草地における脱窒についての実態調査

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Short Report

A Survey of Denitrification in the Grassland

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Introduction

Denitrification is one of the important factors in nitrogen loss from cultivated land as well as removal of harvesting plants, surface run-off, leaching through the soil profile and volatilization[3].

Grasslands are distributed in wide environmental ranges of soil water and accumulate a large amount of organic matter such as dead roots, fallen leaves. Therefore, the grassland has a possibility to bring on a transient denitrification when the anaerobic conditions are established by rainfall or carbon dioxide gas evolved from microbial respiration. This experiment shows the denitrification that actually takes place in the grassland by detecting N_2O gas evolved with the introduction of C_2H_2 into the denitrifying system.

Key words: Grasses, Denitrification, N_2O.

Materials and Methods

1. Selection of Experimental Sites and Analysis of N_2O Gas

Twenty experimental plots of 1 m^2 size were prepared in the grassland of Nagoya University Farm on the basis of plant growth and plant coverage as shown in **Table 1.** Urea was applied at the rate of 200 kg/ha for each plot. On thirteen days after fertilizer application, plant tops were cut and soil with root systems was taken from each plot by an iron core (10.5 cm diameter × 15 cm length). The iron cores with soil and root systems were placed in each plastic bag with or without watering to the maximum water holding capacity. Then, the gas mixture of 0.9 atm (v/v) of air and 0.1 atm of acetylene gas was introduced into the plastic bag. After a 3-day incubation at room temperatures of 25–30℃, a portion of aerial part was taken with a gas tight syringe and nitrous oxide evolved was analysed by a gas chromatography in the usual method[5].

2. Analysis of Soil Physical Properties

Soil after incubation was air-dried for the analysis.

Organic Matter and Gravels: A portion of air-dried soil was passed through a 2 mm sieve, and a remainder on the sieve was separated into organic matter and gravels. Organic matter in this experiment signifies mainly litter and roots.

Results and Disscussion

The denitrification data of the plots without watering were not presented in this paper because N_2O was not detected entirely.

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Table 1. Denitrification as N_2O from the field cores with the introduction of C_2H_2

Plot	Denitrification as N_2O (μmol/core/day)	Plant	Coverage (%)**
1	5.1	Young grasses*	10
2	63.2	Young grasses*	10
3	40.7	Bahiagrass	90
4	15.3	No plant	0
5	111.9	Italian rye grass	80
6	71.2	Ladino clover	80
7	56.0	Ladino clover	80
8	10.2	No plant	5
9	0	Young grasses*	10
10	0	Orchard grass	20
11	20.3	No plant	0
12	152.5	No plant	0
13	111.9	Orchard grass	90
14	20.3	No plant	0
15	35.6	No plant	0
16	25.4	Italian rye grass	10
17	15.3	No plant	0
18	45.8	No plant	0
19	56.0	Alfalfa	10
20	30.5	Alfalfa	10
Mean	44.36±41.22		

* Could not identify because they were so young.
** Well and poor growing sites of plant were chosen as experimental ones in this survey.

Table 1 shows the estimation of N_2O evolved per day under watered condition. In most of the soil samples examined, N_2O was not detected or negligible when C_2H_2 was not introduced into the system. This indicates that C_2H_2 blocked the pathway, $N_2O \rightarrow N_2$.

Generally, ammonification and nitrification from urea in the soil take place rapidly at adequate temperature[1]. Since temperature was high enough for denitrifying process during the experimental period, the nitrification of urea did not seem to restrict denitrification.

Soil nitrate nitrogen contents before the setting of incubation for denitrification were not determined. The average and the maximum denitrification rates for the 3-day incubation period from nitrogen supplied as urea were calculated as 4.2% and 14.2%, respectively. From this survey, denitrification seems to occur even in the grassland when soil is moistened with enough water by rainfall, especially at concave sites and bottom sites of sloping grassland where water drainage is unfavorable.

Denitrification is known to be affected not only by soil environmental factors but also by soil physical and chemical properties[1]. Since soil chemical properties were not examined before the incubation experiment, the relation between denitrification and some soil physical factors such as the contents of gravel and organic matters, and plant coverage was investigated. As shown in **Fig. 1**, the plant coverage had the highest correlation ($r=0.708$, $P<0.01$) among them. Denitrifying bacteria other than thiobacillus belong to the heterotrophs require organic substrates as a hydrogen donor[1]. Therefore, the presence of plant would offer energy source as exudes from plant roots for denitrifying bacteria[2], and decom-

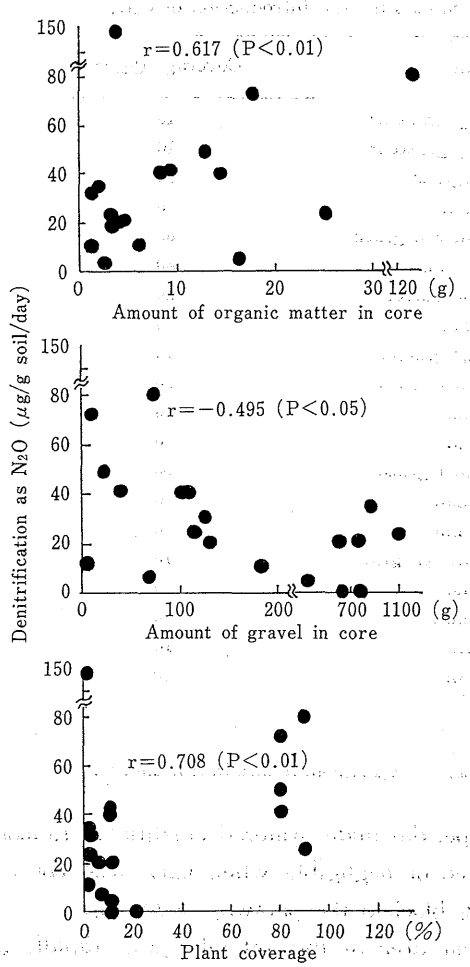

Fig. 1. Relationship between denitrification and some factors

position of roots or litters would decrease the Eh of soil and consequently would stimulate denitrification. In fact, soil organic matters had a comparatively high correlation to denitrification ($r=0.617$, $P<0.01$).

On the contrary, the amount of gravels in the soil had a negative correlation to denitrification ($r=-0.495$, $P<0.05$). Gravels might increase the pore space ratio of the soils, and would decrease denitrification due presumably to the increased aeration into soil[4]. It is well known that denitrifying bacteria belong to facultatives utilize both oxygen and nitrates as electron acceptors but they take oxygen preferentially under aerobic conditions.

It has been recognized that denitrification is negligible at the upland soil because it usually prevails in the well aerated sites[1]. Therefore, the importance of denitrification has often been neglected in the grasslands. Even in the grassland, however, denitrification took place in this experiment, when the soil was saturated with water to its maximum water holding capacity.

Since this result was obtained from only a 3-day incubation study from 13 th to 16 th day after urea application, more denitrification may occur in the natural system when soil is saturated with water. In the agro-ecosystem, the rainfall frequency and its amount may play the most important role in denitrification. In addition, nitrification of applied nitrogen may affect the amount of denitrification. Accordingly, it may be necessary to comprise above factors concerning the measur ement of denitrification in the grassland ecosystem.

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