

Original Research Article

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## Variation in Growth Traits of *Acrocarpus fraxinifolius* Wight and Arn Populations in Southern Karnataka, India

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### ABSTRACT

#### Keywords

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The present investigation was carried out to quantify the variation in growth characters of *Acrocarpus fraxinifolius* across the selected populations in the coffee growing regions of southern Karnataka. The growth parameters such as total tree height, clear bole height and girth at breast height were recorded and basal area and volume were estimated. Tree height varied significantly and the maximum tree height was recorded in Mudigere and Chikamagaluru (26.14 m) populations. The difference in GBH was found to be non-significant across the populations, which could be due to selection of trees in particular girth class. The clear bole height of trees varied across the populations from 9.19 m in Bhagamandala to 18.93 in Totadagadde. Basal area of *A. fraxinifolius* was relatively higher in Shuntikoppa (0.157 m<sup>2</sup>) and volume was maximum in Balehonnuru population (1.298 m<sup>3</sup>).

### Introduction

Forests provide myriad tangible and intangible benefits for human wellbeing. In recent decades, wood has become one of the vital forest products and it is an important raw material for forest-based industries such as sawmills, composite and plywood, pulp and paper industries. *Acrocarpus fraxinifolius* is one of the fast-growing indigenous tree species which is considered to be the promising tree species suitable for making plywood, planks, panel and construction purpose with its other multi-purpose services such as erosion control, fodder, gum, fuel

wood, etc. (Nath *et al.*, 2012). *Acrocarpus fraxinifolius* is a large sized tree belongs to sub-family Caesalpinioideae under family Fabaceae. *A. fraxinifolius* is the only species under genera *Acrocarpus*. It is commonly known as Belanji and Havalige (Kannada), Mandane (Bengali), Nelarai (Tamil), Kurangadi (Malayalam), Pink cedar, etc. in different parts of the country. Belanji can grow up to 60 m tall with the cylindrical bole free from branches up to ¾ of its total height. Balanji, being timber yielding tree species; it is naturally distributed in high rainfall areas in the evergreen forests of Western Ghats, Sikkim, West Bengal and Assam. It is mostly

cultivated in Kodagu and South Canara as shade-tree in coffee estates (Troup, 1921; Ghildyal, 1989). Belanji is the most adapted tree species for shade purposes in the coffee plantation with its fast-growing nature and multi-utility purpose among diverse native shade trees viz., *Dalbergia*, *Syzygium*, *Lagerstroemia*, etc. (Nath *et al.*, 2011).

The sapwood of *Acrocarpus* is white and the heartwood is pinkish, which is commonly used in making veneers and plywood. It is also used as timber in furniture, door, windows, beams, rafters, etc. The wood is used as pulp for making paper (Orwa *et al.*, 2009). The pulp is best suitable for Kraft paper. Though the species is leguminous, it is not capable of fixing the nitrogen; however, it has been recommended for erosion control due to its strong taproot. Leaves are suitable for mulching. Timber is odourless and is suitable for fruit packing cases (Ghildyal, 1989). Trees exude gum like resinous substance when it is felled or cut. Belanji was termed as the tree for the future because of its multi-purpose utility (Mishra *et al.*, 2015) and also recommended as one of the promising species for Agroforestry. The evaluation of variation in growth character is necessary for the delineation of better provenances and the conceptualization of advanced breeding strategies.

For initiation of any breeding program knowing the variation or variability is essential. When the exception is more, there is scope for selection. Variation is influenced by genetic parentage as well as the environment where it is growing. In this context, an effort has been made to assess the variation among the populations from different populations in southern Karnataka.

## Materials and Methods

The present study was carried in three major coffee-growing districts of Karnataka viz.,

Kodagu, Chikamagaluru, and Hassan. Nine populations of *Acrocarpus fraxinifolius* (Table 1) were selected from the three major coffee growing districts. In order to avoid the variation influenced by the age, 20 trees in the range of 120 cm to 150 cm girth at breast height (GBH) were randomly selected from each population in each district. Tree growth parameters such as total tree height, clear bole height and girth at breast height were recorded on each selected trees to study the variation in growth across the selected populations. The basal area and volume were estimated based on the standard formulas mentioned below;

$$BA = G^2 / 4\pi$$

$$V = BA \times H \times ff$$

Where,

BA is basal area, G is girth at breast height, V is volume, H is total tree height, ff is form factor (0.33).

