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# ASSESSING NUTRIENT STATUS IN ORGANIC TEA GARDEN OF UPPER BRAHMAPUTRA VALLEY ZONE OF ASSAM

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## ABSTRACT

**This study investigates the soil nutrient status of an organic tea garden situated in the upper Brahmaputra valley zone of Assam in the year 2021. Covering a geographical area of 4.80 km², 300 soil samples were collected and subjected to analysis for key physico-chemical properties employing standard methodologies. Results revealed a consistent silty clay texture across all sections of the tea estate. Mean values for bulk density, particle density, total porosity, and water holding capacity were determined as 1.41 g/cm³, 2.43 g/cm³, 41.98%, and 31.5%, respectively. Soil pH ranged from 4.1 to 5.4, indicating an acidic nature, with a mean pH of 5.2. Electrical conductivity (EC) ranged from 0.01 to 0.04 dS m$^{-1}$, with a mean value of 0.015 dS m$^{-1}$. Organic carbon content measured 0.76%, while available nitrogen, phosphorus, and potassium content varied from low to medium, with mean values of 180.4 kg ha$^{-1}$, 35.7 kg ha$^{-1}$, and 141.1 kg ha$^{-1}$, respectively. Calcium, magnesium, and sulfur content averaged at 0.82 cmol (p+) kg$^{-1}$, 0.95 cmol (p+) kg$^{-1}$, and 31.90 kg ha$^{-1}$, respectively. Additionally, iron, manganese, copper, and zinc content were determined, with mean values of 74.8 ppm, 8.8 ppm, 0.39 ppm, and 0.94 ppm, respectively. The study concluded that organic system of tea cultivation has a great effect on the physical and chemical properties of the soil. The physical and chemical properties like bulk density, water holding capacity and porosity appeared to be favourable under organic system in terms of maintaining the pH of the soil at a desired level. These findings provide valuable insights into the soil characteristics of the tea estate, essential for informed agricultural management practices.**

**(Key words: Soil nutrient status, organic tea garden, physico-chemical properties, texture)**

## INTRODUCTION

The Upper Brahmaputra Valley zone of Assam stands as a pivotal region in the global tea industry, renowned for its production of high-quality Assam tea. The soil nutrient status of tea gardens within this zone plays a fundamental role in shaping the vitality and yield of tea plants, thereby influencing the region's economic landscape and cultural heritage. Assam, nestled in the north-eastern part of India, boasts a unique geographical and climatic setting ideal for tea cultivation (Bhuyan*et al.,* 2023). The Upper Brahmaputra Valley, characterized by its rich alluvial plains and subtropical climate, offers good environment for the growth of *Camellia sinensis*, the tea plant. However, the productivity and quality of tea in this region are intricately linked to the nutrient composition of the soil. Improvement of soil fertility is a critical component of soil health management which play a key role in sustainable agricultural production (Metwall and Hefney, 2018). Since last decade, organic tea is gaining increased momentum in international market in terms of production and productivity. In this context, some of the tea gardens and small tea growers have shown keen interest in organic tea cultivation.

Moreover, emerging trends in sustainable agriculture and environmental stewardship have prompted a re-evaluation of soil nutrient management strategies in tea plantations. The integration of organic farming practices, soil conservation techniques, and precision agriculture holds promise for enhancing soil health and mitigating environmental impacts in the Upper Brahmaputra Valley zone. Against this backdrop, this study aims to explore the current soil nutrient status of tea gardens in the Upper

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Brahmaputra Valley zone of Assam. By examining the levels of key nutrients and assessing soil fertility indicators, this research endeavours to contribute to the optimization of soil management practices, thereby fostering the sustainable growth and resilience of the tea industry in the region. Jayasuriya (2003) had shown that long term exploitation of soils in tea gardens can lead to soil degradation. Similarly, Wang *et al.* (2010) observed that continuous cultivation of tea caused soil acidification leading to decrease in basic cations, altering the structural makeup of the soil, which they infer due to mineralization of nitrogen and organic carbon imparting availability of air and water to roots, nutrient cycling and mechanical resistance to root development and proliferation (Iori *et al.,* 2012). In light of the evolving agricultural landscape and the imperative of ensuring food security and environmental sustainability, an in-depth understanding of the soil nutrient status in tea gardens assumes paramount significance. Through collaborative efforts among researchers, policymakers, and industry stakeholders, it is envisaged that innovative solutions can be devised to address soil fertility challenges and bolster the prosperity of tea cultivation in the Upper Brahmaputra Valley zone of Assam.

