

## EFFECT OF CHLORIDES OF COBALT, NICKEL AND COPPER ON NITRIFICATION IN PEAT

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Mineralization of N in the presence of 0 to 2000 mg kg<sup>-1</sup> each of Co, Ni and Cu as chlorides in peat was studied. These salts of metals did not produce any significant change in the process of nitrification and ammonification up to 40 and 50 days respectively. However, thereafter the general trend was for NH<sub>4</sub>-N to decrease up to 110 days as (NO<sub>2</sub>+NO<sub>3</sub>)-N accumulated. Nitrification was increasingly suppressed as the Co, Ni and Cu were increased, especially with the highest level of Cu where NH<sub>4</sub>-N remained high and (NO<sub>2</sub>+NO<sub>3</sub>)-N remained at about the initial level suggesting that nitrification was virtually prevented. Between 110 and 130 days of incubation ammonification increased slightly in all treatments but nitrification showed an unexplained flush at the highest level of applied Cu.

**Key words:** Peat, Nitrification, Heavy metals.

### Introduction

It is well established that heavy metals are highly toxic and can cause serious hazards in the soil-plant-animal system. Heavy metals may originate from deliberate application to correct deficiencies, as pesticides or from industrial waste and sewage [1]. As no information is available it may be interesting to see what could be the course of their reactions on nitrification in soil.

However, studies on the role metal ions in soils are difficult to plan and put into practice in selecting a correct soil environment conditions. In soils these elements are strongly chelated by organic matter and their availability is chiefly regulated by pH. At normal pH values in mineral soils they become insoluble while at low pH the solubility is at maximal. An acid peat was chosen as the suitable medium because of its low metal content to study the effect of chlorides of Co, Ni and Cu on nitrification.

### Materials and Methods

Commercially available Fisons peat (II) originally derived from Somerset was air-dried and passed through 2 mm sieve. The physical and chemical characteristics of the peat are presented in Table 1.

For this experiment a different commercial sample of peat was used with an initial pH of 4.4 compared to that of 3.4 for the sample used in the previous two papers. So comparisons are not feasible. Its organic matter content of 72% (C x 1.72) is similar and its C/N ratio is 30 compared to 36 for the Red Moss peat but its (NO<sub>2</sub>+NO<sub>3</sub>)-N is considerably higher 90 compared to 7. Its available P is also considerably lower 0.28 compared to 1.58.

Three concentrations of each of Co, Ni and Cu as chloride in addition to one control treatment, in duplicate, were used. Aqueous solution of each salt of metal was applied separately at the rate of 500, 1000 and 2000 mg kg<sup>-1</sup> peat. Samples treated with salts received lime as estimated from pH lime curve to maintain the initial pH of 4.40. The experiment was arranged according to a randomized block design.

Portions of air-dry peat (50 g) were weighed into a series of clean-dry 500 ml conical flasks and incubated at 50% WHC at 25° with "clingfilm" covering. A constant moisture content was maintained gravimetrically removing the "clingfilm" cover for 5 min each day in order to make up the loss of water and provide aeration.

Peat samples (5 g) were collected, in duplicate, every 10 days up to 70 followed by 20 days intervals up to 130 days. These samples were extracted with 1M KCl and the extracts analyzed for NH<sub>4</sub>-N and (NO<sub>2</sub>+NO<sub>3</sub>)-N using a Technicon Auto-Analyzer.

TABLE 1. GENERAL CHARACTERISTICS OF THE PEAT EXAMINED.

Sample	pH	WHC	Org.C		Total N	C/N	CEC
			Percent				
Fisons Peat (II)	4.40	287	41.9		1.39	30	928.5
		Available		KC1 exch. cations			
	NH <sub>4</sub> -N	NO <sub>2</sub> +NO <sub>3</sub> -N	P	Co	Ni	Cu	
mg kg <sup>-1</sup> peat							
	18.9	90.0	0.28	bdl	bdl	2.66	

bdl = below detection limit.

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pH was measured with a combined glass/calomel electrode using a pH meter from a saturation past in the beginning and at the end. Organic carbon was determined by wet oxidation method [2], total N by Kjeldahl procedure, CEC by 1M  $\text{NH}_4\text{OAc}$  (pH 7.0) and 1M KCl exchangeable Co, Ni and Cu by atomic absorption spectrophotometer (Shandon Southern Model A 3400). 0.5 M acetic acid [3] extractable P was estimated colorimetrically using a Cecil Spectrophotometer (Model E 272).

### Results

Figure 1A (Co), 2A (Ni) and 3A (Cu) show that release of  $\text{NH}_4\text{-N}$  increased rapidly up to 20 days of incubation, declined slightly up to 30 days in most of the treatments and then decreased gradually up to 90 days until it became nil for each salt of metals in two treatments (0 and 500  $\text{mg kg}^{-1}$ ). The decrease in  $\text{NH}_4\text{-N}$  continued up to 110 days in samples treated with 1000  $\text{mg kg}^{-1}$  salt of metal. Addition of 2000  $\text{mg kg}^{-1}$  showed almost a steady state in  $\text{NH}_4\text{-N}$  between 50 and 110 days. After 110 days a significant flush in  $\text{NH}_4\text{-N}$  in all the treatments was observed. None of the salts of metals showed any significant effects up to 50 days.

