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SHORT COMMUNICATION

Urease activity in tropical rice soils and flood water

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Soil properties affecting urease have been studied in upland soils (McGarity and Myers, 1967, Dalal, 1975, Zantua *et al*, 1977) but there have been few studies of the urease activity in rice soils (De Laune and Patrick, 1970) even though urea is the most commonly used N fertilizer on rice soils in the tropics It would be useful to understand how adverse soil conditions such as alkalinity, salinity, iron toxicity on acid soils and Histosol problems (Ponnamperuma, 1976) affect urea transformations to NH_4^+ by soil urease

I have studied urease activity in some rice growing soils of the Philippines with widely different soil properties Urease activity associated with the flood water of the rice soils was studied with a view to separating the urea hydrolyzing power of flood water from that of the soil

The soils used (Table 1) were surface (0–1 5 cm) samples, air dried and ground (<2 mm) Organic C and total N were determined as described by Walkley and Black (1934) and Bremner (1965a) respectively and pH was measured by a glass electrode

The methods used for the assay of urease in soils and flood waters were modifications of the non-buffer method of Zantua and Bremner (1975) The non-buffer method was preferred to the conventional and commonly-used buffer method to estimate the urea-hydrolyzing potential of these soils under simulated field conditions Dried soil samples (10 g) in 125-ml conical flasks were treated with 20 ml water or 20 ml water containing 10 mg urea N The flasks were gently swirled to mix the urea with the soil, covered with aluminium foil and incubated at 30°C for 4 h The soil samples were extracted by shaking for 1 h with 100 ml of 2 M KCl containing 100 μg Ag_2SO_4 ml^{-1} to inhibit urease After filtering through Whatman filter paper No 40, 20 ml of the extract was steam distilled with MgO, to determine the amounts of NH_4^+ released during urea hydrolysis (Bremner, 1965b) Blanks were run simultaneously to correct for urea hydrolysis in soils in the presence of the urease inhibitor added to soil samples just before adding urea Blanks were also run to allow for urea decomposition, if any, during steam distillation A correction was made for the amount of NH_4^+ fixed during incubation NH_3 evolved during steam distillation with MgO was absorbed in 2% boric acid solution containing mixed indicator and NH_4^+ was determined by titration with 0 01 N H_2SO_4 (Bremner, 1965b)

Flood water was collected from low land rice fields or from soils flooded in pots in the green-house The surface waters were collected so as to avoid soil contamination and the unfiltered water was used to assay urease Flood water (25 ml) was transferred to 125 ml conical flask after adding 1000 μg urea—N ml^{-1} and incubated at 30°C for 4 h Urease activity was stopped by adding 100 μg Ag_2SO_4 ml^{-1} The NH_4^+ formed by urea hydrolysis was determined by distilling the sample with MgO as described above Blanks were run to correct for NH_4^+ present in the flood water, and NH_4^+ formed by urea hydrolysis in the presence of urease inhibitor and by chemical decomposition during steam distillation All soil and water urease determinations were run in duplicate and quadruplicate respectively

In soil the rate of urea hydrolysis varied from 8 0 to

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Table 1 Analyses of soil used

Soil	pH	Organic C (%)	Total N (%)	Urease activity (μg NH_4^+ g^{-1} h^{-1})
Malinao loamy sand (acid sulfate)	3 7	1 22	0 09	8 0
Bani clay (saline)	6 1	1 20	0 07	8 4
Calalahan sandy loam (acid sulfate)	3 4	1 57	0 11	8 8
Buenavista clay loam	5 7	0 64	0 07	10 3
Quingua silty loam	6 5	1 22	0 11	11 8
Maahas clay	6 3	1 50	0 13	12 0
Maahas clay, salinized (Maahas clay + 0 5% NaCl, e c e = 10mmho/cm)	6 9	1 50	0 13	12 0
Pila clay	7 5	2 26	0 19	15 6
Lipa loam	7 5	2 50	0 19	18 2
Luisiana clay	4 3	1 94	0 18	20 0
Lam Aw peat (organic)	6 1	22 70	1 20	20 1
Paete clay loam	5 6	4 76	0 48	23 6
Maahas clay, alkalized (Maahas clay + 1 3% Na_2CO_3)	8 6	1 50	0 13	32 0

Table 2 Urease activity in flood water of soils

Soil	Flood water Source	pH	Urease activity Range (μg NH_4^+ 25 ml^{-1} h^{-1})	Mean
Calalahan sandy loam	Greenhouse	3 9	0–0	0
Quingua silty loam	Greenhouse	6 8	4–6	5
Luisiana clay	Field	6 0	5–7	6
Buenavista clay loam	Greenhouse	7 6	5–7	6
Maahas clay salinized	Field	8 8	6–10	8
Maahas clay	Field	8 0	8–11	9
Pila clay	Greenhouse	7 6	8–11	10
Paete clay loam	Greenhouse	7 5	10–14	12
Lipa loam	Field	8 5	13–19	16
Maahas clay, alkalized	Field	9 4	27–31	29
Lam Aw peat	Field	6 0	33–40	36

32 0 μg NH_4^+ formed h^{-1} g^{-1} soil at 30°C (Table 1) The highest urease activity was detected in the alkalized Maahas clay (Maahas clay + 1 3% Na_2CO_3) and the least in the Malinao acid-sulfate soils While the presence of salt had hardly any effect on the rate of soil urease activity, alkali increased it To further elucidate the influence of salt and alkali on urease activity in Maahas clay the soil urease activity in Maahas clay, salinized Maahas clay (Maahas clay + 0 5% NaCl) and alkalized Maahas clay (Maahas clay + 1 3% Na_2CO_3) was assayed up to 8 h (results not presented) Salt hardly affected soil urease activity but alkali increased the activity 2–3 times over the urease activity in the normal Maahas clay These results imply that in alkaline soils, the rate of urea hydrolysis is more rapid, and this increases N loss through NH_3 volatilization

In the flood waters of 11 lowland rice soils (Table 2) urease activity varied from 0 to 36 NH_4^+ formed 25 ml^{-1} flood water h^{-1} The least urease activity was measured in the Calalahan acid sulfate soil and the highest in the flood water of a Histosol Urease activity in the surface water was not affected by salinity but was greatly increased by alkalinity in the Maahas clay These results imply that urease activity in the flood water of some rice soils may be enough to hydrolyze part of the urea applied on the surface water but its contribution seems to be far less than that of soil urease

The results show that the flood water of tropical lowland rice soils may have measurable amounts of urease activity These findings differ from those of De Laune and Patrick (1970), who did not detect appreciable urease activity in the flood water of rice soils incubated in the laboratory I collected flood water samples from the low-land rice fields or from the flooded soils in the green-house, where soils have been placed and flooded under more natural environments as far as sunlight, temperature etc, are concerned from those under laboratory conditions This might be the reason for the difference in the urease activity of flood water from different soils when placed under laboratory and field or green-house conditions There is a need to investigate further the various factors affecting the urease activity in surface waters of lowland rice soils

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