



Clonal evaluation for early growth performance of *Eucalyptus* in South Gujarat, India

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Abstract: This study was carried out in College of Forestry, Navsari Agricultural University, Navsari, Gujarat. Total 20 clones having age of 5 ½ years were selected for early growth evaluation at field condition. There was a significant variation ($P < 0.05$) among 20 clones of *Eucalyptus* for growth parameters viz., tree height, DBH, mid-diameter, form quotient and volume of standing tree. Tree height varied from 18.5 to 23.6 m with DBH range of 11.47 to 16.07 cm. Mid-diameter indirectly helps to assess the tapering of tree and it ranged from 6.99 to 10.57 cm among 20 clones. The form quotient was used while calculation of volume of *Eucalyptus* clones. The form quotient varied between 0.58 and 0.71 with overall mean of 0.63 at studied site. Volume of standing tree ranged from 0.12 to 0.28 m³. The overall results showed that clones such as C12 (P2045), C17 (B2253), C4 (P413), C8 (P526), C7 (P498), C16 (SRO16) and C11 (P3020) performed superior for early growth attribute and stem form and these clones suggested for large scale plantation in South Gujarat region.

Keywords: Clone, DBH, *Eucalyptus*, Form quotient, Growth, Height, Volume

INTRODUCTION

Eucalypts is one of the fast growing tree species widely planted in the Tropics mainly for the purpose of pulp wood for paper and rayon. They are essentially Austro-Malayan trees with a natural latitudinal range extending from 7°N to 43°39' S. It flourishes from coastal areas to areas situated at an altitude of 2000 m, tropical to warm temperate climate and rainfall ranges of 400-4000 mm (Tewari, 1992). As a short rotation and fast growing nature, this species is widely preferred by farmers, where there is a great demand from pulp and paper industries as well as local market for pole (Saigal and Kashyap, 2002; Behera, 2016). Significant improvements in quality of produce and reductions in per unit production costs have also been possible with the use of true to type, uniform and genetically improved clonal planting stock of *Eucalyptus* (Lal, 2001). The demand of wood from forest or commercial plantation for timber, fuelwood, pulp and paper production is increasing year after year. Among many, *Eucalyptus* is widely planted in farm forestry system in the form of block plantations, boundary plantations, strip plantations and agroforestry systems throughout the world more particularly in India to provide wood products especially in the region of scarcity (Boland, 1980; Dogra and Sharma, 2003). India is one of the largest *Eucalyptus* growing countries with a total area of 1.36 million ha plantations up to 1999 (FSI, 1999), which is increased to around 8.00 mha up to 2010

(Aregowda *et al.*, 2010). More than 65 *Eucalyptus* species and various provenances were tried to meet the various wood based demands of the country (Kulkarni, 2004 and 2008). The productivity of *Eucalyptus* varies from country to country with changing climatic, edaphic and topographic conditions. In Congo, Brazil and Papua New Guinea, clonal plantations of *Eucalyptus* have produced 80-90 m³/ha/year (Ugalde and Perez, 2001) whereas in Indian conditions, the productivity ranged from 6 to 10 m³/ha/yr in seed route plantations (Lal, 1993) to 20 to 23 m³/ha/yr in rainfed conditions and 50 m³/ha/yr in clonal based managed farm plantations (Lal, 2001; Kulkarni, 2002), sometimes, it reached to 100 t/ha in pulp wood plantation (Kulkarni, 2014). The present study was undertaken to evaluate the different clones of *Eucalyptus* in South Gujarat conditions, India for further their selection and multiplication.

MATERIALS AND METHODS

The present trial was carried at the instructional farm of College of Forestry, Navsari Agricultural University, Navsari. The plantation was established during September 2009 consists of 20 clones planted at 2 x 2m spacing in three replications following Randomized Block Design (RBD). For the present study, total nine ramets per clone (3 ramets x 3 replications) were selected randomly and various growth parameters such as Diameter at Breast Height (DBH), mid-diameter, tree height were recorded at the age of 5½ years fol-

lowing Chaturvedi and Khanna (2000). DBH was measured 1.37 m from ground level using Mantax Blue Caliper whereas mid-point diameter (mid-diameter) was measured at the mid-point (*i.e.*, half of the height of tree) by using 1000 Criterion Dendrometer and total height of tree was measured from ground to the tip of the leading shoot by using Electronic Clinometer. Form quotient (FQ) was calculated by formula given by Schiffel (1899). Similarly, volume was also calculated following Panwar and Bhardwaj (2005) and Qunekham (2009). The experimental data were subjected to the statistical analysis as per the procedure suggested by Gomez and Gomez (1984) using RBD.

