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## Assessment of growth variation among different species of Bamboo

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### Abstract

The present investigation was carried out at Singalkhanch, Ukai, Tapi, Gujarat. The experiment comprised of 15 species of bamboo viz., *Dendrocalamus asper*, *Bambusa balcooa*, *Bambusa tulda*, *Dendrocalamus stocksii*, *Bambusa nutans*, *Bambusa vulgaris* (Green), *Bambusa vulgaris* (Yellow), *Gigantochloa atroviolacea* (Java Black - Bamboo), *Bambusa bambos*, *Dendrocalamus strictus*, *Bambusa polymorpha*, *Schizostachyum pergracile*, *Melocanna bambusoides*, *Bambusa jantiana* and *Schizostachyum dullooa*. This experiment was laid out in Randomized Block Design (RBD) comprising of fifteen species of bamboo as treatment and three replications. Among the growth parameters bamboo species with the maximum value were found as in *Bambusa bambos* for culm diameter at breast height (7.75 cm); *Bambusa vulgaris* (Green) for culm height (17.73 m) and clump height (18.80 m); *Bambusa polymorpha* for internodal length (86.25 cm); *Schizostachyum dullooa* for culms per clump (105); *Melocanna bambusoides* for clump girth (10.80 m) and leaf area (76.31 cm<sup>2</sup>); *Bambusa balcooa* for leaf length (23.73 cm) and leaf width (4.61 cm). In the trial, there was definite variation found for growth parameters among different species of bamboos in South Gujarat conditions

**Keywords:** Bamboo, Culm height, Growth, Variation

### Introduction

Bamboo popularly known as green gold or poor man's timber belongs to Poaceae family, a woody grass and an important component of many forest ecosystems. Again, it is a multipurpose, fast growing woody species, which occupies an important place in the diverse phases of life and culture of the people. It is the most universally useful plant known to man. Bamboos represent one of the world's most important natural and renewable bio-resources and are among the most useful plants known to mankind. They constitute a major part of the natural vegetation of tropical, sub-tropical and wild temperate regions. According to an estimate, 2-5 billion people depend on or use bamboo materials to a value of 7 million US \$ per annum (Liese, 1992) [11]. The multiple uses of bamboos for food, fodder, raw material for pulp and paper industry, handicraft industries, construction. Bamboos are having largest use in paper and pulp industry (Varmah and Pant, 1981) [30] and in India, it constitutes nearly 70% of the raw material for this industry (Rout and Das, 1994). Besides their application in paper industry, they are extensively used as timber for house building, furniture making, daily sundry goods, agriculture and fisheries tools and crafting materials. Besides these, leaves serve as an excellent cattle fodder (Sahoo *et al.*, 2010) [21]; shoots are one of the most widely consumed delicacies (Tripathi, 1998) [29] and also consumed fresh, cooked, pickled, fermented and canned (Nirmala *et al.*, 2008) [14]. Additionally, new products such as bamboo charcoal, bamboo vinegar, bamboo juice and bamboo fiber products have been developed. Besides, their immense economic applications, bamboos render many ecological services as well (Ogunwusi and Jolaoso, 2012) [15].

There are about 88 genera and 1400 species of bamboos distributed worldwide covering an area of more than 14 million hectares with 80% of species and area under bamboos confined to south and south-east Asia, largely in China, India and Myanmar (Wu and Raven, 2006) [31]. India is second after China in bamboo resources having 125 species belonging to 23 genera, spread over an area of 8.96 million hectares which constitutes 12.8% of total forest area (Anonymous, 2003 and Rathore *et al.*, 2009) [2, 19] and produces 4-6 million tonnes of bamboos annually, out of which 2.2 million tonnes is used in the paper industry (Sharma, 1980 and Gillis *et al.*, 2007) [4]. New uses of bamboo, particularly as a substitute of wood, housing sector and value added products will increase further demand of bamboo (Pandey, 2008) [17].

In Gujarat state, only two species *Dendrocalamus strictus* and *Bambusa arundinacea* are industrially most important species found naturally in the forests. It also cultivated by farmers mainly on the periphery of their farmlands and found in 15 districts of the state and spread over an area of 5850 km<sup>2</sup> which forms about 3% of the total geographical area of the state (FSI, 2013) [3]. Though bamboo is a fast growing in nature but growth characters varies among it's species, climatic, edaphic factors influence and other factors. By keeping bamboo's usefulness and growth character variation, the present investigation was formulated with the objective of assessment of growth variation among different species of bamboo in South Gujarat condition.

