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Soil characteristics governing the distribution of rattans in Cachar, Assam, Northeast India

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Abstract: The present paper describes the soil characteristics of five rattan palms namely, *Calamus acanthospathus*, *C. erectus*, *C. flagellum*, *C. mastersianus* and *Daemonorops jenkinsianus* growing on the hill slopes of Cachar district of Assam in Northeast India. The rattans prefer strong to medium acidic soil. There are indications that bulk density and porosity differ in the vicinity of different species. Water holding capacity, pH and conductivity of soil are changed differently by different species. The soil characteristics associated with the different species varied significantly.

Key words: Rattans, multivariate analysis of variance, Northeast India, soil characteristics.

INTRODUCTION

In India, there are about 60 species of rattans under five genera (Renuka, 1995). Rattans comprise important components of the floral diversity of Northeast India, which is one of the major rattan diversity centers of India. Beccari (1908, 1911) reported 20 species and four varieties; Renuka (1996) reported three genera (*Calamus, Daemonorops* and *Plectocomia*) with 16 species and two varieties; Bora *et al.* (2001) reported three genera and 18 species and Sarmah *et al.* (2001), 23 species.

Rattans are also of considerable economic value as non-timber forest produce that are extensively used for making furniture, walking sticks, baskets and other household and ornamental items. Despite having such economic and utilitarian value, rattans are harvested only from their natural stock in the forests or wetlands, and commercial cultivation has not been attempted, particularly in India. Consequently, unsustainable exploitation resulting in shrinkage of natural habitat has led to a rapid decline in

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rattan resources, with several species becoming increasingly rare and on the verge of extinction (Basu, 1985; Sarmah *et al*., 2001). Thus, there is an urgent need for both *in situ* and *ex situ* conservation of rattan species, especially the rare and endemic species like *Calamus floribundus, C. acanthospathus, C. mastersianus, C. gracilis, Plectocomia bractealis* and *P. himalayana*. As most of these species have a patchy distribution even within a given geographical area, it is important to identify the soil conditions governing their occurrence and distribution that in turn would enable us to achieve *ex situ* conservation and commercial farming to reduce the pressure on natural populations. The present study is confined to five species of rattans namely, *C. acanthospathus, C. erectus, C. flagellum, C. mastersianus* and *Daemonorops jenkinsianus*. The study attempts to identify the soil conditions governing the distribution of five species of rattans of South Assam, of which *C. acanthospathus* is known to be an endemic. The only comparable work is that of Goswami *et al*. (2000) who worked on the soil characteristics of some rattans of Arunachal Pradesh.

MATERIALS AND METHODS

Study Area

The five species of rattans occur in a degraded forest in the Assam University Campus at Dargakona (24° 41′ 36.5″ N and 92° 45′ 2.3″ E altitude 59 ± 10 m asl), dominated by tree species like *Artocarpus chaplasha, Bombax ceiba, Ficus benghalensis* and a fairly dense secondary growth of *Melocanna baccifera, Dillenia pentagyna* and others. The area is traversed by several small water channels, and has several ephemeral water bodies. Of the five species, *D. jenkinsianus* and *C. mastersianus* grow on the relatively higher dry hill slopes and ridges, while *C. flagellum* and *C. erectus* occur on the lower slopes and at the base of the hills, in relatively moist ground. In contrast, *C. acanthospathus*, only a single clump of which was recorded in the area, grows in a hollow at the base of hillocks, surrounded by wet, marshy ground.

Since, the rattans are growing on the hill slopes, soil samples were collected from the upper and lower slopes at 1 m distance from plant base. Samples were collected from three different depths of 0-10, 10-20, and 20-30 cm. Three replicate samples were collected from each spot. The pH and conductivity were determined with a pH meter (Systronics) and a conductivity meter (WTW), respectively. Bulk density, porosity, water holding capacity and organic carbon were measured using standard methods (Brady, 1995), while soil texture was analysed with a sieve set as well as by the gravimetric method with a soil hydrometer (Michael, 1984). Sodium and potassium contents were estimated with a flame photometer (Systronics). The data were analyzed using SPSS 11.0.

