et al., 2002). Mehmood et al. (2005) reported that the mixed application of the organic (Farmyard manure at 3 t/ha) and inorganic (90 kg N/ha) fertilizers was the most favorable in terms of plant growth of tea. Also, Hati et al. (2007) indicated that application of balanced rate of mineral fertilizers in combination with organic manure could sequester soil organic carbon in the surface layer, improve the soil physical environment and sustain higher tea productivity.

The result of the study indicated that the available P content increased significantly in all cultivated soil as compared to control soil. The availability and concentration of macronutrients in all cases increased with increased soil pH. In continuous

application of P fertilizers, soil phosphorus undergoes significant changes both chemical form and its build up was highly observable. In the long-term tea cultivated soil demonstrates that organic matter highly significantly correlated to Nitrogen, phosphorus and potash. Therefore, a continuous supply of organic materials must be added to maintain soil productivity. However, continuous application of the same nutrient form for a long time can lead to the occupation of most of the adsorption sites there by creating toxicity problem of the released one. The formula may also contain elements other than the nutrient under study, which will favor the release or fixation of other nutrients. Under highly weathered condition over long period of time and continuous application of fertilizer, soil phosphorus undergoes significant change both in chemical forms and its location in soil profile (Thimma et al., 1991 and Iyengar et al., 1982). The effect of potash application over years significantly increased the amount of K compared to control soil (Reddy et al., 1993). It was concluded that the applied K has contributed to the luxury consumption of K by the crops and this will still continue to supply K to crops for some more seasons without reducing yield (Mahendra singh et al., 1982). The objective of the present study was to study the fate of the macro-nutrients in the soil as a result of continued application of N, P, and K fertilizer on tea plantation.

MATERIALS AND METHODS

Initially 180 Soil samples were collected from three different soil depths at 0-15, 15-30 and 30-60 cm respectively from 20 tea estates over 25 years old tea cultivated soil and studied for the concentration of N, P and K. The selection of tea estates for study in Sivasagar and Dibrugarh districts are shown in Table 1. The approximate locations of the sampling sites are shown in Fig 1. The data were compared with control soil. The collected soil samples were air-dried, grinded 2 mm meshes. Soil pH was measured 1:2.5 soil H₂O. The total organic matter was estimated by Walkley-Black method (1974). The total nitrogen and phosphorus was determined colorimetrically using molybdenum blue and ammonium molybdate method respectively. Potassium was determined by flame photometer.

Table 1. The selection of tea estates for study in Sivasagar and Dibrugarh districts.

Sl. No.	Tea Estate	District
1	Sepon	Dibrugarh
2	Moran	Dibrugarh
3	Doomar Dullung	Sivasagar
4	Hingrijan	Sivasagar
5	Khumtai	Sivasagar
6	Teloijan	Dibrugarh

7	Thowra	Dibrugarh
8	Mahkhooti	Sivasagar
9	Maskara	Sivasagar
10	Rajmai	Sivasagar
11	Amarawati	Dibrugarh
12	Borborooah	Dibrugarh
13	Bamunbari	Dibrugarh
14	Khowang	Dibrugarh
15	Duliabam	Dibrugarh
16	Diksam	Dibrugarh
17	Ghoorania	Dibrugarh
18	Durgapur	Dibrugarh
19	Dirai	Dibrugarh
20	Lepetkata	Dibrugarh

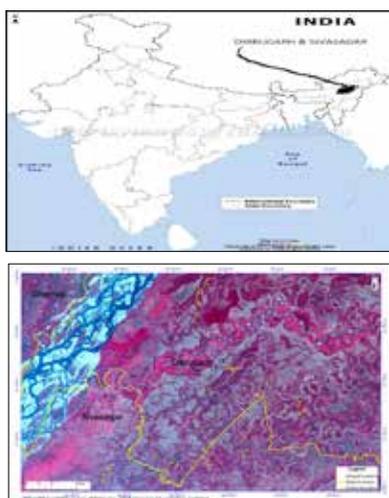


Fig.1 Location of study area and soil sampling stations.

