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# Distribution of organic carbon and nitrogen in some Tarai soils of West Bengal

*A.K.Saha, N. Saha* and S.K. Pal*

North Bengal Campus, Bidhan Chandra Krishi Viswavidyalaya, Cooch Bihar, Pundibari 736 165, India

* Present Address : Gosanimari High School, Gasanimari, Cooch Bihar, India

*Abstract*

Depthwise distribution of organic carbon and different forms of nitrogen was studied on twenty four soils of Tarai region of West Bengal. Like organic carbon, forms of nitrogen decreased with depth in the profiles of tea gardens and forest areas. But no consistent pattern of distribution was observed in profiles of cultivated lands. Organic carbon and forms of nitrogen were significantly correlated among themselves. The C/N ratios which also decreased down the profile, were somewhat wider in these profiles, indicating the slower rate of mineralisation possibly due to low temperature and soil acidity. Ammoniacal nitrogen alone can explain 94% variation in available nitrogen content in the surface soils of these pedons.

Additional keywords : C/N ratio, forms of nitrogen.

## Introduction

Distribution of organic carbon in soils varies with climate, vegetation and soil horizon (Broadbent 1953) and also with land use (Kononova 1966). Organic matter plays an important role in crop production through its positive influence on nutrient availability in soil. There are accounts of distribution of organic matter/carbon in some soils of West Bengal (Lahiri and Chakravarti 1955). However, there seems to be limited report on the distribution of organic carbon and nitrogen in Tarai soils of West Bengal.

## Materials and methods

Horizonwise soil samples from eight soil profiles in the tea gardens of Jalpaiguri, twelve in the cultivated areas of Cooch Bihar and four in the forest areas of Jalpaiguri district of Tarai region of West Bengal were collected. Samples were ground to pass through 2 mm sieve.

Organic carbon content was estimated by Walkley and Black method (Piper 1966). Available nitrogen was estimated by alkaline permanganate method of Subbiah and Asija (1956) and total nitrogen according to Brewer (1965). Ammonium and nitrate-nitrogen content in the soils were determined following Bremner and Keeney (1966). The soils were categorised into low, medium and high status considering the critical limits of FAI (1977). Particle size distribution and textural classes of the soils were determined following the pipette method (Piper 1966).

Linear and stepwise regression equations were developed using the regression module of SPSS. In stepwise regression, available nitrogen was used as the dependent variable, and organic carbon, total N and mineral forms of nitrogen were considered as independent variables.

## Results and discussion

*Organic carbon and C/N ratio* : Soils of tea gardens and forest areas recorded their highest organic carbon in the surface horizons and then decreased sharply with depth (Table 1). However, the depth distribution of organic carbon in the soils of cultivated lands did not follow any regular trend (Table 1). On the basis of organic carbon content in the surface samples, all the pedons under tea gardens and forest areas were rated as high ($> 7.5$ g $kg^{-1}$), and among the twelve pedons from cultivated area, three as low ($<5.0$ g $kg^{-1}$), six as medium (5.0–7.5 g $kg^{-1}$) and three as high. Relatively high organic matter status in these pedons is actually attributed to low temperature and high rainfall which favour more vegetation.

The higher values of the C/N ratios occur in the surface soil and the ratio tends to decline with depth in all the pedons except few from the cultivated areas (Table 1). By and large, wider C/N ratios in these profiles indicate the slow rate of N-mineralisation possibly due to low temperature and soil acidity.

*Nitrogen* : The contents of total, available, ammoniacal and nitrate forms of nitrogen in the soil profiles decrease with depth. Depth distribution of nitrogen forms showed the similar trend as that of organic carbon.

