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Growth performance of some woody medicinal tree species in the western coastal belt of Bangladesh

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ABSTRACT

Two trials were conducted to assess the growth performance of thirteen woody medicinal tree species planted in the year 2015 and 2018 at two different sites respectively named Baherchar and Haridrakhali of Rangabali Upazila under Patuakhali district (western coastal belt). Data on survival, height, diameter at breast height (dbh), collar diameter, stem length and number of branches was recorded from 3.5 years and 1.5 years old two trial plantations. At Baherchar site highest survival was recorded for Arjun (90%) followed by Khoier (81%), Kadam (73%), Kalojam (70%), Bohera (60%) and Shimul (60%). The highest height was recorded for Kadam (10.09m) followed by Khoier (6.72m), Gora neem (5.54m), Shimul (4.15), Arjun (3.55m) and Horitaki (3.31m). The greater dbh was also recorded for Kadam (8.57cm). The highest stem length was found in Kadam (6.89m). The greater number of branches was found in Gora neem (5). At Horidrakhali site the result revealed that the highest survival was recorded for Arjun (100%), Katbadam (100%), Pitraj (100%) and Punial (100%). The highest height was recorded in Khoier (2.97m). The highest collar diameter was observed in Satiyan (3.81cm). Considering the survival, height and diameter growth, Khoier, Arjun, Gora neem, Satiyan, Shimul, Punial, Pitraj, Horitaki, Sonalu, Katbadam, Kadam and Kalojam were found promising and suitable for planting in the raised lands of the western coastal belt of Bangladesh.

Key Words: *Medicinal tree, Plantation, Survival, Growth performance, Rangabali and Coastal belt*

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I. Introduction

Plants that possess therapeutic properties or exert beneficial pharmacological effects on the human body are generally designated as medicinal plants (Ghani, 2003). Various medicinal plants were traditionally used as early as 5,000 to 4,000 B. C. in China and 1,600 B. C. by Assyrians, Babylonians, Hebrews and Egyptians (Hill, 1952). As a result, various woody medicinal species have been used as major sources of medicine throughout human history in the traditional healthcare system. Accordingly, on a global basis, approximately 80% of the world population is believed to rely to some extent on medicinal plants for their medicinal applications (Cotton, 1996). Recently, the World Health

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Organization (WHO) estimated that 80% of people worldwide trust herbal medicines partially for their primary health care. Modern pharmacopeia still contains at least 25% of drugs derived from plants and many others which are synthetic analogues built on prototype compounds isolated from plants (Silva, 1997). From the socio-economic point of view, medicine is an important commodity in our life, often considered as a lifesaving item. About 90% of the total medicines come from plant kingdom (Rahman, 2003). In Germany, about 600-700 plant–based medicines are available and are prescribed by some 70% of German physicians. There has been dramatic increase in the demand for medicinal plants for use in traditional medicine in both developing and developed countries (Lee et al., 2008).

The rural people of Bangladesh have traditionally depended on folk medicinal healers for treatment of their ailments (Hossan et al., 2010). In Bangladesh, the use of traditional medicine is widespread among most of the ethnic people and village dwellers (Motaleb et al., 2011). Even today, use of medicinal plants in primary health care systems is very important especially in remote rural communities and poorly accessible areas. The World Health Organization (WHO) enlisted some of 21,000 medicinal plant species all over the world (Penso, 1980). Bangladesh is a country of fertile deltaic land. The country is enriched with the diversity of flora of medicinal plants scattered throughout the forests, crop fields, roadsides, home gardens and wastelands (Motaleb et al., 2011). They play a significant role in providing primary health care services to the rural people of the country. Most of the identified plant species were virtually left on growing in the natural habitats in forests, villages, rural households which contributed directly or indirectly in the rural economy of Bangladesh through providing forest products, fruits, fodder and fuel. In addition, it also supplies raw materials for medicinal purposes (Bashu and Manna, 1997). About 5700 species of higher plants have been recorded (Mondol, 1990). Among these about 500 plant species including trees, herbs and shrubs in Bangladesh are used as medicinal plants because of their therapeutic properties (Ghani, 2000). Yusuf et al. (2009) reported that 747 plant species in Bangladesh have therapeutic properties. There are some medicinal plants having wood values providing a variety of forest produces, as well as a range of ecosystem services (Piotto et al. 2004; Motaleb et al., 2011). Day by day many native medicinal plant species have become scarce and threatened largely due to population, overexploitation, widespread habitat degradation and loss and failure of natural regeneration. Due to shifting (Jhum) cultivation, encroachment, population pressure, settlement and urbanization, wrong management practices, overexploitation of forest resources, deforestation, salinity increase and change in land use patterns, many medicinal plants have reached the fate of extinction or severe genetic loss (Ghani, 2003; Motaleb et al., 2011). Xiao (1991) stated that destruction of forests, overgrazing of remote and marginal lands, expansion of industries and urbanization as well as excessive harvesting of wild rare and endangered plant species, biological diversity of medicinal plants has been reduced day by day. In addition, the country will face serious consequences of bio-diversity loss from the global climatic change. The loss of habitats and overharvesting has threatened the availability of the medicinal plants. On the other hand in the coastal region of Bangladesh, the population of medicinal tree species is very poor.