## Statistical analysis

The data obtained on growth parameters such as total tree height, clear bole height, girth at breast height (GBH) were subjected to the One-way ANOVA to understand the variation across different populations as described by Panse and Sukhatme (1978) using SPSS 16.0 software.

## Hierarchical Grouping

Hierarchical grouping and dendrogram was done by cluster analysis method of Average Linkage (between groups) with the measure of Squared Euclidean Distance using SPSS 16.0 software as suggested by Pande *et al.*, 2013.

## Results and Discussion

Phenotypic traits such as total tree height, GBH and clear bole height were considered as the variables and reported to be under adequate control of genotype and environment (Zobel, 1981). The results of the present study exhibited the noticeable dissimilarity among the populations (Table 2).

The total tree height was significantly varied across the populations with a maximum tree height of 32.00 m and a minimum height of 13.40 m. Among nine populations, Chikamagaluru and Mudigere populations showed maximum mean height of 26.14 m followed by Balehonnuru (25.81 m), Sakleshpura (25.68 m), Shuntikoppa (24.85 m), Totadagadde (23.61 m), Shreemangala (22.76 m), Bhagamandala (22.16 m) and Vanaguru (19.99 m) (Fig. 1 a). The clear bole height showed a significant difference (Fig. 1 b) with a maximum mean clear bole height of 18.93 m in Totadagadde and minimum of 9.18 m in Bhagamandala population.

Difference in GBH was found to be non-significant across the populations which could

be due to selection of trees in particular girth class (1.20 m to 1.50 m) to avoid the effect of age on other parameters. Across the populations GBH varied between 1.23 to 1.48 m among the selected trees (Fig. 1 c). The basal area was also showed statistically non-significant variation across the populations. Among the different populations, the highest average basal area of trees was recorded in Shuntikoppa (0.157 m<sup>2</sup>) and lowest in Vanaguru (0.135 m<sup>2</sup>) population.

The average basal area varied from 0.109 to 0.225 m<sup>2</sup>. Estimated volume of the selected trees in different populations is presented in Table 2. Tree volume varied significantly across the populations (Fig. 1 d). The highest mean volume was recorded in Balehonnuru (1.298 m<sup>3</sup>) population whereas, the lowest mean volume was recorded in Vanaguru (0.886 m<sup>3</sup>) population. The average volume for populations was 1.298 m<sup>3</sup>, 1.296 m<sup>3</sup>, 1.276 m<sup>3</sup>, 1.267 m<sup>3</sup>, 1.264 m<sup>3</sup>, 1.129 m<sup>3</sup>, 1.111 m<sup>3</sup>, 1.075 m<sup>3</sup> and 0.886 m<sup>3</sup> in Balehonnuru, Shuntikoppa, Mudigere, Chikamagaluru, Sakleshpura, Totadagadde, Shreemangala, Bhagamandala and Vanaguru, respectively.

**Table.1** Details of geographic locations and weather parameters of selected populations of *Acrocarpus fraxinifolius*

Districts	Population	Latitude (N <sup>o</sup> )	Longitude (E <sup>o</sup> )	Altitude (m) (a.m.s. l)	Mean annual rainfall (mm)	Temperature (°C)	
						Max.	Min.
Kodagu	Shreemangala	12°06'	76°00'	832	1986.40	28.98	<b>17.95</b>
	Shuntikoppa	12°27'	75°50'	981	1558.90	27.95	<b>17.79</b>
	Bhagamandala	12°23'	75°31'	946	4854.50	28.66	<b>17.87</b>
Chikamagaluru	Chikamagaluru	13°16'	75°43'	1084	1305.00	28.99	<b>16.56</b>
	Balehonnuru	13°22'	75°31'	727	1584.90	30.06	<b>17.32</b>
	Mudigere	13°10'	75°39'	1030	1964.00	28.49	<b>17.91</b>
Hassan	Sakleshpura	12°57'	75°48'	945	2103.23	30.70	<b>18.67</b>
	Vanaguru	12°47'	75°45'	929	3559.00	29.24	<b>17.50</b>
	<b>Totadagadde</b>	<b>12°56'</b>	<b>75°46'</b>	<b>932</b>	<b>2304.50</b>	<b>29.73</b>	<b>17.82</b>

