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PHYSICAL AND CHEMICAL PROPERTIES OF SOIL IN ALBIZIA FALCATARIA PLANTATIONS

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INTRODUCTION

The genus *Albizia* comprises about 100 species of which *A. falcataria* (L.) Fosberg' (Syn. *A. moluccana* Miq.), native to the eastern islands of the Indonesian archipelago (notably the Moluccas) and the New Guinea (particularly west Irian) is one of the fastest growing trees in the world. It has been introduced to South-east Asia and Philippines during 1870s (Anon, 1979). Plantations of *A. falcataria* have been established in Trichur, Quilon and Trivandrum districts under afforestation programmes during mid 1970s. So far about 1350 ha of plantations have been raised by Kerala Forest Department and Kerala Forest Development Corporation.

Even though a few studies have been conducted on nursery as well as plantation soils elsewhere (Dalmacio, 1987; Liu *et a/,* 1978), no systematic attempt has so far been made to study the soils in *Albizia* plantations in Kerala. Hence the present investigation was initiated for in-depth study of soil physical and chemical properties.

MATERIALS AND METHODS

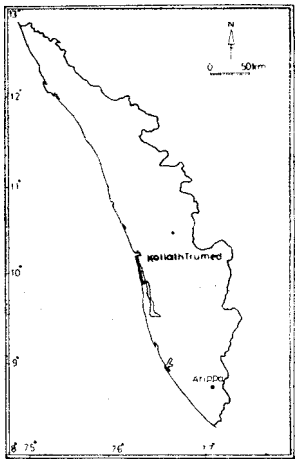

Fig.1 **Location of Study Area**

Two study areas were selected, one at Arippa and the other at Kollathirumed (Fig. 1). The plantation at Arippa belongs to Arippa sub-unit of Kerala Forest Development Corporation while that at Kollathirumed is from Kollathirumed Range of Vazhachal Forest Division. Both the plantations were established in 1977. The terrain at Arippa *is* hilly while at Kollathirumed, it is gently rolling. The areas under plantations are 34 ha at Arippa and 25 ha at Kollathirumed. Leaving about 10 m on the periphery on all sides, 20 ha were demarcated in the two study areas Plots of 10m x 10 m were laid out randomly for every hectare in the two areas. From each plot, one soil pit was taken and samples from 0-20, 20-40 and 40-60 cm layers of soil pits were collected. Also, one core sample was taken from 0-20 cm layer for bulk density determination. Height and girth at breast height (gbh) of 20 trees around each soil pit were also recorded.

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* Recently Neilson eta/ (1983) transferred A. falcataria into the genus Paraserianthes, and accordingly the current name of the species is *Paraserianthes falcataria* (L.) Neilson.

Soil samples were air-dried, passed through 2 mm sieve and gravel content (particles >2 mm) was calculated. Analyses were carried out for particle-size separates (hydrometer method), organic carbon (potassium dichromate-sulphuric acid wet digestion), pH (20:40 soil-water suspension), exchange acidity (0.5N BaOAc extraction), exchangeable bases (0.1N HCI extraction) and total N (Kjeldahl digestion followed by Nessler reagent spectrophotometry). For analysing total P, K, Ca and Mg, the soil samples were digested in tri-acid (9:2:1 $HN0_3$:$H2S0_4$: $HClO_4$). P and K were determined by spectrophotometry using ascorbic acid as the reducing agent (Alexander and Robertson, 1972) and sodium cobaltinitrite, respectively. Ca and Mg were analysed by titration with EDTA. Soil organic matter fractionation (humic acid, fulvic acid and humin) was done with 0.5N NaOH followed by concentrated HCI and ethyl alcohol (Stevenson, 1965). Only surface (0-20 cm) samples were subjected to soil organic matter fractionation.

