

INFLUENCE OF ALUMINIUM CHLORIDE ON NITRIFICATION IN PEAT*

R. MANDAL AND J.W. PARSONS

Department of Soil Science, University of Aberdeen, Aberdeen, AB9 2UE, Scotland, U.K.

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The effect of aluminium on ammonification and nitrification was studied in a series of incubations of peat with and without added $(\text{NH}_4)_2\text{SO}_4$. Addition of AlCl_3 (0, 200, 400, 600 $\mu\text{g Al g}^{-1}$) caused a nonsignificant increase in $\text{NH}_4\text{-N}$ up to 25 days of incubation in the absence of $(\text{NH}_4)_2\text{SO}_4$ and the release followed by immobilization of $\text{NH}_4\text{-N}$ in the presence of applied $(\text{NH}_4)_2\text{SO}_4$. Similarly a significant change in nitrification occurred after 25 days of incubation and was found to be a function of $\text{NH}_4\text{-N}$ concentration. Aluminium upto 200 $\mu\text{g g}^{-1}$ peat appeared to stimulate nitrate production but the successive increments resulted in partial suppression (5-14%) of nitrification. Greatest inhibition (14%) was caused by the highest level of aluminium. Results showed that added AlCl_3 had no significant toxic effect on ammonification. Change in pH at 60 days of incubation was controlled but did not change significantly.

Key words : Aluminium chloride, Nitrification, Peat.

Introduction

Nitrification is a microbiological process and is influenced by a number of environmental factors. It has been reported that low nitrification rates in acid soils are chiefly due to low pH [1-3]. However, Greaves [4] and Singh *et al.* [5] suggest that high concentration of soluble aluminium may be responsible for the suppressing of the activity of nitrifiers in acid soils. Thus, the study of nitrification particularly at low pH deserves further attention to evaluate the role of aluminium ions.

However, to design this type of experiment is practically difficult. The insolubility of aluminium at the normal pH of mineral soils and the unavailability due to organo-metal complex formation in organic soils present serious problems in selecting correct environmental conditions.

Thus, an acid peat, low in aluminium content, was chosen to test the impact of aluminium on nitrification in an incubation experiment.

Materials and Methods

A commercial peat (pH 4.38) was collected, air-dried and ground to pass through 2 mm sieve. Some physical and chemical properties of the sample were determined and are presented in Table 1.

A portion of peat (50 g) was weighed out into a series of 16 clean-dry 500 ml conical flasks. Two rates of nitrogen (0,

100 $\mu\text{g N g}^{-1}$ peat) as $(\text{NH}_4)_2\text{SO}_4$ and four rates of aluminium (0, 200, 400, 600 $\mu\text{g Al g}^{-1}$ peat) as AlCl_3 solution (pH 2) were applied in all possible combinations using a 2 x 4 complete factorial arranged in two randomized blocks. The peat sample was maintained at pH 4.38 by adding $\text{Ca}(\text{OH})_2$ in amounts estimated from a pH titration curve in aluminium treated samples. The treated samples were brought to 50% water holding capacity (WHC) and incubated at 25° with clingfilm covering the neck of the flask. The moisture content was maintained constant by daily weighing and addition of water. The samples were aerated every day for 5 min. by removing the clingfilm covering. Changes in $\text{NH}_4\text{-N}$ and $(\text{NO}_2+\text{NO}_3)\text{-N}$ were measured in sub-samples collected every 5 days over 30 days followed by 10 days upto 60 days. The pH of the subsamples were recorded only at the beginning and the end. The percentage inhibition of nitrification by addition of aluminium was calculated by the method of Bremner and Bundy [6].

pH was measured by using a combined glass/calomel electrode. Estimation was made of organic carbon by the wet oxidation method [7]. Total N was determined by the Kjeldahl procedure and that of CEC using 1M NH_4AOc (pH 7.0). An automated procedure was used for the colorimetric determination of 2M KCl extractable $\text{NH}_4\text{-N}$, $(\text{NO}_2+\text{NO}_3)\text{-N}$ [8] and exchangeable aluminium [9] using a Technicon Auto-Analyzer.

TABLE 1. SOME PHYSICAL AND CHEMICAL PROPERTIES OF THE PEAT.

Peat	pH	WHC	Org.C Per cent	Total N	C/N ratio	CEC meq kg^{-1} peat	Exch. Available N		
							Al	$\text{NH}_4\text{-N}$	$(\text{NO}_2+\text{NO}_3)\text{-N}$
							ug g^{-1} peat		
Commercial peat	4.38	259	41.41	1.53	27.1	902.2	2.9	30	215

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Results and Discussion

Changes in extractable NH₄-N and (NO₂+NO₃)-N with time are presented in Fig. 1.

Fig. 1A shows that in all the treatments without (NH₄)₂SO₄, NH₄-N increased by a small amount upto 25 days of incubation. The same treatments in the presence of (NH₄)₂SO₄ resulted in a release followed by immobilization during that period. However, after 25 days, NH₄-N content declined with time. The effect of the treatments became significant after 25 days of incubation.

