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RESEARCH ARTICLE

ALLOMETRY IN *S. apetla* SEEDLINGS OF INDIAN SUNDARBANS

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ABSTRACT

Biomass of mangrove seedlings serves as proxy to environmental health. Accurate assessment of mangrove seedling biomass at the site- scale is lacking, especially in the World Heritage Site of Indian Sundarbans. *Sonneratia apetala* (locally known as keora) is a common fresh water loving mangrove species. This study assessed the biomass of the vegetative parts (leaf, stem and root) of *S. apetala* seedlings from 18 sampling stations distributed in the western, central and eastern sectors of Indian Sundarbans with contrasting salinity profile. The study conducted during June 2016 revealed highest total biomass of the seedlings collected from the eastern sector (mean value = 11.313 gm m^{-2}) followed by the western (mean value = 11.182 gm m^{-2}) and central (mean value = 8.627 gm m^{-2}) sectors. The role of salinity in regulating the growth and biomass of *S. apetala* seedlings is confirmed from the present study. Another aim of this study is to develop allometric equation considering the total biomass of the species as dependant variable (Y) and various vegetative parts (leaf, stem and root separately) as independent variables (X).

INTRODUCTION

Mangroves are important for their ecological, economic, and societal value (Lacambra Friess, Spencer, and Moller, 2013; Saenger, 2002). Recent research has focused on the coastal protection value of mangroves especially following the 2004 Indian Ocean Tsunami (Barbier, 2006). A recent study in the Indo- Pacific region showed that mangroves play a critical role in carbon sequestration, potentially storing four times as much carbon as other tropical forests, including rain forests (Donato *et al*. 2011). It is therefore important to focus our attention on the survival rate and growth of the mangroves seedlings. Often the seedlings are destroyed due to grazing, erosions of intertidal mudflats, wave actions, tidal surges etc. High salinity also retards the growth of mangroves seedlings (Mitra *et al*. 2004; Mitra, 2013; Mitra and Zaman, 2015; Mitra and Zaman, 2016). The objective of this study is to develop allometric models to evaluate the individual contribution of leaf, stem and root on the total biomass of *S. apetala* seedlings collected from three different sectors of Indian Sundarbans with contrasting salinity (Trivedi *et al*. 2016).

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MATERIALS AND METHODS

Study Site

The study was conducted within 9630 sq km of Indian Sundarbans situated at the apex of Bay of Bengal. 18 sampling stations (6 in each sector) were selected for the present study (Figure. 1). All the sampling stations were selected behind a long frontal beach that reduces tidal and wave energy, providing an environment conducive to the establishment of mangroves seedlings on the intertidal mudflats.

Sampling

Quadrate sampling technique was used in each station which contained 3 to 4 months old seedlings of *S. apetala*. 30 sample quadrates (1.0 m × 1.0 m) were established (on the intertidal mudflats) through random sampling. Above Ground Biomass (AGB) is the sum total of stems and leaves of the seedlings and Below Ground Biomass (BGB) comprises the roots of the seedlings. The seedlings of the species after collection from each quadrate were thoroughly washed with double distilled water to remove any sticking debris, dried at 70°C and the average values of about 120 seedlings from 30 quadrates from each station were finally converted into biomass (gm/m^2) in the study area.

