

COMPOSITION AND NATURE OF HUMUS IN TYPICAL ARIDISOLS OF RAJASTHAN

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ABSTRACT

In arid soils bulk of the organic carbon was present in the non humic form. Organic carbon associated with humic and fulvic acid varied from 3.2 to 48.4 and 3.1 to 30 per cent respectively. With increase in silt + clay mean values tended to increase slightly for humic and decreases for fulvic acid associated carbon. The humic acids were characterized by well aromatised, condensed nuclei and their nature was similar in different soils.

INTRODUCTION

Variations in the content of organic matter and nature of humus have been attributed to the hydrothermal conditions, type of vegetation cover and soil characteristics. Sandy soils because of their low clay content and occurrence in the relatively hot and arid climate have lowest organic carbon, however, build up of soil organic matter has been observed under tree plantation (Aggarwal and Lahiri, 1981) and grasses (Dhir and Gajbhiye, 1973). Information on the composition and nature of humus in the aridisols of Rajasthan is not available. Present communication is an attempt to bridge this gap.

MATERIAL AND METHODS

Surface samples of soil series/groups representing a variety of soils in Jaisalmer, Jodhpur, Nagaur, Barmer and Pali district of Rajasthan were studied. The parent material varied from wind worked sand to fine and coarse grained alluvium over a mean annual rainfall of 100 to 400 mm. Soil samples were analysed for CaCO_3 , organic carbon, particle size distribution and pH (1:2.5) following the standard methods (Piper 1950). Organic Carbon associated with humic and fulvic acid was determined in the extract of soil with 0.1 N NaOH and 0.1 M sodium pyrophosphate solution (pH 13), according to Tyurin's methods as described by Kononova (1966). Humic acid fraction was dissolved in 0.05 N NaHCO_3 solution and absorbance was recorded with the help of spectro-photometer at the wave lengths 465 nm and 665 nm. Relationships between the humus attributes and the soil characteristics were determined with the help of HCL micro computer.

RESULTS AND DISCUSSION

Dune, interdune and sandy plain soils are fine sand/loamysand with clay content of 2.9 to 9.7% and alkaline in reaction (pH₂ 8.2-9.0). CaCO₃ content in these soils ranges from 0.01 to 6.0%. Alluvial soils are medium and fine textured with slightly higher amount of clay (6.6 to 32.8%) grading in sandyloam, loam and clay loam texture. These soils also have alkaline range of reaction (pH 7.5 to 9.2). The coefficient of variation for different soil attributes namely pH, CaCO₃, organic carbon; clay and silt works out to be 5.1, 127.5, 56.7, 58.7, 58.3 and 99.0 per cent respectively.

Data on the composition of humus and nature of humic acids are reported for dune, interdune and sandy plain soils in Table 1 and for medium and fine textured soils in Table 2. Mean values of carbon associated with humic and non humic fractions in relation to silt and clay are presented in fig. 1. The organic carbon content in coarse textured dune, interdune and sandy plain soils (0.05 to 0.24%) was slightly less than in medium and fine textured alluvial soils (0.08 to 0.48%).

