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BIOMASS PRODUCTION AND TRANSPORT OF MACRONUTRIENTS IN FOUR FAST GROWING TREE SPECIES IN BANGLADESH.

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Abstract

Acacia auriculiformis produced highest amount of biomass compared to three other species. Samanea saman stood as the second highest in this regard. Among the four tree species, the highest amount of distribution of K was recorded in Anthocephalus cadamba in all its three organs, the maximum concentration being in the leaf. Concentration of Ca was found higher in stem and leaf compared to that in root of Acacia auriculiformis. The concentration of Na was found higher in leaves of all four tree species. The results showed that the distribution of Mg was much higher in leaf of all tree species compared to root and stem. Besides the study indicated that there was higher concentration of Fe in roots compared to stem and leaf in all tree species. As regards the removal of nutrients per unit production of biomass, Acacia auriculiformis removed highest amounts of nutrients whereas Samanea saman produced the same amount at the expense of much lower amount of nutrient capitals.

INTRODUCTION

Recognition of the finite extent of world fossil fuel reserves has focused attention on forests as a renewable source of energy. Plantations of fast growing species with short rotation could provide an economically viable alternative source of energy in many parts of the world (Kimmins, 1977). Maximising the efficient production of energy by means of optimisinig the biomass growth of selected woody species is the goal of energy production (White and Gambles, 1988). However, such plantations would exert a high nutrient demand on the soil and the question of nutrient withdrawals and their replacement must be considered before switching over to forest plantations as an energy source. Successful biomass species will be those that require minimal inputs in their production (Rockwood and de Valerio, 1986). *Acacia auriculiformis*, *Samanea saman*, *Eucalyptus tereticornis* and *Anthocephalus cadamba* are multipurpose fast growing trees. The reported uses of these trees are for industrial purposes, fuelwood produc-tion, soil conservation, shade and shelter, pulp-making, building poles etc. (Carlwitz, 1986).

The present communication reports the biomass production potentials of one year-old fast growing tree species and the distribution of nutrients in different parts of the plant body and the quantum of nutrients thus removed from the soil and by each plant species.

MATERIALS AND METHODS

Two month old seedlings of four fast growing trees such as *Acacia auriculiformis*, *Samanea saman*, *Anthocephalus cadamba* and *Eucalyptus tereticornis* were obtained from local nursery of Dhaka. The seedlings were planted at a field near the Institute of Food and Radiation Biology, Atomic Energy Research Establishment campus at Savar, Dhaka, Banglaesh. Originally the site was densely covered with grass. These were removed and holes of 25 X 25 X 25 cm were made. These holes were filled with equal volume of soil and cowdung. Natural condition was kept in the field as far as possible. Plant to plant and row to row spacings were 1m X 1m. Each plot was separated by a 2m raised soil barrier from the adjacent plot. Ten trees of one-year old selected at random from the three replications of 20-tree plot of each species were felled and measured for their biomass production potentials.

Analysis of plant materials:

Three different organs namely root, stem and leaf of the plant species were used for their elemental analysis. All plant materials were washed with distilled water and dried at 85°C for 48tr in an oven. Then to a two gram sample was added a mixture of conc. nitric acid (10 ml), 60% perchloric acid (5 ml) and water (5 ml) in a teflon vessel. The vessel was placed in a sealed stainless steel container and heated at 150°C for 2 hrs in and oven. After cooling, the vessel was removed and the sample solution was transferred to a teflon beaker containing 25 ml distilled water. The resulting solution was further heated to 100°C for 15-20 minutes, and filtered; the filtrate was diluted to 100 ml with distilled water. An analytical blank was prepared in a similar manner without the sample. All glasswares were carefully cleaned with hot nitric acid followed by thorough rinsing with distilled water before use. The aqueous digest was analyzed directly using Pye Unicam SP-2900 atomic absorption spectrophotometer with hollow cathode lamp (Ca, K, Mg, Fe, Na). Standards were prepared in 0.1N perchloric acid. The analytical procedure was checked using standard reference material, Pepperbush, the plant material provided by the NIES (The National Institute For Environmental Studies). Results of the analysis are given in Table-1. The results are in excellent agreement with the certified values.