**Table.2** Variation in growth parameters across the populations

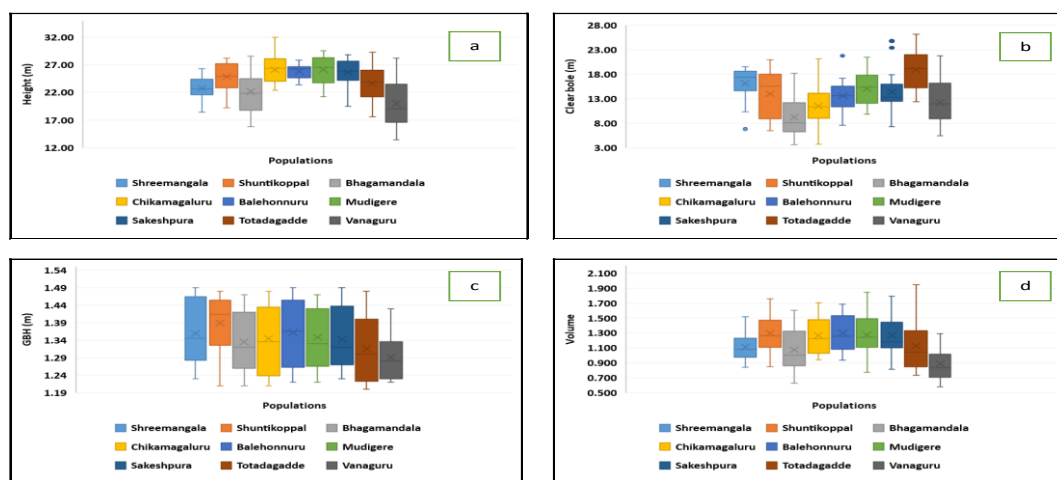
Populations	Total tree height (m)	Clear bole height (m)	GBH (m)	Basal Area (m <sup>2</sup> /tree)	Volume (m <sup>3</sup> /tree)
Shreemangala	22.78 <sup>b</sup>	16.15 <sup>d</sup>	1.36	0.147	1.111 <sup>bc</sup>
Shuntikoppa	24.85 <sup>cd</sup>	14.03 <sup>bcd</sup>	1.41	0.157	1.296 <sup>c</sup>
Bhagamandala	22.16 <sup>b</sup>	9.19 <sup>a</sup>	1.35	0.145	1.075 <sup>b</sup>
Chikamagaluru	26.14 <sup>d</sup>	11.53 <sup>ab</sup>	1.35	0.146	1.267 <sup>c</sup>
Balehonnuru	25.81 <sup>d</sup>	13.61 <sup>bcd</sup>	1.38	0.152	1.298 <sup>c</sup>
Mudigere	26.14 <sup>d</sup>	15.02 <sup>d</sup>	1.36	0.147	1.276 <sup>c</sup>
Sakleshpura	25.68 <sup>d</sup>	14.38 <sup>cd</sup>	1.36	0.149	1.264 <sup>c</sup>
Totadagadde	23.61 <sup>bc</sup>	18.93 <sup>e</sup>	1.33	0.143	1.129 <sup>bc</sup>
Vanaguru	19.99 <sup>a</sup>	12.21 <sup>bc</sup>	1.30	0.135	0.886 <sup>a</sup>
Mean	<b>24.13</b>	<b>13.89</b>	<b>1.36</b>	<b>0.147</b>	<b>1.178</b>
SEm(±)	<b>0.643</b>	<b>0.871</b>	<b>0.024</b>	<b>0.005</b>	<b>0.059</b>
CD @ 5%	<b>1.79</b>	<b>2.432</b>	<b>NS</b>	<b>NS</b>	<b>0.165</b>