The coastal belt of Bangladesh extends over 710 kilometers long along the Bay of Bengal with numerous chars and islands. The coastal regions of Bangladesh cover an area of about 47,201 km^2 extending the Bay of Bengal (Islam et al., 2013). This region now covers 19 coastal districts facing, or in proximity to the Bay of Bengal (Islam et al., 2006). The Bangladesh Forest Department has raised 1,92,395 ha mangrove, 8690 ha non-mangrove and 12,127 km strip plantations in the coastal area until 2013 (Hasan, 2013). Among the mangrove plantations, *Sonneratia apetala* (keora) and *Avicennia officinalis* (baen) are the major planting species in the newly accreted lands (Siddiqi, 2001). Among the non-mangrove *Samanea saman* (rain tree), *Acacia nilotica* (babla), *Casuarina equisetifolia* (jhao), *Swietenia macrophylla* (mehogoni) and *Acacia auriculiformis* (akashmoni) are the major planting species in the raised lands of the coastal areas. In the western coastal belt population of woody medicinal tree species is very poor. Islam et al. (2013) surveyed 150 coastal homesteads of the western coastal belt under Borguna, Patuakhali and Bhola district. They found the highest number of woody medicinal tree species of *Terminalia catappa* (6.23 nos per homestead) and lowest were found in *Neolamarckia cadamba* and *Terminalia belerica* (0.01nos per homestead) and there were no *Alstonia scholaris* species. The plantations of woody medicinal species may also act as a greenbelt component in the coastal belt of Bangladesh. Cultivation of woody medicinal trees in the coastal

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homesteads, embankment and raised lands in these areas can directly contribute to the economic improvement of the coastal peoples as well as the establishment of a sound healthy environment. So, immediate attention is most needed for woody medicinal tree species planting in the coastal areas of Bangladesh. There is no systematic plantation or study that has not yet been carried out for introducing woody medicinal tree species in the western coastal areas. Therefore, elimination trials with 13 medicinal tree species were carried out to find out the suitable species for the raised coastal lands.

II. Materials and Methods

Plantation Trial Unit Division of Bangladesh Forest Research Institute (BFRI) carried out experiments on some woody medicinal tree species at two sites of the western coastal belt of Bangladesh. Experimental plots were established at Baherchar and Horidrakhali of Rangabali upazila under Patuakhali district in June, 2015 and June, 2018 respectively. The experiment sites lie between latitude 21^0 59'193N and longitude 90^0 28'482 E. and latitude 21^0 59'272 N and longitude 90^0 28'496E (GPS= 3m) respectively. The amount of annual rainfall 2377mm and mean annual temperature is minimum 12.2^0c and maximum 25.03^0c (Patukhali District statistics, 2011). Soil p^H was found 5.5 at Baherchar and 6.5 at Horidrakhali. Soil is alluvium, non-calcareous and salinity is varying between 1.1 - 9.9dS/m (SRDI, 2010).

