THE EFFECT OF STORAGE OF SOILS UNDER WATER-LOGGED CONDITIONS UPON SUBSEQUENT MINERALIZATION OF NITROGEN, NITRIFICATION AND FIXATION OF AMMONIA

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SUMMARY

Four soils were incubated for 10 weeks at 29°C, without added nitrogen and with 100 ppm N as (NH₄)₂SO₄ at 65% waterholding capacities, either fresh or after water-logged storage for 1 to 4 months. The amounts of ammonium-N in the soils increased with length of storage period. During subsequent incubation the ammonium-N was nitrified in all soils. Nitrification, however, was delayed for one or more weeks in some of these soils, and was further retarded by adding (NH₄)₂SO₄.

Water-logging increased the amounts of nitrogen mineralized on subsequent incubation and decreased the amounts of ammonia fixed after adding (NH₄)₂SO₄. Oxidation of nitrite to nitrate was delayed for the first week following water-logging in a humic clay and the numbers of bacteria decreased as the period of water-logging increased. In the soils water-logged for 3 and 4 months the microbiological balance was not completely restored even after 10 weeks incubation.

The numbers of nitrifying organisms were markedly decreased by water-logging for 2, 3, and 4 months and remained fewer during the incubation period compared with untreated soil. Adding (NH₄)₂SO₄ did not increase numbers of nitrifiers.

INTRODUCTION

Little has been done to examine the effect of water-logging or incubation of soils on rate of mineralization of nitrogen or on the nitrification when they were drained.

Wallihan noted that water-logging increased the rate of nitrate production after drainage and suggested that water-logging reduced nitrates to some form such as was the ammonium ion that was not easily leached from the soil but readily nitrified under suitable conditions. This agrees with data...
from England (Subrahmanyan 11 12) and India (De and Sarkar 8), suggesting that these effects occur quite generally. However, there is no work using the isotope $^{15}$N to substantiate this view. All evidence points to denitrification loss as gaseous N compounds (van Schreven 8).

Harmsen 4 5 showed that soils inundated during war for 4 months with brackish or salt water did not lose their nitrifying capacity, although there was some indication that the numbers of nitrifying organisms decreased during the inundation. After the water had receded the soils still contained 800 to 2000 nitrifying organisms per gram of soil and usually large amounts of ammonium nitrogen. This phenomenon was first observed on the isle of Tholen and was called by Harmsen the Tholen effect.

Sawarjan 6 who studied the transformation of nitrogen in rice soils noted that the soils contained much ammonia shortly after water-logging, but this then decreased. Chen and Chou 2 found that nitrification proceeded in flooded rice soils whether under rice in summer or kept bare in winter. Nitrifying bacteria were 23–377 times more numerous than in soils under dry-land cropping. In contrast, soils of the IJssel lake polders initially contained very few nitrifying bacteria after the water had receded (van Schreven and Harmsen 10), numbers depending very much on the maturation processes of the soil. In the 0–20 cm layer of the soil numbers increased greatly only after good drainage had been established. At the bottom of the IJssel lake small numbers of nitrifying bacteria are only present in the thin aerated 1–3 cm layer (van Schreven 7).

A delay of nitrification processes, due to anaerobic metabolism in soil, has been observed by Brandt, Wolcott and Erickson 1.

This paper examines the effects of water-logging soils for 1, 2, 3 and 4 months on (1) the amounts of ammonia, (2) the nitrification of ammonia, (3) the mineralization of nitrogen, (4) the amounts of nitrite and (5) on the numbers of nitrifying organisms during subsequent incubation at 65 per cent water holding capacity (WHC). The effect of water-logging of soils on the amounts of ammonia fixed after adding (NH$_4$)$_2$SO$_4$ is also reported.

**MATERIALS AND METHODS**

The agricultural soils used were a sandy loam and a clay loam from the Noord-Oost Polder, a humic clay from the Koekoek polder and a clay from the Oostelijk Flevoland polder. Table 1 gives some properties of the soils taken from the 0–20 cm layer.

Each soil was stored for 0, 1, 2, 3, or 4 months at room temperature under water-logged conditions in soda glass jars of 370 ml capacity. The jars were filled with soil to the neck, water was added until the jar was almost full and stirred with a spatula to remove as much air as possible. They were then completely filled with water so that the soil was covered with a 2 to 3 cm