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AGE-AGE CORRELATION IN *CASUARINA EQUISETIFOLIA*

*Kannan C.S. Warrier and B. Gurudev Singh

Institute of Forest Genetics and Tree Breeding
(Indian Council of Forestry Research and Education)
PB 1061, Forest Campus, RS Puram, Coimbatore India – 641 002

ABSTRACT: Considering the ever-increasing demand for supply of raw materials for the forest based industries, there is an urgent need to increase the area under superior planting stock and enhance the productivity. In tree species, evaluation of a clonal trial at an early age using information on age-age correlations would pave the way for early supply of superior clones for production forestry programmes. It is therefore, essential to determine the optimum age at which early selection can be made. Eighty-seven clones of *Casuarina equisetifolia* selected from the clone bank of the Institute of Forest Genetics and Tree Breeding, Coimbatore, India were tested for age-age correlation. Age-age genotypic correlations between different observations were higher when compared to age-age phenotypic correlations. The results revealed that selection for tree height, DBH, and volume index at age 3 using age 1 data would respectively be 88.3, 79.6 and 76.6 per cent as effective as selection at age 3.
Key Words: Age-age correlation, Juvenile-adult correlation, *Casuarina equisetifolia*, Association studies

*Corresponding author: Kannan C.S. Institute of Forest Genetics and Tree Breeding PB 1061, Forest Campus, RS Puram, Coimbatore India – 641 002 Email: kannan@icfre.org, kannanwarrier@gmail.com

INTRODUCTION

Casuarina equisetifolia L. is one among the widely accepted tree species by the farmers in South India due to its fast growth, multiple end uses and suitability in the agrarian ecosystem. It is generally harvested at 4 years under irrigated condition and 8 years under rain-fed lands. Considering the ever-increasing demand for supply of raw materials for the forest based industries, there is an urgent need to increase the area under superior planting stock and enhance the productivity. In tree species, evaluation of a clonal trial at an early age using information on age-age correlations would pave the way for early supply of superior clones for production forestry programmes. It is therefore, essential to determine the optimum age at which early selection can be made.

MATERIALS AND METHODS

Eighty-seven clones selected from the clone bank of the Institute of Forest Genetics and Tree Breeding, Coimbatore, India were used for the experiment. The field trial was established at Mayiladumparai, Karur district in Tamil Nadu, India (Latitude: 10^o 52.080' N and Longitude: 78^o 27.376' E, Inland red soil)

Phenotypic and genotypic correlations were calculated by using the method given by Goulden [1]

$r(x_1x_2) = COV(x_1x_2) / V(x_1).V(x_2)^{1/2}$

where,

$r(x_1x_2)$ - Correlation between x_1 and x_2
$COV(x_1x_2)$ - Covariance between x_1 and x_2
$V(x_1)$ - Variance of x_1
$V(x_2)$ - Variance of x_2

Phenotypic correlation

$$rp.\ 1.2 = \frac{\text{Phenotypic covariance between 1 and 2}}{(\text{Phenotypic variance of 1} \times \text{Phenotypic variance of 2})^{1/2}}$$

Genotypic correlation

$$rg.\ 1.2 = \frac{\text{Genotypic covariance between 1 and 2}}{(\text{Genotypic variance of 1} \times \text{Genotypic variance of 2})^{1/2}}$$

Age-age phenotypic correlation for a trait was estimated using the following formula:

$r(age\ x,y) = (\sigma x \,.\, \sigma y) / (\sigma^2 x \,.\, \sigma^2 y)^{1/2}$ where,

$\sigma x \,.\, \sigma y$ is phenotypic covariance for a trait at age x and age y

$\sigma^2 x$ is phenotypic variance for a trait at age x

$\sigma^2 y$ is phenotypic variance for a trait at age y

$r(age\ x,y)$ is phenotypic age-age correlation between age x and age y

Age-age genotypic correlation for a trait was estimated using the formula

$r(age\ x,y) = (\sigma x \,.\, \sigma y) / (\sigma^2 x \,.\, \sigma^2 y)^{1/2}$ where,

$\sigma x \,.\, \sigma y$ is genotypic covariance for a trait at age x and age y

$\sigma^2 x$ is genotypic variance for a trait at age x

$\sigma^2 y$ is genotypic variance for a trait at age y

$r(age\ x,y)$ is genotypic age-age correlation between age x and age y

Phenotypic and genotypic age-age correlations were worked out for tree height, DBH and volume index (d^2h) between various combinations of ages from 1 to 3.