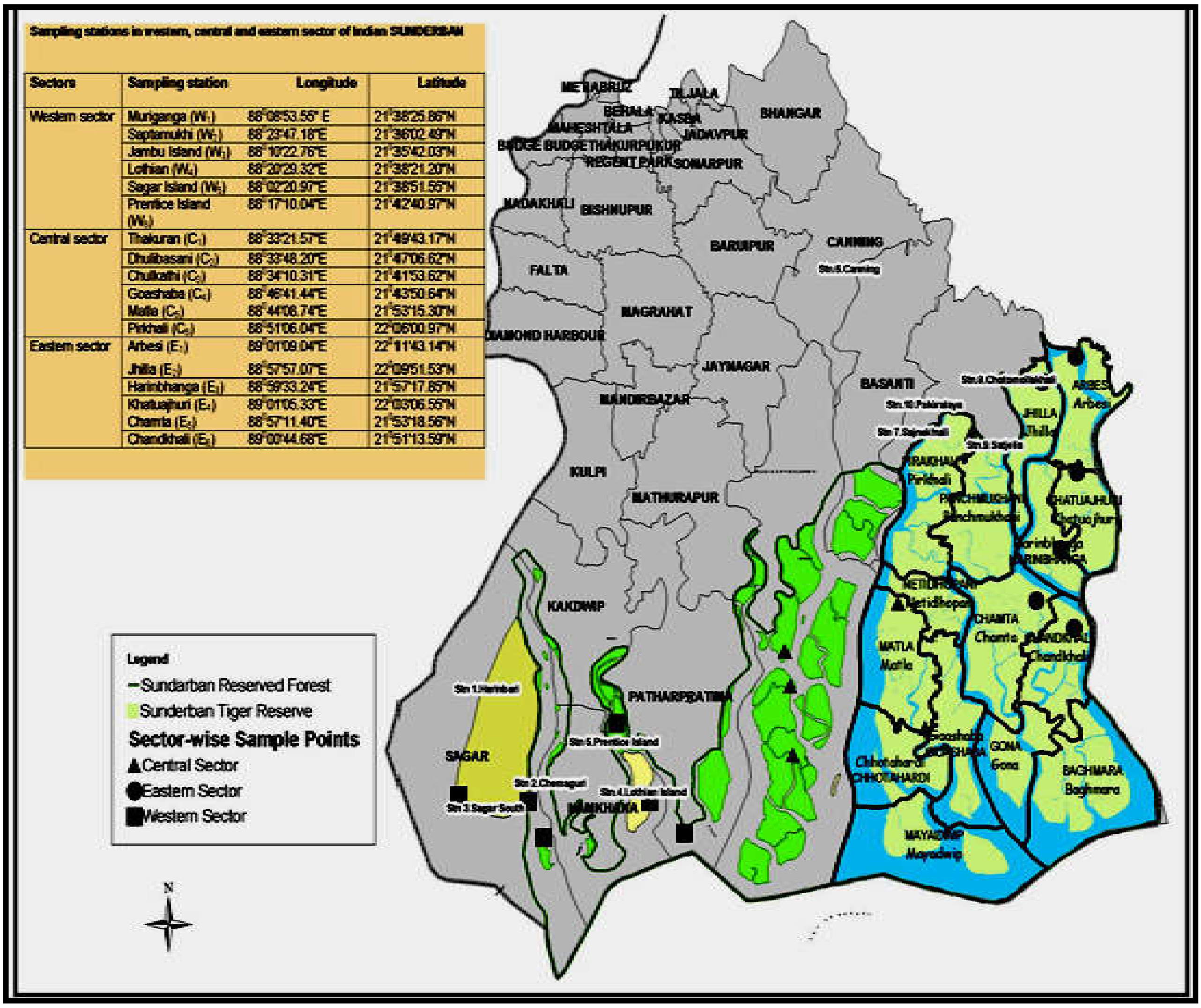

Figure 1. Location of sampling stations in Indian Sundarbans

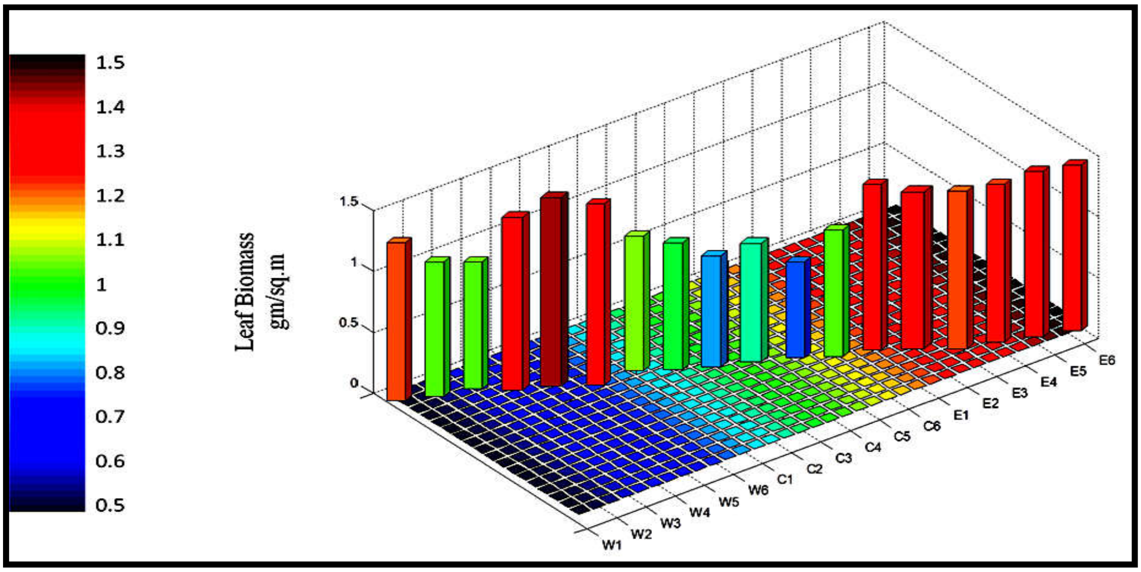

Figure 2. Leaf biomass of *S. apetala* seedlings in the western ($W_1 – W_6$), central ($C_1 – C_6$) and eastern ($E_1 – E_6$) sectors

