

Comparative Growth of *Avicennia officinalis* L., *A. marina* (Forsk.) Vierh. and *A. alba* Bl. in the Eastern Shorelines of Bangladesh

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Abstract

A comparative growth study of *Avicennia officinalis*, *A. alba* and *A. marina* along the eastern shorelines of Bangladesh showed an average annual diameter increments of 0.99, 0.90 and 0.97 cm respectively for plantations varying 11 and 16 years age. Average annual height increments of these species were 0.31, 0.37 and 0.31 m respectively. Annual volume production per tree was 0.025, 0.025 and 0.024 m³ respectively. All the individuals of *Avicennia* species had a promising growth and the plantation was successful along the eastern coast of the country. On the contrary much human interference was observed on the established plantations. The growth of *Avicennia officinalis*, *A. alba* and *A. marina* showed that plantation areas and newly accreted lands may be suitable for planting with *Avicennia* species.

সারসংক্ষেপ

বাংলাদেশের পূর্বাঞ্চলীয় উপকূলে বনায়নকৃত তিনটি বাইন বৃক্ষ প্রজাতি (*Avicennia officinalis*, *A. alba* and *A. marina*) ১১-১৬ বছর বয়সী বৃক্ষের তুলনামূলক বর্ধনের উপর একটি গবেষণা কর্মকাণ্ড পরিচালনা করা হয়, যার গড় বাৎসরিক বেড় বৃদ্ধির হার যথাক্রমে ০.৯৯, ০.৯০ এবং ০.৯৭ সে.মি. পাওয়া গিয়াছে। উক্ত বৃক্ষ প্রজাতিগুলোর গড় বাৎসরিক বৃদ্ধির হার যথাক্রমে ০.৩১, ০.৩৭ ও ০.৩১ মি. এবং ভলিউম উৎপাদন ছিল ০.০২৫, ০.০২৫ ও ০.০২৪ ঘনমিটার। উক্ত বাইন বৃক্ষ প্রজাতির বৃদ্ধি বনায়নের জন্য উপযোগী। বিভিন্ন ধরনের প্রতিকূলতা সত্ত্বেও জেগে ওঠা চরাঞ্চলে উক্ত বাইন বৃক্ষ প্রজাতিগুলো সফল বনায়ন করা যেতে পারে।

Key words: *Avicennia* spp., biotic interference, diameter, height, increment, volume

Introduction

Mangrove plantation in the inter-tidal shorelines of Bangladesh was initiated in 1966, and almost all the commercial species available in the natural mangrove forests were tried in the plantation programs.

Considering the initial success, planting was under taken mainly with *Sonneratia apetala* and *Avicennia officinalis* which comprised about 92.7 and 4.7 percent of the total plantation programs (Siddiqi 2001).

Sonneratia apetala proved promising in all along the shorelines. Mean annual height (m) and diameter (cm) increments of *S. apetala* were 0.96 m and 1.10 cm respectively for 10-11 years old plantations (Siddiqi and Khan 1990).

Avicennia officinalis grows well in the eastern part of the coastline, i.e., coastal areas of Chittagong and Cox's Bazar. *Avicennia* has three species namely, *Avicennia officinalis* L., *A. marina* (Forsk.) Vierh. and *A. alba* Bl. found in the natural mangrove forests of the Sundarbans and the Chakoria Sundarbans of Bangladesh. The growth of these species also varies from area to area but remained unrecorded for a particular site or in general. Survival success and growth increment of these species have not been determined for this region. Thus, the study was carried out in Cox's Bazar coastal areas along the eastern shorelines of Bangladesh to obtain a clear idea about growth performance of the existing three species of *Avicennia*.

Materials and Methods

Young plantations of age vary from 11 and 16 years old *Avicennia* were selected in the coast of Cox's Bazar region (latitude 20°30' and 20° N; longitude 90°45' and 92°15' E). Initial information about the different species of *Avicennia* was collected from the plantation journals and information from forest personnel and confirmed by subsequent field visit. In all 36 plots were undertaken during 2006. Data collecting spots and planting areas were selected following in initial survey along the shorelines. *Avicennia* trees were demarcated at a random at each plot and plot size was 5 m x 5 m. Data on height and diameter of trees were recorded using hypsometer and diameter tape respectively. Volume was

estimated from volume equations (Drigo *et al.* 1987; Latif 1994). Ten trees of each species (*A. officinalis*, *A. marina* and *A. alba*) were measured in a plot. Trees for measurement were identified at six plots in different locations in the inter-tidal areas (Fig. 1). Thus, a total of 180 trees for each species of *Avicennia* were measured. Overall condition of the stand, survival, site condition and biotic interference were also noted. Soil textures of the sites were cited from literature and salinity was measured using refractometer. Duration and frequency of tidal inundation were noted through direct observations and discussion with the fishermen.

