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Selecting Model Parameter to Predict Yield Function in Two Year Old *Acacia bivenosa*

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Abstract Estimation of yield functions (fuel, fodder and biomass) in 2 year old *Acacia bivenosa* DC stand under different set of conditions has been reported in this papers. The precise estimate of stem diameter just above ground (immediately prior to branching point) appeared to be reasonable predictor of yield. It has also been observed that planting seedlings of the species in wider spacing, only benefits the height increment.

Key words Parameter, Prediction, *Acacia bivenosa*, Yield

Acacia bivenosa was for the first time introduced at Central Arid Zone Research Institute, Jodhpur (India) during the year 1980 to assess its adaptability, growth behaviour and utility in environmental conditions of arid western Rajasthan. The results of last ten years experimentation on the plant have proved its potential as a highly adaptable multipurpose species for arid tracts of India (Tewari *et al.* 1991).

It is often very difficult and time consuming to measure precisely the various growth and yield parameters of this plant as it has complex multi-stemmed and dense spreading structure right from the base. Therefore, there is growing necessity for a simple, preferably non destructive method for reliably estimating various yield parameters (fuel, fodder and biomass) of the plant. Mensurationists from time to time have advocated various models for estimating growth and yield of different woody species of simple architecture (Sadiq 1985). However, no such study is known to authors in which complex structured species like *A. bivenosa* was involved. This paper attempts to present a reliable model for predicting important yield functions of *A. bivenosa* by using certain growth parameters under defined set of conditions.

Materials and Methods

Observations on plant height, crown diameter and stem diameter (above 5 cm from the ground prior to branching point) of forty, 2 year old *A. bivenosa* plants maintained at 3x3 m spacing on silvatum of CAZRI, Jodhpur was recorded in 1990 just after growing season was over. They were then

Table 1 *Regression results of growth parameters on biomass in 2 year old A.bivenosa*

Explanatory variable	Regression coefficient	T–value	Intercept	FC	R^2	Durbin-Waston Statistic
a) Height (H)	11.29	0.427	–4294.45	5.23	0.374	0.220[a]
Stem diameter (s)	1452.54**	2.693				
Crown diameter (c)	25.40	1.630				
No. of branches (B)	64.19	0.278				
b) Height (H)	12.84	0.478	–4374.58	7.13	0.372	0.219[a]
Stem diameter (s)	1485.24	2.858				
Crown diameter (c)	25.82	1.687				
c) Stem diameter (s)	1592.02	3.430	–3745.75	10.81	0.368	0.224[a]
Crown diameter (c)	27.01	1.894				
d) Stem diameter (s)	1869.65**	4.108	1927.68	16.88	0.307	0.213[a]

a = No autocorrelation

Table 2 *Regression results of branch diameter (d) on leaf weight (L) and twig weight (TW) in 2 yr old A. bivenosa.*

Curves		Equations	R^2
Linear	L	$= -1134.66 + 102.07\,d$	0.633
	TW	$= -658.23 + 661.12\,d$	0.525
Simple	L	$= 70.63 \times 3.25^d$	0.688
Exponential	TW	$= 67.93 \times 2.85^d$	0.635
Power	L	$= 162.90d^{2.28}$	0.680
	TW	$= 142.16d^{2.04}$	0.633
Exponential	L	$= 70.63 \times e^{(1.17d)}$	0.688
	TW	$= 67.93 \times e^{(1.05d)}$	0.635
Log-linear	L	$= -366.98 + 1924.16 \log d$	0.588
	TW	$= -167.72 + 1251.44 \log d$	0.494

All values significant at 1 % level.

harvested and their total number of branches/ twigs and above ground biomass (branches + leaves) was recorded following Misra (1968). Similarly, from other set of seventy-five plants data on diameter of main branch was recorded. After harvesting all the plants of second set, their leaves and branches were weighed separately.

In another completely randomized experiment *A. bivenosa* seedlings were outplanted at Silvatum of CAZRI, Jodhpur during 1988 under different spacing (viz. 2x2 m, 2x3 m and 2x4 m). In each case though the number of replicates were three unequal number of entries was observed. Observations on plant height and crown diameter were recorded yearly after completion of growing season for two consecutive years.

For all model parameters, data of each tree served as single replicate. Step down regression analysis was done using least square technique and to further substantiate the authenticity of the results obstained, multicollinearity and autocorrelation tests were also performed. Linear and curvilinear regression analyses were also carried out besides usage of standardized residuals for justifying linear relationship between plant height and crown diameter in the spacing trial.