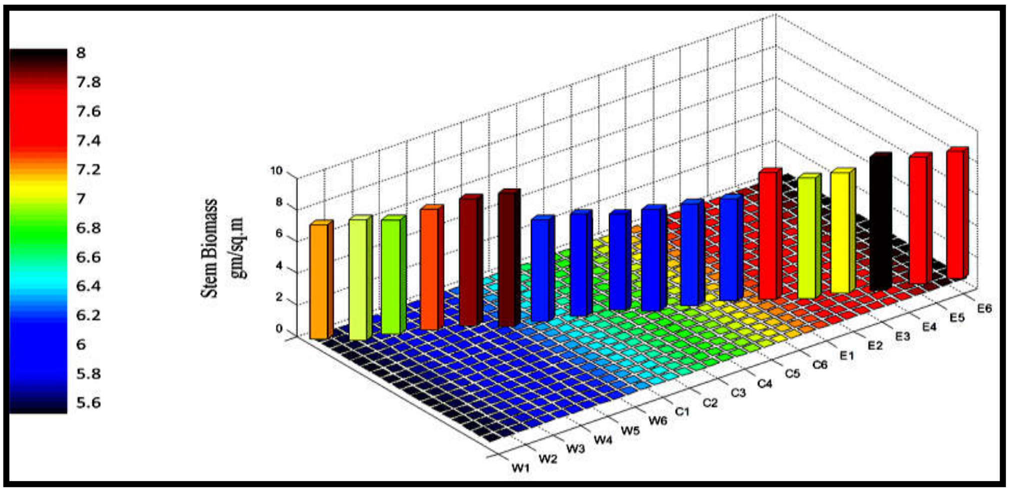

Figure 3. Stem biomass of *S. apetala* seedlings in the western (W_1 – W_6), central (C_1 – C_6) and eastern (E_1 – E_6) sectors

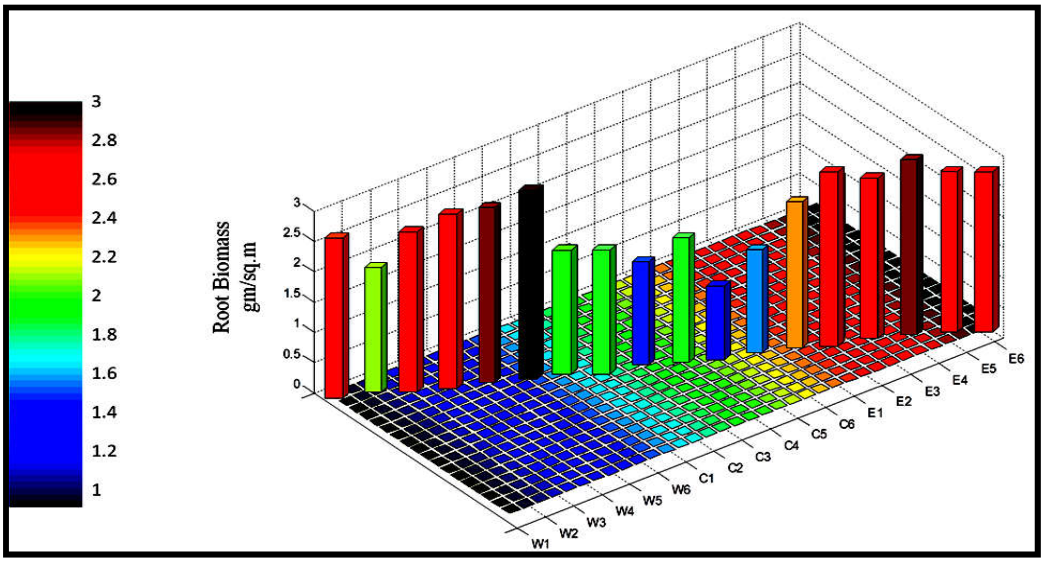

Figure 4. Root biomass of *S. apetala* seedlings in the western (W_1 – W_6), central (C_1 – C_6) and eastern (E_1 – E_6) sectors