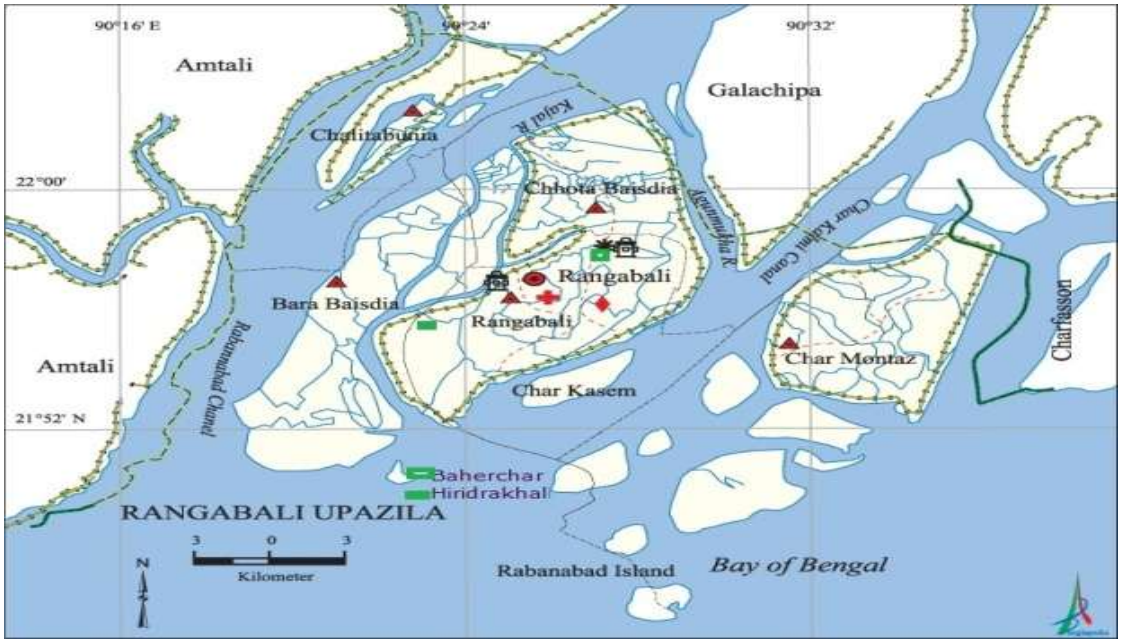

Figure 01. Map showing experimental sites Baherchar and Horidrakhali of Rangabali Upazila, Patuakhali. (Source: Google map).

Ten important woody medicinal tree species namely, *Sygygium cumini* (Kalojam), *Melia azedarach* (gora neem), *Terminalia arjuna* (arjun), *Terminalia belerica* (bohera), *Terminalia catappa* (katbadam), *Bombax ceiba* (shimul), *Acacia catechu* (khoier), *Neolamarckia cadamba* (kadam), *Cassia fistula* (sonalu), *Terminalia chebula* (horitoki) were planted at Baher char. At Horidrakhali twelve woody medicinal tree species were planted including additional three species like *Aphanamixis polystachya* (pitraj), *Alstonia scholaris* (Satiyan), *Calophyllum inophyllum* (punial) with above mentioned ten species except *Sygygium cumini*. The seeds were collected from phenotypically superior trees. Seeds were sown in polybags of size 25cm ×15cm and filled with powdered loamy soil and cowdung at 5:1 ratio. Seedlings were raised in the Rangabali nursery and kept for 6-10 months. The experiment was laid out in Randomized Complete Block Design with three replications. In each plot (9 x 9) 81 seedlings were planted at 1.5m × 1.5m spacing. Six to ten months old seedlings were planted in the field. Planting was done in June by digging holes. The data concerning survival, height, collar diameter, dbh and number of branches were collected in October 2019 from two experimental plantations (Figure 02 and Figure 03). Survival, height, diameter at breast height (dbh), collar diameter (at an early stage) and braches (at an early stage) are the main characteristics for observing the growth performance of the tree species. The greater survival, height, dbh, collar diameter and braches indicate

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better growth performance. Data were computed and analyzed using Excel spreadsheet and Minitab statistical package.

Figure 02. 3.5 years old *Terminalia arjuna* (arjun) Plantation at Baherchar, Rangabali, Patuakhali.

Figure 03. 1.5 year old *Aphanamixis polystachya* (pitraj) plantation at Horidrakhali, Rangabali, Patuakhali.

