UNDERPLANTING – A WAY TO MAINTAIN SUSTAINABLE COASTAL PLANTATION IN BANGLADESH

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Abstract

A study was undertaken in 1990 at Char Kashem, Rangabali under Patuakhali Coastal Afforestation Division in Bangladesh to find out the suitable mangrove species for underplanting in the established coastal plantation. Nine major mangrove species namely *Ceriops decandra, Aegiceras corniculatum, Phoenix paludosa, Excoecaria agallocha, Heritiera fomes, Lumnitzera racemosa, Xxlocarpus mekongensis, Cynometra ramiflora and Bruguiera sexangula* were tried. The highest survivability was found in *A. corniculatum* and *P. paludosa* (87.67%) and lowest in *L. racemosa* (61.33%). The maximum and minimum diameter after 11 years of planting were found in *E. agallocha* (10.15 ± 0.73cm) and in *L. racemosa* (2.20 ± 0.04cm) respectively. The maximum and minimum heights were found in *E. agallocha* (10.30 ± 0.36m) and in *L. racemosa* (3.60 ± 0.05m) respectively. *C. decandra, A. corniculatum, P. paludosa, E. agallocha, H. fomes, X. mekongensis* and *C. ramiflora* were found promising (survivability more than 80%). Among these species *E. agallocha, H. fomes* and *X. mekongensis* are tree species and others are shrub or small tree or thorney palm. Considering the types of plants, survival rate, diameter and height growth, *E. agallocha, H. fomes* and *X. mekongensis* are found highly promising for underplanting in the western coastal belt of Bangladesh.

Introduction

There is 710 km coastline in the south of Bangladesh from west to east (Saenger and Siddiqi 1993). The coastal areas of Bangladesh experience cyclone damage almost every year. During the period 1960 to 1970, eight severe cyclones were recorded. The Forest Department of Bangladesh initiated mangrove afforestation in 1966. Bangladesh is one of the leading countries where man made afforestation programme with mangrove species is widely practised (Nandy *et al*., 2001). The primary objective was to save lives and properties of the coastal dwellers (Das and Siddiqi 1985). The secondary objectives of the coastal plantation were to (i) reclamation and stabilization of newly accreted land and acceleration of further accretion, (ii) production of timber and fuel wood and (iii) creation of employment opportunity in coastal areas (Saenger 1987). The project gained a momentum with the involvement of Word Bank in 1975 (Imam 1982). A total of 1,48,526 hectare of mangrove plantation has been established up to 2001 under different afforestation programme. Initially most of the commercially importanat mangrove species were tried for the massive planting programme (Chowdhury 1971, Alim 1974, Siddiqi and Khan 1990). But no systematic studies were carried out for selectiong mangrove species (Siddiqi *et al.,* 1992). However *S. apetala* and *A. officinalis* proved to be most successful by their higher survival and growth performance (Siddiqi *et al*., 1992). *S. apetala* constitute 67% of the planted species (Drigo *et al*., 1987). *A. officinalis* is the principal species in the eastern part and forms 68% of the plantation of Chittagong coastal areas. But the established mangrove plantation along the coastal belt and offshore islands are encountered with a number of serious problems like site unsuitability, lack of regeneration for second rotation crop and insect infestation (Serajuddoula *et al*., 1995). In the coastal belt due to non availability of seed source and behaviour of the tidal current natural succession cannot occur in order to ensure sustainable yield and continuity of the forest.

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On the other hands stem borer infestation in *S. apetala* plantation has caused a serious threat for maintenance of sustainable plantation (Saenger and Siddiqi 1993). In 1988 a mean of 52% trees was affected due to stem borer *Zeuzera conferatae* (Cossidae; Lepideptera). Generally intensity of infestation is higher in monospecific crop. Mixed plantation may reduce the affect of stem borer infestation (Siddiqi *et al*., 1992). A positive result is yet to achieve (Anon 1991). Dalmacio *et al*. (1991) pointed out that natural regeneration was sparse or absent. It may also be mentioned that unlike the pioneer species, such species can flourish under an optimal light condition (Troup 1921, Sasaki and Mori 1981, Hutchings and Saenger 1987), inundation level and on relative matured soil. In order to maintain a continuous forest cover in the coastal areas and to enhance the production of coastal forest while *S. apetala* is maturing, underplanting is highly desirable. So, in 1990 a study was undertaken to conduct underplanting trial in different parts of the coastal belt of Bangladesh to observe the feasibility of raising other preferably valuable species in the existing *S. apetala* plantation. In the present study *Ceriops decandra, Aegiceras corniculatum, Phoenix paludosa, Excoecaria agallocha, Heritiera fomes, Lumnitzera racemosa, Xylocarpus mekongensis, Cynometra ramiflora and Bruguiera sexangula* were tried.

Materials and Methods

Location of the experiment

The experiment was conducted in the western coastal belt at Char Kashem under Patuakhali Coastal Afforestaton Division, Bangladesh in 1990. General characteristics of the soils of the western coastal belt are shown in Table 1.