RESULTS AND DISCUSSION

Results of the age-age correlation studies carried out at Mayiladumparai are presented in Tables 1 and 2. Significant and positive coefficients of phenotypic and genotypic correlations were observed for the three traits (tree height, dbh and volume index) among all the combinations of ages. Age-age genotypic correlations between different observations were higher when compared to age-age phenotypic correlations. The values of phenotypic and genotypic correlation coefficients varied from 0.705 to 0.896 and 0.883 to 1.000 for total height, 0.700 to 0.902 and 0.796 to 0.968 for DBH and 0.674 to 0.896 and 0.766 to 0.961 for volume index respectively from ages 1 to 3. The correlation coefficients between age 2 and age 3 were found to be the maximum (> 0.960) for all the variables. However, the correlation coefficients between age 1 and 3 were also found highly significant.

Age-age correlation studies are performed to understand the relation between observations of the same trait recorded at different ages and are generally used in studying the juvenile-mature correlations. Juvenile-mature correlations are of major interest in breeding of forest trees because it helps to develop efficient early selection techniques. The most frequently cited advantage of early selection in tree breeding is reduction in the length of breeding cycle [2,3,4] Shortening a tree breeding cycle through early selection could produce more genetic gain per unit time if there is sizable genetic correlation between early and mature traits [5].

Increasing amounts of research programmes are being devoted to description and quantification of juvenile-mature relationships in commercially important forest tree species. Age-age correlations for growth parameters have been worked out mainly in *Eucalyptus globulus* [6], *E. grandis* [7], *E. nitens* [8], *E. urophylla* [9], *Pinus massoniana* [10], *Cunninghamia lanceolata* [11], *Populus deltoides* [12], *Pinus maximinoi* [13], *P. sylvestris* [14] and *Casuarina equisetifolia* [15].

In the present study, the genotypic correlation coefficients were higher in magnitude than the phenotypic correlation coefficients for all the traits indicating that the association between these traits was genetically controlled. Similar trend was reported by many researchers in different species [16,17,18,19,20].

Significant and positive correlations were recorded for tree height, DBH and volume index among all combinations of ages at phenotypic and genotypic levels at all the three locations. As the efficiency of early selection strongly depends on the genetic age-age correlation, genotypic correlation coefficients were given due importance. Phenotypic age-age correlations need not be reliable as the environmental effects could bias the covariances and correlations [21] A refined analysis of age-age correlations requires a break-up of the phenotypic age-age correlation into a genetic and an environmental component. Such an analysis was possible in the present study as the experimental materials were clones.

Though the maximum values of correlation were recorded between ages 2 and 3, genetic correlation coefficients obtained between ages 1 and 3 were also very high in magnitude (0.760 to 1.000) for all the characters. Selection for tree height, DBH, and volume index at age 3 using age 1 data would respectively be 88.3, 79.6 and 76.6 per cent as effective as selection at age 3 at Mayiladumparai.

The results imply that observations recorded on tree height, DBH and volume index at age 1 could be reliable indicators for the growth at age 3 and selection at an early age may be practised to maximize the gain per unit time. Studies on age-age correlations in a progeny test with 31 families of *Casuarina junghuhniana* revealed that significant and positive correlation existed between height at 5 months and 5 year, and DBH at 1 and 5 year after planting [22].

Table 1. Age-age phenotypic correlation for selected characters at Mayiladumparai

Tree Height

	Year 1	Year 2	Year 3
Year 1	1.000	0.728	0.705
Year 2		1.000	0.896
Year 3			1.000

Diameter at Breast Height

	Year 1	Year 2	Year 3
Year 1	1.000	0.800	0.700
Year 2		1.000	0.902
Year 3			1.000

Volume Index

	Year 1	Year 2	Year 3
Year 1	1.000	0.747	0.674
Year 2		1.000	0.896
Year 3			1.000

Table 2. Age-age genotypic correlation for selected characters at Mayiladumparai Tree Height

	Year 1	Year 2	Year 3
Year 1	1.000	0.899	0.883
Year 2		1.000	1.010
Year 3			1.000

Diameter at Breast Height

	Year 1	Year 2	Year 3
Year 1	1.000	0.923	0.796
Year 2		1.000	0.968
Year 3			1.000

Volume Index

	Year 1	Year 2	Year 3
Year 1	1.000	0.905	0.766
Year 2		1.000	0.961
Year 3			1.000

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