



PATH ANALYSIS IN CLONES OF *CASUARINA EQUISETIFOLIA*

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**ABSTRACT:** Path analysis was performed in 33 select clones of *Casuarina equisetifolia* at the Institute of Forest Genetics and Tree Breeding, Coimbatore. Path analysis is a special use of multiple regression to help understand and parcel out the sources of variation. In the integrated structure of the plant, the overall correlation observed between two variables will be a function of series of direct and indirect relationships between different variables. Though correlation analysis measures the relationship between dependent and independent characters, it does not provide information on how much a character contributes on its own and through other characters on the dependent variable. Path analysis was performed in the present study to understand the direct and indirect effects of characters namely, crown length, cladode length, cladode diameter and number of primary branches on volume index. Crown length only showed positive direct effect on volume. However, cladode length, cladode diameter and number of primary branches exerted positive indirect effects through crown length. Among these three traits, number of primary branches registered the maximum indirect effect. Crown length also registered high values for broad-sense heritability, genetic gain and genotypic coefficient of variation and thus, emerged as an important parameter for selecting superior genotypes.

**Key Words:** Casuarina, Clonal Forestry, Path Analysis, Genetic Studies, Regression

**INTRODUCTION**

Path analysis is a special use of multiple regression to help understand and parcel out the sources of variation. In the integrated structure of the plant, the overall correlation observed between two variables will be a function of series of direct and indirect relationships between different variables. Though correlation analysis measures the relationship between dependent and independent characters, it does not provide information on how much a character contributes on its own and through other characters on the dependent variable. Path analysis [1] on the other hand, partitions correlation coefficients into direct and indirect effects and provides more realistic approach for understanding the interrelationship of characters and helps in identification of the effective components. Whenever it is suspected that there are casual, rather than spurious or coincidental correlations within the independent variables, path analysis can be applied that looks explicitly at the cause.

**MATERIALS AND METHODS**

The basic experimental materials comprised of clones of *Casuarina equisetifolia* L. selected and assembled in the clone bank of Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore (Latitude 11° 01' N, Longitude 77° 02' E) from Chidambaram (CH), and Chengalpet (CP) in Tamil Nadu, India. Thirty-three CH/CP clones grown in a randomized block design with six replications were used for the study.

**Selection of Clones:** Extensive survey of 3 to 4-year-old *C. equisetifolia* plantations in the coastal belt of Tamil Nadu was carried out and plantations raised by the State Forest Department (Tamil Nadu) and private planters at Chidambaram (Latitude 11° 24' N, Longitude 79° 44' E) and Chengalpet (Latitude 12° 42' N, Longitude 80° 01' E) [2]. The selection of trees was carried out by dividing each of the plantations into 50 grids (blocks) to minimize the soil heterogeneity effect on the performance of individual trees. In each grid, trees with good height, high collar diameter (CDM) and diameter at breast height (DBH), straight and clear main bole, self pruning capacity, narrow crown with fewer branches and no incidence of disease and pests were selected.

The block adjustments of phenotypical values were carried out following Cotteril and Dean [3]. The phenotypic selection was followed by the construction of selection index for each selected tree with the block adjusted phenotypical values. The main bole volume was considered as the principal trait for the construction of selection index and its correlation with tree height, CDM, DBH, frustum volume and pole value was estimated.

The index of each character was calculated by multiplying the block adjusted phenotypic value with the correlation coefficient of the trait with main bole volume, since the correlation coefficient of main bole volume with other traits was considered as the weightage for the index selection. The total selection index was calculated by adding all the six values for each selected tree.

$$TSI = x_1R_{1,6} + x_2R_{2,6} + x_3R_{3,6} + x_4R_{4,6} + x_5R_{5,6} + x_6$$

where, TSI is the total selection index,  $x_1, x_2, x_3, x_4, x_5$  and  $x_6$  are the block adjusted phenotypic values for tree height, CDM, DBH, frustum volume, pole value and main bole volume, respectively and  $R_{1,6}, R_{2,6}, R_{3,6}, R_{4,6}, R_{5,6}$  are the correlation coefficients (weightage) for tree height, CDM, DBH, frustum volume and pole value with the main bole volume, respectively. After calculating selection index for all the initially marked trees, final selection of superior trees was carried out. In this way 106 phenotypically superior trees of *C. equisetifolia* were selected and assembled in the clone bank of IFGTB [2, 4]. Among the 106 clones, 33 clones were used for the present study.

Path analysis was performed to understand the direct and indirect effects of characters namely, crown length, cladode length, cladode diameter and number of primary branches on volume index recorded at 8 years of age. Path coefficients were obtained by setting simultaneous equations following Dewey and Lu [5].

$$r_{1,y} = P_{1,y} + r_{1,2}P_{2,y} + \dots + r_{1,p}P_{p,y}$$

$$r_{2,y} = r_{2,1}P_{1,y} + P_{2,y} + \dots + r_{2,p}P_{p,y}$$

$$r_{p,y} = r_{p,1}P_{1,y} + r_{p,2}P_{2,y} + \dots + P_{p,y}$$

Where,  $P_{1,y}, P_{2,y}, \dots, P_{p,y}$  are the direct effects of characters 1, 2, .....p on y and  $r_{1,2}, r_{1,3}, \dots, r_{p,y}$  are the correlation coefficients.