Values in column carrying same alphabets does not differ significantly at P<0.05  
NS= Non-significant

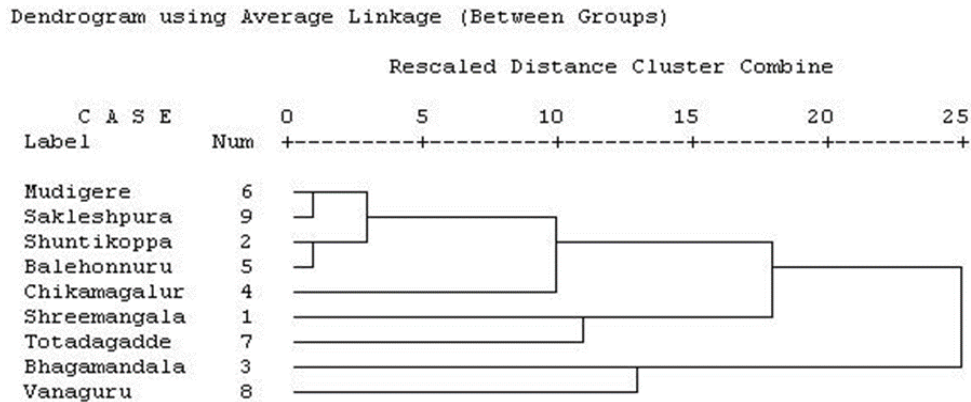
**Table.3** Population composition of different clusters

Cluster No.	No. of populations	Populations
I	5	Mudigere, Sakleshpura, Shuntikoppa, Balehonnuru, Chikamagaluru
II	2	Bhagamandala, Vanaguru
III	2	Shreemangala, Totadagadde

**Fig.1** Variation in (a) total tree height, (b) clear bole height, (c) girth at breast height, (d) volume across the selected *Acrocarpus fraxinifolius* population



**Fig.2** Dendrogram showing clusters of selected populations



### Hierarchical Grouping

Data collected for growth traits from nine populations were subjected to Hierarchical cluster analysis to categorize populations based on the degree of similarity. Based on Squared Euclidean distances, nine locations were grouped into three clusters. Cluster I had five populations (Mudigere, Sakleshpura, Shuntikoppa, Balehonnuru, Chikamagaluru), followed by cluster II with two populations (Bhagamandala, Vanaguru) and cluster III with two populations (Shreemangala, Totadagadde) (Table 3). The dendrogram (Fig. 2) was prepared using the Between-groups linkage method to reveal a similar pattern of information.

All living organisms are unique in their scale of variability. In the absence of variability, no amount of selection pressure can significantly improve the character. In the present investigation, the variation across the population was significant. The variability in these growth parameters could be attributed to varying rainfall and other climatic factors along with the altitude and latitude. In a similar study by Prasad *et al.*, (2010) in *Dipterocarpus indicus* natural populations from different parts of Western Ghats, attributed the variation in growth parameters to varying rainfall and latitude. Rowth (2016)

noticed similar observations in natural habitats of *Dalbergia latifolia* and attributed the population variation to different altitudinal ranges. Similar observations have been made by Sharma *et al.*, (2017) in *Dalbergia sissoo*, Pande *et al.*, (2013) in *Leucaena leucocephala* in 24 populations from Andhra Pradesh, Tamil Nadu and Orissa. Meena *et al.*, (2014) attributed the variation in different growth and yield parameters of *Melia azedarach* to varying climatic condition.

The pattern of variability on growth traits was significant across the selected populations. Considering the important growth parameters, Balehonnuru, Shuntikoppa Chikamagaluru and Mudigere populations are found to be better compared to other populations. Future selections (candidate plus trees) could be made from these populations.

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