# Transformation of organic N newly added to red soil treated with different cultural practices*

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**Abstract** By using $^{15}N$ tracer method, transformation of organic N, which was newly added to red soil treated with different cultural practices, was studied under the laboratory incubation condition. The experimental results showed that the transformation of N from newly added organic matter and soil native pool during incubation was influenced by cultural practice treatment before incubation. Fallow was favorable to the mineralization of newly added organic N and soil N compared with the planting wheat treatment. Planting wheat greatly increased the loss of soil N. Application of fertilizers stimulated the mineralization of newly added organic N and application of organic matter reduced the mineralization, but stimulated microbial transformation of newly added organic N.

**Keywords** Organic matter, Red soil, Transformation, Cultural practice

## 1 Introduction

Numerous studies have been conducted to investigate turnover of nitrogen from $^{15}N$-labelled organic matter in various types of soils.[1~4] Nitrogen released from the mineralization of organic matter may be readily available to plants or be incorporated into microbial biomass as a fraction of potentially available plant nutrients. The decomposition of added organic materials could accelerate the transformation of nutrients and the formation of new soil organic matter, therefore, increasing input of organic materials is an useful approach to improve soil fertility. Organic materials have been proven to be the most effective amending material for red soil[6~8]. The decomposition and transformation of organic C and N in soil could be affected by many factors, such as bioecosystemic conditions, plant cover, rotation and cultivation.[9~11] We have studied the transformation of added ryegrass N and indigenous soil organic N in red soils from different agroecosystemic conditions (another paper to be published). In this experiment, we further investigated the nitrogen transformation in red soils treated with different cultural practices.

## 2 Materials and methods

### 2.1 Treatments of soil

The test red soil (clayey) was taken from the surface layer of cultural land in Longyou County of Zhejiang Province. It contained $14.7\,g\cdot kg^{-1}$ organic matter, $11.75\,mg\cdot kg^{-1}$ Olsen P and $943\,mg\cdot kg^{-1}$ total N, in addition, it had a cation-exchange capacity of $5.64\,cmol\cdot kg^{-1}$ and a pH of 4.82 ($H_2O$). Air-dried and ground soil was passed through a sieve of 20 mesh, each 750 g of the soil sample was moistened and treated as described in Table 1, and then was put into small pots.

Wheat seeds were sowed in the pots except the treatment $T_1$ on 4 d after fertilization. The pots were placed in the field with normal wheat field management. The wheat was removed two months later and the soil was air-dried, ground and passed through a sieve of 20 mesh.

### 2.2 Incubation of soil samples with labelled ryegrass

The treated soil was adjusted to 40% of water holding capacity (WHC) and incubated at 25°C for 10 d. The pre-incubated soil was mixed with $^{15}N$-labelled ryegrass at an amending rate of 3% (contained $0.821\,mg\cdot ryegrass\text{-}N\cdot kg^{-1}soil$), and then the soil moisture was adjusted to 60%

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of WHC and incubated at 25°C for 15 d.

**Table 1** Treatments of clayey soil with different cultural practices

| No | Treatment | Fertilization | | | | Plantation |
|---|---|---|---|---|---|---|
| | | $(NH_4)_2SO_4$/mg | Ryegrass/g (<40 mesh) | $Ca(H_2PO_4)_2$/mg | $K_2SO_4$/mg | |
| $T_1$ | FL | 0 | 0 | 0 | 0 | fallow |
| $T_2$ | W | 0 | 0 | 0 | 0 | wheat |
| $T_3$ | W+F | 750 | 0 | 500 | 300 | wheat |
| $T_4$ | W+OM | 0 | 3.18 | 0 | 0 | wheat |
| $T_5$ | W+F+OM | 375 | 1.59 | 250 | 150 | wheat |

FL represents fallow treatment; W, wheat plantation; F, fertilization; OM, organic matter amendment

### 2.3 Analysis of N in different forms in soil samples

The soil samples were taken to analyze the amount of total N, biomass N, mineral N, humic N and $^{15}N$ abundance at the end of incubation as methods described in previous paper.[12] Based on the amount of total N and $^{15}N$ abundance, the amount of N in different forms from ryegrass and soil could be calculated. The lost N was the difference between the applied N plus initial soil N and the total N in samples. The sum of mineral $^{15}N$, biomass $^{15}N$, humic $^{15}N$, extractable organic $^{15}N$ and lost $^{15}N$ from ryegrass was considered as the transferred N from ryegrass, and thus the difference between applied ryegrass N and transferred N was considered as the residual N. All results were expressed as percentage of applied N and initial soil N.