The indirect effect of  $i^{\text{th}}$  variable via  $j^{\text{th}}$  variable was calculated as  $(P_{jy} \times r_{ij})$  and the residual effect, representing all other unknown factors which might effect the yield, was calculated as follows.

$$P_{Ry} = 1 - P_{1,y}r_{1,y} - P_{2,y}r_{2,y} - \dots - P_{p,y}r_{p,y}$$

Where,  $P_{Ry}$  is the residual effect

## RESULTS

The genotypic correlation coefficients of volume index with crown length, cladode length, cladode diameter and number of primary branches were further divided into direct and indirect effects using path analysis. As volume index and frustum volume are derived parameters, to exclude the effect of co-linearity, total height, CDM and DBH were not considered for the analysis. Table 1 explains the results obtained for path analysis in CH / CP clones.

**Table 1. Direct (Diagonal) and indirect effects of selected characters on volume index in CH / CP clones**

Characters	Crown Length	Cladode Length	Cladode Diameter	Primary Branches No.	'r' value
Crown Length	<b>0.989</b>	-0.006	-0.047	-0.050	0.886
Cladode Length	0.308	<b>-0.019</b>	-0.051	-0.013	0.225
Cladode Diameter	0.348	-0.007	<b>-0.134</b>	0.009	0.216
Primary Branches No.	0.538	-0.003	0.014	<b>-0.091</b>	0.458

Residual Effect: 0.0380

**Direct effects:** Among the four characters, only crown length showed positive direct effect (0.989) on volume index. Cladode length, cladode diameter and number of primary branches recorded negative direct effects in the tune of -0.019, -0.134 and -0.091 respectively.

**Indirect effects:** Crown length exhibited negative indirect effects through cladode length (-0.006), cladode diameter (-0.047) and number of primary branches (-0.050). Cladode length, cladode diameter and number of primary branches exerted positive indirect effects on volume index through crown length (0.308, 0.348 and 0.538 respectively).

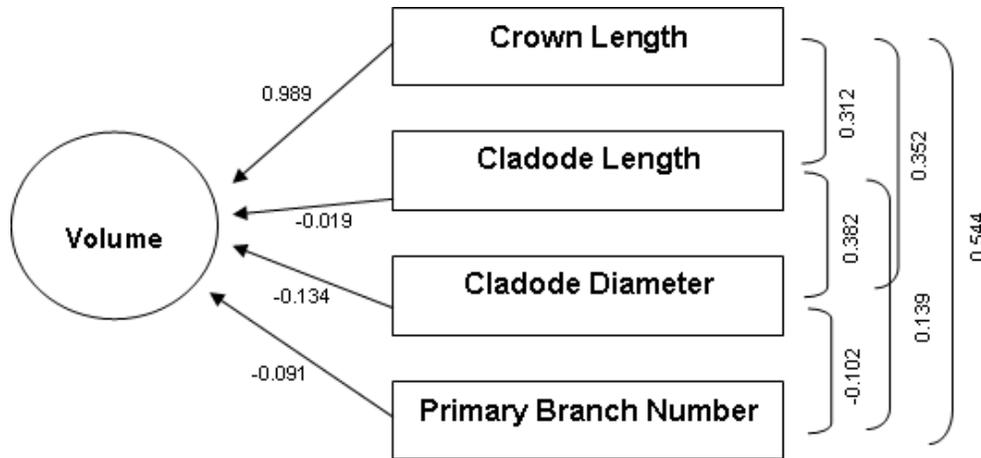


Fig.1. Path diagram showing relationship among the selected characters in CH / CP clones

## DISCUSSION

Path coefficient analysis was carried out for volume index using four independent characters namely, crown length, cladode length, cladode diameter and number of primary branches which were not used to obtain the derived parameter. In CH/CP clones, crown length only showed positive direct effect on volume. However, cladode length, cladode diameter and number of primary branches exerted positive indirect effects through crown length. Among these three traits, number of primary branches registered the maximum indirect effect (Table 1 and Fig.1).

If the correlation between dependent and independent character is due to the direct effect of the character, it reflects the true relationship between them and thus, selection can be practised for such a character in order to improve the dependent trait. If the correlation is due to indirect effect of the characters through a component trait, the selection has to be done for the latter trait through which the indirect effect is exerted. Hence, a change in one character alters its relationship with other component character(s) and finally reflects on the dependent character [2]. The present results suggest that crown length alone can bring improvement for volume. Crown length also registered high values for broad-sense heritability, genetic gain and GCV (data not shown) and thus, emerged as an important parameter for selecting superior genotypes. Crown length and clear bole length were identified as the main components affecting volume directly when path analysis was carried out to partition the direct and indirect effects of volume contribution traits including tree height, DBH, clear bole length, crown length, crown diameter, taper, primary branch number and branch length in *Populus deltoides* [6].

Unlike agriculture, reports on path analysis are available only for limited number of species in the field of forestry. Studies have been carried out in *Terminalia tomentosa*, *T. arjuna* [7], *Spondias tuberosa* [8], *Casuarina equisetifolia* [2,9], *Populus* species [10], *Santalum album* [11], *Dalbergia sissoo* [12], *Pseudotsuga menziessii*, *Tsuga heterophylla* [13], *Picea glauca* and *Alnus crispa* [14], *Pinus gerardiana* [15].

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