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NOTE

Relationship between different fractions of N and characteristics of some dominant soil series of West Bengal

Arunava Das and Dipankar Saha*

Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, Nadia, West Bengal, India

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Abstract : A study was conducted to make a relationship between different forms of inorganic and organic N with some important physical and chemical properties of dominant soil series of West Bengal. Results revealed that in general, alluvial soil contains higher amount of different forms of N than that of soils of Red and Laterite zone. Amongst different forms, exchangeable NH_4^+ and hydrolysable NH_4^+ and amino acid fractions contributed more to the total pool of total N. Correlation studies pointed out a significant relationship between finer fractions of soils with fixed NH_4^+, total hydrolysable organic N and total N. Total hydrolysable NH_4^+ is also significantly correlated with C.E.C. of the soils.

Keywords : Soil, inorganic and organic N, cation exchange capacity.

Introduction

The distribution of different organic and inorganic forms of N depends on the factors like, cropping history and climate which remain operating over a long period of time[1,2] in addition to the physical and chemical properties of soils. Native fixed NH_4^+ is usually increased with increase in clay content and cation exchange capacity of soils[3,4]. Bera and Majumdar[5] reported the total N content in alluvial soils of north-eastern region is around 0.115% and in laterite and lateritic soils varies from 0.095 to 0.128% and about 0.203% in forest soils of Assam. Distrbution of different forms of organic N varies from soil to soil[6] and the dominant fraction is amino acid-N[2] followed by non-hydrolysable organic N[7].

Very few important studies have been conducted for different forms of N along with different physical and chemical properties of particular soil series. Study of N distribution in the series is important because the data can be more confidently extended to similar areas for agro-technology transfer. Keeping above information in view, the present investigation was undertaken to make a relationship between different fractions of organic and inorganic forms of N including fixed NH_4^+ with different physical and chemical properties of dominant soil series of West Bengal.

Experimental

The surface (0–15 cm) soil samples, representing ten soil series, were collected from South 24-Parganas, Nadia, Hoogly, Bankura, Birbhum, Burdwan and Purulia districts covering New alluvial, Old alluvial, Red and Laterite and Coastal-saline Agro-climatic zones of West Bengal[8]. Soil samples were dried and passed through either 20 mesh, 80 mesh and 2 mm sieve according to different items of analysis. Triplicate samples of each soil series were analyzed for determination of exchangeable NH_4^+ and soluble NO_3^--N[9] and fixed NH_4^+-N[10]. Different forms of organic and total N were estimated by the method of Stevenson[11]. Different physical, chemical and physico-chemical properties of the soil samples were determined following standard procedures.

Results and discussion

Results (Table 1) revealed that out of ten soil series under study, nine belong to Inceptisol and the remaining Raghunathpur belongs to Alfisol order. Clay content of the soil series ranged between 21.5 to 58.0 per cent and the textural class varied from clay to sandy clay loam. Chakdaha and Chunchura soil series of New alluvial zone, are clayey in nature but on the other hand soil series of Red and Laterite zone are generally sandy clay loam in texture. Kakdweep soil series representing Coastal-Saline zone, is loam in nature.

Table 1. Mechanical separates of different soil series under study

Name of the soil series	Soil series under agro climatic zones	Mechanical separates (%)				Organic matter (%)	Taxonomic classification according to U.S.D.A. system
		Sand	Silt	Clay	Textural class		
Amarpur	New Alluvial	40.6	25.0	34.4	Sandy clay loam	1.55	Endoaquepts
Bishnupur	Red and Laterite	64.5	10.0	25.6	Sandy clay loam	0.69	Endoaquepts
Chakdaha	New Alluvial	22.1	33.9	44.1	Clay	1.38	Aeric Endoaquepts
Chunchura	New Alluvial	10.5	31.6	58.0	Clay	1.03	Aeric Endoaquepts
Jagadishpur	Alluvial	35.9	27.3	36.8	Clay loam	0.86	Typic Endoaquepts
Kakdweep	Coastal Saline	37.7	32.6	29.8	Loam	0.52	Typic Endoaquepts
Kalna	New Alluvial	33.3	27.4	39.4	Clay loam	1.20	Typic Endoaquepts
Patrasayer	Red and Laterite	59.6	15.2	25.2	Sandy clay loam	1.03	Typic Endoaquepts
Raghunathpur	Red and Laterite	62.3	16.2	21.5	Sandy clay loam	1.03	Lithic Haplustalfs
Taldangra	Laterite	52.5	9.6	37.9	Sandy clay	0.69	Typic Endoaquepts

Comparatively higher order of water holding capacity (W.H.C.) were shown by soil series representing New alluvial zone (Table 2). This is due to higher amount of clay content and organic matter (Table 1). Bishnupur showed lowest (30.2%) and Kalna soil series represented highest (57.9%) W.H.C.

