ALLOMETRIC RELATIONSHIPS OF FREQUENTLY USED SHADE TREE SPECIES IN LANDSCAPING IN KANDY, SRI LANKA

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Introduction

Landscape designers may have different choices in selecting plant species for gardens depending on the general or specific requirements of the client. Plants play an important role in landscape designing as they have many functions such as modulating microclimate, shading, reducing wind, air and noise pollution in addition to their esthetic values. Within the context of landscape designing in tropical countries, shade trees have become an increasingly demanding choice due to their shading and cooling effects while meeting the personal benefits of the landscape designing. Therefore, landscape designers should have a vast knowledge on structural characteristics of shade tree species in order to align with the requirements of the client.

However, trees show considerable variations and flexibility in their height, size of the crowns and diameter at breast height (DBH). Crown size is an important factor of plant growth which determines the solar radiation interception. Tree crown dimensions, especially the mean crown radius (MCR) are well correlated to the DBH of a stem. DBH of a tree is also an important structural characteristic which determines the dimensions of a tree. However, there is a lack of quantitative assessments on structural characteristics of shade tree species in relation to landscaping.

Therefore, the objectives of this study was to develop the relationships between canopy width, height and DBH for selected six shade tree species which are frequently used in landscaping in Kandy.

Methodology

The study was conducted in University of Peradeniya and nearby areas (70˚15'N latitude, 80˚36' longitude). Six species of shade trees; *Amherstia nobilis*, *Tabebuia rosea*, *Mesua ferrea*, *Filicium decipiens*, *Jacaranda mimosifolia* and *Mangifera* spp. were selected for the investigation. Selected trees were measured for the following variables; tree height (TH), crown width (CW) and stem DBH and all the measurements were taken in meters.

Total height was measured using a clinometer and a measuring tape. To measure the tree height, the peak of the canopy was pointed with the clinometer at a certain distance of the tree, and then the distance from the tree base to the operator and reading of the angle on the clinometers were taken. Stem DBH, ~1.3 m above ground level was measured using DBH tape and each tree was ocularly assessed for crown radius in eight directions.

For the determination of allometric relationships, Pearson's correlations and regression analyses were carried out for all variables using the statistical software Minitab.

Results and Discussion

For each of the six shade tree species, the means of the tree height, DBH and canopy width were calculated with the standard error and results are given in Table 1. The results of the regression analysis for CW/TH, DBH/TH and CW/DBH allometric relationships are summarized in Table 2, 3 and 4 respectively.

The relationship between canopy width and tree height appeared to be linear in all shade tree species (r^2>0.85) except in *A. nobilis*, which is appeared to be logarithmic (Table 2). The results also agree with the finding of Peper *et al.*, 2001 who predicted diameter, height, crown width and leaf area for twelve street tree species in San Joaquin Valley in where ten of the twelve species displayed good fit for tree height and crown width.

The reason for the deviation of *A. nobilis* in this research would be the fast growing canopy that it has, compared to the tree height at early stages of their growth. Trees having wider canopies maximize their light interception and thus photosynthetic rates. Though taller trees have higher metabolic rates and growth requirements, their wider canopies can furnish them. According to the one-way ANOVA for comparison of the means of canopy width to tree height ratio for each species, there were no significant differences (p>0.05) between each species except *T. rosea* and *J. mimosifolia.* Among the shade tree species considered in this study, landscape designers may have choices in selecting tree species having wider canopy for a large shade area except *T. rosea* and *J. mimosifolia.*

Table 1. Means for Tree height, Canopy width and DBH

Shade tree species	*No. of trees*	*Tree height (m) ± S.E.*	*Canopy width(m) ± S.E.*	*DBH (m) ± S.E.*
A. nobilis	14	9.33 (0.91)	8.57 (0.57)	0.49 (0.05)
F. decifiens	15	14.35 (1.53)	11.67 (0.94)	0.39 (0.06)
M. ferrea	15	11.10 (1.21)	10.47 (1.33)	0.53 (0.10)
T. rosea	23	14.71 (0.85)	8.14 (0.52)	0.35 (0.03)
J. mimosifolia	13	13.09 (0.99)	8.41 (0.41)	0.37 (0.03)
M. zeylanica	14	10.21 (1.04)	7.68 (0.27)	0.30 (0.02)

