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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^{-1} 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_4-N to decrease up to 110 days as (NO_2+NO_3)-N accumulated. Nitrification was increasingly suppressed as the Co, Ni and Cu were increased, especially with the highest level of Cu where NH_4-N remained high and (NO_2+NO_3)-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 chelald 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_2+NO_3)-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^{-1} 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 minc 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_4-N and (NO_2+NO_3)-N using a Technicon Auto-Analyzer.

TABLE 1. GENERAL CHARACTERISTICS OF THE PEAT EXAMINED.

Sample	pH	WHC	Org.C	Total N	C/N ratio	CEC meq kg^{-1} peat
		Percent				
Fisons Peat (II)	4.40	287	41.9	1.39	30	928.5

Available			KCl exch. cations		
NH_4-N	NO_2+NO_3-N	P	Co	Ni	Cu
mg kg^{-1} 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 NH_4OAc (pH 7.0) and 1M KC1 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 NH_4-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 mg kg^{-1}). The decrease in NH_4-N continued up to 110 days in samples treated with 1000 mg salt of metal kg^{-1}. Addition of 2000 mg salt of metal kg^{-1} showed almost a steady state in NH_4-N between 50 and 110 days. After 110 days a significant flush in NH_4-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 (NO_2+NO_3)-N up to 40 days was similar to

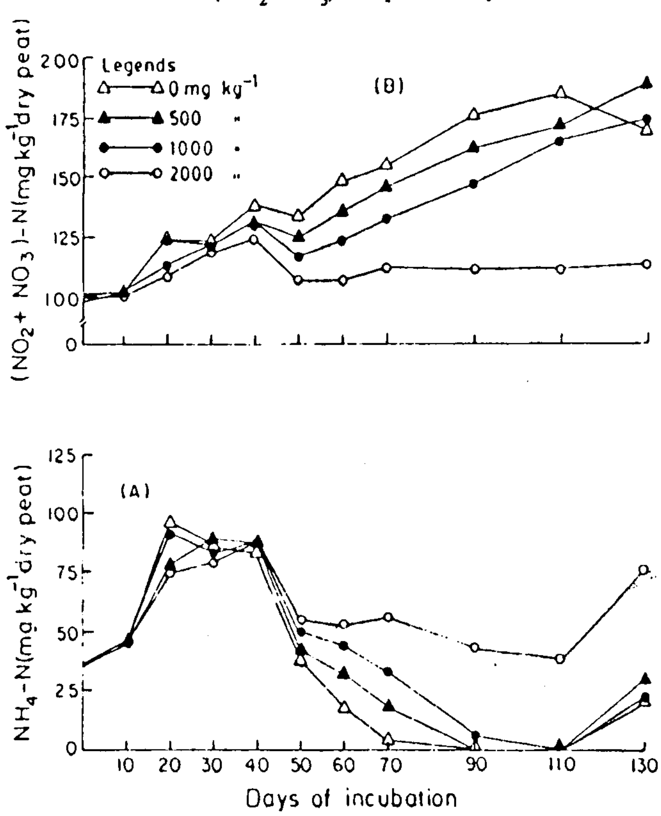

Fig. 1. Changes in NH_4+N (A) and (NO_2+NO_3)-N (B) as influenced by $CoCl_2$ during aerobic incubation of Fisons peat (II).