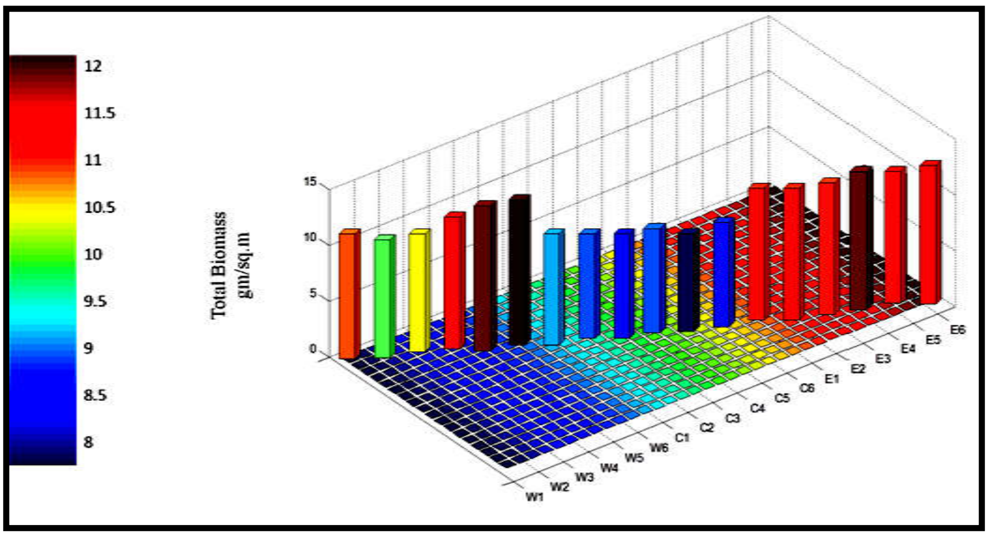

Figure. 5. Total biomass of *S. apetala* seedlings in the western (W_1 – W_6), central (C_1 – C_6) and eastern (E_1 – E_6) sectors

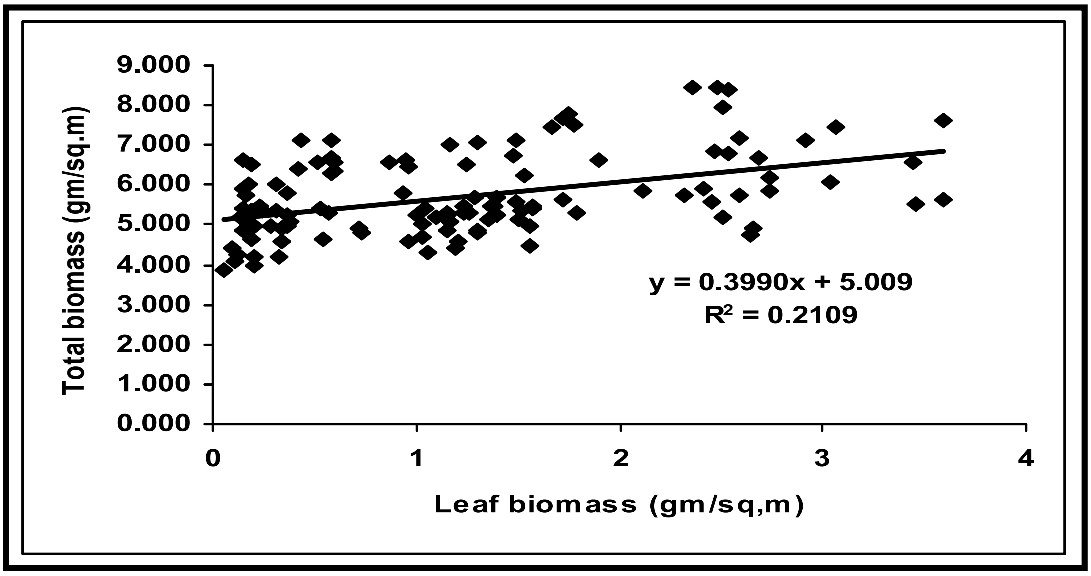

Figure. 6. Allometric model relating total biomass of *S. apetala* seedlings (Y) with leaf biomass in the western sector