Table 1. Rattan species and mean values of soil parameters at different depths

Soil parameter	Species	Depth of soil						Overall	
		0-10 cm		10-20 cm		20-30 cm			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Density (g cm^{-3})	*D. jenkinsianus*	1.23	0.28	1.52	0.17	1.23	0.27	1.33	0.25
	C. mastersianus	1.07	0.09	1.21	0.08	1.05	0.60	1.11	0.31
	C. flagellum	0.76	0.30	1.18	0.40	1.20	0.63	1.05	0.46
	C. acanthospathus	0.59	0.20	0.95	0.27	1.13	0.32	0.89	0.33
	C. erectus	0.92	0.08	1.17	0.18	0.92	0.13	1.00	0.17
	Overall	0.92	0.29	1.21	0.28	1.11	0.39	1.08	0.34
Porosity (%)	*D. jenkinsianus*	53.66	10.22	42.83	6.21	53.78	10.02	50.09	9.51
	C. mastersianus	59.57	3.23	54.40	2.81	60.30	22.62	58.09	11.84
	C. flagellum	71.49	11.46	55.54	14.85	55.00	23.94	60.67	17.24
	C. acanthospathus	77.89	7.58	64.39	10.21	57.45	12.08	66.58	12.57
	C. erectus	65.17	3.05	56.00	6.54	65.21	5.03	62.13	6.36
	Overall	65.56	11.08	54.63	10.49	58.35	14.55	59.51	12.75
Water holding capacity (%)	*D. jenkinsianus*	38.82	4.14	36.63	1.60	37.50	2.49	37.65	2.72
	C. mastersianus	49.53	4.37	47.96	2.23	44.37	6.84	47.29	4.79
	C. flagellum	56.68	0.27	38.45	1.98	40.45	6.88	45.19	9.37
	C. acanthospathus	68.81	5.48	50.69	1.37	54.24	5.21	57.91	9.16
	C. erectus	75.44	4.88	72.42	1.39	63.82	4.47	70.56	6.22
	Overall	57.86	14.06	49.23	13.31	48.08	11.03	51.72	13.32
pH	*D. jenkinsianus*	4.71	0.25	5.09	0.19	5.22	0.14	5.01	0.29
	C. mastersianus	6.67	0.11	6.72	0.04	6.76	0.01	6.72	0.07
	C. flagellum	5.51	0.36	6.15	0.10	6.02	0.23	5.89	0.36
	C. acanthospathus	4.78	0.07	5.00	0.14	5.13	0.01	4.97	0.17
	C. erectus	6.44	0.16	6.69	0.16	6.63	0.15	6.59	0.18
	Overall	5.62	0.86	5.93	0.79	5.95	0.72	5.83	0.79
Conductivity (mS)	*D. jenkinsianus*	0.87	0.15	0.67	0.25	0.54	0.17	0.69	0.22
	C. mastersianus	1.02	0.02	0.85	0.21	1.11	0.83	0.99	0.44
	C. flagellum	2.57	0.57	1.64	0.29	1.59	0.69	1.94	0.67
	C. acanthospathus	2.02	0.56	0.86	0.46	0.65	0.22	1.18	0.74
	C. erectus	3.23	1.53	2.90	0.36	1.75	0.31	2.63	1.05
	Overall	1.94	1.14	1.38	0.90	1.13	0.67	1.48	0.96
C (%)	*D. jenkinsianus*	1.43	0.17	1.34	0.43	1.12	0.11	1.30	0.27
	C. mastersianus	1.85	0.03	1.30	0.12	1.01	0.11	1.39	0.38
	C. flagellum	1.55	0.54	1.23	0.31	1.18	0.38	1.32	0.41
	C. acanthospathus	1.15	0.14	0.47	0.26	0.22	0.17	0.61	0.45
	C. erectus	1.24	0.11	0.92	0.09	0.84	0.13	1.00	0.21
	Overall	1.44	0.34	1.05	0.41	0.87	0.40	1.12	0.45
K (ppm)	*D. jenkinsianus*	0.80	0.35	0.73	0.42	0.27	0.12	0.60	0.37
	C. mastersianus	0.33	0.12	0.27	0.12	0.60	0.53	0.40	0.32
	C. flagellum	3.27	1.62	2.00	1.40	2.33	1.27	2.53	1.37
	C. acanthospathus	1.00	0.53	0.47	0.31	0.33	0.23	0.60	0.45
	C. erectus	5.13	1.62	4.27	1.29	5.33	2.77	4.91	1.80
	Overall	2.11	2.09	1.55	1.71	1.77	2.32	1.81	2.02
Na (ppm)	*D. jenkinsianus*	6.40	1.40	6.40	2.71	5.53	2.23	6.11	1.94
	C. mastersianus	2.53	0.12	2.13	0.61	2.73	1.86	2.47	1.01
	C. flagellum	8.40	5.26	4.20	1.00	4.67	0.81	5.76	3.36
	C. acanthospathus	7.07	2.30	5.80	2.43	6.73	3.74	6.53	2.57
	C. erectus	9.73	1.47	6.40	1.31	6.73	0.61	7.62	1.90
	Overall	6.83	3.41	4.99	2.28	5.28	2.40	5.70	2.80