Table 1. Comparison of metal concentration in standard reference material Pepperbush (NIES) the present results (dry weight)**

Metal	Value given by NIES (Wt%)	Present values* (Wt%)	Deviation %
K	1.51+0.06	1.50+0.08	- 0.66
Ca	1.38+0.07	1.35+0.05	- 2.17
Mg	0.408+0.02	0.407+0.0	- 0.25
Fe (μg/g)	205+17	200+15	- 2.44
Na (μg/g)	106+13	110+10	+ 3.77

* Average of three replicates.

** Dry weight : Dry in an air-oven at 85°C for 48 hrs.

RESULTS DISCUSSION

The results on the weight of root, stem, twigs and leaves and total biomass are presented in Table 2. The results indicated that the *Acacia auriculiformis* produced higher amount of biomass compared to three other species. The second hig-hest amount of biomass was found in *Samanea saman*.

Table 2. One year growth of four fast growing tree species in Bangladesh (weight on fresh weight basis).

Plant species	Height (m)	Weight of root (kg)	Weight of stem, leaves, twigs (kg)	Total Biomass (kg)
Acacia auriculiformis	3.2a	0.31b	1.8a	2.1a
Samanea saman	2.5b	0.55a	1.0b	1.5b
Anthocephalus cadamba	1.5c	0.25c	0.7c	0.9c
Eucalyptus tereticornis	1.8c	0.19d	0.4d	0.6d

Note: Means sharing the same letters do not differ significantly at P= 0.05%

The major mineral constituents such as K, Ca, Na, Mg, and Fe are recorded in tables 3 and 4. The highest amount of transport of K was recorded in *Anthocephalus cadamba* in all its three organs. However, the maximum concentration was found in leaf of this variety. The Ca distribution was found higher in stem and leaf of *Acacia auriculiformis* whereas a comparatively lower value was obtained in root. The distribution of this nurtient was found to be comparatively lower in the stem of *Samanea saman*. Sodium accumulation was more pronounced in leaf of *Eucalyptus tereticornis* (Table 3). In the roots and leaves of *Samanea saman*, Na accumulation was found to be minimum.

Table 3. Concentrations of K, Ca and Na in the root, stem and leaf of four fast growing tree species ($\mu g\ g^{-1}$, dry weight basis).

Element	Plant part	*Samanea saman*	*Anthocephalus cadamba*	*Eucalyptus tereticornis*	*Acacia uriculiformis*
K	Root	10253.09 ±131.82	10719.13 ±131.82	5033.33 ±131.82	8482.10 ±263.64
	Stem	5724.18 ±139.57	11843.14 ±0.00	8783.66 ±139.75	11547.06 ±241.75
	Leaf	12080.00 ±273.98	14988.00 ±158.18	13310.37 ±158.18	7158.52 ±158.18
Ca	Root	10479.05 ±105.63	5649.20 ±60.99	9487.20 ±60.99	5519.83 ±60.99
	Stem	6899.81 ±53.03	7312.30 ±0.00	9299.75 ±53.03	11024.70 ±91.86
	Leaf	15159.98 ±48.07	13052.54 ±83.26	15397.92 ±83.26	16145.72 ±96.14
Na	Root	61.18 ±0.00	159.38 ±0.00	133.95 ±0.35	129.16 ±0.62
	Stem	130.17 ±0.36	132.18 ±0.62	118.34 ±0.35	166.43 ±1.78
	Leaf	113.05 ±0.71	157.62 ±0.94	271.67 ±0.36	173.35 ±0.00

The results also indicated that the Na accumulation was higher in leaves of all four plant species. The distribution of Mg in different parts of four plant species is presented in Table 4. The results indicated that the distribution of Mg was much higher in leaf of all the plant species as compared to that of root and stem. The results also show that the *Samanea saman* accumulated the minimum amount of this element in the root and stem as compared to the other plant species. The results of the accumulation of Fe in different plant parts in different plant species are shown in Table 4. The results indicated that the *Eucalyptus tereticornis* accumulates a very low concentration of Fe in its stem and leaf. Similarly a very lower

Table 4. Concentrations of Mg and Fe in the root, stem and leaf of four fast growing tree species (µg g^{-1}, dry weight basis).

