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Organic Constituents in Soils

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INTRODUCTION

Energy for microorganisms responsible for decomposition is provided by the breakdown of organic materials on and in the soil. Depending on the degree of decomposition, the material can be classified into humic and nonhumic fractions. As the material becomes more weathered and decomposed, it becomes more resistant and less energy is available. In desert soils, the amount of carbon which represents potential energy in the various fractions of soil organic matter is not known. Therefore, the purpose of this investigation is to provide soil organic matter fractionation data that would be useful in development and validation of a decomposition model for desert soils.

OBJECTIVES

1. To determine amount of organic carbon and nitrogen in litter overlying desert soil profiles.
2. To fractionate soil organic matter extracted from desert soil profiles into humic, nonhumic, humin, humic acid, and fulvic acid fractions and determine organic carbon and nitrogen in each fraction.

METHODS

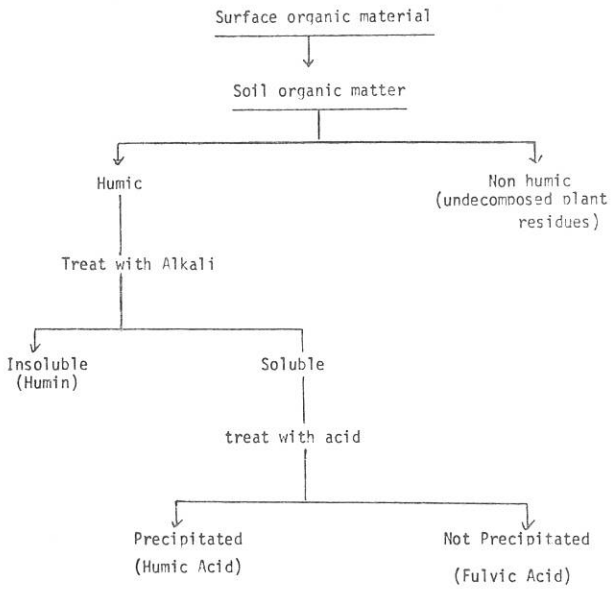
Three replicates of surface organic material overlying Sonoita sandy loam profiles (DSCODE A3UTH08) were collected. The surface material consisted of grass and debris under mesquite canopies.

Sampling sites were located at the Santa Rita Validation Site. The surface organic material was dried at 105 C for 24 hr and the dry matter per m^2 recorded. Organic materials were saved for C and N analyses. A barren Sonoita sandy loam site was selected and soil samples were collected from the 0 to 5-, 5 to 15- and 15 to 30-cm depths at all three sites (i.e., barren grass and mesquite). Soil samples were air dried, crushed and passed through a 2-mm sieve and saved for organic matter fractionation.

Standard organic matter fractionation procedures (Stevenson, 1965) were followed. The soil was passed through a 0 to 25-mm sieve and checked for the presence of $CaCO_3$ with dilute HCl. Free $CaCO_3$ was not present in the samples. One kg of the soil was placed in a 20 l polyethylene carboy and 10 l of 0.5 N NaOH were added. The carboy was shaken intermittently for 24 hr on a reciprocating shaker. After extraction, the supernatant was separated from the residue by centrifugation at 2000 rpm. The residue (humin) was lyophilized, passed through a 2-mm sieve and saved for organic C and N analyses. The supernatant was acidified with 6 N HCl to pH 2.0 and allowed to settle for 24 hr at room temperature. The supernatant (fulvic acid) was collected by centrifugation and evaporated in a water bath to a final volume of 2 l, and saved for organic C and N analyses.

The residue (humic acid) was redissolved in 0.5 N NaOH, and reprecipitated by acidification with HCl to pH 2.0. After precipitation, the humic acid was washed with distilled water until free of chlorides, lyophilyzed and saved for organic C and N analyses.

The organic matter fractionation scheme is as follows:



After fractionation of the organic matter, the dry material (humin and humic acid) was weighed and the yield recorded. Organic C analyses are not complete on the various fractions. At present, we are having difficulty with our carbon apparatus and are not getting complete recovery. The apparatus being used is an N analyzer which has been converted for organic C analyses. Organic N was determined by micro-Kjeldahl digestion using H_2SO_4 and $K_2SO_4 \cdot Cu_2SO_4 \cdot Se$ catalyst mix (100:10:1), steam distillation into H_3BO_3 indicator solution and titrating with 0.01 N $KH(IO_3)_2$.