Table 1. Humus composition of coarse textured soils

Location	Organic carbon (%)	Percent of organic carbon			HA carbon/FA carbon	E ₄ /E ₆ Ratio
		Non humic fraction	Humic acid	Fulvic Acid		
Dune and interdune : Typic Torripsamments						
Jaisalmer	0.09	87.8	8.9	3.3	2.66	3.5
Nachna	0.14	81.1	5.8	13.1	0.44	4.1
Masitawali	0.24	67.8	26.8	5.9	4.49	4.7
Khetolai	0.09	79.1	4.2	16.7	0.25	4.1
Shergarh	0.06	88.8	4.5	6.7	0.66	6.4
Dechu	0.07	83.7	6.1	10.2	0.60	6.2
Ajwa	0.12	68.8	9.9	21.3	0.46	4.4
Molasar	0.12	57.6	32.7	9.7	3.38	5.3
Palsana dune	0.06	69.6	17.9	12.5	1.43	3.5
Palsana interdune	0.15	73.7	10.3	16.0	0.64	3.5
Sandy plain : Coarse loamy Typic camborthids/calciorthids						
Sheo	0.07	67.0	12.9	20.1	0.67	6.3
Chirai I	0.17	76.7	10.9	12.4	0.88	4.1
Manaklav	0.16	75.6	15.1	9.3	1.63	4.1
Jhanwar	0.09	66.2	10.5	23.3	0.45	4.6
Chirai II	0.14	83.0	13.9	3.1	4.53	6.4
Soila	0.18	79.2	16.9	3.9	4.27	4.6
Kumparabas	0.17	80.4	13.4	6.1	2.22	4.9
Bher	0.15	74.5	6.1	19.4	0.32	4.3
Playa : Salorthids						
Pokaran	0.05	84.0	10.0	6.0	1.70	3.5
Pachpadra	0.22	91.3	3.2	5.5	0.58	2.5

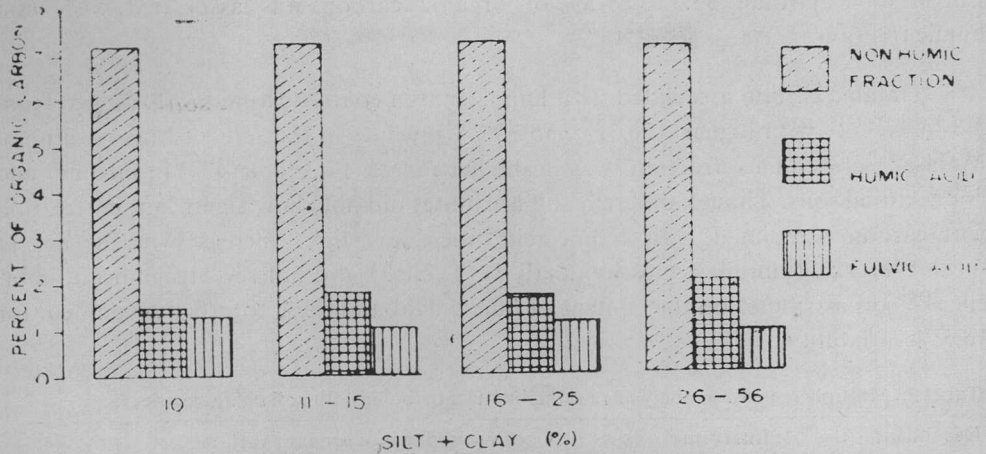


Fig. 1. MEAN VALUES OF ORGANIC CARBON ASSOCIATED WITH NON HUMIC AND HUMIC FRACTIONS.

Table 2. Humus composition of medium and fine textured soils

Location	Organic carbon (%)	Percent of organic carbon			HA carbon/FA carbon	E ₄ /E ₆ Ratio
		Non-humic fraction	Humic acid	Fulvic acid		
Medium textured soils : Typic camborthids/caciorthids						
Jodhpur	0.16	62.2	27.8	9.3	2.99	5.1
Pal	0.16	58.4	29.6	12.0	2.46	2.8
Bhopalgarh	0.08	35.0	35.0	30.0	1.16	3.5
Jayal	0.14	66.5	14.6	18.9	0.79	4.5
Katoti	0.13	69.8	7.3	22.9	0.32	4.7
Panchroli	0.29	79.4	13.4	7.2	1.85	3.9
Parbatsar	0.16	43.5	48.4	8.1	5.94	4.5
Bilu	0.30	70.8	14.6	14.6	1.00	4.6
Fine textured soils : Typic camborthids/calciorthids						
Pipad	0.18	64.8	30.3	4.9	6.09	5.3
Silgaon	0.38	82.5	12.9	4.6	2.82	4.6
Khajwan	0.39	76.0	20.5	3.5	5.95	4.6
Gajsinghpura	0.31	68.1	23.1	8.8	2.62	4.0
Asop	0.19	67.3	20.4	12.3	1.65	4.2
Dengiabas	0.29	67.9	21.3	10.8	1.97	4.7
Merta	0.31	67.4	23.6	8.6	2.75	4.2
Pali	0.48	68.7	25.0	6.3	4.00	5.0

Clay and silt were positively related with organic carbon content ($r=0.619, 0.863, P=0.01$). Major part of this organic carbon was present in non humic form, with slightly higher values in dune, interdune and sandy plain soils (65-88%). These values are comparable with the results of Joshi (1981) who also observed that in

Entisol of Rajasthan 35.3 to 85.5% of organic carbon was associated with non humic fraction.