RESULTS AND DISCUSSION

Clonal variation for growth parameters such as DBH, mid-diameter, height, form quotient and volume was recorded and it was significantly differ among 20 clones of *Eucalyptus*. Results showed that DBH varied between 11.47 and 16.07 cm with an overall mean of 13.28 cm (Table 1). Maximum DBH was attained by clone C4 which was statistically at par with clones C17, C12, C8, C11 and C7. Variation among clones in growth parameter may be due to genetic make-up and interactions with the environmental factors. Kumar *et al.* (2010) reported significant variation among clones of *E. tereticornis* for DBH at the age of 5.5 years, where as Dhillon and Singh (2010) also found difference in diameter growth among clones of *E. tereticornis* Sm. at the age of 3.5 years. Luna and Singh (2009) also studied clonal variation for growth parameters including DBH among 12 clones of *Eucalyptus* tested

at Ludhiana. Such kind of variation would be helpful in selection of superior clones to the region for multiplication and plantation purposes to obtain higher biomass and economic returns. Lal *et al.* (2006) identified best clones out of 36 *viz.*, clone 2070, 285, 316, 288, 498, 286 and 2045 for Punjab ecological condition.

Significant variation among clones for tree height was recorded and it varied from 18.5 to 23.6 m (Table 1). Clones *viz.*, C17, C8, C12, C7, C15, C4, C18, C11 and C6 showed better tree height than other clones. This variation may be due to genetic factor, where all these clones are grown in a small piece of land having similar environmental condition. Such genetic based improvement would be ideal for selection of superior genotypes for further multiplication and afforestation programme in similar environmental condition. Such report is also recorded by several researchers in different eucalyptus species. Lal *et al.* (1997) reported that clone number 6 proved to be the best among all the 20 clones of *Eucalyptus* and exhibited maximum height of 23 m at 7 years age. Similarly, Lal *et al.* (2006) evaluated growth performance of 36 clones of *Eucalyptus* and clone 2070 performed best with maximum mean height of 16.29 m as compared to other clones at the age of 4 years. Luna and Singh (2009) studied the growth performance of 12 clones of *Eucalyptus* at Ludhiana. Clones bearing no. 413 and 2070 recorded significantly higher height growth as compared to other clones. Kumar *et al.* (2010) evaluated different clones of *Eucalyptus tereticornis* for different growth characters including tree height. Further, they identified Clone 3 and Clone 37 as a superior genotypes than

Table 1. Clonal variation in tree height, DBH and mid-diameter among 20 clones of *Eucalyptus*.

Clones	Tree height (m)	DBH (cm)	Mid-diameter (cm)
C ₁ : P72	20.50	13.40	8.76
C ₂ : P1	20.07	11.47	7.18
C ₃ : P405	18.53	11.47	7.21
C ₄ : P413	22.00	16.07	9.85
C ₅ : P411	20.13	13.13	8.07
C ₆ : P316	21.40	13.40	8.38
C ₇ : P498	22.13	14.23	9.29
C ₈ : P526	22.53	14.67	9.38
C ₉ : P2136	20.07	12.23	7.31
C ₁₀ : P2155	20.57	12.03	6.99
C ₁₁ : P3020	21.57	14.30	8.92
C ₁₂ : P2045	22.43	14.97	10.57
C ₁₃ : P2069	20.50	11.47	7.58
C ₁₄ : JK08	20.73	12.90	8.01
C ₁₅ : JK02	22.20	12.40	7.31
C ₁₆ : SRO16	20.73	14.23	8.98
C ₁₇ : B2253	23.60	15.23	9.87
C ₁₈ : B2153	22.00	12.97	8.20
C ₁₉ : B271	20.47	11.97	7.67
C ₂₀ : B288	20.37	13.07	9.22
Mean (C)	21.13	13.28	8.44
SEm (±)	0.80	0.88	0.60
CD @ 5.0 %	2.28	2.51	1.70
CV (%)	6.52	11.44	12.22

Table 2. Clonal variation in Form quotient and volume among the clones of *Eucalyptus*.