**Table 1. Distribution of organic carbon and different forms of nitrogen in some typical Tarai pedons of West Bengal**

| Horizon | Depth (cm) | Textural class | Organic carbon | Total N | Available N | $NH_4$–N | $NO_3$–N |
|---|---|---|---|---|---|---|---|
| | | | ------- g $kg^{-1}$------- | | --------- mg $kg^{-1}$----------- | | |
| **Pedon-1 : Mathura Tea Estate (Jalpaiguri), Coarse loamy Typic Udorthents** | | | | | | | |
| Ap | 0–26 | Silty loam | 14.3 | 0.820 | 147 | 84 | 8.2 |
| C1 | 26–85 | Loamy sand | 4.2 | 0.393 | 92 | 60 | 6.4 |
| C2 | 85–120 | Loamy sand | 1.5 | 0.210 | 60 | 31 | 3.1 |
| C3 | 120–150+ | Loamy sand | 0.9 | 0.143 | 32 | 19 | 2.1 |
| **Pedon-2 : Subhasini Tea Estate (Jalpaiguri),Corase loamy Typic Udipsamments** | | | | | | | |
| Ap | 0–22 | Loam | 17.9 | 1.640 | 201 | 99 | 8.2 |
| C1 | 22–65 | Loam | 11.6 | 1.212 | 150 | 79 | 6.1 |
| C2 | 65–95 | Loamy sand | 9.2 | 1.053 | 161 | 82 | 7.2 |
| C3 | 95–125 | Loamy sand | 6.2 | 0.810 | 143 | 71 | 6.2 |
| C4 | 125–150+ | Loamy sand | 4.2 | 0.630 | 120 | 69 | 4.1 |
| **Pedon-3 : District Seed Farm (Cooch Bihar), Fine Loamy Typic Eutrochrepts** | | | | | | | |
| Ap | 0–19 | Silty loam | 6.9 | 0.618 | 100 | 67 | 6.2 |
| A3 | 19–37 | Loam | 1.3 | 0.212 | 39 | 27 | 2.2 |
| B21 | 37–49 | Silty loam | 3.1 | 0.481 | 81 | 62 | 5.7 |
| B22 | 49–86 | Loam | 1.5 | 0.216 | 42 | 27 | 2.5 |
| B23 | 86–122 | Silty loam | 1.4 | 0.206 | 41 | 25 | 2.2 |
| C | 122–150+ | Loam | 1.5 | 0.217 | 41 | 24 | 2.1 |
| **Pedon-4 : B.C.K.V. Farm, Pundibari (Cooch Bihar) Typic Udipsamments** | | | | | | | |
| Ap | 0–17 | Silty loam | 5.2 | 0.349 | 80 | 61 | 5.9 |
| C1 | 17–33 | Silty loam | 3.2 | 0.291 | 51 | 32 | 3.1 |
| C2 | 33–60 | Silty loam | 3.9 | 0.370 | 65 | 45 | 4.2 |
| C3 | 60–70 | Silty loam | 0.5 | 0.050 | 10 | 8 | 1.1 |
| C4 | 70–75 | Loamy sand | 1.1 | 0.109 | 15 | 10 | 1.2 |
| C5 | 75–81 | Loamy sand | 2.9 | 0.320 | 64 | 41 | 3.1 |
| C6 | 81–107 | Loamy sand | 3.6 | 0.389 | 77 | 49 | 3.6 |
| C7 | 107–150+ | Loamy sand | 3.1 | 0.414 | 81 | 51 | 3.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Pedon-5 : CTRI, Dinhata (Cooch Bihar),Corase loamy Typic Udifluvents** | | | | | | | |
| Ap | 0–20 | Loamy sand | 4.5 | 0.372 | 62 | 42 | 4.1 |
| AC | 20–41 | Loamy sand | 3.8 | 0.323 | 63 | 44 | 4.1 |
| C1 | 41–50 | Loamy sand | 1.2 | 0.110 | 21 | 15 | 1.1 |
| C2 | 50–60 | Loamy sand | 1.5 | 0.210 | 47 | 30 | 2.6 |
| C3 | 60–150+ | Loamy sand | 1.6 | 0.260 | 42 | 31 | 2.9 |
| **Pedon-6 : Saheberhat (Cooch Bihar), Loamy Udipsamments** | | | | | | | |
| Ap | 0–16 | Loamy sand | 4.4 | 0.260 | 52 | 39 | 3.7 |
| C1 | 16–65 | Loamy sand | 2.8 | 0.210 | 42 | 29 | 2.5 |
| C2 | 65–102 | Sand | 1.2 | 0.150 | 26 | 16 | 1.1 |
| C3 | 102–150+ | Sand | 1.0 | 0.160 | 26 | 15 | 1.2 |
| **Pedon-7 : Tufanganj (Cooch Bihar), Fine loamy Typic Udifluvents** | | | | | | | |
| Ap | 0–18 | Silt | 9.9 | 0.672 | 99 | 67 | 6.2 |
| C1 | 18–45 | Silt | 7.5 | 0.586 | 87 | 61 | 5.9 |
| C2 | 45–72 | Clay loam | 6.0 | 0.625 | 93 | 69 | 5.1 |
| C3 | 72–112 | Silty clay | 6.5 | 0.670 | 87 | 58 | 4.9 |
| C4 | 112–150+ | Silt | 2.0 | 0.282 | 47 | 29 | 3.1 |
| **Pedon-8 : Chilepata Forest (Jalpaiguri), Corse loamy Typic Udorthents** | | | | | | | |
| Ap | 0–25 | Silt | 14.3 | 0.910 | 160 | 91 | 9.1 |
| C1 | 25–50 | Silt | 6.5 | 0.846 | 112 | 71 | 6.5 |
| C2 | 50–110 | Silt | 3.5 | 0.485 | 61 | 40 | 4.1 |
| | 110–150+ | Loamy sand | 1.5 | 0.225 | 49 | 37 | 2.2 |