Figure 1B (Co), 2B (Ni) and 3B (Cu) show that the trend of accumulation of  $(\text{NO}_2+\text{NO}_3)\text{-N}$  up to 40 days was similar to

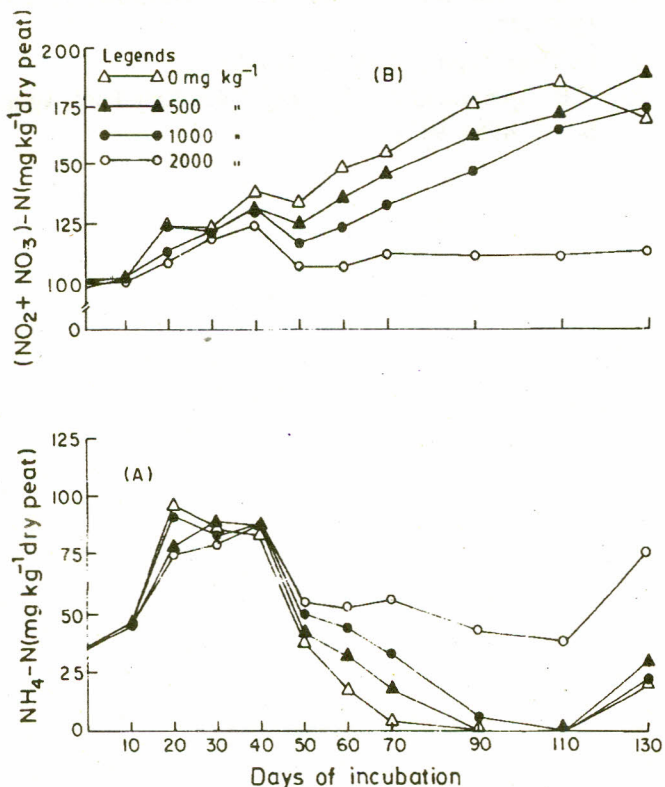


Fig. 1. Changes in  $\text{NH}_4\text{-N}$  (A) and  $(\text{NO}_2+\text{NO}_3)\text{-N}$  (B) as influenced by  $\text{CoCl}_2$  during aerobic incubation of Fisons peat (II).

1M KCl was used because no signifi between 1M and 2M KCl results was observed.

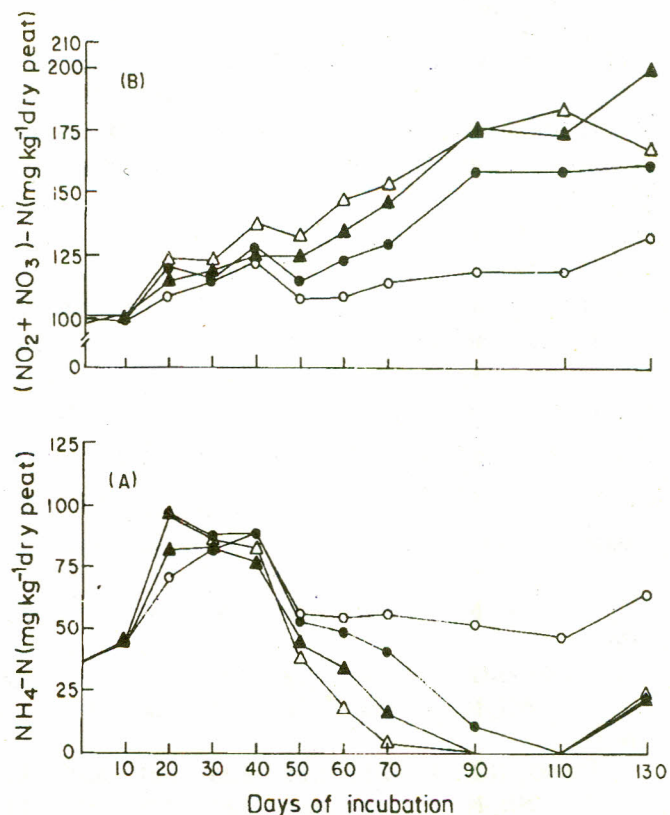


Fig. 2. Changes in  $\text{NH}_4\text{-N}$  (A) and  $(\text{NO}_2+\text{NO}_3)\text{-N}$  (B) as influenced by  $\text{NiCl}_2$  during aerobic incubation of Fisons peat (II). Legends : see Fig. 1.