Organic carbon associated with humic acid in coarse textured soils ranged from 3.2 to 17.9% with higher (26.3% and 32.7%) values in the soils of Masitawali and Molasar series. This fraction was in higher ranges (7.3 to 48.4%) in medium and fine textured soils. Though different soil attributes did not show significant correlation with carbon associated with humic acid, there was slight increase with increase in the silt + clay. Multiple regression analysis (Table 3) did not reveal significant influence of soil attributes on the content of humic acid and these together accounted for 16.5% variability.

Table 3. Multiple regression analysis relating humus attributes with soil characteristics

Dependant variables	Intercept (a)	Coefficients for independant variables					R ²
		Clay	Silt	CaCO ₃	Org. carbon	pH	
Humic acid carbon	-12.93	0.924	-0.346	-1.92	23.6	2.73	0.165
Fulvic acid carbon	49.95	0.237	0.045	-0.126	-39.7	-4.09	0.261
HA carbon/Fa carbon	-6.05	0.083	-0.026	-0.330	8.17	0.79	0.259
E ₄ /E ₆ ratio	5.75	0.012	0.063	-0.137	-4.76	-0.09	0.140

Equation of the type $Y = a + b x_1 + c x_2 + d x_3$

Organic carbon associated with fulvic acid showed wide variations (3.1 to 30% of organic carbon) in different soils. Negative correlation of silt and organic carbon ($r = -0.324, -0.404, P = .05$) with this fraction of humus suggested that soils comparatively low in silt and organic carbon are dominated by fulvic acid. Multiple regression did not reveal significant influence of any soil parameter and these together accounted for only 26.07% variability in the carbon associated with fulvic acid.

In coarse textured soils the ratio of humic acid to fulvic carbon was low and in most situations less than unity indicating preponderance of fulvic acid fraction. In medium and fine textured soils the ratio of humic to fulvic acid carbon was generally in higher range (1.00-6.09). Humic acid to fulvic acid carbon ratio was positively related with silt and organic carbon ($r = 0.348, 0.438$) but multiple regression analysis did not reveal significant influence of any of the soil attributes. Combined effect of soil attributes accounted for 25.88% variability in the ratio.

Organic matter fraction of coarse textured dune, interdune and sandy plain soils was dominated by the fulvic acid and in the medium and fine textured alluvial soils by the humic acid fraction. Laura (1973) for Delhi soils and Joshi and Ghonsikar (1979) for some Rajasthan soils also observed that humic acid carbon was associated with clay fraction.

Optical density ratio (E₄/E₆) indicated the proportion of aromatic to aliphatic part in the structure of humus molecule. Kononova (1966) suggested that E₄/E₆ ratio

between 3 to 5 indicated well aromatised, condensed nuclei in humus molecules. In present study this ratio for humic acids varied from 3.5 to 6.4 for dune, interdune and sandy plains soils and from 2.8 to 5.3 for medium and fine textured soils. The ratio also did not show significant correlation with the soil attributes. Different soil parameters were not seen to have significant influence on the optical density ratio and these together accounted for only 14.02% variability. The narrow ranges in the E_4/E_6 ratio of humic acids are comparable to those reported by Schnitzer and Khan (1972), Adityachaudhury and Saha (1973) and Joshi (1981) which suggested that the structural pattern of the humic acids obtained from different soils was similar.

Thus in arid soils the composition of humus is influenced by the soil attributes but nature of humic acid is not much different.

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