Highest amount of exchangeable NH_4^+ (78.6 mg kg^{-1}) was recorded in Chunchura soil representing New alluvial zone and the lowest amount was found in Raghunathpur soil series (38.4 mg kg^{-1}) of Red and Laterite zone (Table 3). However, Kakdweep soil of Coastal-Saline belt also showed higher order of exchangeable

Table 2. Chemical properties of different soil series under study

Name of the soil series	Soil series under Agro climatic zones	W.H.C. (%)	pH	C.E.C. [cmol(p^+) kg^{-1}]	Exch. Ca^{2+} [mg 100 g^{-1} of soil]	Exch. Mg^{2+} [mg 100 g^{-1} of soil]	Oxidizable organic carbon (%)	Total N (mg kg^{-1})
Amarpur	New Alluvial	45.9	5.12	10.1	6.7	0.3	0.9	999.4
Bishnupur	Red and Laterite	30.2	5.88	9.1	3.4	0.2	0.4	1010.7
Chakdaha	New Alluvial	49.5	7.17	11.4	13.1	0.4	0.8	1209.8
Chunchura	New Alluvial	50.9	7.09	11.6	13.3	0.4	0.6	1144.2
Jagadishpur	Old Alluvial	44.5	7.58	8.5	7.4	0.7	0.5	968.4
Kakdweep	Coastal Saline	52.2	7.82	9.8	6.0	0.4	0.3	1009.1
Kalna	New Alluvial	57.9	6.88	10.2	11.1	0.67	0.7	1178.8
Patrasayer	Red and Laterite	35.7	5.45	8.4	2.5	0.2	0.6	1012.4
Raghunathpur	Red and Laterite	39.4	6.06	8.3	3.2	0.2	0.6	908.4
Taldangra	Red and Laterite	34.4	5.04	8.0	3.8	0.1	0.4	1037.0

No remarkable variation was noticed within results of chemical properties of different soil series under study (Table 2). However, in general, Chakdaha soil of New alluvial zone showed high values with regard to different chemical properties. Red and Laterite soils are poor in chemical properties showing a little variation among themselves (Table 2). The observed higher order of physical and chemical properties of the soil series under New alluvial zone is due to the presence of clay content and organic matter[12].

NH_4^+-N (70.1 mg kg^{-1}). Highest and the lowest amount of soluble NO_3^--N was accumulated in Patrasayer and Chakdaha soil respectively. It is interesting to note that NO_3^--N production was not controlled by the origin of the soil. Although soils of New alluvial zone (Chunchura) accumulated highest amount of exchangeable NH_4^+ but that of soluble NO_3^- was found in soils of Red and Laterite zone (Patrasayer). Per cent contribution of available N (exchangeable NH_4^+ + soluble NO_3^-) to total N varies greatly from soil to soil. Highest amount of contribution

Table 3. Different inorganic forms of nitrogen (mg kg^{-1}) of soil series under study

Name of the soil series	Soil series under Agro climatic zones	Exch. NH_4^+	Soluble NO_3^-	Available N (Exch. NH_4^+ + soluble NO_3^-)	Fixed NH_4^+-N	Total inorganic N (Exch. NH_4^+ + soluble NO_3^- + fixed NH_4^+)
Amarpur	New Alluvial	62.6	45.9	108.5	606.9	715.4
Bishnupur	Red and Laterite	56.0	39.1	95.1	405.4	500.5
Chakdaha	New Alluvial	49.6	23.5	73.1	572.4	645.5
Chunchura	New Alluvial	78.6	56.9	135.5	607.3	742.8
Jagadishpur	Old Alluvial	41.1	45.7	86.8	473.3	560.1
Kakdweep	Coastal Saline	70.2	58.2	128.4	644.9	773.3
Kalna	New Alluvial	47.9	62.8	110.7	338.3	449.0
Patrasayer	Red and Laterite	45.2	66.7	111.9	408.1	520.0
Raghunathpur	Red and Laterite	38.4	37.5	75.9	406.7	482.6
Taldangra	Red and Laterite	65.3	45.7	111.0	442.8	553.8

of available N towards total N was found in Kakdweep soil (12.7%) which is representative of Coastal-Saline zone, whereas, that of lowest amount was recorded in Chakdaha soil (6.04%) of New alluvial zone. Amongst the different soil series under study highest and the lowest amount of fixed NH_4^+ were recorded in Kakdweep (644.9 mg kg^{-1}) and Bishnupur (405.4 mg kg^{-1}) respectively. Data of fixed NH_4^+ further revealed that although there is a great variation in amount within different soil series but the per cent contribution towards total inorganic N (exchangeable NH_4^+ + soluble NO_3^- + fixed NH_4^+) differ little between the highest (83.4) and the lowest (81.0). Results of present investigation are in agreement with earlier works of Saha[13].