Study sites

In comparison to the western and middle portion of Bangladesh coastline, soil texture in the eastern part was coarser (Khan *et al.* 1998). Soil texture in the visited plots was sandy, loam or with relatively greater proportion of fine particles. Water salinity varied between monsoon (June-August) and dry season (March-May) because of fresh water discharge in the rainy season from the mainland to sea. In the monsoon water salinity was recorded in the range of 8-10 ppt, while in the dry season it was 25-32 ppt. However, at plot no. 6 salinity in the dry season was 10-15 ppt due to perennial flow of water through Moheshkhali and Kutubdia canal (Table 1).

Duration, frequency and tidal inundation varied greatly (Table 1). Some plots were raised which received tidal water for a short time, usually 4-5 hours in a day. Except plot 1, inundation was in the range of 15-20 hours a day in wet season. The plots were disturbed by human interference and illicit felling of planted trees was common.

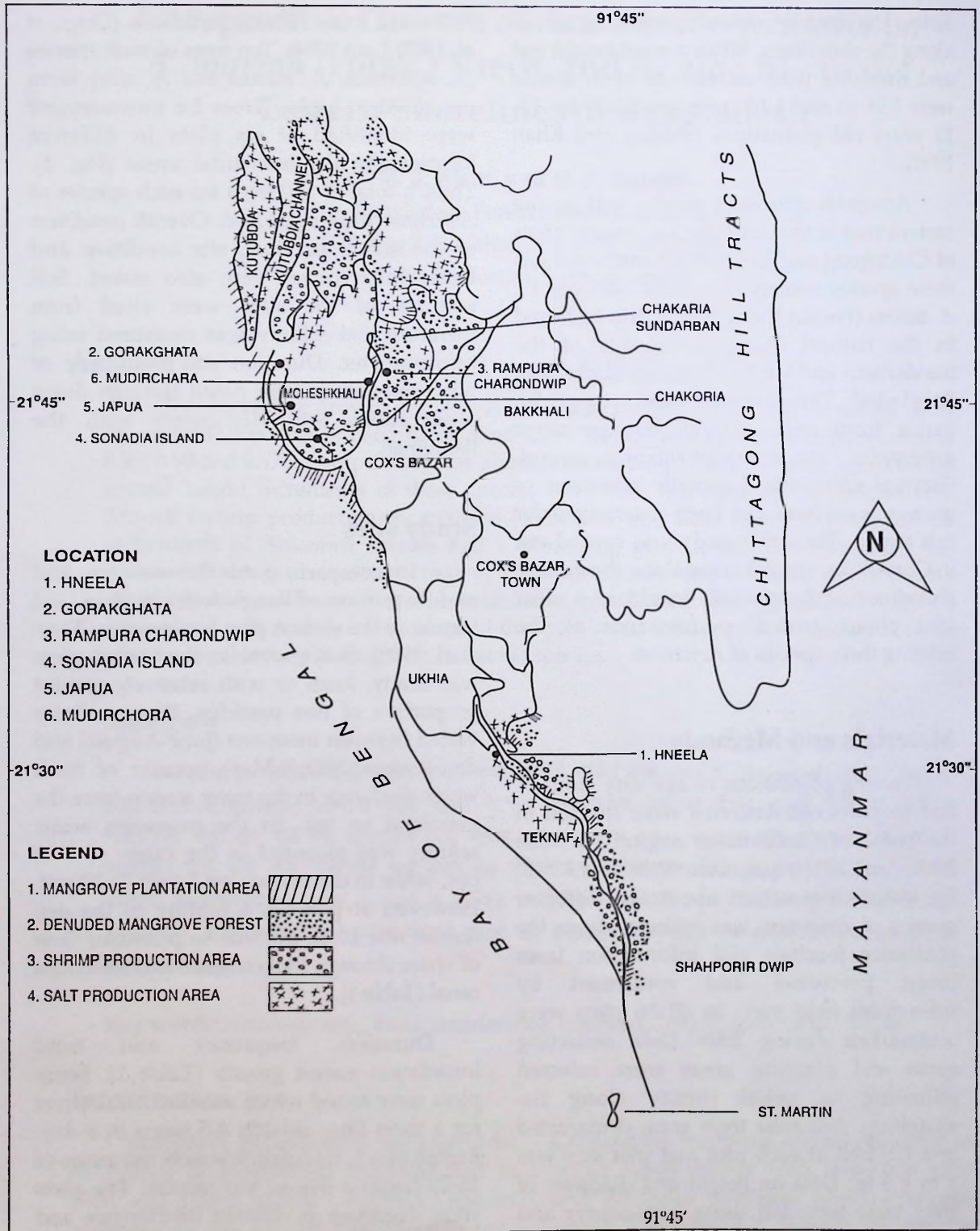


Figure 1. Map of Cox's Bazar district showing the location of data collection plots in the coastline

Table 1. Tidal inundation, water salinity and soil texture at different sites of Cox's Bazar shoreline.

Location of plot	Duration of tidal inundation (hrs/day)		Water salinity (ppt)		Soil texture	Remarks
	Wet season	Dry season	Wet season	Dry season		
1. Hneela, Teknaf Forest Range, Teknaf.	4-5	3-4	8-10	26-30	Loamy	Biotic interference like shrimp farming, salt production and illicit felling. Dense plantation also exists.