## MATERIALS AND METHODS

Hatikhuli Tea Estate, located in Assam, lies between latitude 26°35'0.50"N and longitude 93°21'12.40"E, covering a geographical area of 4.80 sq.km. Established in 1907, it embarked on the journey of converting from an inorganic to an organic tea estate in 2007, achieving certification in 2011. The research was conducted in the year of 2021. To assess its soil nutrient status, surface (0-20 cm) soil samples were meticulously collected using GPS technology from an irregular grid across the tea garden, amounting to a total of 300 samples. Soil physiochemical properties were analysed following standard procedures outlined by Baruah and Barthakur (1997).

## RESULTS AND DISCUSSION

### Physical characteristics

Results on physical properties under tea cultivation are presented in Table 1. The texture of the soil of the tea estate was silty clay. Sand, silt and clay fractions of the soils varied from 55.5 to 78.5, 2.4 to 14.8 and 11.3 to 31.9 per cent. The bulk density of the soil ranged from 1.05 to 1.45 g/cm$^3$ with a mean value of 1.41 g/cm$^3$. The particle density ranged from 2.1 to 2.71 g/cm$^3$ with a mean value of 2.43 g/cm$^3$ and total porosity of the soil ranged from 27.6 to 48.2 per cent with a mean value of 41.98 per cent and water holding capacity from 30.00 to 34.1 per cent with a mean value of 31.5 per cent. The management practices employed at the tea estate resulted in favourable bulk density and total porosity, indicative of enhanced soil structure and aeration. The results concerning soil bulk density and total porosity indicated the increase of soil porosity (Rejak and Kandu, 2023). Soil bulk density was found as an important index of the looseness of agricultural soil and had a significant effect on soil quality (Zheng *et al.*, 2021). Hakansson *et al.* (2000) stated that increasing soil bulk density increased soil permeability resistance and compactness, but decreased porosity, which affected farming and crop growth.

**Table 1. Soil physical properties of the tea estate**

| Parameters | Mean | Range | Standard deviation | Variance |
|---|---|---|---|---|
| BD (gm/cm$^3$) | 1.41 | 1.05-1.45 | 0.207 | 0.043 |
| PD (gm/cm$^3$) | 2.43 | 2.1-.2.71 | 0.326 | 0.106 |
| Porosity (%) | 41.98 | 27.6-48.2 | 4.51 | 20.38 |
| WHC (%) | 31.5 | 30.00-34.12 | 1.17 | 1.39 |
| Sand (%) | 70.3 | 55.5-78.5 | 4.94 | 6.02 |
| Silt (%) | 6.8 | 2.4-14.8 | 2.45 | 24.44 |
| Clay (%) | 22.9 | 11.3-31.9 | 4.29 | 18.44 |

### Chemical characteristics

The pH of the soils varied from acidic in reaction ranging from 4.1 to 5.4 with a mean value of 5.2 under whereas the EC ranged from 0.01 to 0.04 (dSm$^{-1}$), with mean value of 0.015 (dSm$^{-1}$) (Table 2). The organic carbon content of the soils ranged from 0.46 to 1.81 per cent with mean value of 0.76 per cent (Table 2). The CEC ranging from 4.1 to 14.7 cmol (p$^+$) kg$^{-1}$ with mean value of 7.9 cmol (p$^+$) kg$^{-1}$(Table 2).The increase in organic carbon in organic management is probably due to microbial biomass contained in the organic amendment. These results are in accordance with Glover *et al.* (2000), who observed that organic system maintains soil organic matter at high level than conventional system.

