Ms. 4663

MINERALIZATION OF BIURET NITROGEN IN SOIL

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Key words

Aerobic incubation Anaerobic incubation Nitrification Release of ammonium Slow release

Summary

Study of the mineralization of biuret N under aerobic and anaerobic conditions in a sandy loam showed that higher amounts of mineral N accumulated under anaerobic incubation than under aerobic conditions. Under waterlogged incubation, 46.8% of the 100 ppm biuret N was mineralized while under aerobic conditions only 18.3% of biuret-N was converted into mineral N during 5 weeks at 30°C. The results of the study bring out slow-release nature of biuret-N.

Introduction

Fertilizer urea is sometimes found to contain biuret as an impurity, which is formed during the prilling or granulation of crystalline urea, when the temperature of the reaction rises above its melting point. When urea is heated above its melting point, it decomposes to form isocyanic acid and ammonia. Isocyanic acid then condenses with urea to form biuret.

$$NH_2CO\,NH_2 \xrightarrow{\text{Heat}} HNCO + NH_3$$

$$HNCO + NH_2CO\,NH_2 \rightarrow NH_2\,CONHCONH_2$$

Studies have reported that biuret contamination of urea causes injury to plants, when applied through foliage or soil[1, 2, 3, 4, 9]. In an earlier paper, I reported that biuret did not affect urea hydrolysis but retarded the conversion of NH_4^+ to NO_2^- and the subsequent oxidation of NO_2^- to NO_3^- which resulted in accumulation of larger amounts of both NH_4^+ and NO_2^- in soil as compared to soil receiving urea without biuret[7].

The toxicity of biuret has been attributed to the residual cyanate, and cyanate-free biuret has been claimed to be a good slow-release nitrogen source (for review see Murray and Horn[5]). The objective of the work reported was to evaluate the mineralization of

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Plant and Soil 62, 469–471 (1981). 0032-079X/81/0623-0469$01.35.

biuret-N in soil under aerobic and waterlogged conditions in the light of the findings of Japanese workers who reported that biuret decomposed rapidly in waterlogged soils[6].

Material and methods

The soil used was a sandy loam (70% sand, 17% clay, 13% silt) alluvial soil: pH 7.7; organic C 0.58%; total N 0.07%; cation exchange capacity 8.9 meq/100 g soil; water holding capacity (w h c) 32%; NH_4^+–N, 4.0 ppm and NO_3^-–N 7.3 ppm. The soil was air dried and ground to pass through a 2 mm sieve before use. The soil analysis was carried out as described earlier[7].

Analytical reagent grades of both urea (Fisher Scientific Co.) and biuret (Eastman Organic Chemicals, N.Y.) were used in the study.

Incubation methods

To study the mineralization of biuret under aerobic conditions, samples of 10 g soil were treated with 1.6 ml of water or 1.6 ml of water containing 1000 μg biuret-N in 125 ml conical flasks. The flasks were covered with polythene sheets and incubated at 30°C. Moisture regime of the samples was maintained by periodically adding water lost. For anaerobic incubation, 10 g soil lost were treated with 10 ml of water or 10 ml of water containing 1000 μg biuret-N and incubated at 30°C.

Soil samples in duplicate were analysed for NH_4^+–N, NO_2^-–N and NO_3^-–N every week upto 5 weeks following the method described by Sahrawat and Prasad[8]. Nitrogen mineralized from biuret was calculated by subtracting the amounts of N mineralized in control samples (not treated with biuret) after different incubation periods. Under waterlogged incubation, NH_4^+–N accounted for most of the mineral N and NO_3^-–N and NO_2^-–N formed less than 1% of the total mineral N realised at any time of incubation.

Results and discussion

Results on the mineralization of biuret-N under aerobic and waterlogged soil conditions are shown in Tables 1 and 2. It is evident from the results shown that mineralization of biuret-N was very slow and biuret behaved like a true slow release nitrogen source. The mineralization of biuret was even slower under aerobic incubation and only 18.3% of biuret-N was mineralized within 5 weeks (Table 1). Mineralization of biuret was relatively faster under waterlogged conditions and 46.8% of the biuret-N was mineralized during 5 weeks (Table 2). It is also evident that under aerobic incubation, nitrate was the dominant form in which mineralized N from biuret accumulated on the other hand NH_4^+–N was the mineral N form released during anaerobic incubation of biuret. Nitrite did not accumulate in any significant amounts in the soil samples treated with biuret. It is of interest to note that in an earlier study biuret retarded nitrification of urea nitrogen in soil which resulted in accumulation of higher amounts of NH_4^+–N and NO_2^-–N in the soil treated with biuret[7]. In the present study mineralization of biuret did not result in accumulation of nitrite probably because NH_4^+–N was released slowly and never accumulated in amounts to be toxic to Nitrobacter, which oxidizes NO_2^-–N to NO_3^-–N. Hydrolysis of urea N in soil added at the rate of 100 μg N g^{-1} soil was complete within one week of aerobic or waterlogged incubation in the present study and in comparison biuret mineralized at a very slow rate.

The results of this study suggest that biuret can be used as a slow release nitrogen source.

Table 1. Mineralization of biuret nitrogen in soil incubated under aerobic conditions

Mineral N form	Inorganic N (μg/g soil) after weeks					
	0	1	2	3	4	5
NH_4^+	0.0	1.5	2.3	3.0	2.5	4.0
NO_2^-	0.0	0.0	0.5	0.8	0.0	0.0
NO_3^-	0.0	1.0	6.8	8.1	12.8	14.3

Table 2. Mineralization of biuret nitrogen in soil incubated under waterlogged conditions

NH_4^+–N released (μg/g soil) after weeks					
0	1	2	3	4	5
0.0	6.2	12.8	20.3	31.0	46.8

However, there is an obvious need to carefully evaluate the phytotoxic effects of biuret with regard to how the plant metabolism is affected by this source of N specially during seedling stage before its use may be recommended as a slow-release nitrogen source.

Acknowledgement

I am thankful to Dr. S. K. Mukerjee, Head, Division of Agricultural Chemicals, Indian Agricultural Research Institute, New Delhi for encouragement and the facilities provided during the study.

Received 3 February 1981. Revised June 1981

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