DBH = Diameter at Breast Height, S.E. = Standard Error (within parenthesis)

Table 2. Regression Analysis for Canopy width Vs. Tree height relationship

Shade tree species	*b*	*A*	*Prediction model*	*r*	r^2
A. nobilis	4.74	1.90	y = 4.74ln(x) - 1.9	0.88*	0.85
F. decifiens	0.50	3.40	y = 0.5(x) + 3.4	0.93*	0.87
M. ferrea	1.07	1.40	y = 1.07(x) - 1.4	0.95*	0.91
T. rosea	0.50	0.17	y = 0.5(x) + 0.17	0.83*	0.86
J. mimosifolia	0.39	3.25	y = 0.39(x) + 3.25	0.95*	0.91
M. zeylanica	0.25	5.07	y = 0.25(x) + 5.07	0.97*	0.95

b = Regression coefficient/slope, A = intercept, r = Pearson's correlation coefficient, r^2 = Coefficient of determination

The relationship between tree height and stem DBH appeared to be depending on the species considered. It was linear for both *A. nobilis* and *T. rosea* and rest of the tree species appeared to be logarithmic in the relationship (Table 3). This linearity of this relationship confirmed that tree trunk should be strong enough to withstand wind pressure and tree's own weight. Higher r^2 values for the relationship between tree height and stem DBH given by those tree species, further confirmed that they are strong enough to withstand those harsh conditions.

The crown width and DBH of all six tree species appeared to be strongly correlated (Table 4). Results of the present study indicated that *A. nobilis*, *F. decipiens*, *M. ferrea*, *and T. rosea* have logarithmic relationship between crown width and DBH and *J. mimosifolia* has a linear relationship while *M. zeylanica* having an exponential relationship.

Table 3. Regression Analysis for DBH Vs. Tree height relationship

Shade tree species	*b*	*A*	*Prediction model*	*r*	*r^2*
A. nobilis	0.05	0.01	y = 0.05(x) + 0.02	0.98*	0.97
F. decifiens	0.12	0.05	$y = 0.05e^{0.12x}$	0.97*	0.91
M. ferrea	0.16	0.06	$y = 0.06e^{0.16x}$	0.96*	0.96
T. rosea	0.03	0.17	y = 0.03 (x) - 0.17	0.89*	0.91
J. mimosifolia	0.08	0.11	$y = 0.11e^{0.08x}$	0.96*	0.94
M. zeylanica	0.17	0.09	y = 0.17ln(x) -0 .09	0.96*	0.92

DBH = Diameter at Breast Height, b = Regression coefficient/slope, A = intercept, r = Pearson's correlation coefficient, r^2 = Coefficient of determination

Table 4. Regression Analysis for Canopy width Vs. DBH relationship

Shade tree species	*b*	*A*	*Prediction model*	*r*	*r^2*
A. nobilis	5.06	12.30	y = 5.06ln(x) + 12.30	0.88*	0.82
F. decifiens	4.76	17.03	y = 4.76ln(x) + 17.03	0.94*	0.92
M. ferrea	5.86	15.77	y = 5.86ln(x) + 15.77	0.94*	0.94
T. rosea	6.35	15.29	y = 6.34ln(x) + 15.29	0.91*	0.85
J. mimosifolia	12.33	3.90	y = 12.33x + 3.90	0.95*	0.92
M. zeylanica	1.89	4.29	$y = 4.29^{\,e1.89x}$	0.97*	0.93

DBH = Diameter at Breast Height, b = Regression coefficient/slope, A = intercept, r = Pearson's correlation coefficient, r^2 = Coefficient of determination

Conclusions and Recommendations

Allometric study of six frequently used shade tree species in landscaping revealed positive correlations between CW/TH, DBH/TH and CW/DBH. The relationships were linear, logarithmic and exponential among tree parameters. Revealing species specific allometric relationships, this study provides important criteria for selecting shade trees compatible with the environmental conditions such as wind, sunlight, space and expectations of people such as shade and canopy cover.

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