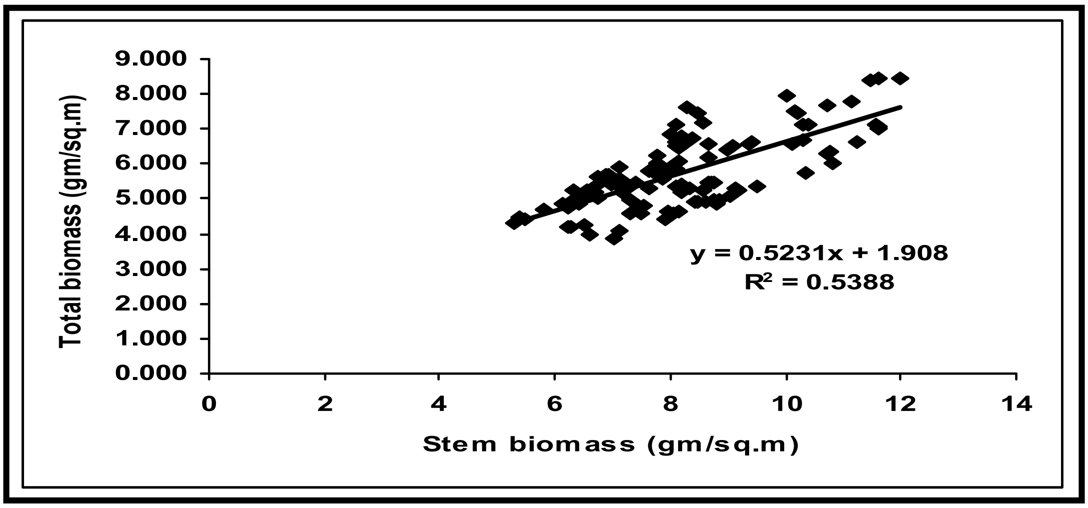

Figure. 7. Allometric model relating total biomass of *S. apetala* seedlings (Y) with stem biomass in the western sector

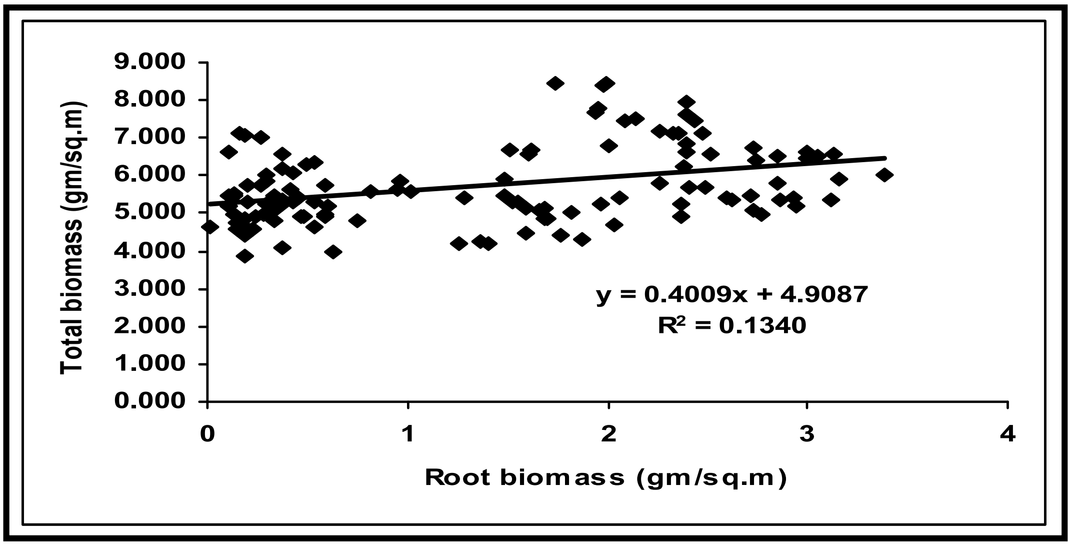

Figure. 8. Allometric model relating total biomass of *S. apetala* seedlings (Y) with root biomass in the western sector

