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NITROGEN MINERALIZATION IN ACID SULFATE SOILS

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Key words

Aerobic incubation Anaerobic incubation Low pH Nitrification Organic matter Release of ammonium Total N.

Summary

Mineralization of soil nitrogen studies with two acid sulfate soils under anaerobic and aerobic incubation at 30°C for 2 weeks showed that the mineral N was released and accumulated entirely as NH_4^+ in both soils. Nitrification did not occur in either of the soils under conditions that stimulate nitrification. The acid sulfate soils studied release good amounts of mineralizable N, and, because of lack of nitrifying activity, denitrification may not be a serious problem in these soils.

Introduction

Agricultural productivity in millions of hectares of low-lying coastal land in the tropics is affected by the presence of potential and actual acid sulfate soils. Despite the high acidity and associated adverse effects on crop growth, these soils have characteristics favourable for wetland rice, for example, they are usually well supplied with plant nutrients from a high organic matter content and from 2 : 1 clay minerals[7]. Also flooding of these soils increases the pH to favourable values, where the iron concentration in solution falls below toxic levels and the availability of other nutrients is increased[3,4,7]. Perhaps this is the reason why some of the moderate acid sulfate soils are used for growing wetland rice.

Mineralization of organic matter in lowland rice soils is very important in that even in well-fertilized soils about two-third of the total N taken up by rice crop comes from the soil. Yet, information on mineralization of organic nitrogen in acid sulfate soils is lacking. These soils have an adequate supply of organic matter but are very acid, with a pH, often below 4.0. So mineralization of N and nitrification may be affected. Sahrawat[5] reported relatively low but adequate urease activity in two acid sulfate soils from the Philippines.

The objectives of this work were to study the mineralization of soil organic nitrogen

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Table 1. Properties of soils

Soil type	pH (1:1)	Organic C %	Total N %	NH_4^+ ppm	NO_3^- ppm	Urease activity*
Calalahan sandy loam	3.4	1.57	0.110	58	0	8.8
Malinao loamy sand	3.7	1.22	0.09	15	0	8.0

* Urease activity expressed as μg NH_4^+ released per g of soil per hour at 30°C.

and its subsequent nitrification in two acid sulfate soils. Mineralizable N released under anaerobic incubation may serve as a useful index for soil nitrogen availability to wet land rice[6].

The nitrification potential of a soil may give an idea about the extent of denitrification losses that could occur.

Materials and methods

The two acid sulfate soils used were surface (0–15 cm) samples collected from Calalahan and Malinao, Philippines. The soil samples were air-dried and ground to pass a 2-mm screen. Some properties of these soils are given in Table 1. Soil pH was measured in the 1:1 soil to water suspension by a glass electrode. Organic C and total N were determined as described by Walkley and Black[8] and Bremner[1] respectively. NH_4^+ and NO_3^- were measured after extraction with 2 *M* KCl and by distillation of the filtered extracts with MgO and Devarda's alloy[2]. The urease activity of the soil was determined by a non-buffer method as described by Sahrawat.[5].

Incubation methods

Anaerobic incubation at 30°C for 2 weeks. Ten g soil samples were transferred to 125 ml conical flasks containing 20 ml of distilled water. The flasks were covered with aluminium foil and incubated at 30°C for 2 weeks in an anaerobic incubator. After incubation, the amounts of NH_4^+ and NO_3^- formed were estimated by analysis of the 2 *M* KCl extract[2]. The amounts of net NH_4^+-N released during 2 weeks were determined by subtracting the amounts of the mineral N present in the soil before incubation.

Aerobic incubation. Ten g soil samples were incubated in 125 ml conical flask at 50% WHC moisture and at 30°C for 2 weeks. The soil samples were aerated regularly by removing the aluminum foil from the mouth of the flask. NH_4^+ and NO_3^- produced during 2 weeks of incubation were determined by subtracting the amounts present in the soil before incubation.

Results and discussion

Mineralized nitrogen in the two acid sulfate soils accumulated entirely as NH_4^+ under both anaerobic and aerobic incubations at 30°C for 2 weeks. No nitrate would be detected even after 2 weeks of aerobic incubation. (Tables 2 and 3).

The net amounts of NH_4^+ released by the Calalahan and Malinao soils during anaerobic incubation were respectively 83 and 72 ppm and the mineralizable N formed

Table 2. Mineralizable nitrogen produced under anaerobic incubation at 30°C for 2 weeks

Soil	NH_4^+ released (μg/g soil)	Mineralizable N as % of total N
Calalahan sandy loam	83	7.5
Malinao loamy sand	72	8.0

Table 3. Mineralizable nitrogen in the soils under aerobic (50% WHC moisture) incubation at 30°C for 2 weeks

Soil	Inorganic N (μg/g soil) NH_4^+	NO_3^-
Calalahan sandy loam	72	0
Malinao loamy sand	68	0

7.5 and 8.0% of the total N content of these soils. Lack of nitrate formation in these soils may be due to lack of nitrifiers at the low pH of 3.4 and 3.7. However, these soils demonstrate adequate urease activity to hydrolyse urea[5].

As noted earlier most acid sulfate soils have adequate organic matter and consequently release moderate amounts of NH_4^+ that could be helpful in nitrogen nutrition of plants if other growth adverse factors like iron toxicity, acidity etc. are absent. In fact in earlier studies it was observed that after Fe^{2+} in soil solution has fallen below toxic levels, the N supplying capacity of Calalahan acid sulfate was adequate to give good growth of rice without added N fertilizer[6]. Lack of nitrate formation in these soils should be viewed as a plus point for nitrogen nutrition as this will minimize losses through denitrification and leaching.

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