RESEARCH NOTE

KINETICS OF UREA HYDROLYSIS IN SOILS

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Abstract

Kinetic study of urea hydrolysis in three soils using a non-buffer method showed that it followed a zero order kinetics at least upto 12 hours. The urea hydrolysis rate coefficient (k_2) of the soils ranged from 0.083 to 0.167 μ moles/g soil h^{-1} and remained fairly constant for each soil during the 12 hours of study of urease activity. The urease activity of the soils varies from 5.1 to 10.0 μ g urea hydrolysed/g of soil h^{-1} and increased with the increase in the organic carbon content of soils.

Urea is the most important nitrogen fertiliser in the world agriculture and is fast replacing ammonium sulphate especially in the developing countries including India. Most of the urea nitrogen utilized by plants come from its hydrolysis product ammonium carbonate caused by soil urease.

$$NH_2CONH_2 + 2H_2O \xrightarrow[\text{Urease}]{\text{Soil}} (NH_4)_2CO_3$$

The rapid hydrolysis of urea added to soils through soil urease activity to ammonium carbonate causes most of the problems faced in the use of this fertiliser, which include damage to seeds and young seedling plants, nitrite toxicity and loss of urea nitrogen through volatilization as ammonia gas (1, 2, 3, 4, 7). There is an obvious need for research to reduce the problems encountered in the use of urea fertiliser and the study of its hydrolysis in soils by urease activity is an important component of such research.

Soil urease has been investigated in details (for review see 8, 10), however, little attention has been devoted to this research for the soils in the semi-arid tropical regions in general and for Indian soils in particular. This study investigated the kinetics of urea hydrolysis in three alluvial soils from the farm of the Indian Agricultural Research Institute, New Delhi. The non-buffer method proposed by Douglas and Bremner (6) was adopted to follow urea hydrolysis in soils with a view to getting realistic estimates of soil urease activity in soils under simulated field conditions. Because it is known that the buffer method detects the soil urease activity that does not occur when soils are treated with urea in the absence of buffer and thus the non-buffer method of assaying urease activity provides a much better index than the buffer method of the ability of soils to hydrolyse urea under natural conditions (11).

Materials and Methods

The soils used (Table 1) were surface samples collected from the Indian Agricultural Research Institute, New Delhi farm. The soil samples were air dried and ground to pass through a 2-mm sieve before use. Soil analyses reported in Table 1 were performed as described earlier (9).

The following non-buffer method based on the one proposed by Douglas and Bremner (6) was adopted for assaying the soil urease activity.

Ten g soil samples were treated with 1000 ppm urea N and included at 30 ± 2°C at 60 per cent water holding capacity (WHC) moisture level for 5 hours. After the incubation period, the soil samples were extracted with 2 M KCl solution, containing 5 ppm of urease inhibitor, phenyl mecuric acetate. Urea in the filtered extract was measured by the colorimetric method of Douglas and Bremner (5) and the amounts of urea hydrolysed calculated. Blank determinations were also made by adding urease inhibitor to the soil samples just before addition of urea to account for the amounts of urea hydrolysed in the presence of the urease inhibitor

Table 1—Important properties of the soils used.

Soil No.	Texture	pH (1:2.5)	Organic carbon (per cent)	Total N per cent	Clay (per cent)	Sand (per cent)	Urease activity*
1.	Sandy loam	7 5	0 98	0.090	18	71	10 0
2.	Sandy clay loam	7 7	0 60	0 072	24	61	8 0
3.	Sandy loam	7 2	0 38	0 045	17	70	5.1

*Expressed as μg of urea hydrolysed per g of soil per hour at 30 ± 2°C

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In another experiment, the kinetics of urea hydrolysis in soils was studied upto 12 hours. The soil samples were incubated at 30 ± 2°C for 12 hours and the urease activity assayed every other hour to find out the amounts of urea hydrolysed as described. Urea hydrolysis rate coefficient (ko) for each soil at each interval were calculated from the zero order kinetic equation, ko=x/t where x is the amount of urea hydrolysed in μ moles and t is the time hours. All the determinations were made in duplicate.

Results and Discussion

The urease activity of the three soils ranged from 5.1 to 10.0 μ g urea hydrolysed per g of soil per hour and increased with the increase in the organic carbon content of soils (Table 1).

The urea hydrolysis coefficients, [ko] after regular intervals of time were calculated from the zero order reaction equation, ko=x/t, where x is the amount of ureat hydrolysed in μ moles and t is the time in hours for each soils. As shown by the results reported in Table 2 in page 50, that the values of [ko] ranged from 0.083 to 0.167 μ moles urea hydrolysed/ g of soil h^{-1} . It is also evident that the value of [ko] remained fairly constant during the 12 hours of soil urease assays (Table 2) for each soil, demonstrating that the urea hydrolysis in these soils followed a zero order kinetics.