### Materials and Methods

The recent investigation was carried out at Bambusetum, Singalkhanch, Ukai, Tapi, Gujarat which was established in the year 2005 for different experimental and research purposes by Gujarat State Forest Department. The total number of species planted in this bambusetum were 28 and out of these, 15 species were selected for the present study. The climate of Singalkhanch (Ukai) was tropical characterized by fairly hot weather, moderately cold winter with humid and warm monsoon coupled with moderately heavy rainfall. The monsoon commenced from second week of June and lasted up to first week of October. Most of the precipitation received from the South-West monsoon during July and August. The average annual rainfall was 1055 mm. These 15 species of bamboo species such as *Dendrocalamus asper*, *Bambusa balcooa*, *Bambusa tulda*, *Dendrocalamus stocksii*, *Bambusa nutans*, *Bambusa vulgaris* (Green), *Bambusa vulgaris* (Yellow), *Gigantochloa atrovioleacea* (Java Black -bamboo), *Bambusa bambos*, *Dendrocalamus strictus* and *Bambusa polymorpha* *Schizostachyum pergracile*, *Melocanna bambusoides*, *Bambusa jantiana* and *Schizostachyum dullooa* were selected as treatment for the study of growth variation in South Gujarat. This experiment was laid out in Randomized Block Design (RBD) comprising of fifteen species of bamboo as treatment and three replications. The observations for growth parameters such as culm diameter at breast height, culm height, internodal length, number of culms/clump, clump girth, clump height, leaf length, leaf width and leaf area were recorded and analysed as per RBD statistical method prescribed by Panse and Sukhatme (1967) [18].

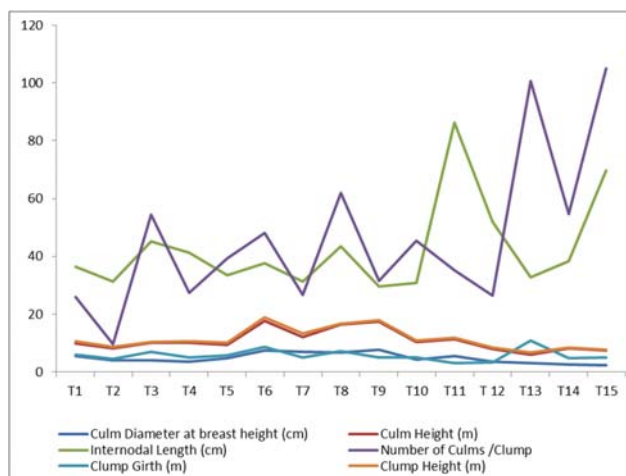
### Results

Results of different growth parameters such as culm diameter at breast height, culm height, internodal length, number of culms/clump, clump girth, clump height, leaf length, leaf width and leaf area are presented in Table – 1 and in Fig-1 & 2. The culm diameter at breast height of bamboos was recorded maximum in *Bambusa bambos* (7.75 cm) which was statistically at par with *Bambusa vulgaris* (Green- 7.54 cm), *Bambusa vulgaris* (Yellow- 6.95 cm) and *Gigantochloa atrovioleacea* (Java Black Bamboo- 6.81 cm) whereas lowest in *Dendrocalamus dullooa* (2.47 cm). Similarly maximum culm height was recorded in *Bambusa vulgaris* (Green- 17.73 m) which was on same bar with *Bambusa bambos* (17.56 m) and *Gigantochloa atrovioleacea* (Java Black Bamboo- 16.44 m) whereas significantly lowest culm height was recorded in *Melocanna bambusoides* (6.06 m). Incase of internodal length, maximum was noted in *Bambusa polymorpha* (86.25 cm) which was followed by *Schizostachyum dullooa* (69.79 cm) and significantly lowest internodal length was in *Melocanna bambusoides* (32.85 cm). The number of culms per clump of bamboos was noted maximum in *Schizostachyum dullooa* (105.00) which was at par with *Melocanna bambusoides* (100.67) and significantly lowest number of culms per clump was recorded in *Bambusa balcooa* (9.67). Similarly significantly maximum clump girth was recorded in *Melocanna bambusoides* (10.80 m) whereas minimum was in *Bambusa polymorpha* (2.98 m). The clump height of bamboo was recorded maximum in the *Bambusa vulgaris* (Green- 18.80 m) which was statistically at par with *Bambusa bambos* (18.00 m) whereas lowest was in *Melocanna bambusoides* (6.65 m). The leaf length was noted maximum in *Bambusa balcooa* (23.73 cm) which was statistically at par with *Bambusa vulgaris* (Yellow- 22.24 cm), *Bambusa vulgaris* (Green-21.86 cm) and *Gigantochloa atrovioleacea* (Java Black Bamboo-21.81cm) whereas significantly lowest was recorded in *Bambusa bambos* (10.40 cm). The maximum leaf width 4.61 cm was reported in *Bambusa balcooa* and significantly lowest leaf width 1.17 cm was recorded in *Bambusa polymorpha*. The leaf area was noted highest in *Melocanna bambusoides* (76.32 cm<sup>2</sup>) which was statistically at par with *Bambusa balcooa* (74.63 cm<sup>2</sup>) and lowest leaf area 6.19 cm<sup>2</sup> was recorded in *Bambusa polymorpha*.

