Research Article

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# Mineralisation of nitrogen in some soils of Kerala

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## Abstract

Four soil types from Kerala viz. Sandy (Oxic quartzipsamments), Red sandy loam (Arenic paleustults ), Laterite (Oxic haplustults) and Kari (Tropic fluvaquents) were taken for studying their rate of nitrogen mineralization. The inorganic N production in the case of red sandy loam, sandy and laterite soils decreased from 20 days upto 40 days after incubation. Further, a marginal decline in net mineralisation of N after 60 days of incubation followed by increase upto 80 days after incubation was observed. However, in case of Kari soil, the inorganic N production decreased from 20 days to 60 days after incubation, after which it registered an increase upto 80 days after incubation. The rate of mineralisation of inorganic N was more in case of Kari soil (0.543 µg N /day) followed by red sandy loam (0.042 µg N/day), sandy (0.027 µg N/day) and lastly, laterite (0.024 µg N /day). Linear and first order kinetics were worked out. Except for sandy soil which had high $R^2$ value in first order transformation, all the other soil types followed linear transformation, thereby, indicating that the rate of N mineralised is time dependent for Red sandy loam, laterite and Kari soils.

*Keywords:* Kerala soil types, nitrogen, mineralisation

## Introduction

Nitrogen is one of the most important nutrients required by the crops. Difficulties encountered in building up the plant available N fraction in soils lead to manifold increase in importance of N for crop production particularly in humid tropical climate. Most of the N (80-90 %) in soil is locked up in organic fraction. Subsequent availability depends upon the mineralisation potential of the soil. The easily mineralized pool is usually thought to be most important in providing N to a crop (Jenkinson, 1968 ; Stanford and Smith, 1972) and therefore, its quantification has been the focus of much of the N availability research (Carski and Sparks, 1987). Broadbent (1986) stated that in soils with low or moderate concentration of organic matter, the rate of N release by the plants is thought to be controlled by the size of active organic pool. Janssen (1958) postulated this pool to be in equilibrium with a larger, more inert source of organic N.

Coconut is grown mainly in four different soils of Kerala viz. sandy, red sandy loam, laterite and kari soils. Understanding their nitrogen mineralisation potential will help us in formulating suitable nitrogen management strategies for coconut in different soil types. The present investigation aims at studying the nitrogen mineralisation of four different soil types of Kerala.

## Materials and Methods

Four different soils types viz. Sandy (*Oxic quartzipsamments*), Red sandy loam (*Arenic paleustults*), Laterite (*Oxic haplustults*) and Kari (*Tropic fluvaquents*) were taken for studying the rate of mineralization of nitrogen. Surface soil samples representing 0-30 cm layer were collected, air dried and sieved to pass through 2 mm mesh sieves. The soil samples were analysed for its mechanical composition, pH(1:2.5), Organic carbon, total N following the procedure outlined by Jackson (1967) and the details are given in Table 1.

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Table 1. Basic characteristics of soils

| soil type | pH | Org. C (%) | Total N (%) | Mechanical Composition (%) Sand | Silt | Clay |
|---|---|---|---|---|---|---|
| Sandy soil | 5.9 | 0.25 | 0.023 | 98.0 | 0.20 | 0.7 |
| Red Sandy Loam | 5.3 | 0.48 | 0.093 | 76.0 | 1.92 | 22.0 |
| Laterite | 5.5 | 0.41 | 0.107 | 45.0 | 9.95 | 35.0 |
| Kari | 4.2 | 5.20 | 0.148 | 7.2 | 26.5 | 52.4 |

An incubation experiment was carried out for mineralisation studies in three replications. 30 g representative sample of the four soils under field moist condition was collected and transferred into sintered glass leaching tubes after keeping a pad of glass wool pad. A thin glass wool pad was also placed over the soil to avoid dispersing the soil when leaching solution was poured. The soil was then leached with 150 ml lots of 0.01 M KCl 4-5 times to remove mineralised N in soil and excess solution was allowed to drain for 24 hours under gravity. The leaching was done at an interval of 20 days upto a period of 80 days. The leachate thus obtained were analysed for inorganic-N by Kjeldahl procedure. The moisture content of the columns was adjusted every 3rd day with deionised water by weighing the columns.

## Results and Discussion

The inorganic N production as influenced by the time of incubation is depicted in Fig.1 and 2. The inorganic N production in the case of red sandy loam, sandy and laterite soils decreased sharply from 20 days upto 40 days after incubation followed by marginal decline upto 60 days after incubation. Further, a marginal increase in net N mineralisation was observed after 60 days upto 80 days after incubation. This decrease in inorganic N production upto 40 days after incubation might be due to assimilation of nitrogen by microorganisms owing to decomposition of small amounts of low N plant material (Stanford and Smith, 1972) as well as highly resistant organic complexes e.g. lignoprotein complexes present which required more time for decomposition (Waksman and Tenney, 1927). Secondly, the toxic metabolites associated with decomposition might have inhibited the mineralisation. Only when these materials have broken down into simpler compounds then again the mineralisation of N increased as evident at 80 days after incubation. However, the trend in case of Kari soil was different. The inorganic N production decreased from 20 days after incubation to 60 days after incubation, after which it registered an increase upto 80 days after incubation. The reason for initial decrease upto 60 days after incubation and subsequent increase to 80 days after incubation has already been outlined in earlier discussion.