2. Gorakghata, Gorakghata Forest Range, Moheshkhali.	15-18	4-5	12-18	25-32	Sandy loam	Illicit felling and salt production. Plantation developed but dense plantation exists.
3. Rampura, Charondwip Forest Range, Chakoria.	15-18	4-5	12-15	25-30	Silty clay loam	Shrimp farming and salt production. Plantation developed.
4. Sonadia, Gorakghata Forest Range, Moheshkhali.	18-22	8-12	10-15	25-30	Sandy clay	Illicit felling by local people for shrimp farming and salt production.
5. Japua, Gorakghata Forest Range, Moheshkhali.	18-20	2-3	18-15	25-30	Sandy	Greater emphasis on salt production and depletion of planted trees.
6. Mudirchora, Gorakghata Forest Range, Moheshkhali.	16-18	3-4	10-15	10-12	Sandy	Less disturbed area with dense plantation.

Results and Discussion

Diameter (cm), height (m) and volume increment ($\text{m}^3 \text{h}^{-1} \text{yr}^{-1}$)

Average height of 11-16 years old *A. officinalis* was 3.99 m and the yearly mean height increment was 0.31 m. Mean height/diameter and mean yearly increment of *A. alba* were 4.68 m and 0.37 m, while *A. marina* was 3.88 and 0.33 m (Table 2). As regards diameter, yearly mean increments for

A. officinalis, *A. alba* and *A. marina* were 0.99, 0.90 and 0.97 cm respectively (Table 2). It indicates that the relationship between increasing height with diameter was lacking. Height increment was the highest for *A. alba* followed by *A. officinalis* and *A. marina* and diameter increment was the highest for *A. officinalis* followed by *A. marina* and *A. alba* (Table 2). Siddiqi and Khan (1990) mentioned

Table 2. Mean height and dbh increments and total tree volume of *Avicennia* spp. in different locations of Cox's Bazar shoreline.