Nursery raising

The seeds or propagules were collected from Sundarbans and nursery in polybags was raised. Nursery was maintained by weeding and watering.

Species tried

Nine commercially important mangrove species were tried to underplant (Table 2) for observing their survival and growth performance.

Site preparation

The experimental site was prepared by weeding and jungle cutting.

Experimental Design

The experiment was laid out in Randomized Complete Block Design (RCBD) with 9 treatments and 3 replications. Replication is defined here as block.

Experimental layouts

Experimental lay out is shown in Table 3.

Method of Planting

Ten months old seedlings were planted in 10 years old thinned S*. apetala* plantations. In each plot 100 seedlings (10 × 10) were planted by removing polybag at 1.2m × 1.2m spacing.

Maintenance of experimental plots

The experimental plots were maintain by weeding, jungle cutting and protecting from biotic interferences.

Data collection

Data on survival and height were recorded at every three month interval up to three years and six month interval up to next two years. After five years data on survival, diameter at breast height (1.30m) and height were measured once in a year. The final data were collected in June, 2005.

Results and Discussion

Data on survival, diameter at breast height and height were collected lastly in June, 2005. Data were compiled and statisticaly analyzed and shown in table 4, 5 & 6. After 11 years of plantation highest survivability was found in *A. corniculatum, P. paludosa* (87.67%) and lowest in *L. racemosa* (61.33%) (Table4).

Survivability of *A. corniculatum* and *P. paludosa* > *E. agallocha*> *X. mekongensis*> *H. fomes*> *C. ramiflora* >*C. decandra*> *B. sexangula*> *L. racemosa*. The maximum and minimum diameter were found in *E. agallocha* (10.15 ± 0.73cm) and *L. racemosa* (2.20 ± 0.04cm) respectively (Table 5). Diameter growth of *E. agallocha*> *X. mekongensis*> *H. fomes*> *P. paludosa* > *A. corniculatum*> *C. ramiflora* > *B. sexangula* > *C. decandra*>*L. racemosa.* Maximum and minimum heights were found in *E. agallocha* (10.30 ± 0.36m) and *L. racemosa* (3.60 ± 0.05m) respectively (Table 6). Height growth of *E. agallocha*> *H. fomes*> *X. mekongensis*> *A. corniculatum*> *C. ramiflora*> *C. decandra*> *P. paludosa*> *B. sexangula* > *L. racemosa.* Considering the survivability *C. decandra, A. corniculatum, P. paludosa, E. agallocha, H. fomes, X. mekongensis* and *C. ramiflora* were found mostly promising (survivability more than 80%) for planting under the canopy of previously established *S. apetala* plantation. On the other hands considering the types of plants (Tree/small tree/ shrub/thorny shrub), survivability, diameter and height growth *E. agallocha, H. fomes, X. mekongensis* were found highly promising species for underplanting.

According to Siddiqi *et al*. (1992) *E. agallocha, X. mekongensis* and *H. fomes* appear promising after one year of plantation in the western coastal belt like Patuakhali and Bhola (Table 7). But in the eastern coastal belt the prospect of underplanting is uncertain (Siddiqi *et al*.,1992) (Table 7).

Table 1. General characteristic of the soils of the western shoreline

S. No.	Soil characteristics	Western shoreline (Patuakhali, Bhola)
1	Texure	Silt loam to Silty Clay- loam
2	pH (H_2O)	7.5-8.1
3	Ece(dSm^{-1})	Wet season 1.5-2.5; Dry season 3.0-7.5
4	Salinity	Slight to Moderate
5	Organic carbon (%)	0.5 to1.8
6	Total nitrogen (%)	0.05 to 0.15
7	Available –N (ppm)	65-125
8	Available –P (ppm)	15-20
9	Available –K (ppm)	200-300
10	Available –S (ppm)	150-250

Source: Hasan (1987); Chowdhury and Chowdhury (1994); Karim (1994); Khan *et al.* (1998).

Table 2. Name of the species tried for underplanting

Treatm. No.	Local Name	Scientific Name	Family	Types of Plants
T1	Goran	*Ceriops decandra*	Rhizophoraceae	Shrub or small tree
T2	Khalshi	*Aegiceras corniculatum*	Myrsinaceae	Shrub or small tree
T3	Hantal	*Phoenix paludosa*	Palmae	Thorny Palm
T4	Gewa	*Excoecaria agallocha*	Euphorbiaceae	Tree
T5	Sundri	*Heritiera fomes*	Sterculiaceae	Tree
T6	Kirpa	*Lumnitzera racemosa*	Combrataceae	Small tree
T7	Passur	*Xylocarpus mekongensis*	Meliaceae	Tree
T8	Shingra	*Cynometra ramiflora*	Leguminosae	Shrub or small tree
T9	Kankra	*Bruguiera sexangula*	Rhizophoraceae	Tree

Source: Siddiqi (2001)