Element	Plant organ	*Samanea saman*	*Anthocephalus cadamba*	*Eucalyptus tereticornis*	*Acacia auriculiformis*
Mg	Root	761.55 ±12.52	1700.03 ±21.84	1505.40 ±12.52	974.08 ±12.52
	Stem	611.02 ±21.69	1726.78 ±0.00	1416.85 ±12.52	1301.73 ±0.00
	Leaf	12882.39 ±66.41	2807.13 ±25.05	3506.63 ±37.66	3046.22 ±25.05
Fe	Root	454.16 ±3.45	595.37 ±5.80	998.97 ±1.10	1037.87 ±3.97
	Stem	357.88 ±4.36	238.84 ±3.69	112.80 ±3.30	499.48 ±1.10
	Leaf	456.69 ±2.20	430.23 ±6.80	110.47 ±1.90	72.54 ±4.48

concentration of this nutrient was found in the leaf of *Acacia auriculiformis*. The results also indicate that there is a general presence of higher concentration of Fe in roots as compared to stem and leaf in all plant species. Results on the removal of different nutrients per kilogram of biomass production per year per plant species have been presented in Table 5. The results indicate that *Acacia auriculiformis* removed highest amount of calcium, sodium and second highest amount of potassium and iron. *Samanea saman* removed lowest amount of potassium, sodium, and magnesium. It is clear from the study that for producing the same amount of biomass, *Acacia auriculiformis* removed the highest amount of nutrients. On the other hand *Samanea saman* produced the same amount of biomass at the expense of much lower quantity of nutrients.

Table 5. Removal of K, Ca, Na, Mg and Fe per kilogram of biomass produced by four fast growing tree species.

	Acacia. Auriculiformis	*Samanea saman*	*Anthocephalus cadamba*	*Eucalyptus tereticornis*
			g kg^{-1} Biomass $year^{-1}$	
K	17.20	15.12	22.59	16.59
Ca	23.98	17.95	16.49	19.79
Na	0.30	0.17	0.25	0.30
Mg	3.85	2.52	3.78	3.82
Fe	0.64	0.68	0.64	0.47

Loss of fertility and productivity as a result of forest harvesting has attracted little attention until recently. Long rotations and low utilization have meant that nutrient withdrawals in harvested materials were small in relation to site nutrient capital. Shortening of rotations and increase in utilization are changing this situation. Management of the site nutrient capital becomes increasingly important as the proportion of the capital that is removed increases and as rates of removal approach or exceed natural rates of replacement. The success of plantations for fuelwood and lumber is dependent upon the climatic and edaphic factors of each site (Allen, 1986).

The results of the present study hane indicated that the maximum concentration of K, Ca, Na and Mg were found in the leaves of all plar species. However, it did not hold tr for Fe. In this study it was found that root accumulated the maximum concentration of Fe. Foliage generally has by far the highest concentrations of nutrients, followed in order by fine roots and twigs, branches and large root and the stem (Kimmins, 1977, Babalonas *et. al.*, 1984). The results indicate that the higher the production of biomass, the higher the removal of nutrients by a given species. The present findings have indicated that the *Acacia auticuliformis* produced higher amount of biomass as compared to other species, but it must be remembered that this enhanced growth has been achieved by the plant species at the expense of nutrient capital of the soil.

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REFERENCES

Allen, J.C. 1986. Soil properties and Fastgrowing tree species in Tanzania. Forest Ecology and Management, 16: 127-47.

Babalonas, S.D., S. Kartagalis and V. Kabassakalis. 1984. The ecology of plant populations growing on serpentine soils. Phyton., 24:2, 225-38.

Carlowitz, P.G.V., 1986. Multipurpose tree and shrub directory. ICRAF, Nairobi, Kenya.1st ed. p 264.

Kimmins, J.P., 1977. Evaluation of the consequences for future tree productivity of the loss of nutrients in whole-tree harvesting. Forest Ecol and Management. 1: 169-83.

Rockwood, D.L. and J.T. De Valerio. 1986. Promising species for woody biomass production in warm humid environments. Biomass 11 : 1-17.

White, H.W. and R.L. Gambles. 1988. Experiences with willow as a wood biomass species. Biojoule, 10 : 4-6.