Location	Planting year	<i>A. officinalis</i>				<i>A. alba</i>				<i>A. marina</i>			
		Height (m) ±SE	dbh (cm) ±SE	Yearly mean		Height (m) ±SE	dbh (cm) ±SE	Yearly mean		Height (m) ±SE	dbh (cm) ±SE	Yearly mean	
				Height (m)	dbh (cm)			Height (m)	dbh (cm)			Height (m)	dbh (cm)
1. Hneela, Teknaf Forest Range, Teknaf.	1992 (12 yrs)	4.70 ±0.42	13.92 ±1.00	0.39	1.16	5.06 ±0.68	12.61 ±0.34	0.42	1.05	1.03 ±0.54	11.94 ±0.75	0.33	1.07
2. Gorakghata, Gorakghata Forest Range, Moheshkhali.	1995 (11 yrs)	3.61 ±0.42	10.67 ±0.34	0.32	0.37	4.91 ±0.28	10.51 ±0.26	0.44	0.95	3.78 ±0.26	10.57 0.60	0.34	0.96
3. Rampura, Charondwip Forest Range, Chakoria.	1991 (11 yrs)	4.10 ±0.30	13.38 ±1.11	0.31	1.02	4.76 ±0.41	10.83 ±0.31	0.36	0.83	3.99 ±0.33	12.99 ±0.38	0.30	0.99
4. Sonadia, Gorakghata Forest Range, Moheshkhali.	1993 (13 yrs)	3.01 ±0.41	12.80 ±0.49	0.30	0.98	3.83 ±0.38	10.70 ±0.45	0.29	0.82	3.94 ±0.39	11.6 ±0.34	0.30	0.89
5. Japua, Gorakghata Forest Range, Moheshkhali.	1992 (12 yrs)	3.41 ±0.29	11.53 ±0.50	0.28	0.96	4.42 ±0.31	10.99 ±0.40	0.36	0.91	3.63 ±0.39	10.92 ±0.47	0.30	0.91
6. Mudirchora, Gorakghata Forest Range, Moheshkhali.	1990 (16 yrs)	4.26 ±0.52	12.61 ±0.49	0.26	0.78	5.12 ±0.57	12.29 ±0.26	0.32	0.76	3.91 ±0.39	14.97 ±0.85	0.24	0.93
Mean height/diameter	-	3.99	12.48	0.31	0.88	4.68	11.32	0.37	0.89	3.88	12.18	0.30	0.78
Mean yearly increment	-	0.31	0.99	-	-	0.37	0.90	-	-	0.33	0.97	-	-
Mean volume/tree (m ³)	-		0.025				0.025				0.024		

height increment for young plantation of *A. officinalis* (0.34–0.66 m) and for *A. marina* (0.36–0.53 m) for the coastal belt of Bangladesh. The diameter increment for *A. officinalis* was 0.46–1.24 cm and 0.46–1.24 cm for *A. marina*.

The growth of *Avicennia* species varies greatly from place to place. With regard to volume, volume increment of the three species was almost same, e.g. volume per tree for *A. officinalis*, *A. alba* and *A. marina* was 0.025 m³, 0.025 m³ and 0.024 m³ respectively (Table 2). However, Drigo *et al.* (1987) reported that the mean annual increment (MAI) for *Avicennia* species in the coastal of Chittagong south and north was 1.3–1.9 and 6.9 m³/ha/year respectively.

Different species have different silviculture requirements and Siddiqi (2001) mentioned that salinity and inundation of forest floor, rate of sedimentation and soil texture influenced the growth of mangrove species.

In comparison to other plantation and natural mangrove species, the growth of *Avicennia* spp. appears to be higher except for *Sonneratia apetala*. For young plantations, annual diameter increment of *S. apetala*, the principal planting species, is in the range of 0.78–1.23 cm (Siddiqi and Khan 1990). *Heritiera fomes* and *Excoecaria agallocha* are the dominant species in the Sundarbans natural forest. Annual diameter increment of *H. fomes* was 0.13 cm in less saline, 0.10 cm in moderately saline and 0.06 cm in strongly

saline zone. However, in a research plot annual diameter increment for seven years old plantations was in the range of 0.30-0.50 cm. With regard to *E. agallocha*, annual diameter increment for plantations ranges between 0.50 and 0.93 cm (Siddiqi and Khan 1990). However, in the natural forest of Sundarbans, the increment rates for *E. agallocha* were 0.19, 0.09 and 0.05 cm in less saline, moderately saline and strongly saline zones (Siddiqi 2001).

Conclusion

The growth performance of *Avicennia officinalis*, *A. alba* and *A. marina* was satisfactory in comparison with other available mangrove species. Along the

eastern shorelines, the initial plantation success was good. However, the plantation became subject to tremendous human interference in the form of shrimp farm expansion, salt production practices, illicit tree cutting and cattle grazing. Considering protective role of coastal plantation against cyclone, storm surge and Tsunami, the degraded areas or newly accreted land in the eastern shoreline may be reforested or afforested with *Avicennia* species. There is no significant difference in volume production among three *Avicennia* species. Survival of the three species was not reported earlier in the eastern coastline. Since there is no remarkable difference in volume production among the species, it may be recommended to plant all the three species to conserve species diversity.

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