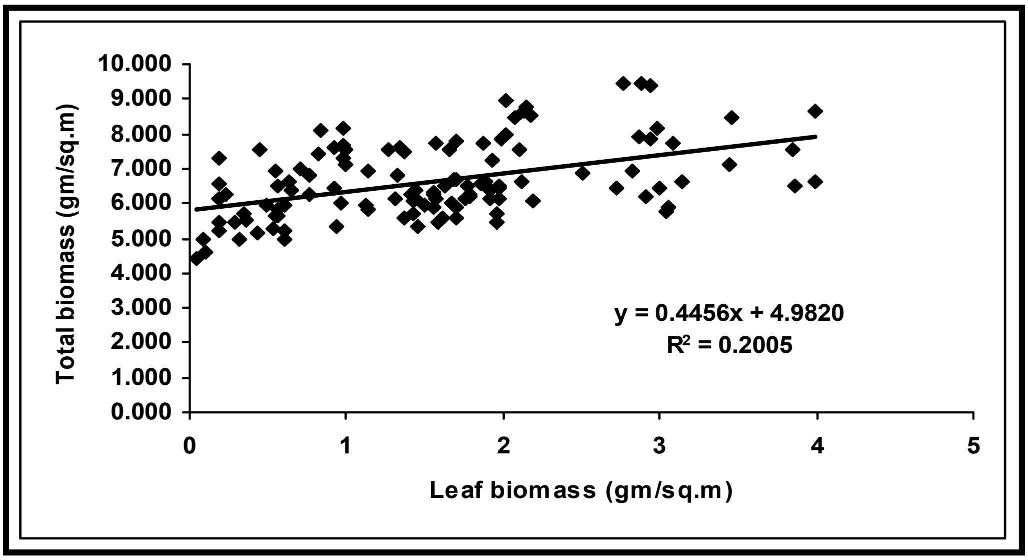

Figure. 9. Allometric model relating total biomass of *S. apetala* seedlings (Y) with leaf biomass in the central sector

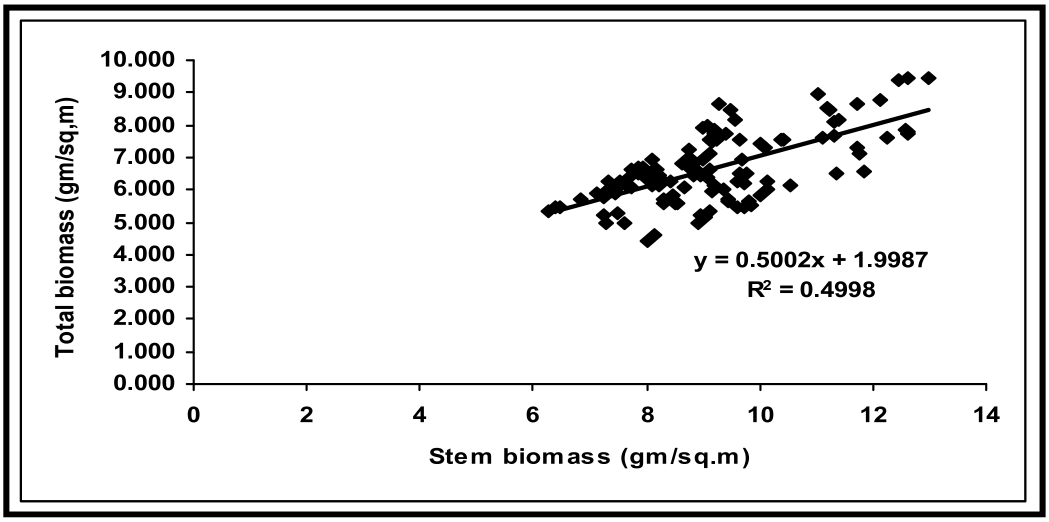

Figure. 10. Allometric model relating total biomass of *S. apetala* seedlings (Y) with stem biomass in the central sector

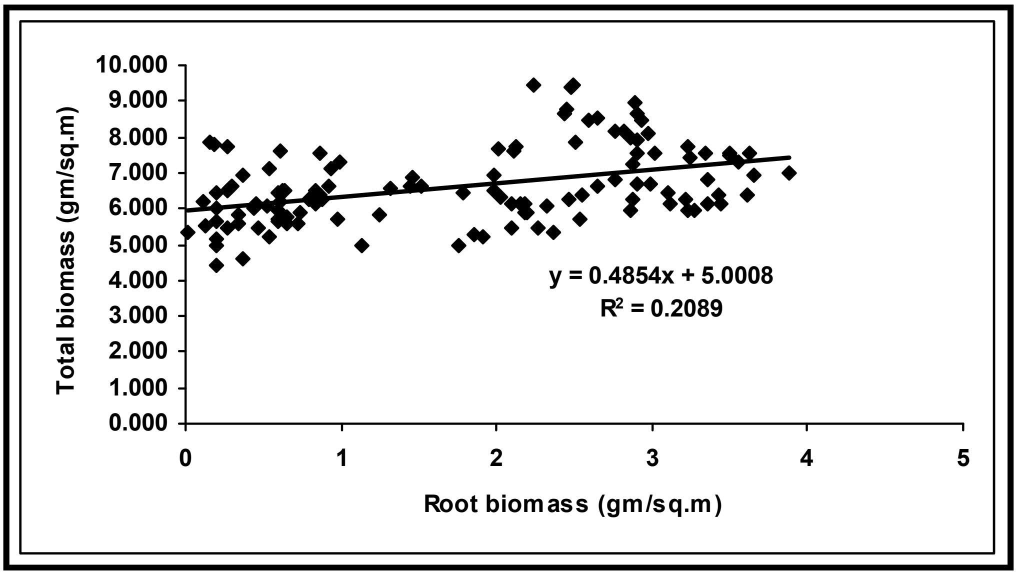

Figure. 11. Allometric model relating total biomass of *S. apetala* seedlings (Y) with root biomass in the central sector

