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Soil properties regulating urease activity in inceptisol

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Abstract
The use of urea by the farmers as a source of nitrogen has been increased in the recent years. However, the nitrogen use efficiency of applied chemical nitrogen fertilizers is less than 50% due to leaching, volatilization, denitrification and surface runoff. These losses are undesirable because of environment concerns and the high cost of crop production. After application of urea to soil, it hydrolyses to ammonia and carbon dioxide in soil-by-soil urease enzyme which is under influences of soil factors. Thus, study of soil properties regulating soil urease activity are the most important in regulating the process of urea hydrolysis which is the main concern in improving the use efficiency of urea and minimize the problems related to use of urea. In this context, the present investigation was undertaken so as to understand the soil properties regulating urease activity in the Inception. Total 15 surface (0-15 cm) GPS based soil samples of an Inception with wide range of variations in soil properties from the Central Campus of the MPKV, Rahuri were collected and analysed for important physic-chemical and biological soil properties for the correlation studies with urease activity. Correlation studies between soil properties and urease activity from soil samples were analysed by simple linear correlation study. The present study results indicated that, the urease activity is positively and highly significantly correlated with organic carbon (0.87**), total nitrogen (0.806**), available nitrogen (0.61**) and Clay (0.52*). The content of $CaCO_3$ (-0.487*) has significant negative correlation with urease activity. The other soil properties studied *i.e.* pH, EC, silt, sand and microbial population did not show any significant correlation with urease activity in an Inception soils.

Keywords: Inception, nitrogen, soil property, urease activity

Introduction
Soil enzymes are essential and continuously playing a key role regularly in maintaining soil ecology, physical and chemical properties, overall soil fertility, and soil health. The soil enzymes work in biochemical processes of overall organic matter decomposition in the soil system (Sinsabaugh *et al.*, 1991; Srinivasa *et al.*, 2017; Kocak, 2020) [15, 16, 9]. Many extracellular enzymes are involved in decomposition of organic matter in soils. Measurements of enzymes activities from soil are believed to indicate the extent of specific processes in soil and in some cases as indicator of soil fertility. Among the extracellular enzymes related to nitrogen (N), the enzyme urease (Urea amidohydrolase, EC 3.5.1.5) is an important and responsible enzyme for breakdown of C-N bonds in various organic nitrogen compounds in soil particularly regulates the fate of applied urea to soil, which deserves much attention since the urea is the important and most preferred synthetic nitrogen fertilizers by the majority of farmers due to its ease of application, relative cheapness and low price per unit of N and favourable economics of manufacturing, handling, storage and transportation (Cookson and Lepiece, 1996) [4]. However, the nitrogen use efficiency of applied chemical nitrogen fertilizers is less than 50% due to leaching, volatilization, denitrification and surface runoff. These losses are undesirable since it leads to high cost of crop production and also environment concerns like volatilization of urea N as ammonia, nitrite toxicity, increase in soil pH and damage to germinating seedlings and young plants (Gasser, 1964; Hutchinson and Viets, 1969; Bremner and Krogmeier, 1988; Bremner, 1995) [7, 8, 17]. The growing importance of the more use of urea as a nitrogen fertilizer in world agriculture necessitates research to reduce these problems. Thus, the study of soil urease and factors regulating its activity is very important to to reduce the related problems in soils, crops and environment with use of urea. With this background the present study was conducted with objective to study the correlation between the urease activity and the soil properties in Inception.

Material and Methods

The present investigation entitled, "Effect of soil properties on urease activity in Inception" was undertaken during 2020-21 at the laboratory of the Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuria, so as to study the soil factors regulating urease activity in Inception of MPKV, Rahuria soils. The details of the materials used, laboratory experiments conducted, methods adopted in the present investigation are given in this chapter. A survey was made for locating 15 sites of soil samples with wide variations in physic-chemical properties, the details of 15 locations, soil descriptions and other relevant information are given in table 1. These soil samples were processed and used for the measuring activity of urease by Tabatabaei and Bremmer (1972) [17] method and simultaneously these soil samples were analysed for their various proposed physic-chemical and biological properties of soil by using standard methods of soil analysis so as to study the correlation between urease activity and soil properties. Based on correlation studies, the soil factors regulating urease activity in Inception were studied and reported in table 2. The data generated in present study were tabulated and analysed statistically by using completely randomized design (CRD) and simple correlation study methods.