RESULTS

Estimates of undecomposed organic material on top of Sonoita sandy loam soils in the Santa Rita Validation Site are reported in Table 1. Approximately three times more litter was present under mesquite canopies than was on top of soils covered with grass. The twigs, branches and limbs are much more resistant to decomposition and tend to accumulate with time. The yields reported in Table 1 are only estimates that were obtained at random and do not represent an adequate sampling of the population. However, with a larger yield of organic litter under mesquite, more humic material would be synthesized.

Yields of organic constituents extracted from soils in Santa Rita Validation Site are reported in Table 2. Yield of humic acid was highest in soils that were under canopies of mesquite. In soils covered with grass and mesquite, humic acid decreased with depth. In the surface soils 0.4 to 0.6% of the total weight of soil was in the humic acid fraction and decreased to approximately 0.1% in the 15 to 30-cm depth. The soils contained less than 0.01% nonhumic material. The humin fraction (residual nonsoluble material) comprised 96 to 99% of the total soil weight. Dry weight yields of fulvic acid have not been determined.

Table 1. Organic litter overlying Sonoita sandy loam profiles in the Santa Rita Validation Site

Observation	Grass	Mesquite
	Kilograms/hectare	
1	9.6	25.3
2	16.2	32.7
3	12.3	47.8
Mean	12.7	35.7

Table 2. Yield of organic constituents extracted from Sonoita sandy loam profiles

Type Vegetation	Soil Depth	Organic Fractions			
		Humic			Nonhumic
		Humin	Humic Acid	Fulvic Acid	
		g/kg of soil		Vol./1kg of soil	
Barren	0-5	999.5	1.18	2 liters	trace
	5-15	1000.3	0.94	2 "	"
	15-30	999.8	3.92	2 "	"
Grass	0-5	974.2	4.01	2 "	"
	5-15	986.4	1.71	2 "	"
	15-30	987.4	0.97	2 "	"
Mesquite	0-5	967.7	5.84	2 "	"
	5-15	980.0	0.99	2 "	"
	15-30	-	-	2 "	"

trace = < 0.01% by weight (estimate)

Table 3. Nitrogen content of organic constituents extracted from Sonoita sandy loam profiles

Type Vegetation	Soil Depth (cm)	Organic Fractions		
		Humin	Humic Acid	Fulvic Acid*
		ppm N		
Barren	0-5	137	19900	11.8
	5-15	155	16300	____
	15-30	161	7000	10.4
Grass	0-5	250	21000	16.5
	5-15	167	15500	32.2
	15-30	173	19300	3.1
Mesquite	0-5	____	____	____
	5-15	____	____	____
	15-30	____	____	____

*represents N concentration in 2 l vol./kg of soil (fulvic acid weight has not been determined)

____samples have not been analyzed for N

Nitrogen concentrations in organic constituents extracted from soils are reported in Table 3. The humin (residual) fraction was very low in nitrogen and there were no apparent trends with depth. Nitrogen concentration in the humic acid fraction was highest in the surface and tended to decrease with depth, except in the 15 to 30-cm depth of the grass-covered soil. Perhaps this was the result of a clay accumulation in the lower depth of the profile. Weight of the fulvic acid fraction has not been determined and the concentration of N reported is in the final 2-l volume of extract for 1 kg of soil. However, when yields of fulvic acid are determined it is estimated that N concentration in the fulvic acid fraction will be similar in magnitude to those reported for humic acid.

Organic carbon in the various fractions has not been determined because of mechanical problems with the carbon apparatus.

DISCUSSION

Data showing yield of organic material overlying soils that have had organic matter extracted and fractionated and carbon and nitrogen determined in each of the fractions as influenced by depth should be very useful for verification of decomposition models. The C/N ratios in each of the fractions as well as the humic acid ratios and percentage humic and nonhumic materials in desert soils should provide useful data points.

EXPECTATIONS

Organic nitrogen and carbon analyses for organic constituents fractionated from Sonoran Desert soils are expected to be completed within the next few months.

LITERATURE CITED

STEVENSON, F. J. 1965. Gross chemical fractionation of organic matter. *In* C. A. Black (ed.), Methods of soil analysis. Agronomy 9:1409-1421.