RESULT AND DISCUSSION:

Soils were analyzed for pH and Organic carbon .The results of analysis in Table 2 indicated that average soil pH was 5.05. The organic carbon content ranges from 1.87% to 3.60 % and the average organic carbon content was found to be 2.74% for the surface soil, 1.19% to 2.81% and average of 2.00 for the subsurface(I) soil and 0.88 % to 2.46% and average of 1.67% for the subsurface (II) soil respectively.

Table-2 Range and average values of Physico-Chemical properties of soil samples.

S/N	Parameters	Range	Average	Control
1	Soil pH [surface soil]	4.48—5.62	5.05	5.86
2	Total organic matter (%) [surface soil]	1.87—3.60	2.74	1.34
3	Total organic matter (%) [Subsurface soil, I]	1.19—2.81	2.00	1.20
4	Total organic matter (%) [Subsurface soil, II]	0.88—2.46	1.67	0.80
5	Sand (%) [surface soil]	73.09—89.12	81.11	80.00
6	Silt (%) [surface soil]	0.02—0.04	0.03	0.02
7	Clay (%) [surface soil]	10.85—26.89	18.87	19.98

Soils were analyzed for NPK (Table 3 to 5).The total nitrogen content was ranged from 0.167 to 0.34 mg/kg and the average value was 0.25mg/kg for the surface soil, 0.102 to 0.26 mg/kg

and average of 2.5mg/kg for subsurface (I) soil and 0.073 to 0.228mg/kg and average of 0.151mg/kg for the subsurface (II) soil respectively. The available P content ranges from 44 to 213 mg/kg and the average available P content was 128.5 mg/kg for the surface soil, 40.03 to 199.67 mg/kg and average of 120 mg/kg for the subsurface (I) soil and 39 to 188.33 mg/kg and average of 113.67 mg/kg for the subsurface (II) soil respectively. Extractable K were medium with ranged of 2.13--2.97 meq/kg, 2.08--2.93 meq/kg and 2.01--2.87 meq/kg for the surface, subsurface (I) and subsurface (II) respectively.

Table-3. Range and average values of Macronutrients of surface soil samples

S/N	Macronutrient	Surface soil		Control
		Range	Average	
1	N (mg/kg)	0.167—0.340	0.254	0.098
2	P (mg/kg)	44.00--213.00	128.5	110.4
3	K (meq/kg)	2.13--2.97	2.55	1.22

Table-4. Range and average values of Macronutrients of subsurface (I) soil samples

S/N	Macronutrient	Subsurface (I) soil		Control
		Range	Average	
1	N (mg/kg)	0.102--0.260	0.181	0.084
2	P (mg/kg)	40.33--199.67	120.0	96.24
3	K (meq/kg)	2.08--2.93	2.51	1.12

Table-5. Range and average values of Macronutrients of subsurface (II) soil samples

S/N	Macronutrient	Subsurface (II) soil		Control
		Range	Average	
1	N (mg/kg)	0.073--0.228	0.151	0.068
2	P (mg/kg)	39.00--188.33	113.67	98.75
3	K (meq/kg)	2.01--2.87	2.44	0.98

Available P content increased significantly in all fertilized plots compared to unfertilized sites (controlled soil). Unlike N, which is highly liable to mineralization, leaching and volatilization the residual effect and build up of P in the long term fertilized plot is highly observable. In general, the availability of P increased with the high dose of fertilizer in all tea soil. The analysis of tea soil indicated that there were significant effects of the application on the concentration of available P in soil. Particularly P compared with control. Therefore, P fertilization was able to raise the P status of the soil. According to analysis K fertilization increased potassium concentration of the soil K compared with control. This was also confirmed in the earlier work (Paulos Dubale, 1994 and Höfner and Schmitz, 1994). It was observed that soil pH in the cultivated soils showed increasing trend (acidity increased) and available Phosphorus in fertilized soils increased significantly owing to its low mobility. The total nitrogen content of the soils was generally low to medium . The exchangeable potassium in soils was high. However, the level of K did not show significant differences compared to unfertilized sites. This may be due to the relatively high organic matter in this heavy textured soil. The results of analysis showed that the availability and concentration of macronutrients in all cases increased with increased soil pH ranges.