Table 3. Experimental layouts

Plot/ Block	Plot No-1	Plot No-2	Plot No-3	Plot No-4	Plot No-5	Plot No-6	Plot No-7	Plot No-8	Plot No-9
Block-1	T5	T9	T3	T6	T2	T7	T1	T8	T4
Block-1	T3	T8	T5	T9	T1	T4	T6	T7	T2
Block-1	T2	T7	T6	T4	T5	T9	T3	T1	T8

Table 4. Mean survivability (%) of different mangrove species after 11 years of planting under the canopy of S*. apetala* plantation

Treatm.	Name of species	Survivability (%)			Mean ± sd
		Rep-1	Rep-2	Rep-3	
T1	*Ceriops decandra*	89	66	86	80.33 ± 12.50
T2	*Aegiceras corniculatum*	97	81	85	87.67 ± 8.33
T3	*Phoenix paludosa*	85	92	86	87.67 ± 3.79
T4	*Excoecaria agallocha*	82	85	87	84.67 ± 2.52
T5	*Heritiera fomes*	81	87	80	82.67 ± 3.79
T6	*Lumnitzera racemosa*	65	62	57	61.33 ± 4.04
T7	*Xylocarpus mekongensis*	79	90	84	84.33 ± 5.51
T8	*Cynometra ramiflora*	84	82	77	81.00 ± 3.61
T9	*Bruguiera sexangula*	65	62	60	62.33 ± 2.52

Table 5. Mean diameter (cm) growth of different species after 11 years of planting under the canopy of S*. apetala* plantation

Treatm.	Name of species	Average diameter (cm)			Mean of Average± sd	Mean annual increment
		Rep-1	Rep-2	Rep-3		
T1	*Ceriops decandra*	3.69	4.14	3.00	3.61 ± 0.57	0.33
T2	*Aegiceras corniculatum*	4.68	4.49	5.63	4.93 ± 0.61	0.45
T3	*Phoenix paludosa*	5.41	5.54	5.85	5.60 ± 0.23	0.51
T4	*Excoecaria agallocha*	10.85	9.39	10.21	10.15 ± 0.73	0.92
T5	*Heritiera fomes*	6.05	4.30	6.90	5.75 ±1.33	0.52
T6	*Lumnitzera racemosa*	2.17	2.25	2.18	2.20 ± 0.04	0.20
T7	*Xylocarpus mekongensis*	7.19	7.45	5.34	6.66 ± 1.15	0.61
T8	*Cynometra ramiflora*	6.11	3.31	5.25	4.89 ± 1.43	0.44
T9	*Bruguiera sexangula*	5.79	3.85	4.67	4.77 ± 0.97	0.43

Table 6. Mean height growth (m) of different species after 11 years of planting under the canopy of S*. apetala* plantation

Treatm.	Name of species	Average height (m)			Mean of Average ± sd	Mean annual increment
		Rep-1	Rep-2	Rep-3		
T1	*Ceriops decandra*	4.80	5.15	6.90	5.62 ± 1.13	0.51
T2	*Aegiceras corniculatum*	5.15	5.35	6.95	5.82 ± 0.99	0.53
T3	*Phoenix paludosa*	5.25	4.90	5.85	5.33 ± 0.48	0.48
T4	*Excoecaria agallocha*	10.40	9.90	10.60	10.30 ± 0.36	0.94
T5	*Heritiera fomes*	7.20	6.20	11.40	8.27 ± 2.76	0.75
T6	*Lumnitzera racemosa*	3.55	3.65	3.60	3.60 ± 0.05	0.33
T7	*Xylocarpus mekongensis*	6.77	8.55	6.70	7.34 ± 1.05	0.67
T8	*Cynometra ramiflora*	6.00	4.75	6.60	5.78 ± 0.94	0.53
T9	*Bruguiera sexangula*	5.30	5.05	4.33	4.89 ± 0.50	0.44

Table 7. Performance of mangrove species in the underplanting trials after one year planting in the established *Sonnratia apetala* plantations

Species	Survival (%) after one year			Annual height (cm) increment		
	West coast		East coast	West coast		East coast
	Patuakhali	Bhola	Chittagong	Patuakhali	Bhola	Chittagong
H. fomes	73	97	64	36	09	17
X. mekongensis	73	99	79	57	37	16
E. agallocha	99	100	48	97	73	03
C. decandra	71	97	61	10	66	12
B. sexangula	95	93	44	15	09	06
A. corniculatum	97	97	86	70	24	14
P. paludosa	96	100	40	32	57	10
C. ramiflora	48	93	-	48	37	-
L. racemosa	81	-	-	81	-	-
X. granatum	64	97	-	64	86	-

- Not Planted. Source: Siddiqi *et al*. (1992).

Conclusions

For sustainable management of the man made coastal plantation in Bangladesh, it is very much necessary to maintain the continuous production of forest resources. There is no alternative of underplanting in the established coastal plantation for maintaining continuous production of forest resources. Underplanting with *H. fomes E. agallocha* and *X. mekongensis* in the established coastal plantation is likely to offer sustainable yield and continuity of permanent forest cover in the western coastal areas of Bangladesh.

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