Ref 1/1/1976

BANGLADESH J. BIOL. SCI.
Vol. 5. No. 1. 1976
Printed in Bangladesh.

Effect of addition of Cu, Cr, Pb and Zn on nitrogen mineralisation and nitrification during incubation of sandy soils.

*M. R. H. Bhuiya and A. H. Cornfield
Chemistry Department,
Imperial College of Science & Technology,
London, S. W. 7., Great Britain.

ABSTRACT

A sandy soil of pH 6 and the same soil treated with sufficient $CaCO_3$ to raise the pH to 7 were treated with 1,000 ppm Cu, Cr, Pb and Zn (as oxides) and kept moist for two months. After air drying, portions of soils of pH 7 were treated with 2% $CaCO_3$ and kept moist for two weeks and then air-dried (calcareous soil). The three soils were set up for incubation at 30°C and 50% maximum water holding capacity (mwhc) and mineral-N levels were measured after 6 and 12 weeks.

Cu increased N-mineralisation and nitrification in the calcareous soil, but decreased both processes at pH 6 and 7. Chromium (cr) increased N-mineralisation only at pH 6 and increased nitrification at pH 6 and in the calcareous soil. The toxic effects of Cr at pH 7 on both processes decreased with time. Pb (lead) stimulated nitrification at pH 6 only after 12 weeks. Apart from this, Pb tended to have toxic effects on both processes and there was a general trend for its toxicity to increase with increased pH. Zn (Zinc) was generally toxic to both processes in all soils and there was a general trend for its toxicity to increase with pH.

INTRODUCTION

Metallic elements are incorporated into soils through the use of pesticides and application of industrial and domestic wastes etc. Their accumulation in soils, by degrees, may ultimately be toxic to the soil microbial processes and plant growth. Little or no work seems to have been reported on the effects of high levels of metallic elements on soil microbial processes. The present work is, therefore, intended to study the effects of 1,000 ppm Cu, Cr, Pb, and Zn on soil nitrogen changes, e.g., N-mineralisation and nitrification under different pH conditions.

MATERIALS AND METHODS

The soil used in this study was a sandy soil treated with 1,000 ppm Cu, Cr, Pb and Zn (as oxides) two months before incubation. During pre-incubation period the soils were kept moist at an aerobic moisture level and leached intermittently to remove accumulation of soluble salts. Another imposed variable was pH. One series of matallic element-treated soils used were the soils of pH 6. A second series was done with soils adjusted to pH 7 by addition of $CaCO_3$ together with metallic elements for the pre-incubation period. A third series involved the use of metallic element-treated soils of pH 7 to which were added 2% $CaCO_3$ and which was then kept moist for two weeks before incubation. With each series, the soils were airdried and passed through 2 mm sieve before being set up for incubation at 30°C and 50% mwhc. Sufficient tubes were set up to allow analyses in duplicate for mineral N and nitrate-N initially and after 6 and 12 weeks. With each series, appropriate controls (soils receiving no metallic element, but subjected to the same incubation treatment) were also set for incubation. During incubation the BaO_2 method

*Asst. Professor, Dept. of Biochemistry, B. A. U., Mymensingh.

9207

was used for aeration and absorption of CO_2 (1). Mineral-N and nitrate-N initially and after 6 and 12 weeks were determined by methods used by Bremner and Shaw (2) and Premi and Cornfield (3).

RESULTS AND DISCUSSION

The results are compared on the basis of accumulation values (obtained by subtracting the values of controls from those of the treated soils) for mineral-N and nitrate-N during incubation over 6 and 12 weeks. Because of differences in values obtained with the control soil of each group, a suitable method showing the effects of the added metallic elements was to take the control of each soil as 100 and to calculate the values obtained with each metallic element treatment on this basis. The mineral-N and nitrate-N accumulation values are shown (Table I and Table II respectively).

Effects of Cu

The lack of any effect of Cu in affecting N-mineralisation at pH 6 and its effect in increasing N-mineralisation in the calcareous soil was similar after 6 and 12 weeks. At pH 7 Cu was less effective in decreasing N-mineralisation and nitrification after 12 weeks than after 6 weeks. The decrease in nitrate accumulation at pH 6 and its incrrase in the calcareous soil were similar after 6 and 12 weeks.

It is reported that toxic effects of certiain elements including Cu can be ameliorated by liming soils of low pH (4, 5). But in the calcareous soil Cu seemed to have consistently stimulated N-mineralisation and nitrification.