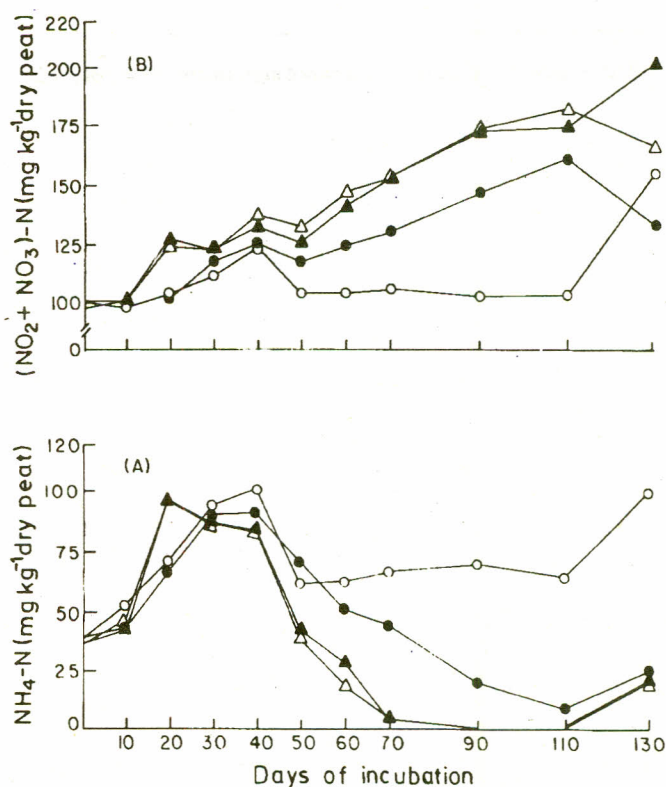


Fig. 3. Changes in  $\text{NH}_4\text{-N}$  (A) and  $(\text{NO}_2+\text{NO}_3)\text{-N}$  (B) as influenced by  $\text{CuCl}_2$  during aerobic incubation of Fisons peat (II). Legends : see Fig. 1.

that of  $\text{NH}_4\text{-N}$  (Figs. 1A-3A), there being no significant suppression of nitrification (Table 2). Between 50 and 110 days nitrification increased steadily in the 0 and 500 mg salt of metal treatments but it was significantly and increasingly inhibited at the higher levels (Table 2). None of the salts of metals at the concentration  $2000 \text{ mg kg}^{-1}$  completely curtailed nitrification which remained nearly constant from 50 to 110 days but Ni showed a slight increase and Cu a greater increase in nitrification at 130 days. By the end of the experiment in the control and  $1000 \text{ mg kg}^{-1}$  of Cu the amount of  $(\text{NO}_2+\text{NO}_3)\text{-N}$  declined after 110 days.

TABLE 2. STATISTICAL TREATMENT OF THE DATA (LSD) AT 5%.

Treat- ment	N	Days of incubation					
		50	60	70	90	110	130
Co	$\text{NH}_4\text{-N}$	ns	2.50	2.00	1.81	**	1.95
	$(\text{NO}_2+\text{NO}_3)\text{-N}$	2.41	4.92	3.2	1.11	3.41	4.25
Ni	$\text{NH}_4\text{-N}$	ns	3.78	3.01	4.00	**	2.44
	$(\text{NO}_2+\text{NO}_3)\text{-N}$	2.55	2.88	5.26	1.81	6.55	7.12
Cu	$\text{NH}_4\text{-N}$	ns	4.05	5.62	3.78	**	3.71
	$(\text{NO}_2+\text{NO}_3)\text{-N}$	4.61	5.55	6.66	7.51	7.22	5.55

0 to 40 days not significant, ns = not significant, \*\* = not done.

### Discussion

As regards Cu toxicity, Peremi and Cornfield [4] reported that excess of Cu ( $10000 \text{ mg kg}^{-1}$ ) caused significant reduction in nitrification. Similar views were also expressed by Tyler [5]. Lipman and Bericks [6] showed that a tolerable range of Cu was  $100 \text{ mg kg}^{-1}$  soil and above that was detrimental for nitrification. It has been noted that mineral-N showed an unusual flush at 130 days in salt treated samples except one treatment where  $1000 \text{ mg kg}^{-1}$  Cu was added.

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### References

1. F.A.M. De Haan and G.H. Bolt, *Pollution in the Encyclopedia of Soil Science*, ed. R.W. Fairbridge and C.W. Finkl. Jr. (Dwoden, Hutchinsons and Ross, Inc., 1979), Part 1., pp. 386-390.
2. J. Tinsley, *A Manual of Experiments* (Department of Soil Science, University of Aberdeen, Scotland, U.K., 1970).
3. E. G. Williams and A.B. Stewart, *J. Soc. Chem. Indust.*, **60**, 291 (1941).
4. P. R. Premi and A. H. Cornfield, *Geoderma.*, **3**, 233 (1969-70).
5. G. Tyler, *Nature.*, **255**, 701 (1975).
6. C.B. Lipman and W.F. Gericke, *Univ. Calf. Publ. Agric. Sci.*, **1**, 495 (1917).