

DISTRIBUTION OF ORGANIC CARBON, NITROGEN, ORGANIC PHOSPHORUS AND ORGANIC SULPHUR IN THE TROPICAL AND SUBTROPICAL FOREST SOILS AND THEIR INTER-RELATIONSHIPS

A major portion of organic matter (OM) is constituted by carbon, nitrogen, phosphorus and sulphur apart from oxygen and hydrogen and the relative proportions of these elements vary depending upon the stage of decomposition. It was reported that 98% of N, 60% of P and 80% of S were associated within organic compounds in soils (Swaby, 1968). Depending upon the environmental conditions, this proportion varied which in turn affected the availability of any one of these nutrients and their ratios provide information on the rate of mineralisation. An attempt was made to determine the organic carbon, N, organic P and organic S and their inter-relationships in the tropical and subtropical forest soils.

A hilly region was selected at Arippa, E₁ (150 m asl) in Trivandrum Forest Division, Chandanathod, E₂ (750 m asl) in Wynad Forest Division and Myladumpara, E₃ (1450 m asl) in Munnar Forest Division. The vegetation types

in E₁ and E₂ are west coast tropical evergreen forest while that at E₃ is southern subtropical broad leaved hill forest. In each hilly region, areas of 250 m x 250 m were demarcated to represent square plots. Five sub-plots of 50 m x 50 m were then laid out in each square plot. One soil pit was taken from every sub-plot at random and samples from 0-15, 15-50 and 50-100 cm depths were collected. The soils were analysed for particle size distribution and pH as per standard procedure (Jackson, 1958). Organic carbon (OC) was estimated by Walkley and Black's method (1934) and total N was determined by the micro-kjeldahl method as given by Jackson (1958). Organic phosphorus was analysed by the procedure described by Hesse (1971) and organic sulphur by the method of Evans and Rost (1945) and Chesnin and Yien (1951). The data were then compared between elevations (Snedecor and Cochran, 1975). The ratios OC:N, OC:P, OC:S, N:P, N:S and P:S have also been worked out.

Table 1. Mean values of soil properties in different layers

Elevation	Depth (cm)	Soil properties							
		Sand, ppm	Silt, ppm	Clay, ppm	pH	OC (%)	Total N, ppm	Org. P, ppm	Org. S, ppm
E ₁	0-15	66.5	10.3	23.2	6.0	1.41	1290	112	225
	15-50	64.5	13.8	21.7	6.1	1.32	935	25	208
	50-100	61.2	13.8	25.0	5.9	1.01	770	24	190
E ₂	0-15	59.5	17.5	23.0	5.7	1.98	1478	165	430
	15-50	58.7	19.6	21.7	5.5	1.45	1159	64	336
	50-100	55.2	17.8	27.0	5.3	1.10	952	26	291
E ₃	0-15	57.7	24.2	18.1	5.3	3.49	2150	251	718
	15-50	53.9	25.4	20.7	4.8	1.62	1380	66	491
	50-100	53.5	25.1	21.4	4.9	1.50	1385	38	358

The soils in E₁ were clay loam while in E₂ and E₃ they were loam and silt loam, respectively (Table 1). The soils were medium acid in E₁, strongly acid in E₂ and very strongly acid in E₃. The OC, N, P and S values increased significantly with elevation (Table 1 and 3).