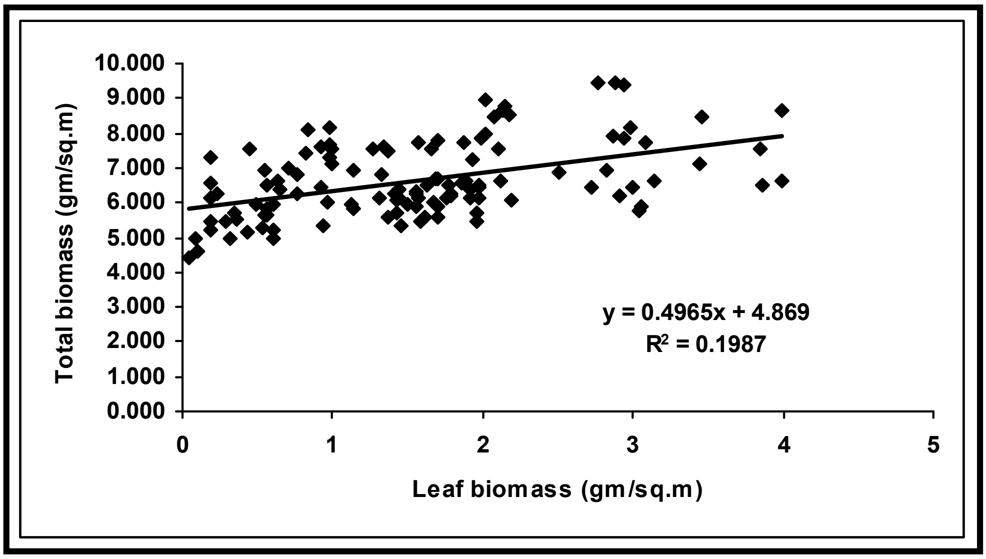

Figure. 12. Allometric model relating total biomass of *S. apetala* seedlings (Y) with leaf biomass in the eastern sector

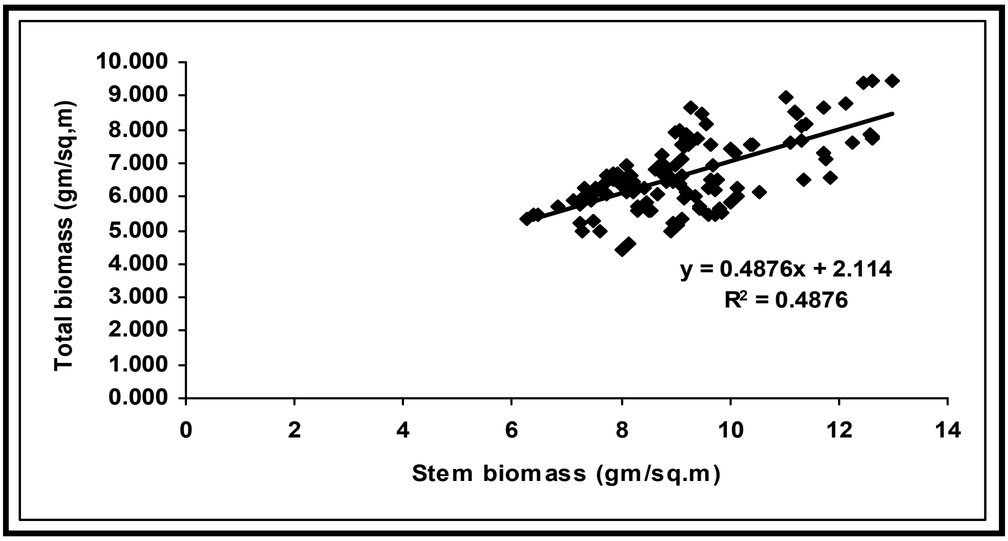

Figure. 13. Allometric model relating total biomass of *S. apetala* seedlings (Y) with stem biomass in the eastern sector