Table 01. List of woody medicinal plant species and their medicinal uses tried in the western coastal belt of Bangladesh

Sl No.	Vernacular name	Scientific Name	Family	Medicinal value	Plant part used
1	Kalojam	*Syzygium cumini*	Myrtaceae	Cecoction of bark is used as a gargle and mouthwash, Extracts of leaves possess antibacterial activity, bark and leaves are astringent and cure dysentery, fruits are nourishing, stomachic, carminative and diuretic. Seeds reduce blood sugar levels.	leaf, bark, fruit, seed.
2	Gora neem/ Bokain	*Melia azedarach*	Meliaceae	It is anthelmintic, antilithic and diuretic. It is used in relieving nervous headaches and skin diseases. Seeds oil is used in leprosy and scrofula.	Leaf, bark, fruit
3	Aurjun	*Terminalia arjuna*	Combretaceae	Used in hypertension, heart disease, blood pressure, cholesterol, dysentery, piles, leucorrhoea etc.	Bark
4	Bohera	*Terminalia belerica*	Combretaceae	Anal fissure, dysentery, hyper acidity, constipation, hypertension, jaundice, rheumatism and loss of appetite.	Fruit and Seed
5	Katbadam	*Terminalia catappa*	Combretaceae	Used in skin diseases, headache, abdominal pain, indigestion, spleen fever and loss of appetite.	Bark, leaf, seed
6	Shimul	*Bombax ceiba*	Bombacaceae	Fever, small pox, rheumatism, leprosy, bleeding gums, enlarged spleen, leucorrhoea, diarrhea, dysentery, boils, acne, pimples, cough. Roots have stimulant, tonic and aphrodisiac properties and are given in impotency.	Bark, young root.
7	Khoier	*Acacia catechu*	Mimosaceae	Bark is anti-dysentric, anthelmintic and antipyretic. The dried extract is used in leucoderma, leprosy, eczema, iching,	Bark, wood extract

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Sl No.	Vernacular name	Scientific Name	Family	Medicinal value	Plant part used
				hemorrhages, ulcer, boils, inflammations, bronchitis, asthma, colic pain, piles, leucorrhoea and diarrhea.	
8	Kadam	*Neolamarckia cadamba*	Rubiaceae	Bark is used as astringent, febrifuge and tonic, in the treatment of snakebite.	Leaf, bark
9	Sonalu	*Cassia fistula*	Caesalpiniaceae	Used in chest and heart diseases, ringworm fungal infection, rheumatism, snakebite, jaundice, diabetes and skin diseases.	Leaf, flower, fruit, root.
10	Horitoki	*Terminalia chebula*	Combretaceae	Fruitsare given internally in the treatment of indigestion, constipation, dysentery, jaundice, piles, and painful menstration, fevers, cough, asthma, enlarged spleen, liver rheumatism and urinary diseases.	Fruit.
11	Pitraz/ Royna	*Aphanamixis polystachya*	Meliaceae	Bark is used in spleen and liver diseases, tumors and abdominal complaints. Seed oil is used in rheumatism and dressing for wounds.	Stem, bark, seed
12	Satiyan	*Alstonia Scholaris*	Apocynaceae	Bark is used in skin diseases and as an alternative, tonic, febrifuge, antiperriodic, astringent drug. Sap, gum and roots are used in tumours and cancer, Crude extract of the bark is hypotensive and anti-cancer. Bark is a valuable remedy for chronic diarrhoea and dysentery, it is also used in snakebite. Latex used in ulcer.	Bark, latex, gum, sap, root,
13	Punial	*Calophyllum inophyllum*	Calophyllaceae	Calanolide and related coumarin derivatives have antiviral activity and are especially suitable for the treatment of retroviral diseases, such as AIDS. Leaves are used in the treatment of chicken pox, skin inflammations and scabies. Seeds and seed oil are useful in rheumatism, gonorrhea, gleets and scabies. Decoction of bark is applied in orchitis and indolent ulcers.	

Sources: Ghani, 2003; Motaleb et al., 2011; Hossain, 2015.