Correlation between available macronutrients, organic carbon and pH are presented in Table 6. The available macronutrients increased with soil pH and percentage of organic matter. The total Nitrogen and phosphorus positively correlated with soil organic matter. Exchangeable potassium was positively correlated with soil organic matter. The total nitrogen, available P and exchangeable potassium highly correlated with soil pH.

Table-6. Correlation between macronutrients and soil properties of the soil samples of tea estates of Dibrugarh

and Sivasagar districts.

Soil	N	P	K
Properties	r-value	r-value	r-value
Soil pH	0.94	0.99	0.98
TOM	0.99	0.95	0.94

CONCLUSION

Chemical fertilizers applied long term to the soil can provide crops specific ingredient elements, but not with all essential elements they need. Hence this long-term application of chemical fertilizer might cause some plant nutrients to be depleted and other to be deposited in excess in the soil, and consequently

the acidity of the soil increased. The application of P- fertilizer was effective in every case, while K application had a positive effect only at higher application rate. In continuous application of P fertilizers, soil phosphorus undergoes significant changes both chemical form and its build up was highly observable. In the long-term cultivated plots demonstrate that organic matter highly significantly correlated to Nitrogen, phosphorus and pH soil reaction. Therefore, a continuous supply of organic materials must be added to maintain soil productivity.

Acknowledgement

The author thanks Department of Chemistry, Gauhati University, Guwahati, Assam for assisting laboratory facilities in the analysis of the soil samples.