Table 1: Details of Inception soil samples, their locations and description in field

Soil sample No	Details of locations for Inception soils		Soil texture (Feel method)	Soil colour by Munsell colour chart	Soil depth	$CaCO_3$ content (Field test)	Previous crop grown	Taxonomical class of soil
	Site	GPS reading						
S1	PGI Farm (SSAC)	19.342082 N 74.647789 E	Clay	Very dark brown	60 cm	Medium	Cotton	Typic Haplustept
S2	General PGI Farm	19.340778 N 74.647861 E	Clay	Very dark greyish brown	80 cm	High	Spinach	Sodic Calciudert
S3	STCR Farm	19.358014 N 74.650462 E	Clay	Black	45 cm	Low	Chickpea	Typic Haplustept
S4	Micronutrient Farm	19.356887 N 74.652631 E	Silty clay	Dark yellowish brown	45 cm	Medium	Redgram	Typic Ustorthent
S5	Medicinal block	19.358724 N 74.655001 E	Clay	Brown	65 cm	High	Fallow	Vertic Haplustept
S6	Sorghum improvement scheme	19.362293 N 74.651941 E	Clay	Dark brown	70cm	Low	Sorghum	Vertic Haplustept
S7	Cotton improvement scheme	19.368898 N 74.653796 E	Clay	Very dark grey	75 cm	Low	Cotton	Vertic Haplustept
S8	Pulse improvement scheme	19.370326 N 74.648347 E	Clay loam	Yellowish brown	65 cm	High	Redgram	Typic Haplustept
S9	D block	19.322826 N 74.660213 E	Clay	Very dark greyish brown	65 cm	Very low	Sapota	Sodic Hapludert
S10	B block (B-1)	19.345532 N 74.663212 E	Clay	Very dark brown	45 cm	High	Sugarcane	Typic Haplustept
S11	B block (B-2)	19.337515 N 74.665953 E	Clay	Very dark greyish brown	60 cm	Medium	Lucerne	Sodic Haplustept
S12	C block (C-2)	19.346544 N 74.669063 E	Clay	Very dark greyish brown	85 cm	Medium	Soybean	Sodic Calciudert
S13	Dblock (CAAST)	19.322737 N 74.655210 E	Clay	Very dark greyish brown	75 cm	Very low	Mango	Vertic Haplustept
S14	C block (C-4)	19.333046 N 74.673765 E	Clay	Very dark grey	75 cm	Medium		Vertic Haplustept
S15	C block (C-4)	19.326918 N 74.667805 E	Clay	Very dark grey	90 cm	High	Red gram	Sodic Chomudert

Results and Discussion

Fifteen surface soil samples (0-15 cm) of Inceptions were examined for their physical property i.e., soil texture and chemical properties *viz*., pH, EC, organic carbon (OC), total nitrogen (TN), available nitrogen, calcium carbonate ($CaCO_3$) and biological properties *viz*., bacterial, fungal, and actinomycetes counts and urease activity. The results obtained on soil properties and their correlations with urease activity are presented in table 4.7. The data presented represents the average values of triplicate analysis. Urease activity expressed as µg of NH_4^+ released g^{-1} soil h^{-1} ranged from 5.5 to 13.5 with an average value of 8.83. The range of urease enzyme activity discussed in this study fall in line with earlier study reports (Chaudhuri *et al.*, 2009 and Shilpashee and Kotur, 2009; Reddy *et al*., 2011;) [3, 14, 12] from the soils of India and from various parts of the world. The values of correlation coefficients (r) between soil properties and soil urease were calculated for all the fifteen samples showed a wide range in soil physic chemical and biological properties. These results showed that urease activity was positive and highly significant correlation with organic carbon (r = 0.87**), total nitrogen (r= 0.806**) and available nitrogen (r = 0.61**), urease activity showed positive significant correlation with clay content (r= 0.52*) and they also found negative significant correlation with $CaCO_3$% (r= -0.49*) and no significant correlation with pH, EC, silt, sand and microbial counts.