III. Results and Discussion

The growth performance of ten woody medicinal tree species planted in June, 2015 (3.5 years old) at Baherchar site and twelve species planted in June, 2018 (1.5 years old) at Horidrakhali site of Rangabali coastal area are presented in Table 02 and Table 03. At Baherchar of Rangabali island, the result showed that the significantly highest survival was recorded for *T. arjuna* (90%), followed by *Acacia catechu* (81%) *Neolamarckia cadamba* (73%) *Syzygium cumini* (70%) *T. belerica* (60%) and *Bombax ceiba* (60%). The lowest survival was found in *Cassia fistula* (31%). The significantly highest height was recorded for *Neolamarckia cadamba* (10.09m) followed by *Acacia catechu* (6.72m), *Melia azedarach* (5.54m), *Bombax ceiba* (4.15m), *Terminalia arjuna* (3.55m) and *Terminalia chebula* (3.31m). The lowest height was found in *T. catappa* (1.97m). The greater dbh was also recorded for *Neolamarckia cadamba* (8.57cm) followed by *B. ceiba* (6.22cm), *A. catechu* (5.08cm), *T. arjuna* (4.42cm), *Melia azedarach* (3.81cm) and *Syzygium cumini* (3.57cm). The lowest dbh was found in *Terminalia catappa* (2.41cm). The highest stem length was found in *Neolamarckia cadamba* (6.89m) and lowest was in *T. catappa* (1.34m). The greater number of branches was found in *Melia azedarach* (5) followed by *Terminalia arjun (4), Acacia catechu* (4), *Terminalia chebula* (4) and the lowest was found in *Syzygium cumini* (2) and *Cassia fistula* (2).

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Table 02. Growth performance of ten medicinal tree species planted in June, 2015 (3.5 years old) at Baherchar of Rangabali upazila, Patuakhali (Western coastal belt)

Vernacular name	Scientific name	Survival %	Height (m)	DBH (cm)	Stem length (m)	No. of branch
Kalojam	*Syzygium cumini*	70.00b	2.68cd	3.57c	1.39cd	2.00cd
Gora neem/ Bokain	*Melia azedarach*	35.00d	5.54bc	3.81c	2.26cd	5.00ab
Aurjun	*Terminalia arjuna*	90.00a	3.55de	4.42c	1.87cd	4.00cd
Bohera	*Terminalia belerica*	60.00bc	2.83cd	2.50cd	3.27c	3.00cd
Katbadam	*Terminalia catappa*	44.00c	1.97d	2.41cd	1.34d	3.00cd
Shimul	*Bombax ceiba*	60.00bc	4.15c	6.22b	2.62cd	3.00cd
Khoier	*Acacia catechu*	81.00a	6.72b	5.08bc	3.98bc	4.00b
Kadam	*Neolamarckia cadamba*	73.00b	10.09a	8.57a	6.89a	4.00b
Sonalu	*Cassia fistula*	31.00d	2.85cd	2.90cd	1.86cd	2.00cd
Horitoki	*Terminalia chebula*	56.00c	3.31cd	2.89cd	1.93cd	4.00b

Means followed by the same letter (s) in the same column do not differ significantly at 5% level.

At Horidrakhali site the result showed that the significantly highest survival was recorded for *Terminalia arjuna* (100%), *Terminalia catappa* (100%), *Aphanamixis polystachya* (100%), *Calophyllum inophyllum* (100%) followed by *Alstonia scholaris* (98%), *Bombax ceiba* (97%), *Acacia catechu* (95%), *Cassia fistula* (94%), *Melia azedarach* (92%), *Terminalia belerica* (92%), *Terminalia chebula* (92%). The lowest survival was found in *Neolamarckia cadamba* (23%). The highest height growth was recorded in *Acacia catechu* (2.97m) followed by *Cassia fistula* (2.22m), *Melia azedarach* (2.20m), *Bombax ceiba* (1.98m), *Alstonia scholaris* (1.62m) and *Terminalia arjuna* (1.56m). The lowest height growth was found in *Terminalia catappa* (0.94m). The highest collar diameter was observed in *Alstonias cholaris* (3.81cm) followed by *Bombax ceiba* (3.45cm), *Acacia catechu* (3.14cm), *Melia azedarach* (2.90cm) and the lowest was found in *Aphanamixis polystachya* (2.03cm).

Table 03. Growth performance of twelve medicinal tree species planted in June, 2018 (1.5 years old) at Horidrakhali of Rangabali upazila, Patuakhali (Western coastal belt)