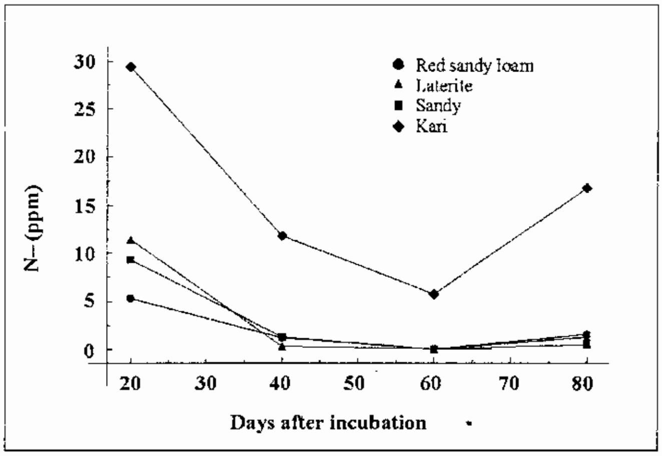


Fig. 1. Nitrogen mineralised

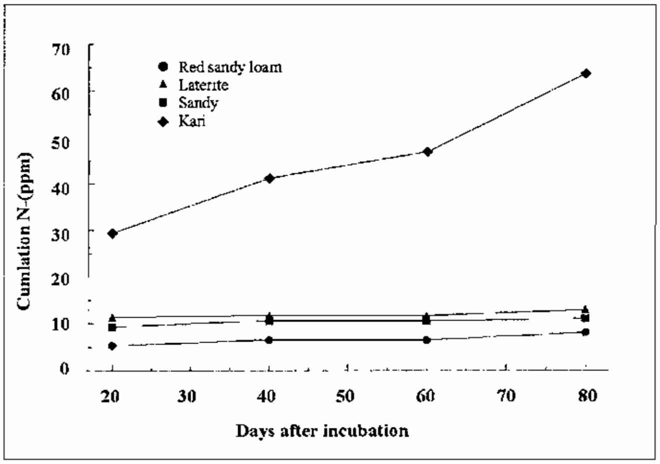


Fig. 2. Cumulative nitrogen mineralised

The rate of mineralisation of inorganic N was more in case of Kari soil (0.543 µg N /day) followed by red sandy loam (0.042 µg N/day), sandy (0.027 µg N/day) and lastly laterite (0.024 µg N /day) (Table 2). The rate of mineralisation was more in kari soils as the organic carbon content is more. Infact, a significant positive correlation was found between the rate of mineralisation and the organic carbon content of the soil (r = 0.999**). Sierra (1996) reported that the rate of N mineralisation during an incubation period was correlated with the lighter fraction (density ≤ 2 Mg/m$^3$) of organic C at the beginning of the period. However, no significant

Table 2. Parameters and correlation coefficients of linear relationship between cumulative nitrogen mineralised in soils and incubation time

| Soil type | Intercept | x coefficient (µg N day$^{-1}$) | $R^2$ Value |
|---|---|---|---|
| Sandy soil | 9.05 | 0.027 | 0.82** |
| Red Sandy Loam | 4.50 | 0.042 | 0.89** |
| Laterite | 10.75 | 0.024 | 0.75** |
| Kari | 18.15 | 0.543 | 0.97** |

** - Significant at 1 % level

correlation could be observed between the total N and the rate of mineralisation (r = 0.712). This can be corroborated by the findings of Tabatabai and Al-Khafaji (1980).

The N mineralization potential ($N_0$) was estimated by using the following first order transformation:

$$N_{min} = N_0 [1-\exp(-kt)]$$

where $N_{min}$ is the cumulative amount of N mineralised during a specific time interval (t) in days, $N_0$ is the N mineralisation potential and k is the first order rate constant. As given by Stanford and Smith (1972), this equation can be transformed to

$$\frac{1}{Nmin} = \frac{1}{No} + \frac{b}{t}$$

Hence, the reciprocal of intercept (b) is an estimate of $N_0$. The first order rate constant (k) can be estimated according to the first order kinetic equation:

$$\log(N_0 - N_{min}) = \log N_0 - \frac{k}{2.303}(t)$$

The dissimilarity in the nitrogen mineralisation potential ($N_0$) values amongst the different soil types may be due to the composition of organic matter in the soil and amount of mineralizable N. The highest mineralisation potential was found in case of Kari soil. This may be due to high organic carbon content present. The differences among the first order rate constant (k) indicate the release of mineral N at different rates. However, except for sandy soil which had high $R^2$ value in first order transformation, all the other soil types followed linear transformation, thereby, indicating that the rate of N mineralised is time dependent. Except for laterite soil, other soils $R^2$ values were significant for first order transformation (Table 3).

**Table 3. Kinetic parameters of nitrogen mineralisation rates of soils**

| Soil type | $N_0$ (µg N $g^{-1}$ soil) | k ($day^{-1}$) | $t_{\frac{1}{2}}$ (days) | $R^2$ Value |
|---|---|---|---|---|
| Sandy soil | 6.828 | 0.0199 | 34.82 | 0.89** |
| Red Sandy Loam | 4.289 | 0.0288 | 24.88 | 0.79* |
| Laterite | 3.259 | 0.0265 | 26.15 | 0.67(NS) |
| Kari | 78.485 | 0.0167 | 41.50 | 0.90** |

* - Significant at 5 % level ; ** - Significant at 1 % level

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