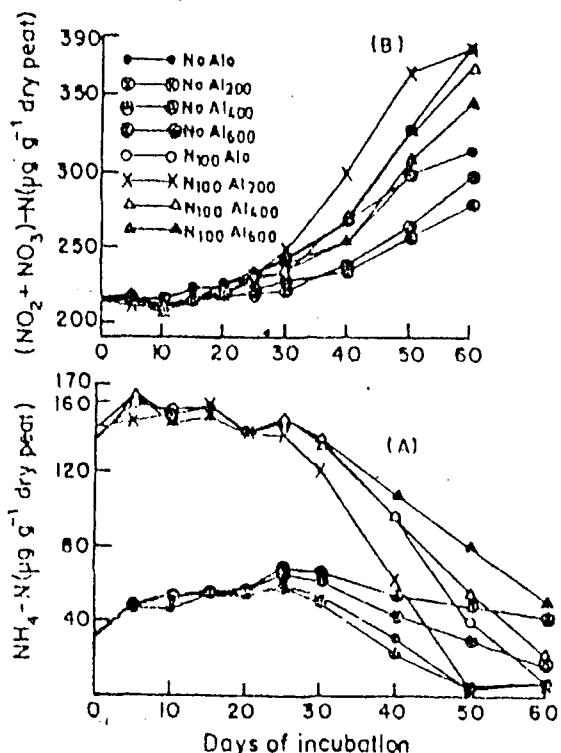


Fig. 1. Changes in NH₄-N (A) and (NO₂+NO₃)-N (B) as influenced by AlCl₃ during aerobic incubation of peat at 25°. L.S.D at 1% level: 1.5, 2.3, 1.0 and 1.2 for NH₄-N and 2.4, 4.6, 5.1 and 3.4 for (NO₂+NO₃)-N at 30, 40, 50 and 60 days respectively.

The results showed that added aluminium was more effective on nitrification (Fig. 1B). After 25 days of incubation NH₄-N was oxidised and (NO₂+NO₃)-N accumulated significantly with time (Fig. 1B). In the initial stage no such effect was observed due to lag effect in the start of nitrification. The amount of NH₄-N nitrified was higher in the corresponding (NH₄)₂SO₄ treatments than in treatments without added (NH₄)₂SO₄. This suggests that nitrification is a function of substrate concentration of NH₄-N (Fig. 1A). Addition of 200 ug Al g⁻¹ peat appeared to promote nitrification significantly over the control but further increments of aluminium additions caused a significant suppression resulting in an accumulation of NH₄-N. Greatest inhibition was caused by the highest level of aluminium (600

ug Al g⁻¹) but it did not suppress nitrate production completely. Aluminium at a concentration of 400 ug g⁻¹ inhibited nitrification by up to 5% after 60 days of incubation. A rise in the quantity to 600 ug g⁻¹ retarded nitrification by a further 6%. Greaves [4] and Singh *et al.* [5] also reported that the presence of aluminium suppressed the activity of nitrifiers in soil.

Changes in total mineralized-N, (NH₄+NO₂+NO₃)-N were similar in all the treatments (Table 2). This suggests that added aluminium had no detrimental effect on the production of ammonium from peat upto the concentration limit used i.e. 600 ug g⁻¹.

TABLE 2. INFLUENCE OF Al ON RECOVERY OF TOTAL MINERALIZED-N (NH₄+NO₂+NO₃)-N (µg g⁻¹ DRY PEAT) FROM COMMERCIAL PEAT INCUBATED WITH (NH₄)₂SO₄ AEROBICALLY AT 25°C.

Days of incubation	N (ug g ⁻¹ peat)							
	0				100			
	Al (ug g ⁻¹ peat)							
	0	200	400	600	0	200	400	600
0	245	245	245	245	345	345	345	345
5	262	264	265	263	364	360	362	360
10	267	267	264	264	365	362	360	360
15	269	268	269	263	374	372	376	376
20	278	278	273	272	368	364	363	363
25	284	289	285	290	371	373	379	376
30	293	293	293	294	369	369	369	368
40	286	281	281	288	363	363	366	361
50	303	303	305	305	379	379	380	380
60	322	322	325	322	389	389	389	389

Control of pH by addition of Ca(OH)₂ was successful and no significant change in pH was observed after 60 days of incubation. The pH changed from 4.25 to 4.35 and 4.20 to 4.22 in treatments without and with (NH₄)₂SO₄. This nonsignificant change could probably be due to the high buffering capacity of the peat. This supports the conclusion that the small but significant suppression of nitrification was due to the presence of aluminium rather than the reduction in pH. Nitrification occurred in all incubations at pH 4.38 which is considered to be below the normal pH for the bacterial oxidation of NH₄-N. Earlier experiments failed to show any benefit from the addition of a soil infusion containing nitrifying organisms [10, 11]. It is possible that in these incubations heterotrophic fungi were responsible for nitrification rather than autotrophic bacteria.

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