## 3 Results and discussion

### 3.1 Effects of cultural practice on transformation of organic N in red soil

The difference in mineral N and biomass N($P$ <0.01) from ryegrass among the treatments showed that plantation of wheat ($T_2$) reduced the amount of mineral N and did not affect microbial transformation of organic N compared with no plantation ($T_1$). Planting wheat with N,P,K fertilizers ($T_3$) stimulated the mineralization of organic N and reduced the microbial transformation of organic N, on the contrary, application of organic matter reduced the amount of mineral N and increased the amount of biomass N from ryegrass significantly. There was no significant effect of plantation and fertilization on humification of organic N. Application of fertilizer and organic matter increased the loss of ryegrass N significantly compared with wheat plantation without fertilization and organic matter amendment. Transformation rate of ryegrass N for the amending treatment was almost the same as that for the treatments of wheat plantation with or without fertilization, and that was slightly higher for the non-plantation treatment. As a result, residual N in fallow treatments was half less than that in the other four treatments (Table 2). The amount of mineral N, biomass N, humic N, extractable organic N, lost N, transformed N and residue N in the same soil before treatment determined in previous experiment was 17.65%, 24.20%, 28.90%, 1.40%, 22.90%, 95.05% and 4.99% of applied $^{15}N$-labelled ryegrass N, respectively . Although the total amount of N transformed in untreated soil was almost the same as that in fallow-treated soil, there was larger amount of mineral N and microbial N and smaller amount of humic N from ryegrass in untreated soil than in the other treated soil samples.

### 3.2 Effects of cultural practice on the forms of N from native soil pool after incubating with ryegrass

There was significant difference in biomass N, humic N and mineral N from soil among the treatments. Planting wheat reduced the amount of mineral N, biomass N and humic N compared with the fallow. Application of fertilizers increased the mineral N, biomass N and humic N compared with the non-fertilized plantation treatment. Application of organic matter also had positive effects on biomass N and humic N, but had little effect on mineral N. Combining application of fertilizer and organic matter increased the amount of mineral N, biomass N and humic N significantly, especially the amount of soil biomass N was increased by two times more than that of the application of fertilizers or organic matter alone, and by 6.6 times than that of non-fertilized wheat plantation treatment. Planting wheat increased the loss of soil N by 154% compared with the fallow, while application of organic matter significantly reduced the loss of soil N (Table 3).

**Table 2** Transformation of organic N in red soils treated with different cultural practice

| Treatment | Mineral N | Biomass N | Humic N | EON | Lost-N | Transferred-N | Residue-N |
|---|---|---|---|---|---|---|---|
| $T_1$ | 16.24±0.22 | 19.11±0.88 | 37.09±0.92 | 4.49±1.40 | 18.55±0.28 | 95.48±2.36 | 4.52 |
| $T_2$ | 14.98±0.15 | 19.48±0.77 | 36.06±0.51 | 3.03±0.53 | 16.85±0.10 | 90.39±0.63 | 9.61 |
| $T_3$ | 17.10±0.66 | 13.18±0.65 | 35.04±0.44 | 5.14±0.24 | 20.03±0.13 | 90.41±0.66 | 9.51 |
| $T_4$ | 10.39±0.73 | 21.57±0.75 | 35.24±1.42 | 2.78±0.67 | 20.98±1.43 | 90.97±1.85 | 9.03 |
| $T_5$ | 12.44±0.33 | 16.02±0.73 | 34.16±0.70 | 4.67±0.46 | 20.69±0.86 | 87.98±2.90 | 12.02 |
| $LSD_{0.05}$ | 0.911 | 1.623 | 1.719 | - | 1.515 | - | - |
| $LSD_{0.01}$ | 1.277 | 2.276 | 2.410 | - | 2.124 | - | |

EON represents extractable organic nitrogen

**Table 3** Effect of cultural practice on the forms of N from soil native pool after incubating with ryegrass for 15 d (% of total N in initial soil)

| Treatment | Mineral N | Biomass N | Humic N | EON | Lost-N |
|---|---|---|---|---|---|
| $T_1$ | 8.24±0.73 | 4.16±1.62 | 38.51±1.57 | 1.53 | 5.11±0.56 |
| $T_2$ | 6.24±0.27 | 3.12±1.84 | 34.61±0.59 | 2.82 | 13.00±1.41 |
| $T_3$ | 7.28±0.16 | 9.06±0.86 | 36.68±1.27 | 0.84 | 6.08±0.82 |
| $T_4$ | 6.30±0.16 | 9.16±0.38 | 42.92±1.28 | 1.24 | 1.91±0.72 |
| $T_5$ | 8.30±0.77 | 20.72±2.07 | 41.19±0.25 | 1.34 | 2.66±0.66 |
| $LSD_{0.05}$ | 0.682 | 2.966 | 2.246 | - | 1.761 |
| $LSD_{0.01}$ | 0.956 | 4.159 | 3.117 | - | 2.469 |

## 4 Conclusion

(a) Fallow was favorable to the mineralization of organic N newly added and soil N compared with the planting wheat treatment. Planting wheat greatly increased the loss of soil N. (b) Application of fertilizers stimulated the mineralization of organic N newly added, but reduced the transformation of organic N into biomass N and increased the amount of soil biomass N. (c) Application of organic matter reduced the mineralization of organic N and stimulated the microbial transformation of organic N newly added. The treatment also increased the amount of soil biomass N and humic N, and reduced the loss of soil N. (d) Combining application of fertilizers and organic matter increased the amount of mineral N, biomass N and humic N from soil though transformation of organic N newly added was not influenced by the treatment significantly.

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