Distribution of different organic forms of N in soil series revealed that hydrolysable NH_4^+ and amino acid-N were the main contributors to total hydrolysable organic N (Table 4). Irrespective of soil series, amino acid and hydrolysable NH_4^+-N contributed most to total hydrolysable organic N. The results further pointed out that hydrolysable NH_4^+ fraction is not directly related to the amount of total hydrolysable organic N of a soil. Non-hydrolysable and hexosamine fractions of organic N did not show any definite results (Table 4).

Correlation study of different forms of N with some important characteristics of ten dominant soil series of West Bengal (Table 5) revealed that different forms of inorganic and organic N are interrelated and interconvertible within themselves as reported earlier by Saha and Mukhopadhyay[14]. Present study confirmed the earlier hypothesis that exchangeable NH_4^+ is the fore runner of fixed NH_4^+[12]. Small sized fractions (either clay or silt) are directly related to total hydrolysable organic N, total N as well as fixed NH_4^+-N content of the soil.

Table 4. Different organic forms of nitrogen (mg kg^{-1}) of soil series under study

Name of the soil series	Soil series under agro zones climatic	Total hydrolysable organic N	Total non-hydrolysable organic N	Hydrolysable NH_4^+	Amino acid-N	Hexosamine-N
Amarpur	New Alluvial	872.8	18.2	361.8	374.4	72.3
Bishnupur	Red and Laterite	894.3	24.2	319.3	408.9	85.6
Chakdaha	New Alluvial	955.0	181.7	327.9	571.9	53.4
Chunchura	New Alluvial	971.8	36.8	396.8	438.9	118.5
Jagadishpur	Old Alluvial	814.6	67.0	191.9	414.9	147.5
Kakdweep	Coastal Saline	832.7	48.0	272.9	320.2	85.0
Kalna	New Alluvial	1051.7	16.4	283.3	476.6	198.2
Patrasayer	Red and Laterite	876.5	24.0	243.2	451.7	79.1
Raghunathpur	Red and Laterite	732.6	99.9	246.9	320.0	40.0
Taldangra	Red and Laterite	906.1	19.9	262.2	463.7	77.1

Table 5. Correlation for different characters of ten dominant soil series of West Bengal

	Exch. NH_4^+	Sol. NO_3^-	Silt %	Clay %	C.E.C.	Ox. Org. C	Exch. Ca^{2+}
Exch. NH_4^+	1.000						
Sol. NO_3^-	0.2333	1.000					
Silt	0.225	0.028	1.000				
Clay	0.539	0.021	0.584	1.000			
C.E.C.	0.466	-0.098	0.772	0.725	1.000		
Ox. Org. C	-0.254	-0.262	0.316	0.230	0.439	1.000	
Exch. Ca^{2+}	0.272	-0.096	0.813	0.865	0.884	0.430	1.000
Total inorg. N	0.748	0.020	0.625	0.461	0.585	0.033	0.384
Total N	0.270	-0.011	0.517	0.734	0.771	0.338	0.833
Fixed NH_4^+-N	0.656	-0.129	0.644	0.429	0.587	0.099	0.393
TH Org. N	0.319	0.235	0.283	0.651	0.602	0.265	0.663
Hyd. Org. NH_4^+	-0.087	-0.393	0.365	0.549	0.667	0.205	0.566
Amino acid-N	-0.087	-0.222	0.157	0.528	0.379	0.376	0.540

	Total inorg. N	Total N	Fixed NH_4^+-N	TH Org. N	Hyd. Org. NH_4^+	Amino acid-N
Exch. NH_4^+						
Sol. NO_3^-						
Silt %						
Clay %						
C.E.C.						
Ox. Org. C						
Exch. Ca^{2+}						
Total inorg. N	1.000					
Total N	0.154	1.000				
Fixed NH_4^+-N	0.986	0.134	1.000			
TH Org. N	-0.002	0.907	-0.071	1.000		
Hyd. Org. NH_4^+	0.464	0.386	0.479	0.328	1.000	
Amino acid-N	-0.161	0.801	-0.136	-0.714	0.021	1.000

Correlation coefficient >0.632 and >0.765 are significant at 5% and 1% level of probability.

Exch. NH_4^+ = Exchangeable NH_4^+, Sol. NO_3^- = Soluble NO_3^-, C.E.C. = Cation Exchange Capacity, Ox. Org. C = Oxidizable Organic Carbon, Exch. Ca^{2+} = Exchangeable Ca^{2+}, Total inorg. N = Total Inorganic N, TH Org. N = Total Hydrolyzable Organic N, Hyd. Org. NH_4^+ = Hydrolyzable Organic NH_4^+.

Positive correlation was also observed between total N and hydrolysable organic NH_4^+ with C.E.C. of the soils.

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