Mean values of soil properties after giving weightage for gravel in the 0-20, 20-40, 40-60 and 0-60 cm layers at Arippa and Kollathirumed are given in Tables 1 and 2. Mean values of height and gbh of trees around the soil pits are presented in Table 3. Correlation coefficients were computed for measuring the extent of linear association among different soil properties in the two study areas, pooled together in the 0-20 and 0-60 cm layers and also that between height and gbh of trees. In addition, to assess the influence of soil properties in the 0-60cm layer on height and gbh in the two study areas, Multiple Linear Regression (MLR) analysis was carried out.

RESULTS AND DISCUSSION

The results show that at Arippa, in the surface the soils are not compacted. It is also seen that gravel, clay and total Mg increase with depth while sand, silt, organic carbon, pH, exchangeable bases, total N, K and Ca decrease. There is no trend for exchange acidity and total P. The soils, in general, are sandy loam in the surface and loam in deeper layers. They are strongly acidic in all layers. For organic carbon: total N, there is also no trend, but all the ratios are greater than 10. The humic acid: fulvic acid ratio is 0.80.

At Kollathirumed, the surface soils are not compacted. There is no trend for gravel, sand, pH and total P while clay and total Mg rise with depth. in the case of silt and total N, even though there is a decline, they remain the same in the two deeper layers. For organic carbon, exchange acidity, exchangeable bases, total K and Ca, the values diminish with depth. The soils, in general, are loam and strongly acidic in all the layers. As regards organic

Table 1. Mean values of soil properties in the different layers at Arippa

Properties	Layers (cm) 0-20	20-40	40-60	0-60
Bulk density (Mg/cm^3)	1.13	—	—	—
Gravel (g/kg)	237	322	377	312
Sand ,,	600	49%	441	514
Silt ,,	78	70	64	70
Clay ,,	85	110	118	104
Org. carbon ,,	17.58	10.25	6.51	11.45
Soil pH	5.5	5.3	5.2	5.3
Exch. acidity (mg/kg)	84	93	63	75
Exch. bases ,,	118	88	43	83
Total N (g/kg)	1.35	0.60	0.50	0.82
Total P (g/kg)	0.49	0.52	0.23	0.41
Total K ,,	11.81	8.19	6.09	8.70
Total Ca ,,	2.99	2.20	1.52	2.23
Total Mg ,,	1.15	1.33	1.49	1.32
Humic acid (g/kg)	3.51	—	—	—
Fulvic acid ,,	4.38	—	—	—
Humin ,,	5.22	—	—	—
Org. carbon: Total N	13.02	17.08	13.02	13.96
Humic acid: Fulvic acid	0.80	—	—	

n = 20

Table 2. Mean values of soil properties in the different layers at Kollathirumed

Properties	Layers (cm) 0-20	20-40	40-60	0-60
Bulk density (Mg/cm^3)	1.09	—	—	—
Gravel (g/kg)	167	230	221	206
Sand ,,	601	537	540	560
Silt ,,	112	108	108	108
Clay ,,	120	125	131	126
Org. carbon ,,	17.14	12.02	10.48	13.21
Soil pH	5.2	53	5.2	5.2
Exch. acidity (mg/kg)	65	54	49	56
Exch. bases ,,	108	74	56	80
Total N (g/kg)	1.20	0.78	0.78	0.92
Total P ,,	0.62	0.53	0.54	0.56
Total K ,,	8.41	4.49	3.38	5.43
Total Ca ,,	3.62	2.51	2.41	2.68
Total Mg ,,	1.09	1.54	1.90	1.51
Humic acid ,,	3.19	—	—	—
Fulvic acid ,,	3.31	—	—	-
Humin ,,	4.54	—	—	—
Org. carbon: Total N	14.28	15.41	13.40	14.36
Humic acid: Fulvic acid	0.89	—	—	

n = 20

Table 3. Mean values of height and gbh around soil pits at Arippa and Kollathirumed