Results and Discussions

The results of step down regression analysis carried out using biomass (Y) as response variable and, height (H), stem diamter (s), crown diameter (c) and number of branches (B_1) as predictors revealed that only stem diameter significantly accounts for biomass (Table 1). The multiple regresssion coefficients are significant at 5% level at all the steps of analysis. Further, calculated Durbin Waston statistic when compared to tabulated d_l and d_u at all the steps clearly demonstrated the complete absence of any autocorrelation. It was also observed that on deleting a variable estimated coefficient (RSQ) did not show abrupt changes. All the values of standardized residuals lie between-2 and +2. In addition to this, the values of correlation coefficients among different predictor variables were not too high (lying between 0.23 and 0.55). This clearly indicated the non-existence of multicollinearity between explanatory variable according to Klein's (1953) criterion. Therefore the predictor equation can be represented as :

$$Y = 1927.68 + 1869.65\,s\ (R^2 = 0.307) \text{.....eq.1.}$$

Linear and curvilinear regression analysis related to branch diameter (d) with total leaf weight (L) as well as twig weight (TW) clearly exhibited that though all types of curves significantly represented their relationships but simple exponential curves are most befitting as they had maximum R^2 values (Table 2). The predictor equations can be represented as :

$$L = 70.63 \times 3.25d\ (R^2 = 0.688) \text{......eq.2}$$

$$\text{and } TW = 67.93 \times 2.85d\ (R^2 = 0.635) \text{.....eq.3}$$

The total number of branches and crown diameter, on the contrary, were not significantly correlated in any of the curves.

Analysis of variance of spacing trial revealed that plant height (H) increment significantly increased with increasing spacing (Table 3). On the contrary, increase in mean crown diameter (c) at wider spacing was statistically non-significant. Further, correlation analysis at different spacings revealed that their relationship was well defined only at 2x4 m spacement. The R^2 value too progressively increased with increasing spacing (Table 3). Thus their relationship for 2x4 m spacement can be represented as :

$$c = -12.16 + 4.43H\ (R^2 = 0.53) \text{...eq.4}$$

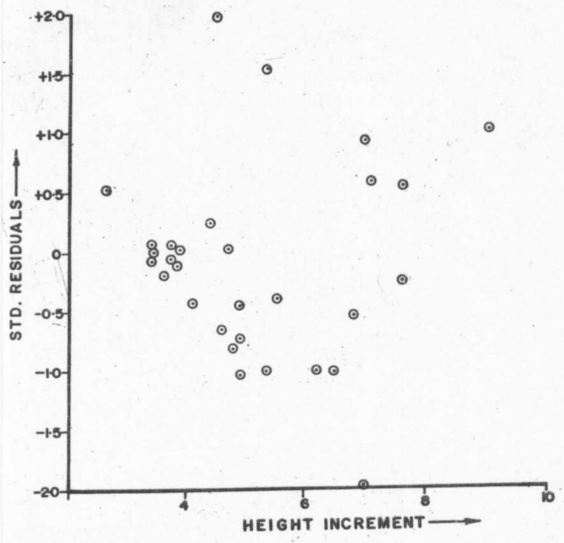

Fig 1 Plot of standardized residuals versus plant height increment in case of 2x4 m spacement.

Table 3 *Increment of plant height (H) and crown diameter (c) and results of their regression at different spacings.*

Spacing	Mean increment in Plant height	crown diameter	Equations	R^2
2 x 3 m	3.877	8.720	c = 0.311 + 2.16H	0.06
2 x 3 m	4.558	10.448	c = −3.520 + 3.06H	0.17
2 x 4 m	5.193	10.849	c = −12.16 + 4.43H*	0.53
CD 1 %	0.872	NS		
5 %	0.658	NS		

* Significant at 1 % level

Sadiq (1985) also developed growth and yield model for *Pinus resinosa* on more or less similar lines and found basal area as reasonable predictor of yield functions. Further, the plot of standardized residuals (all values lying between± 2) versus height increment showed random distribution (Fig.1). This justified the fitness of linear regression equation for representing relationship between plant height and crown diameter.

Thus, it can be concluded that measurement of stem diameter and number & diameter of main branches can give rough estimate of all yield functions in this species. For example selecting mean values of these predictors from table 4 and fitting them in eq 2 and 3 gives rough estimates as depicted in column 2 of the table 4.

Table 4 *Actual mean values of the parameters of the harvested trees and the estimated yield functions.*

Parameters	Actual value (1)	Estimated value (2)
Above ground biomass	11042.250	7941.63*
Height	132.025	
Stem diameter	4.875	
Crown diameter	253.500	
No. of branches	5.050	
Mean branch diameter	2.171	
Twig weight	710.473	659.98 (from eq.2)
Leaf weight	980.054	912.62 (from eq.3)

*Value obtained by multiplying additive values of estimated twig and leaf weight with actual mean number of branches borne on a 2 yr old *A. bivenosa.*

Moreover these statistical analyses also indicated that planting *A.bivenosa* seedlings at wider spacing only benefited height increment. The changes in biomass and crown diameter was not significantly correlated with increasing spacing (Anonymous 1990). However, it is still premature to interpret that wider spacing may not be advantageous as information on the root system of the species is totally lacking.

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