Vernacular name	Scientific name	Survival %	Height (m)	Collar Dia (cm)	No. of branch
Gora neem/ Bokain	*Melia azedarach*	92.00b	2.20bc	2.90bc	3b
Aurjun	*Terminalia arjuna*	100.00a	1.56bc	2.34cd	2bc
Bohera	*Terminalia belerica*	92.00b	1.01cd	2.30cd	2c
Katbadam	*Terminalia catappa*	100.00a	0.94cd	2.32cd	2c
Shimul	*Bombax ceiba*	97.00b	1.98cd	3.45cd	2c
Khoier	*Acacia catechu*	95.00b	2.97bc	3.14bc	4a
Kadam	*Neolamarckia cadamba*	23.00c	1.09cd	2.45cd	3b
Sonalu	*Cassia fistula*	94.00b	2.22cd	2.18d	1cd
Horitoki	*Terminalia chebula*	92.00b	1.08cd	2.19d	2c
Pitraz/ Royna	*Aphanamixis polystachya*	100.00a	1.04cd	2.03d	1cd
Satiyan	*Alstonia scholaris*	98.00b	1.62bc	3.81a	4a
Punial	*Calophyllum inophyllum*	100.00a	1.08cd	2.21cd	2c

Means followed by same letter (s) in the same column do not differ significantly at 5% level.

The greater number of branches was found in *A. catechu* (4), *Alstonia scholaris* (4) followed by *Melia azedarach* (3) *Neolamarckia cadamba* (3) and lowest was found *Aphanamixis polystachya* (1), *Cassia fistula* (1). Islam et al. (2016) reported the growth performance of different medicinal tree species planted in the eastern coastal belt of Bangladesh. They found height and or dbh in *T. arjuna* (1.89m, 2.17cm), *T. belerica* (1.12m), *T. catappa* (1.82m, 2.02cm), *Bombax ceiba* (1.93m, 2.16cm), *Acacia catechu* (3.06m, 3.67cm), *Neolamarckia cadamba* (2.63m, 3.72cm), *Cassia fistula* (1.21m) and *Aphanamixis polystachya* (1.07m) at the age of two years. Nandy et al. (2002) conducted a survey for the assessment of growth performance of different tree species planted in the coastal embankment. They reported that *T. arjuna* showed 4.0m in height and 8.28cm in dbh, *C. fistula* showed 3.50 m in height and 1.59 in dbh at Dauka embankment under Bhola district of western coastal belt at the age of

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three years. They also reported that *M. azedarach* showed 4.08m in height and 4.36cm in dbh *A. catechu* showed 1.60m in height at Char Manika embankment of the western coastal belt at the age of two years and another species *S. cumini* was found 1.31m in height at Choto Charkazol of the western coastal belt. Parkash and Hocking (1986) reported 2-3 meter height growth of *T. arjuna* at the age of three years under favorable conditions. Stump planted of *B. ceiba* species was found12.95 meters in height and 25.2 cm dbh at the age of 7 years in Pakistan (Sheikh, 1993). In the present study, based on survival and initial growth performance, the species like *Neolamarckia cadamba*, *Acacia catechu*, *Terminalia arjuna, Bombax ceiba*, *Terminalia chebula*, *Meliaaz edarach* and *Syzygium cumini* were found promising at Baherchar site at the age of 3.5 years. *Cassia fistula* and *Terminalia catappa* were not satisfactory compare to other planted species. At Horidrakhali site growth performance of *Acacia catechu*, *Terminalia arjuna*, *Melia azedarach*, *Alstonia scholaris*, *Bombax ceiba*, *Calophyllum inophyllum*, *Aphanamixis polystachya*, *Terminalia chebula*, *Cassia fistula* and *Terminalia belerica* appeared more promising among the twelve medicinal tree species. In *Terminalia catappa* survival was found promising but height and collar diameter were less than other species. *Neolamarckia cadamba* found less survival performance (23%).

IV. Conclusion

Cultivation of medicinal plants is in a very rudimentary stage in Bangladesh. For improving the cultivation of medicinal plants, trials were initiated in the coastal areas to select the suitable species of woody medicinal trees. Some of the species like *Acacia catechu*, *Terminalia arjuna*, *Melia azedarach*, *Alstonia scholaris*, *Bombax ceiba*, *Calophyllum inophyllum*, *Aphanamixis polystachya*, *Terminalia chebula*, *Cassia fistula*, *Terminalia belerica*, *Neolamarckia cadamba* and *Syzygium cumini* were found promising at the age of 3.5 and 1.5 years old. These species can be planted in the coastal raised land, embankment, and homesteads for the development of the medicinal plant population for directly contributed to the economic improvement of the coastal rural people as well as sustainable biodiversity in the western coastal belt of Bangladesh. This is, however, an interim report. The experimental trials will be maintained and the comprehensive one will be available after few years.

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