The significant positive correlation of organic carbon, total nitrogen, and clay content with urease activity is in conformity with the earlier conclusions of studies of Sahawat, (1993) [13], Nourbakhsh and Monreal, (2004) [11], Shilpashee and Kotur, (2009) [14] and Vahed *et al.*, (2011) [18]. Soil enzymes appeared to be immobilized on soil organic matter and soil organic matter is indexed by both organic carbon and total nitrogen. So, significant correlation between enzyme activities with organic carbon and total nitrogen are ordinary

(Frankenberger and Tabatabai, 1991) [6]. The higher correlation between enzyme activity and organic carbon content is because the latter is the seat of microbial population and activity. The no significant correlation with pH, EC, silt, sand and microbial counts were observed in present study are in line with earlier study reports of Frankenberger and Dick, (1983) [5], Sahawat, (1983) [13] and Noorbakhsh *et al.*, (2001) [10].

Table 2: Soil properties of experimental soil samples

Soil samples	Urease activity (µg of NH_4^+/g of soil/h)	Particle size Distribution (%)			Chemical properties						Biological properties		
		Clay	Silt	Sand	pH	EC (dSm⁻¹)	$CaCO_3$%	Avail N (kg/ha)	TN%	OC%	Bacteria CFU×10^7 g^{-1} soil	Fungi CFU× $10^4 g^{-1}$soil	Actinomycetes× $10^6 g^{-1}$ soil
S1	8.6	52.5	21.3	22.6	8.42	0.22	4.75	178	0.052	0.45	12	10	13
S2	6.8	42.7	17.8	36.5	8.94	0.56	7.25	156	0.048	0.36	15	8	17
S3	8.5	47.3	25	25.9	8.38	0.21	2.25	162	0.065	0.52	17	12	19
S4	7.2	46.5	41.755	9.745	8.46	0.13	4.375	173	0.042	0.46	22	15	13
S5	5.5	42.8	21.2	34.2	8.42	0.15	7.75	148	0.036	0.18	15	6	15
S6	9.2	54.5	32.3	11.7	8.3	0.16	2.875	142	0.046	0.58	16	15	12
S7	10.6	45	17.5	32.7	8.62	0.23	2.25	209	0.052	0.52	20	18	13
S8	6.3	41.6	34.2	21.7	8.71	0.12	9.25	174	0.042	0.31	13	20	10
S9	13.5	52.5	28.5	17.5	8.26	0.10	1.25	192	0.072	0.62	25	13	16
S10	7.8	60	27.5	10.65	8.63	0.16	6.5	132	0.059	0.45	15	12	19
S11	8.9	52.8	24.6	20.5	8.65	0.15	4.75	164	0.062	0.48	18	17	15
S12	6.2	55	17.2	24.19	8.86	0.19	3.25	148	0.045	0.27	16	9	13
S13	12.4	62	23.5	11.6	8.49	0.15	1.45	172	0.069	0.6	13	7	14
S14	8.7	52.6	23.6	20.7	8.89	0.21	4.0	188	0.068	0.38	14	16	9
S15	12.3	56.3	28.9	12.5	8.68	0.13	8.5	205	0.075	0.57	15	19	15
	r value	0.52*	0.041	-0.404	-0.35	-0.28	-0.49*	0.61**	0.806**	0.87**	0.331	0.223	0.096

Conclusions

The results of the present study indicated that, the urease activity is positive and highly significant correlated with organic carbon, total nitrogen and available nitrogen. Clay content having significant positive and content of $CaCO_3$ having significant negative correlation with urease activity. Other studied soil properties *viz*., pH, EC, silt, sand and microbial population did not show any significant correlation with urease activity.

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