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Evaluation of interrelationship between organic carbon and available nitrogen in some soils where arecanut is grown in India

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ABSTRACT

The relationship between organic carbon and nitrogen hydrolysable with alkaline permanganate was examined in a few important soils where arecanut is grown in India. A significant positive correlation was obtained between them only when the soil organic carbon exceeded 0·7 per cent. When soils rich in organic matter were finely ground, their carbon values increased.

In mineral soils practically all the nitrogen in the surface layer is bound in organic combination. Therefore a close relationship may exist between the organic carbon of the soils and their available nitrogen contents. The possibility of such a relationship was studied at Vittal in some arecanut-growing soils of India.

MATERIAL AND METHODS

Surface soil samples (0–25 cm) collected from different Arecanut Research Stations were used for the study. The particulars of the soil samples, their location and meteorological data (CARS, Vittal, 1970) are presented in Table 1.

The soil samples were air-dried, pounded gently to break the clods, and passed through a 2-mm sieve before they were analysed. Organic carbon was estimated by the Walkley and Black's rapid-titration procedure (Piper, 1966). The available nitrogen was determined by the alkaline permanganate method (Subbiah and Asija, 1956). To test whether grinding of the soil samples to different grades of fineness would improve the relationship between the organic carbon and the available nitrogen, 2 sets of 13 soil samples each collected from Vittal and

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Table 1. Soils and meteorological data

Location	Soil group	pH	Mean annual rainfall (mm)	Temperature range (°C)
Vittal (South Kanara)	Lateritic	About 5·2	3,199	39–13
Peechi (Trichur)	Alluvial, lateritic	5·6–6·8	2,568	36–15
Palode (Trivandrum)	Lateritic	4·2–5·0	2,451	39–14
Mohitnagar (Jalpaiguri)	Alluvial	4·5–6·0	3,347	39– 4
Kahikuchi (Gauhati)	New alluvium, lateritic	4·4–4·8	1,684	36– 8
Hirehalli (Tumkur)	Clay-loam	About 6·2	1,263	38– 5

having organic carbon values above and below 0·7 per cent were ground in an agate morter to completely pass through 100, 70, 50 and 12 mesh, and their organic carbon contents were estimated.

RESULTS AND DISCUSSION

A significant correlation existed between the organic carbon and the available nitrogen of different soil types only when the soils contained more than 0·7 per cent of organic carbon (Table 2). Therefore soils low to medium in their organic carbon content do not give a good estimate of available nitrogen by the alkaline permanganate method. It is because in these soils the easily hydrolysable portions of soil organic matter are mostly absent. The arecanut-supporting soils are generally found in the hot regions and high-rainfall belts of the country where fast oxidation of the soil organic matter is expected to occur (Jenny, 1930). When the mineralizable portion of the organic matter is lost, what remains is probably composed of resistant materials like hemicelluloses and lignin. The proteinaceous matter constitutes only one-third of the total organic nitrogen of the soil (Fraser, 1955). The remaining two-thirds of the nitrogen is mostly in the lignin and chitin forms, which are resistant to chemical action, and therefore may not be attacked by the alkaline permanganate. In course of time, however, these also would be broken down by the microbial population in the soil. Thus the ability to reproduce the results of available nitrogen by the alkaline permanganate method proposed by Subbiah and Asija seems to be limited only to the soils having high organic matter, which again needs further evaluation for each soil type representing a particular agro-climatic zone. Similar results were obtained by Balasundaram *et al.* (1970) in their investigation on some soils of Tamil Nadu.

In the estimation of organic carbon by the Walkley and Black's rapid-titration method, grinding of soil samples to various degrees of fineness has been proposed (Hanna, 1965; Piper, 1966; Jackson, 1967). The effect of grinding the soil samples to different degrees of fineness on their organic carbon contents was studied. The results (Table 3) indicate that in soils having more than 0·7 per cent organic carbon, grinding to different degrees of fineness has significantly increased the carbon values over the carbon values of soils ground to pass through 12

Table 2. Relationship between organic carbon and available nitrogen in different arecanut-growing soil groups of India

Location	Sample size	Mean value		'r' value
		Organic carbon (%)	Available nitrogen (ppm)	
Vittal	20	0·877	120·3	+0·634**
Vittal	15	1·108	160·0	+0·571*
Vittal	13	0·332	187·5	−0·060 NS
Peechi	15	1·691	182·2	+0·648**
Palode	15	1·273	165·4	+0·916***
Mohitnagar	15	1·466	195·9	+0·950***
Kahikuchi	15	0·424	166·3	+0·452 NS
Hirehalli	15	0·545	257·3	+0·354 NS

*, **, ***Significant at 5, 1 and 0·1 per cent levels of probability respectively; NS, non-significant.

Table 3. Effect of grinding soil samples on the values of organic carbon

Mesh	Mean value of organic carbon (%)	
	>0·7	<0·7
100	0·9262	0·367
70	0·9014	0·341
50	0·9055	0·345
12	0·8328	0·332
	Carbon values >0·7 per cent	Carbon values <0·7 per cent
LSD (P=0·05)	0·061	Non-significant
Conclusion:	100 70 50 12	

mesh. The carbon values of soils low in organic carbon were not affected by grinding. However, grinding of soils to pass through 100 mesh is desirable for the estimation of organic carbon by digestion with chromic acid.

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