Soil Pit NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	t5	16	17	18	19	20	OVERALL MEAN
ARIPPA																					
Height' (m)	13.17	13.17	12.20	10.90	10.83	12.53	12.65	11.35	13.25	12.28	13.50	10.45	11.95	11.90	11.65	12.15	12.05	12.47	11.95	12.15	12.13 (± 0.82)
gbh* **(cm)**	70.86	69.43	68.53	69.03	69.37	80.66	85.14	79.79	92.31	76.54	74.14	75.68	73.12	79.37	82.29	74.62	65.90	66.28	71.77	68.36	74.84 (± 6.90)
KOLLATHIRUMED																					
Height* **(m)**	12.47	11.83	13.05	12.60	11.72	11.00	11.20	12.28	11.60	11.40	11.88	41.13	11.57	11.30	12.10	12.75	12.80	13.30	12.84	12.40	12.06 (± 0.68)
gbh* **(cm)**	59.80	49.77	56.68	55.39	57.26	51.23	51.93	63.63	57.03	56.52	52.22	57.56	56.47	63.56	61.36	67 52	59.10	67.49	64.79	62.09	58.82 (± 5.20)

*n = 20; **standard deviations in parentheses.**

carbon : total N, no trend is observed, but all the ratios are greater than 10. The humic acid: fulvic acid ratio is 0.89.

It can be seen from Tables 1 and 2 that bulk density and soil organic matter fractions in the surface, and organic carbon, pH, exchange acidity, exchangeable bases, total N, P,Ca, Mg and organic carbon : total N in the 0-60 cm layer do not vary in the two study areas. As regards sand, silt and clay, they are relatively high while gravel and total K, all in the 0-60 cm layer, are low at Kollathirumed.

The increase in clay contents with depth in the two study areas points to the fact that there is infiltration of finer particles into the deeper layers. The relatively high organic carbon contents in the surface and the strongly acidic conditions could be due to the faster decomposition rate of *Albizia* litter. Since *A/bizia* sp. is a leguminous crop, there will be good amount of atmospheric dinitrogen fixed in the soils by the activity of N-fixing microorganisms. Here this feature is observed mostly in the surface which could be due to the accumulation of feeding roots in this layer. Even though the activity of microorganisms also takes place in deeper layers, it could not be detected by total N values. The organic carbon: total N ratio indicates the humified nature of organic matter in the soils. As the ratios do not vary too much from 10:1. it can be pointed out that the soils are fertile, in general. Moreover the nearing equilibrium stage (0.80 and 0.89) for humic acid: fulvic acid ratio is an indicator of favourable conditions for the growth and proliferation of microorganisms in the soils. It also shows that humus substances decompose to fulvic type in all the samples except one at Kollathirumed where the ratio is less than one.

Intercorrelation among soil properties in the 0-20 cm layer show that bulk density is not correlated significantly with any other soil property. In the 0–60 cm, gravel is negatively correlated with sand, silt, clay, organic carbon, total N, Ca and Mg. Organic carbon shows significant correlation with exchangeable bases and total N. As far as pH is concerned, it shows no correlation with any other property.

Thus it can be seen that in the two study areas, gravel is negatively correlated with most other soil properties. In otherwords, gravel content greatly influences other soil properties. These observations are in agreement with those of Alexander *et a/* (1987). The relationship between organic carbon and total N supports the findings of Foster (1981), Minhas and Bora (1982), and that of organic carbon with exchangeable bases agrees with the results of Muktaanov and Bagautdinov (1982).

Studies on correlation between tree height and gbh show that they are significantly correlated ($r = 0.37$). Further, MLR analysis reveals that tree height and gbh are significantly influenced by soil properties. It is also observed that soil properties account for 46 and 81% variations in height and gbh of trees, respectively, This corroborates the findings of Dalmacio (1987) on *Albizia* and Alexander et al (1987), Buckley (1988) and Chijioke (1988) on other species.

CONCLUSION

Soils in the surface layer of *Albizia* plantations are not compacted. Correlation analysis between soil properties reveals that gravel is negatively correlated with most other soil properties while organic carbon is positively correlated with exchangeable bases and total N. In general, soils under Albizia are fertile and there is sound environment for the growth and proliferation of microorganisms. The humus substances decompose to fulvic type. Tree height and gbh are significantiy influenced by soil properties; 46 and 81% of the variations in height and gbh of trees are attributable to soil properties.

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