Table I. **Mineral-N accumulation in the soils of pH 6 and 7 and calcareous (calc) soil as affected by 1,000 ppm Cu, Cr, Pb and Zn over 6 and 12 weeks of incubation (30°C, 50% mwhc).**

For each group control was taken as 100

Mineral-N

Treatment	6 weeks pH 6	pH 7	Calc	12 weeks pH 6	pH 7	calc
Cu	102	87	107	99	94	110
Cr	112	78	86	103	92	100
Pb	87	81	83	98	90	90
Zn	97	96	66	91	72	74

Table II. **Nitrate-N accumulation in the soils of pH 6 and 7 and calcareous (calc) soil as affected by 1,000 ppm Cu, Cr, Pb and Zn over 6 and 12 weeks of incubation (30°C, 50% mwhc).**

For each group control was taken as 100

Nitrate N

Treatment	6 weeks pH 6	pH 7	calc	12 weeks pH 6	pH 7	calc
Cu	80	83	110	83	96	100
Cr	110	76	92	104	99	107
Pb	90	82	83	113	102	91
Zn	95	92	73	87	69	80

The most likely explanation of this is that in the control calcareous soil Cu was limiting both N-mineralisation and nitrification and the addition of 1,000 ppm Cu not only removed these limitations, but was also effective in stimulating both processes. As far as N-mineralisation is concerned, there appears to be a critical pH near pH 7 where added Cu was toxic to the process, since at pH 6 the added Cu had no effect on N-mineralisation.

Effects of Cr

At pH 6 the effect of Cr in increasing N-mineralisation after 6 weeks had disappeared after 12 weeks. In the calcareous soil the effect of Cr in decreasing N-mineralisation after 6 weeks had disappeared after 12 weeks. At pH 7 Cr was less effective in decreasing N-mineralisation after 12 weeks than after 6 wees. At pH 7 Cr decreased nitrate accumulation after 6 weeks but not after 12 weeks. In the calcareous soil nitrate accumulation was decreased after 6 weeks and increased after 12 weeks.

Added Cr behaved in the opposite way to added Cu by increasing both N-mineralisation and nitrification at pH 6, but behaved similarly in showing maximum toxicity at pH 7. The time factor was important for Cr in that both stimulating and toxic effects tended to be less after 12 than after 6 weeks. The stimulating effect of Cr may be attributed to the ability of Cr (III) to replace Fe (III).

Effects of Pb

After 6 weeks the decrease in N-mineralisation due to Pb was greater at pH 7 and in the calcareous soil than at pH 6. After 12 weeks N-mineralisation was unaffec-

ced by Pb at pH 6, but decreased at pH 7 and in the calcareous soil, although to a lesser extent than after 6 weeks. After 6 weeks nitrate accumulation was decreased to a greater extent at pH 7 and in the calcareous soil than at pH 6. After 12 weeks Pb increased nitrate accumulation at pH 6, decreased it in the calcareous soil and had no effect at pH 7.

The toxic effect of Pb on N-mineralisation decreased with time in all three soils and disappeared by 12 weeks only in the soil of pH 6. The toxic effects of Pb on nitrification also decreased with time in all soils., and in the case of soil of pH 6 nitrification was stimulated after 12 weeks of incubation. Pb was, in general, less toxic to both N mineralisation and nitrification in the soil of pH 6 than in the two other soils.

Effects of Zn

After 6 weeks Zn decreased N-mineralisation to a fair extent in the calcareous soil but had little effect at pH 6 and 7. After 12 weeks N-mineralisation was decreased to a greater extent at pH 7 and in the calcareous soil than at pH 6. After 6 weeks nitrate accumulation was decreased to a greater extent in the calcareous soil than at pH 6 and 7. After 12 weeks the decrease in nitrate accumulation was less in the calcareous soil and more at pH 6 and 7 than after 6 weeks.

The toxic effect of Zn on both N-mineralization and nitrificat on decreased with time in the calcareous soil but increased with time in the other two soils. After 12 we ks the toxic effects on both processes were greater in the soil of pH 7 and in the calcareous soil than in soil of pH 6.

REFERENCES

1. Cornfield, A.H. A simple techniquc for datermining mineralization of carbon during incubation of soils treated with organic materials. Plant and soils. **14** : 90-93 (1961).
2. Bremner, J.M. and Shaw, K. Determination of ammonia and nitrate in soil. J. Agric. Sci. **46** : (3), 320 328 (1955).
3. Premi, P.R. and Cornfield, A.H. The use of iron (II) sulphate for the reduction of nitrate to ammonia in the microdiffusion method for determining nitrate in soil extabts. Analyst **92** : 196-197 (1967).
4. Jackson, M.L. Soils Chemical Analysis. p 183. (1962).
5. Enwezor, W.O. and Cornfield, A.H. Determination of total carbon in soils by wet combustion. J. Sci. Fd. Agric. **16** : 277-280 (1965).