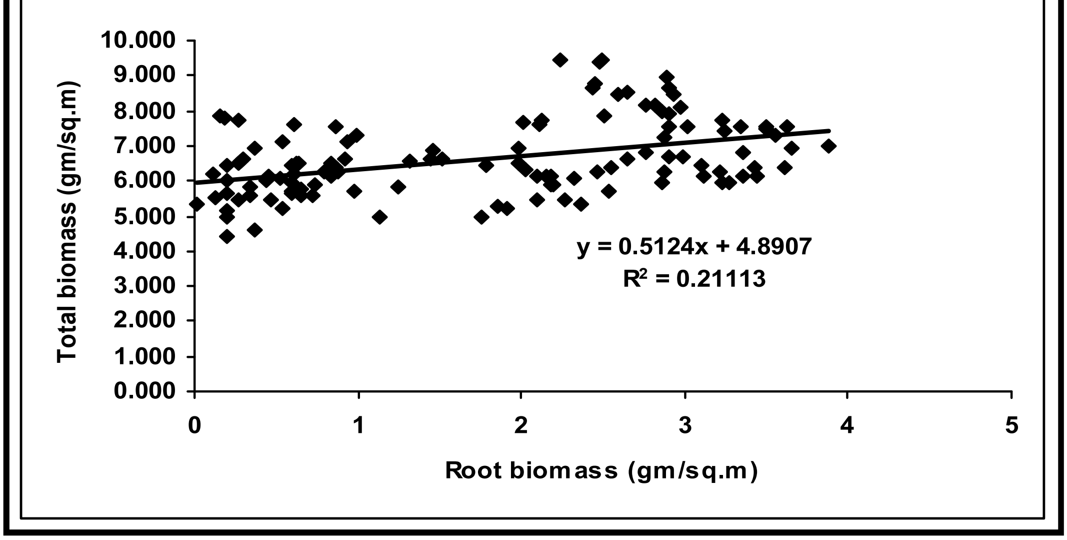

Figure. 14. Allometric model relating total biomass of *S. apetala* seedlings (Y) with root biomass in the eastern sector

Statistical Analysis

Allometric equations for each sector were determined (n = 120 from 30 quadrates/station) as a function of leaf biomass, stem biomass and root biomass separately. The precision of the model in predicting the total biomass of individual seedling was ascertained by the magnitude of the R^2 value of the simple regression and percentage difference of predicted and observed total biomass values of the seedlings. All statistical calculations were performed with SPSS 9.0 for windows.

RESULTS

Analysis of the data set reveals uniform picture in terms of leaf biomass, stem biomass, root biomass and total biomass of *S. apetala* seedlings. The order is stem biomass > root biomass > leaf biomass. The set of data reveals highest leaf biomass in the eastern sector (1.260 gm m^{-2}) followed by the western (1.248 gm m^{-2}) and central (0.930 gm m^{-2}) sectors. The stem biomass followed similar trend with values of 7.465 gm m^{-2}, 7.342 gm m^{-2} and 6.024 gm m^{-2} in the eastern, western and central sectors respectively. The root biomass exhibits a deviation from this trend with highest biomass in the western sector (2.591 gm m^{-2}) followed by the eastern (2.588 gm m^{-2}) and central (1.672 gm m^{-2}) sectors. In case of total biomass of the seedlings highest value is observed in the eastern sector (11.313 gm m^{-2}) followed by the western (11.182 gm m^{-2}) and central (8.627 gm m^{-2}) sectors. The station- wise biomass of vegetative parts of *S. apetala* seedlings are shown in Figures 2, 3, 4 and 5. Allometric models developed to find the contribution of leaf, stem and root biomasses on total biomass of the seedlings reveal significant role of stem biomass and insignificant role of leaf and root biomasses on the dependent variable (total biomass of the seedlings) as seen in Figures. 6 - 14.

DISCUSSION

S. apetala is basically a freshwater loving mangrove species and hence highest biomass is observed in eastern sector, followed by the western and central sectors (except root biomass in which the order is western sector > eastern sector > central sector). The results, however confirm the affinity of the *S. apetala* seedlings towards hyposaline condition (that is witnessed both in the western and eastern sectors of Indian Sundarbans). We tried to observe the influence of each of the vegetative parts of the seedlings (leaf, stem and root) separately on the total biomass through allometric equations.

The model shows greatest prediction error in case of leaf and root biomass suggesting a need for allometric equations based on stem biomass. The estimated total biomass of *S. apetala* seedlings on the basis of stem biomass (irrespective of the sectors) suggests the reliability of this vegetative part as proxy to total biomass of the seedlings. Minimum deviation percentage observed between predicted and observed stem biomass confirms the significant influence of stem biomass on the total biomass of the seedlings. The accuracy of any allometric model is a function of input variability. The uniform magnitude of R^2 value for stem biomass in all the three sectors of Indian Sundarbans indicates that this mangrove forest is in good health (in context to seedlings) despite being located in an area where encroachments for aquaculture and timber and honey extractions are of increasing concern. These observations provide valuable information for site- specific mangrove afforestation and management in Indian Sundarbans region where coastal development and mangrove conservation is considered as priority.

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