REFERENCE

- | Abou Keraisha, M.A. and B.S. Farghaly (2003). Effect of tillage systems and N fertilization interacted with biofertilizer on maize grain yield and yield components under middle and Upper Egypt conditions. *J. Agric. Sci. Mansoura Univ*, 28 (8): 5915-5922. | Darwish, A.A. (2003). The yield and yield components of maize as influenced by nitrogen, zinc and boron fertilization. *J. Agric. Sci. Mansoura Univ*, 28 (2): 799-810. | El-Aref, Kh.A.O.; A.S. Abo El-Hamed and A.M. Abo El-Wafa (2004). Response of some maize hybrids to nitrogen and potassium fertilization levels. *J. Agric. Sci. Mansoura Univ*, 29 (11): 6063-6070. | Hati, K.M.; A. Swarup; A.K. Dwivedi; A.K. Misra and K.K. Bandyopadhyay (2007). Changes in soil physical properties and organic carbon status at the topsoil horizon of a vertisol of central India after 28 years of continuous cropping, fertilization and manuring. *Agric.Ecosystems and Environment*, 119 : 127-134. | Höfner, W. And M. Schmitz 1984. Report on the soil and foliar analysis in CIP areas in socialist Ethiopia. EEC/MCTD, Addis Ababa. IFA. (International Fertilizer Industry Association). World Fertilizer Use Manual IFA, Paris, France, (1995) | Iyengar, B.R.V., C.S.K. Naik and S.G. Bakre, 1982. Transformation and availability of phosphorus applied to soil under coffee. *J. Indian Soc. Soil Sci.* 30(3): 285 | Kabeerathamma, S.; C.R. Mohankumar; G.M. Nair and P.G. Nair (1993). Effect of continuous cropping of cassava with organics and inorganics on the secondary and micronutrient elements status of an Ultisol. *J. Indian Soc. Soil Sci.*, 41: 710-713. | Kurual, A. and R.P. Tripathi (1990). Effect of continuous use of manures and fertilizers on physical properties of soil under paddy-wheat-cowpea cropping system. *Crop Res.*, 3: 7-12. | Mahendra sing, A.P. Singh and S. B. Mittal 1982. Effect of long term fertilization and cropping on the potassium supply capacity soils. *Plant and Soil* 65, 375-382 | Mehmood, K.; Z.I. Ahmed and K.S. Khan (2005). Maize growth as influenced by different manures in Pothwar tract (Pakistan). *Intern. J. of Agric. and Biology*, 7(3): 521-523. | Moser, S.B.; B. Feil; S. Jampatong and P. Stamp (2006). Effects of pre-anthesis drought, nitrogen fertilizer rate and variety on grain yield, yield components and harvest index of tropical maize. *Agric. Water Mana.*, 81: 41-58. | Mowafy, S.A.E. (2002). Effect of organic manure and splitting of different levels of nitrogen on wheat under sprinkler irrigation in sandy soils. *Zagazig J. Agric. Res.*, 29 (1): 191-207. | Nicholson, F.A.; B.J. Chambers; K.A. Smith; and R. Harrison (1999). Spring applied organic manures as a source of nitrogen for cereal crops experiments using field equipment. *J. of Agric. Sci. Cambridge*, 133: 353-363. | Paulos Dubale (ed.) 1994. Mineral fertilization of coffee in Ethiopia. Institute of agricultural Research, Addis Ababa. | Ramos, C. and M. Varela (1990). Nitrate leaching in two irrigated fields in the region of Valencia (Spain). In: R. Calvet (Editor), *Nitrate-Agriculture-Em. Proc. Intern. Sym.*, Paris (France), 335-345 (C.F. Computer Search). | Reddy and R.N. Prasad (Eds.), *Proceedings of the National Workshop on Long-term Soil Fertility Management through Integrated Plant Nutrient Supply*. Indian Institute of Soil Science, Bhopal, India, pp. 54-68. | Shen, S. (2002). Contribution of nitrogen fertilizer to the development of agriculture and its loss in China. *Acta Pedol. Sin.*, 39: 12-25. | Suo, D. and P. Wang. (2000). Effect of long-term fertilizations on land productivity. *Acta Agric. Boreali Occidentalis Sin.*, 9:72-75. | Swarup, A. (1998). Emerging soil fertility management issues for sustainable crop productivity in irrigated systems. In: A. Swarup; D.D. | Thanki, J.D.; A.M. Patel and M.P. Patel (2004). Effect of nitrogen, phosphorus and farmyard manure on growth, yield, quality and nutrient uptake of Indian mustard, *Brassica juncea* (L) Czern and Coss. *J. of Oilseeds Res.*, 21(2): 296-298. | Thimma Reddy, Shanmukhappa D.R., Violet D' Souza, Krishnappa Naaik C.S. and | Jayarqama, 1991. Effect of long term application of phosphorus on the availability, form and uptake of P by coffee. *J. Coffee Res.* 21 (2): 127-134. | Vats, M.R.; D.K. Sehgal and D.K. Mehta (2001). Integrated effect of organic and inorganic manuring on yield sustainability in long-term fertilizer experiments. *Indian J. Agric. Res.*, 35: 19-24. | Walkley, A. and Black, C.A. (1974). Critical examination of rapid method of determining organic carbon in soil. *Soil Sci.* 63: 251-164. | Wang, J.; H. Shen; J. Sun; G. Zhen; H. Liu; Y. Li; B. Zhao and F. Zhang (2002). Effect of long-term fertilization on crop yield, fertilizer and water use efficiency. *Plant Nutr. Fert. Sci.* 8:82-86. | Wopereis, M.C.S.; A. Tamelokpo; K. Ezui; D. Gnakpenou; B. Fofana and H. Breman (2006). Mineral fertilizer management of maize on farmer differing in organic inputs in the West African savanna. *Field Crops Res.*, 96: 355-362. | Youssef, A.M.; A.H.M. El-Fouly; M.S. Youssef and S.A. Mohamedien (2001). Effect of using organic and chemical fertilizers in fertigation system on yield and fruit quality of tomato. *Egypt. J. Hort.*, 28: 59-77. | Zohry, A.A. and B.S. Farghaly (2003). Maize and its relation to plant population and nitrogen fertilizer levels. *J. Agric. Sci. Mansoura Univ*, 28 (7): 5173-5181. |