The fact is further supported by significant relationships between organic carbon and different forms of nitrogen of soils (Table 2). Available N content in the surface soils ranged from 52 to 220 mg $kg^{-1}$ and accounted for 0.087 per cent of total N. Again, mineral N ($NH_4$–N + $NO_3$–N) of the surface soils contributed 53.3 to 83.6 per cent of available N and rest was associated with the organic fractions (Table 1). According to prevalent criteria with respect to available N status of the surface soil most of the pedons collected from cultivated area were low (<250 kg $ha^{-1}$), and the pedons from tea gardens and forest areas were medium (250–500 kg $ha^{-1}$). The status of nitrate nitrogen in these soils were low (ranged from 3.1 to 11.9 mg $kg^{-1}$ in the surface soils) possibly due to the leaching down under high rainfall and coarse texture. A relatively higher content of nitrate nitrogen in the surface horizon may be on the other hand due to high nitrification.

**Table 2. Correlation coefficients* among nitrogen fractions of soils.**

| Parameter | Nitrogen fractions | | | |
|---|---|---|---|---|
| | Total | Available | $NH_4$ | $NO_3$ |
| Organic carbon | 0.926 | 0.906 | 0.851 | 0.855 |
| Total–N | | 0.948 | 0.890 | 0.883 |
| Available–N | | | 0.963 | 0.936 |
| $NH_4$–N | | | | 0.963 |

* All are significant at 0.1% level.

There is a close relationship among the different forms of nitrogen also, when both the total profile samples and the surface samples alone are taken into account (Tables 2 and 3). The result was in conformity with that of Walia *et al.* (1988). A strong positive correlation between $NH_4$–N and $NO_3$–N indicates their inter-relationship in N-transformation in soil. As usual, $NH_4$–N holds a highly significant positive correlation with available–N, as the former form predominates the later.

**Table 3. Correlation coefficients* among nitrogen fractions of soils.**

| Parameter | Nitrogen fractions | | | |
|---|---|---|---|---|
| | Total | Available | $NH_4$ | $NO_3$ |
| Organic carbon | 0.908 | 0.926 | 0.893 | 0.807 |
| Total–N | | 0.950 | 0.903 | 0.858 |
| Available–N | | | 0.972 | 0.921 |
| $NH_4$–N | | | | 0.968 |

* All are significant at 0.1% level.

No restriction was imposed, allowing independent variables to enter competitively into the stepwise regression to predict available soil nitrogen from potential independent variables. The order of entry depends solely upon the extent of contribution of each variable to the regression equation. All the variables in the equation (Table 4) are significant at 5% probability level. From the study of stepwise regression analysis, it was observed that ammoniacal nitrogen alone could explain 94.1% variability in available N content. When the second potential independent variable, total N was entered, the $R^2$ was raised to 0.970 which indicated that 97% variability in available N content could be explained by these two independent variables. So, it is clear that there is a strong dependence among these forms of N.

**Table 4. Stepwise regression equations for predicting available N content (%) of surface soils**

| Step | Variable entered | Equation | Total $R^2$ |
|---|---|---|---|
| 1. | AM | $Y = -31.85 + 2.099\ AM$ | 0.941 |
| 2. | TN | $Y = -9.31 + 1.328AM + 42.046\ TN$ | 0.970 |

AM = Ammoniacal N; TN = Total N

The finding was in conformity with those of Singh and Datta (1988). The positive coefficients of both with ammoniacal and total-nitrogen suggest that available N content in these soils increased with the increase in ammoniacal and total-nitrogen content.

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