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Evaluation of some paddy soils properties on urease enzyme activity

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Abstract

Urease activity influences optimum use of urea fertilizer, nitrogen volatilization, nitrogen leaching and environmental pollution related to N. Laboratory experiments were carried out to evaluate urea hydrolysis, as a function of soil urease activity in 30 different paddy soil samples of Guilan province of Iran and their correlations with some soil physico-chemical characteristics. Urease activities range from 19.8 to 68.3 µg NH_4^+/g soil/2hr. Simple correlation analysis of urease activity with properties of this rice soils differing widely in pH, C:N and organic carbon indicated that urease activity was correlated highly significantly with organic carbon (r = 0.80**) and total N (r = 0.73**) and EC (r = 0.63**) and CEC (r = 0.38*). pH was also negatively correlated with urease activity (r = -0.52**) but was not significantly correlated with clay percentage and C: N. Multiple stepwise regression analysis revealed that 77% of urease variation was accounted by OC and CEC.

Key words: Urease activity, Nitrogen, Paddy soil, Laboratory experiment, Urea hydrolysis

Introduction

Soil microorganisms and soil enzymes not only play an active role in soil fertility as a result of their involvement in the cycle of nutrients like carbon and nitrogen, which are required for plant growth, but also are sensitive biological indicators for soil quality evaluation, which can sensitively reflect minute changes of the soil environment (Huang, 2000). The use of enzyme activity measurements as indicators of soil functionality, and thus as indicators of soil quality, has been extensively discussed (Nannipieri et al., 2002). Urea is one of the most important chemical N fertilizers and its application has been increased in Middle East because of local production and relative low price per unit of N (Cookson and Lepiece, 1996). Urea hydrolysis in soils is an enzymatic decomposition process by the enzyme urease. When applied to soil, urea is hydrolyzed by enzyme ureas to NH_4^+. Urea hydrolysis proceeds rapidly in warm, moist soils, with most of the urea transformed to NH_4^+ in several days. Ureas, an enzyme that catalyzes the hydrolysis of urea is abundant in soils. Soil urease (urea amidohydrolase) is involved in nitrogen mineralization and supplying nitrogen to plants from natural and fertilizer sources. The rate of urea hydrolysis depends on several factors like soil type, organic matter content, soil moisture content, $CaCO_3$ content, temperature, level of salinity and alkalinity. Some of these factors accelerate and others retard the rate of urea hydrolysis in soils (Kumar et al., 1988). The objective of this study was to investigate relationships of urease activities with some physico-chemical properties of predominant paddy soils in Guilan Province, North of Iran.

Materials and Methods

The soil samples, which were used in investigation, were collected from different parts of the rice fields Guilan province, Iran. With this aim,the soil samples were taken 0-30 cm depth and 30 soil samples were used in research in order to represent all soils of Guilan province. The samples were air-dried ground, passed through a 2 mm mesh sieve, and kept in sealed glass containers. Selected soil physical and chemical properties were determined by means of appropriate methods: distribution of soil's particle size by the hydrometer method, pH in saturation paste by pH-meter, electrical conductivity of soil saturation extracts (ECe) with Metrohm conductometer. Organic carbon was determined following the wet digestion method as described by Walkley and Black(1934).Total nitrogen was determined by the Kjeldahl procedure as described by Jackson(1958).Cation exchange capacity (CEC) by Bower method (Chapman, 1965). Urease activity was measured in 0.05 M Tris hydroxymethyl aminomethane (THAM) buffer pH = 9.00 according to the method of Tabatabai (Tabatabai, 1994). Simple linear and stepwise regression analyses were used for describing the relationships between ureas activity and soil physical and chemical properties.

Results and Discussion

Some descriptive statistical results for selected soil physical and chemical properties are given in Table1. Soil properties varied widely with respect to distribution of soil's particle size, OC, TN, CEC, EC_e and Clay (Table 1). Ureas activities in different paddy soils are given in Fig1. Simple linear correlation coefficients between urease and soil physico-chemical properties are shown in Table 2. There were no significant correlations between urease and clay percentage of soils (Table2). The lack of significant relationships between the soil enzyme activities and clay percentage was somewhat surprising; however, Frankenberger and Tabatabai (1991a, b) and Baligar et al (1991) reported the same results.