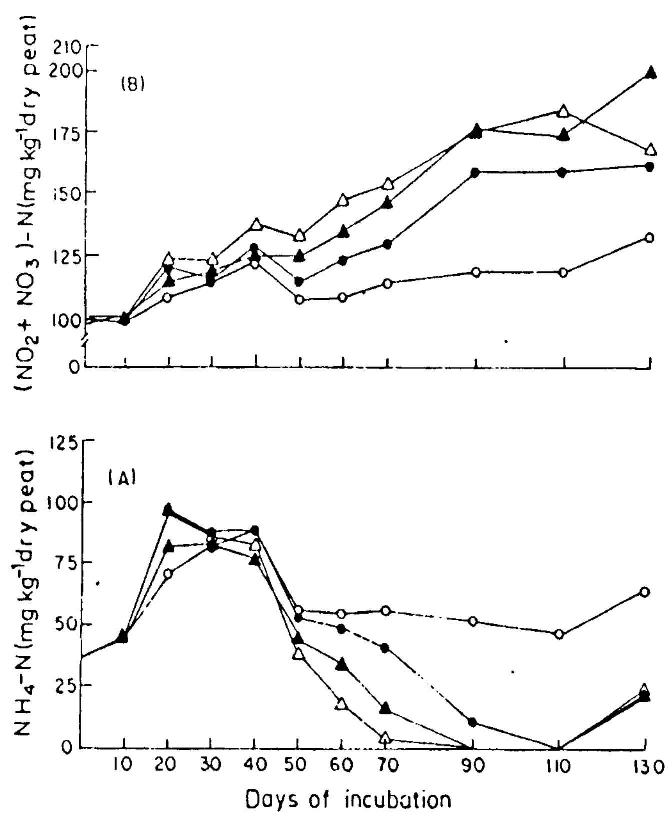

Fig. 2. Changes in NH_4-N (A) and (NO_2+NO_3)-N (B) as influenced by $NiCl_2$ during aerobic incubation of Fisons peat (II). Legends : see Fig. 1.

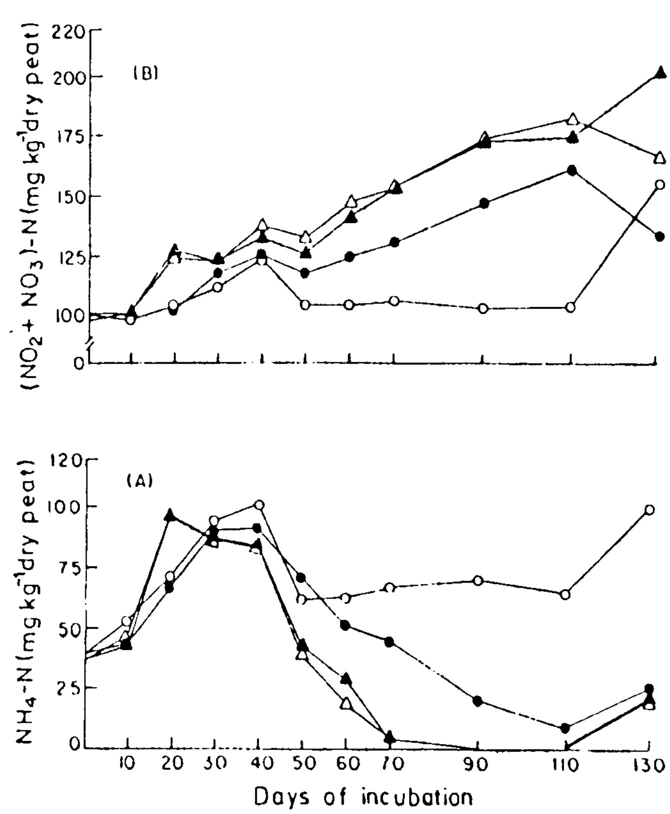

Fig. 3. Changes in NH_4-N (A) and NO_2+NO_3-N (B) as influenced by $CuCl_2$ during aerobic incubation of Fisons peat (II). Legends : see Fig. 1.

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

that of NH_4-N (Figs. 1A-3A), there being no significant suppression of nitrification (Table 2). Between 50 and 110 days nitrification increased steadly 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 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 mg kg^{-1} of Cu the amount of (NO_2+NO_3)-N declined after 110 days.

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

Treat-ment	N 50	Days of incubation 60	70	90	110	130	
Co	NH_4-N	ns	2.50	2.00	1.81	**	1.95
	(NO_2+NO_3)-N	2.41	4.92	3.2	1.11	3.41	4.25
Ni	NH_4-N	ns	3.78	3.01	4.00	**	2.44
	(NO_2+NO_3)-N	2.55	2.88	5.26	1.81	6.55	7.12
Cu	NH_4-N	ns	4.05	5.62	3.78	**	3.71
	(NO_2+NO_3)-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 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 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 mg kg^{-1} Cu was added.

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