Clones	Form quotient	Volume (m ³)
C ₁ : P72	0.65	0.19
C ₂ : P1	0.62	0.14
C ₃ : P405	0.63	0.12
C ₄ : P413	0.61	0.27
C ₅ : P411	0.61	0.17
C ₆ : P316	0.62	0.19
C ₇ : P498	0.65	0.23
C ₈ : P526	0.64	0.24
C ₉ : P2136	0.60	0.14
C ₁₀ : P2155	0.58	0.14
C ₁₁ : P3020	0.62	0.22
C ₁₂ : P2045	0.71	0.28
C ₁₃ : P2069	0.66	0.14
C ₁₄ : JK08	0.62	0.17
C ₁₅ : JK02	0.59	0.16
C ₁₆ : SRO16	0.63	0.21
C ₁₇ : B2253	0.65	0.28
C ₁₈ : B2153	0.63	0.19
C ₁₉ : B271	0.64	0.15
C ₂₀ : B288	0.71	0.20
Mean (C)	0.63	0.19
SEm (±)	0.014	0.028
CD @ 5.0 %	0.041	0.079
CV (%)	3.93	24.82

others. Gangwar *et al.* (2015) identified Clone AP10 of *Eucalyptus* as the best clone among the studied ones based on height. Such genetic based variation is highly suitable for further selection and multiplication.

Mid-diameter measurement is required to determine the rate of taperness of stem and that influences the final quantity of volume. Therefore, mid-diameter help to minimize the error while calculating stem volume. Taper is closely related to the growing space available to the individual tree and is extremely high for solitaries. Similarly, form quotient is also help in precise the tree volume. In the study, both mid-diameter and form quotient showed significant variation among 20 clones. Mid-diameter varied from 6.99 to 10.57 cm among 20 clones (Table 1). Clones such as C₄, followed by C₁₇, C₈, C₇, C₂₀, C₁₆ and C₁₁ recorded highest values for mid diameter as compared to other clones. It indicates that higher mid diameter representing lower taperness or near to the cylindrical shape that indirectly indicating more biomass. Moreover, form quotient value ranged from 0.58 to 0.71 among 20 clones, where clones such as C₁₂ and C₂₀ exhibited more of cylindrical bole form having FQ value > 0.70. However, other 10 remaining clones showed FQ values > 0.65 (Table 2). Stem-form varied among several factors including form quotient (Mu-hairwe *et al.*, 1994). Age of the tree, growing habitat, tree density, slope are major factors that influences the FQ (Chaturvedi and Khanna, 1982; Husch *et al.*, 2003). For instance stand density (Sharma and Par-ton, 2009), thinning (Sharma *et al.*, 2002), pruning (Valenti and Cao, 1986), water availability (Wiklund *et al.*, 1995) and supply of other re-

sources (Socha and Kulej, 2007) influences the FQ values. However, variation among clones for FQ could be due to genetic factor, where all the clones were grown under uniform condition (Gomat *et al.*, 2011). Volume of standing tree varied between 0.12 m³ and 0.28 m³. Clones such as C₁₂, C₁₇, C₄ and C₈ showed better performance as compared to other clones for volume (Table 2). Such kind of variation was also recorded among clones of *Eucalyptus* by different scientist all over India. Lal *et al.* (2006) evaluated 36 clones of *Eucalyptus* for volume and clone 2070 performed better with volume of 121.594 m³/ ha than other clones within a period of 4 years. Luna and Singh (2009) also recorded variation among 12 clones of *Eucalyptus* for volume at the age of 3 years. It is found that, among 12 clones, clone 413 recorded maximum volume (over bark volume of 86.41 m³/ ha and under bark of volume 70.47 m³/ha). Vennila *et al.* (2011) reported that *Eucalyptus* clones *viz.*, EC MTP 48, EC MTP 47 and EC MTP 41 recorded superiority for growth including volume at the age of 8 months than other clones. Similarly, Gangwar *et al.* (2015) also recommended clone AP10 based on superiority of volume and other growth traits in eucalyptus for large scale plantation.

Conclusion

The present study concluded that all the 20 clones significantly varied for tree height, DBH, mid-diameter, form quotient and volume. Clones such as C₁₂ and C₁₇ performed superior with respect to volume of tree (0.28 m³) and which were statistically at par with clones C₄, C₈, C₇, C₁₆ and C₁₁. Therefore, these two clones C₁₂ and C₁₇ along with C₄, C₈, C₇, C₁₆ and C₁₁ are recommended for large scale plantation programme in south Gujarat region.

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