Results shown in Figure 1 further reveal that the urea hydrolysis followed a zero order kinetics at least upto 12 hours as is evident from the linear relationship between the time of incubation and the amounts of urea hydrolysed for the three soils studied. The linearity of relationship between the time of incubation and the amount of urea hydrolysed upto 12 hours further proved that the method used for assaying soil urease was not complicated by the microbial activity. These findings are in general agreement with those of Zantua and Bremner (12), who also observed that the soil urease measurement were not complicated by the microbial activity upto 10 hours.

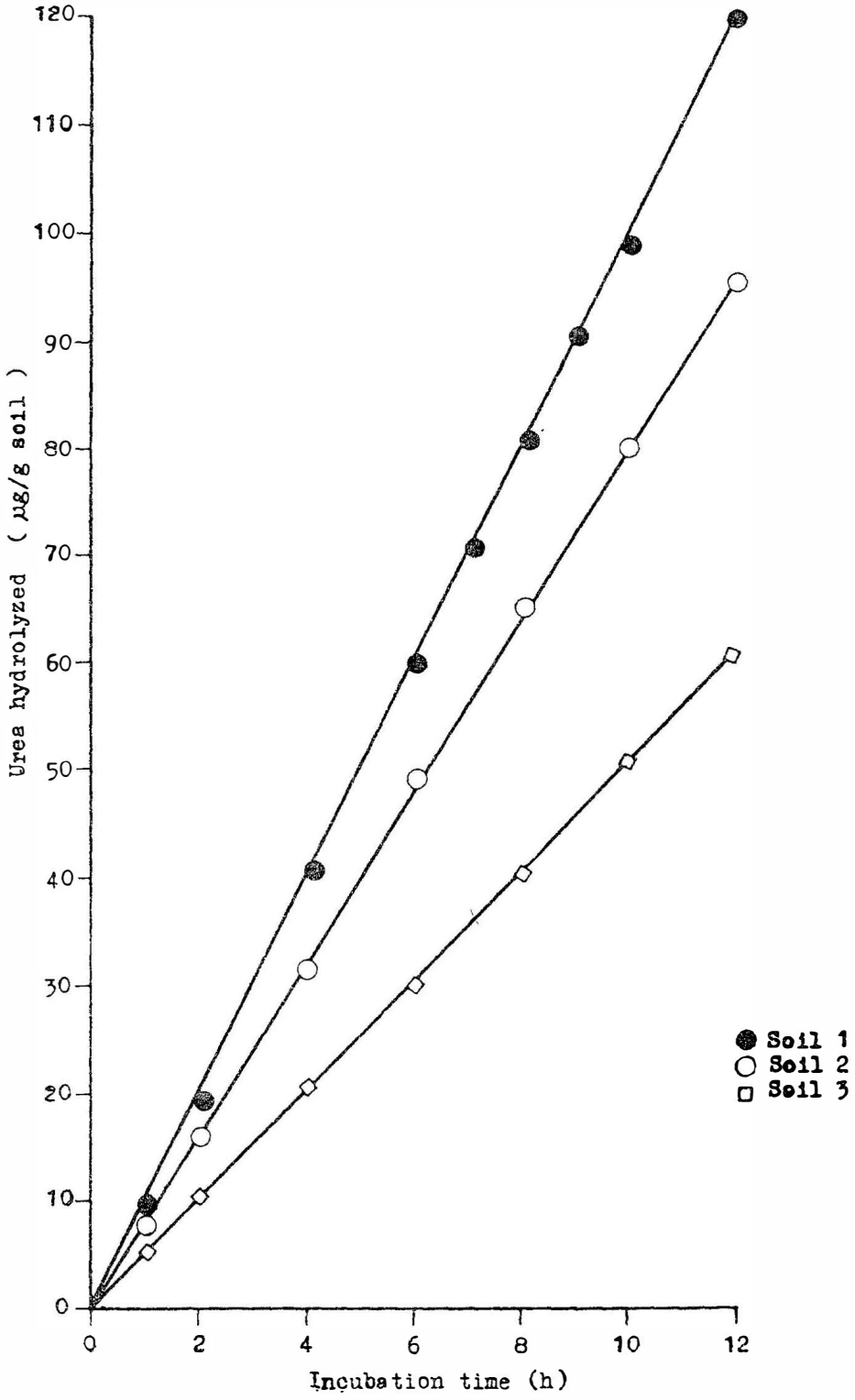

Figure 1—Kinetics of urea hydrolysis in three soils.

Acknowledgements

The author is grateful to Dr. S. K. Mukerjee, Head, Division of Agricultural Chemicals, Indian Agricultural Research Institute, New Delhi, for the facilities and encouragements and to the Indian Council of Agricultural Research for a senior research fellowship during the tenure of this study.

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(*Continued on page* 50)