The organic carbon contents increased with elevation. At higher elevations, the rate of decomposition of OM is slower while the normal addition of litter continues. Thus the condition for building up of higher OM status gained ground and accrued in E₂ and E₃ while

Table 2. Mean values for the ratios in different layers

Elevation	Depth (cm)	Ratios						
		OC:N	OC:P	OC:S	N:P	N:S	P:S	OC:N:P:S
E ₁	0-15	10.93	125.89	62.67	11.52	5.73	0.50	141:12.90:1.12:2.25
	15-50	14.12	528.00	63.46	37.40	4.50	0.12	132:9.35:0.25:2.08
	50-100	13.11	420.00	53.16	32.08	4.05	0.13	101:7.70:0.24:1.90
E ₂	0-15	13.40	120.00	46.05	8.96	3.44	0.38	198:14.78:1.65:4.30
	15-50	12.51	226.56	43.15	18.11	3.45	0.19	145:11.59:0.64:3.36
	50-100	11.55	423.08	37.80	36.62	3.27	0.09	110:9.52:0.26:2.91
E ₃	0-15	16.23	139.04	48.61	8.57	2.99	0.35	349:21.50:2.51:7.18
	15-50	11.74	245.45	32.99	20.91	2.81	0.13	162:13.80:0.66:4.91
	50-100	10.81	394.74	41.90	36.53	3.88	0.11	150:13.88:0.38:3.58

in E₁ the decomposition is rapid when compared with E₂ and E₃ which has a wanner superhumid climate.

Similar to OM, total N also was found to increase with elevation and it showed close correlation with OM. The relatively higher proportions of N at E₂ and E₃ can be adduced to the ability of N forming a variety of compounds in association with other constituent parts of OM, such as fats and waxes, carbohydrates, lignin and various humus fractions.

Organic P was also found to be governed by and associated with elevation. As OM content increases with elevation, the higher organic P at E₂ and E₃ can be traced back to an increase of OM.

The organic S content increased with elevation. The relatively higher content of organic S in E₂ can be partly due to the retention by finer fractions which increase with elevation.

The OC:N ratio of soils in E₁, E₂ and E₃ revealed that this ratio remarkably maintained itself at a constant ratio of 12:1. This is a unique phenomenon in the sense that with large additions of fresh OM which has a widening effect on the OC:N ratio and a rapid rate of decomposition of OM which has a narrowing effect on the ratio, OC:N ratio is observed to be near constant at 12:1.

The ratios of OC:P manifested that in E₁ with low rainfall, the values were found to be lowest. As elevation increased, the P contents also increased. Soil conditions such as aeration, temperature, texture and reaction would affect both OC and organic P. At lower altitude the above effect was found to be more pronounced on OC than on organic P. The higher values for OC:P ratio in E₂ and E₃ could be attributed to higher OM content and relatively lesser proportion of organic P. The microbial activity in E₂ and E₃ was also found to be less as a result of which OC:P ratio widened.

There was a progressive reduction in the OC:S ratio with elevation. It can be inferred that this narrow ratio results from the accumulation of S compounds which form strong linkages with humic substances and therefore resist decomposition. This can also be explained by the fact that under extreme acidic conditions in the higher elevations, the activity of the bacteria, especially S oxidising ones is very much inhibited and this causes greater accumulation of S and consequently lowering of OC:S ratio (Misra *et al.*, 1990). On the contrary, with decrease in acidity, the conditions become favourable for S oxidising bacteria and hence a high ratio at higher pH.

The N:P ratios decreased with elevation. Regular changes in N:P ratio in accordance with OC:P ratio is due to the constancy in the

OC:N ratio indicating that OC and N stabilises themselves and P, the common constituent in OC:P and N:P produces similar variation in N:P ratio as well.

The values of N:S ratio showed that they decreased with elevation. The mean value of N:S ratio, 3.18 showed that the values were close to those reported by Acquaye and Beringer (1989). The low values of N:S ratio in the higher elevations are due to the effect of pH. Under conditions of low pH, S oxidation by microbial activity is suppressed, resulting in

greater accumulation of S and consequently lowering of N:S ratio.

The P:S ratios followed no pattern. The low values were due to the low amounts of P and S and their presence in similar proportion. It has been reported that the association between S and OM was of even higher order than of P and OM (Palaniappan, 1975). This resulted in the above effect. This ratio in E_1 , E_2 and E_3 altered very much and is because of the changes in the individual components in relation to elevation.

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