RESULTS AND DISCUSSION

Table 1 illustrates the mean values of soil parameters of five species of rattans in three different depths (0-10, 10-20 and 20-30 cm). The soil bulk density is the lowest (0.89 g cm^{-3}) in *C. acanthospathus* and highest (1.33 g cm^{-3}) in *D. jenkinsianus*. The lowest porosity (50.09%) occurs in *D. jenkinsianus* and highest (66.58%) in *C. acanthospathus*. The lowest carbon content (0.61%) occurs in *C. acanthospathus* and highest (1.39%) in *C. mastersianus*. These indicate that *C. acanthospathus* prefers light, friable with high organic content soil than *D. jenkinsianus*. The water holding capacity is the highest (70.56%) in *C. erectus* and lowest (37.65%) in *D. jenkinsianus*. The pH also varies among the five species. The lowest pH (4.97) occurs in *C. acanthospathus* and highest (6.72) in *C. mastersianus*, which indicate that rattans prefer strong to medium acidic soil. Similar observations were also reported in different

Table 2. MANOVA for soil characteristics (all depths together)

Effect		Value	F	df	Error df	Sig.
Species	Pillai's Trace	3.875	12.414	40.000	16.000	.000
	Wilks' Lambda	.000	46.697	40.000	5.647	.000
	Hotelling's Trace	.	.	40.000	.	.
	Roy's Largest Root	20335.497	8134.199	10.000	4.000	.000

Table 3a. MANOVA for soil characteristics at depth 0-10 cm

Effect		Value	F	df	Error df	Sig.
Species	Pillai's Trace	3.785	13.200	32.000	24.000	.000
	Wilks' Lambda	.000	13.309	32.000	12.659	.000
	Hotelling's Trace	160.404	7.519	32.000	6.000	.009
	Roy's Largest Root	106.848	80.136	8.000	6.000	.000

Table 3b. MANOVA for soil characterisites at depth 10-20 cm

Effect		Value	F	df	Error df	Sig.
Species	Pillai's Trace	3.833	17.172	32.000	24.000	.000
	Wilks' Lambda	.000	41.579	32.000	12.659	.000
	Hotelling's Trace	734.553	34.432	32.000	6.000	.000
	Roy's Largest Root	554.229	415.672	8.000	6.000	.000

Table 3c. MANOVA for soil characteristics at depth 20-30 cm

Effect		Value	F	df	Error df	Sig.
Species	Pillai's Trace	3.378	4.076	32.000	24.000	.000
	Wilks' Lambda	.000	6.729	32.000	12.659	.000
	Hotelling's Trace	115.728	5.425	32.000	6.000	.021
	Roy's Largest Root	71.302	53.476	8.000	6.000	.000

species of rattans from Arunachal Pradesh (Goswami *et al.*, 2000). The conductivity ranges between 0.69 mS (*D. jenkinsianus*) and 2.63 mS (*C. erectus*). The potassium content varies considerably among different species, which ranges between 0.4 ppm (*C. mastersianus*) and 4.91 ppm (*C. erectus*). On the other hand, sodium varies between 2.47 ppm (*C. mastersianus*) and 7.62 ppm (*C. erectus*).

Statistical analysis and interpretation

Soil properties were measured for five species, at three locations and three depths. With limited number of observations, 3-way MANOVA could not be carried out. First, it was checked whether presence of plants affected the soil properties or not and it was found to be statistically insignificant. Next, a one-way MANOVA was carried out considering the species of rattans as a factor and all soil parameters at all depths as effects. The result is shown in Table 2. Since all four statistical tests are highly significant ($P < 0.01$), it is concluded that different species grow in soils which differ in their properties. It is further confirmed that soil characteristics differ at different depths as can be seen in Tables 3a to 3c.

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