**Table 2. Soil chemical properties of the study area**

| Parameters | Mean | Range | Standard deviation | Variance |
|---|---|---|---|---|
| pH (1:2.5) | 5.2 | 4.1-5. 4 | 0.34 | 0.11 |
| EC (dSm$^{-1}$) | 0.015 | 0.01-0.04 | 0.007 | 4.91 |
| Organic carbon (%) | 0.76 | 0.46-1.81 | 0.28 | 0.083 |
| Cation exch. Capacity [cmol (p$^+$) kg$^{-1}$] | 7.9 | 4.1-14.7 | 2.38 | 0.728 |

### Available macronutrients and micronutrients

The data regarding available nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, manganese, copper content are presented in Table 3. The N content ranged from low to medium (100.3 to 338.6 kg ha$^{-1}$) with a mean value of 180.4 kg ha$^{-1.}$The P content ranged from low to medium (25.8 to 42.5 kg ha$^{-1}$) with a mean value of 35.7 kg ha$^{-1}$.

The K content ranged from low to medium (49.1 to 267.8 kg ha$^{-1}$) with a mean value of 141.1 kg ha$^{-1}$. The Ca value ranged from 0.1 to 2.8cmol (p$^+$) kg$^{-1}$ with mean values of 0.82 cmol / ($p^+$) $kg^{-1}$. The Mg value ranged from 0.1 to 2.9 cmol ($p^+$)$kg^{-1}$ with mean values of 0.95 cmol / ($p^+$) $kg^{-1}$. The S content was found to be almost equal in mean values 31.90 kg $ha^{-1}$ with an average 16.8 to 50.1 kg $ha^{-1}$.The Fe content ranged from 29.1 to 193.02 ppm with a mean value of 74.8 ppm. The Mn content ranged from 4.4 to 15.1 ppm with a mean value of 8.8 ppm. The Zn content ranged from 0.18 to 0.96 ppm with an average value of 0.39 ppm .The Cu content ranged from 0.43 to 1.46 ppm with an average value of 0.94 ppm .The study provides insights into the varying levels of macronutrient and micronutrient. The findings shed light on the dynamic interplay between soil fertility, plant nutrition, and tea yield, emphasizing the need for targeted soil management practices (Das *et al.*, 2023).

From the study it can be concluded that organic system of tea cultivation has a great effect on the physical and chemical properties of the soil. The physical and chemical properties like bulk density, water holding capacity and porosity appeared to be favourable under organic system in terms of maintaining the pH of the soil at a desired level. Overall, the study underscores the significance of soil fertility management in organic tea cultivation within the Upper Brahmaputra Valley zone. The findings contribute valuable insights for tea estate management, emphasizing the need for tailored soil fertility strategies to sustainably support tea production. Collaboration between researchers, policymakers, and industry stakeholders is essential to promote practices that enhance soil health, ensure environmental sustainability, and foster the continued prosperity of the tea industry in the region.

**Table 3. Soil nutrient status of the study area**

| Parameters | Mean | Range | Standard deviation | Variance |
|---|---|---|---|---|
| Nitrogen (kg $ha^{-1}$) | 180.4 | 100.3-338.6 | 53.6 | 2878.7 |
| Phosphorus (kg $ha^{-1}$) | 35.7 | 25.8-42.5 | 3.40 | 11.5 |
| Potassium (kg $ha^{-1}$) | 141.1 | 49.1-267.8 | 53.3 | 2850.8 |
| Calcium (cmol ($p^+$) $kg^{-1}$) | 0.82 | 0.1-2.8 | 0.51 | 0.26 |
| Magnesium (cmol ($p^+$) $kg^{-1}$) | 0.951 | 0.1-2.9 | 0.532 | 0.283 |
| Sulphur (kg $ha^{-1}$) | 31.9 | 16.8-50.1 | 8.9 | 80.86 |
| Iron (ppm) | 74.8 | 29.1-193.0 | 30.4 | 74.8 |
| Copper (ppm) | 0.94 | 0.43-1.46 | 0.190 | 0.036 |
| Manganese (ppm) | 8.83 | 4.42-15.18 | 2.75 | 7.56 |
| Zinc (ppm) | 0.39 | 0.18-0.96 | 0.189 | 0.035 |

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