Table1. Descriptive statistics for selected properties of paddy soils (n=30)

Soil properties	**Unit**	**Mean**	**Min.**	**Max.**	**S_d**
Clay (C)	%	32	8	48	7.7
Electrical conductivity (EC)	$dS\ m^{-1}$	1.89	0.57	5.3	2.31
pH	-	7.2	5.8	7.9	0.62
Organic carbon (OC)	%	2.12	0.66	5.37	1.26
Total nitrogen (TN)	%	0.218	0.055	0.554	0.127
C/N	-	9.94	6.20	20.3	2.77
Cation exchange capacity (CEC)	$Cmol\ kg^{-1}$	34	17	49	8.87
Urease activity (UAc),	μ g NH_4^+/g soil/2hr	38.6	19.8	68.3	11

S_d: standard deviation

Urease activity was correlated significantly with EC (Table 2). Reynolds, et al. (1985) reported similar results for urease activity in humid to semi humid soils. Frankenberger and Bingham (1982) showed, however that hydrolases are not as affected by salinity as oxidoreductases.

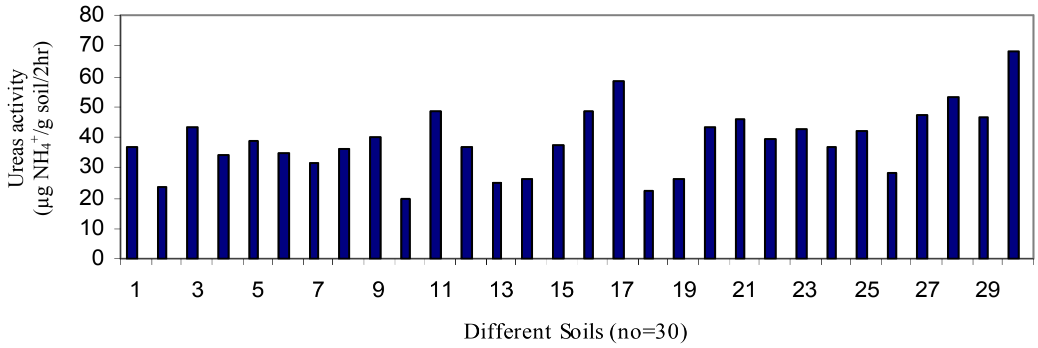

Fig1. Ureas activity in different paddy soils

The activity of soil enzyme was also correlated significantly with OC, TN (Table2). Baligar, 1991, Cookson and Lepiece, 1996 reported that ureas activity was significantly correlated with organic carbon and total nitrogen. Similar relationships were previously obtained for other amidohydrolases including amidase and L-glutaminase (Frankenberger and Tabatabai, 1991b). Because soil enzymes appeared to be immobilized on soil organic matter and organic matter is indexed by both OC and TN and so significant correlation between the enzyme activities and OC and TN are ordinary (Frankenberger and Tabatabai, 1991a).

Table 2. Simple linear correlation coefficients of ureas activity and soil properties.

Soil properties	Correlation coefficients	S_d	Equations
Clay (C)	0.11^{ns}	11.1	UA= 33.677+0.157 C
Electrical conductivity (EC)	0.63^{**}	8.7	UA= 280354+6.335 EC
pH	-0.52^{**}	9.5	UA= 104.813-9.30 pH
Organic carbon (OC)	0.80^{**}	6.7	UA= 23.931+6.959 OC
Total nitrogen (TN)	0.73^{**}	7.6	UA= 25.446+60.514 N
C/N	0.23^{ns}	10.8	UA= 29.795+0.892 C/N
Cation exchange capacity (CEC)	0.38^{*}	10.3	UA= 22.844+0.469 CEC

S_d ; standard deviation   UA; ureas activity   * and ** are significant at 0.05, 0.01 respectively.

They suggested that the close relationship might be related to the adsorption of enzymes on soil organic colloids and that; the enzymes may be strongly associated with organic complexes.

There were also insufficiency correlation between urease and CEC (Table2). Probably clays are major contributors to the CEC of studied soils and insufficiency association between urease and CEC may be due to considerable contribution of clay to CEC. Multiple stepwise regression analysis revealed that 77% of urease variation was accounted by OC and CEC. Significant negative correlations were observed between ureas activity and pH soils. This result shows that urease activity decrease with increase pH soils and has more suitability with acidic conditions. Similar results reported by Beri and Goswami, 1978.

Conclusion

In the soils studied urease activity is mostly controlled by organic carbon and decrease with increase pH soils and has more suitability with acidic conditions. Evidently salinity condition in humid to semi humid soils no problem to urease activity.

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