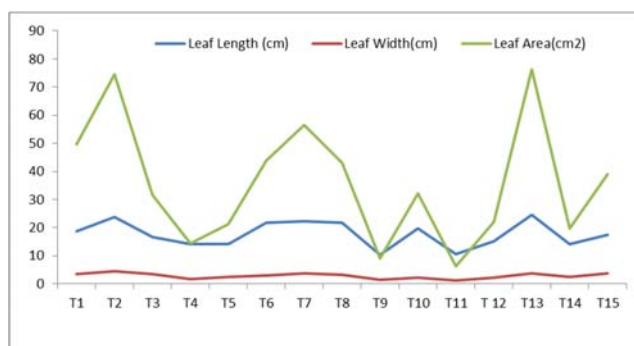
**Table 1:** Mean growth variations in various species of bamboo

Treatments	Culm Diameter at breast height (cm)	Culm Height (m)	Internodal Length (cm)	Number of Culms /Clump	Clump Girth (m)	Clump Height (m)	Leaf Length (cm)	Leaf Width (cm)	Leaf Area (cm <sup>2</sup> )
T <sub>1</sub> : <i>Dendrocalamus asper</i>	5.64	9.93	36.46	26.00	5.90	10.60	18.65	3.47	49.68
T <sub>2</sub> : <i>Bambusa balcooa</i>	4.14	8.28	31.28	9.67	4.52	8.67	23.73	4.61	74.63
T <sub>3</sub> : <i>Bambusa tulda</i>	3.97	10.09	45.19	54.33	7.03	10.48	16.63	3.59	31.73
T <sub>4</sub> : <i>Dendrocalamus stocksii</i>	3.53	10.11	41.31	27.33	4.98	10.52	14.03	1.61	14.49
T <sub>5</sub> : <i>Bambusa nutans</i>	4.84	9.50	33.39	39.33	5.83	10.10	14.19	2.45	21.32
T <sub>6</sub> : <i>Bambusa vulgaris</i> (Green)	7.54	17.73	37.75	48.00	8.57	18.80	21.86	2.84	43.92
T <sub>7</sub> : <i>Bambusa vulgaris</i> (Yellow)	6.95	12.06	31.37	26.67	5.10	13.22	22.24	3.72	56.61
T <sub>8</sub> : <i>Gigantochloa atrovioleacea</i> (Java Black -Bamboo)	6.81	16.44	43.57	62.00	7.28	16.67	21.81	3.26	43.09
T <sub>9</sub> : <i>Bambusa bambos</i>	7.75	17.56	29.55	31.67	5.12	18.00	10.40	1.52	9.07
T <sub>10</sub> : <i>Dendrocalamus strictus</i>	4.42	10.36	30.91	45.33	5.05	10.85	19.73	2.31	32.10
T <sub>11</sub> : <i>Bambusa polymorpha</i>	5.45	11.40	86.25	35.33	2.98	11.83	10.48	1.17	6.19
T <sub>12</sub> : <i>Schizostachyum pergracile</i>	3.64	7.92	51.94	26.33	3.35	8.33	15.06	2.20	22.11
T <sub>13</sub> : <i>Melocanna bambusoides</i>	2.98	6.06	32.85	100.67	10.80	6.65	24.56	3.71	76.32
T <sub>14</sub> : <i>Bambusa jantiana</i>	2.50	8.24	38.35	54.67	4.73	8.47	14.19	2.45	19.71
T <sub>15</sub> : <i>Schizostachyum dullooa</i>	2.47	7.41	69.79	105.00	5.14	7.63	17.51	3.62	39.01

S. EM ±	0.328	0.550	1.586	3.135	0.396	0.567	1.076	0.186	2.294
C.D. @ 5 %	0.95	1.59	4.59	9.08	1.15	1.64	3.12	0.54	6.65
C.V.%	11.73	8.76	6.44	11.77	11.92	8.63	10.55	11.35	11.04



**Fig 1:** Mean Culm Diameter at breast height, Culm Height, Internodal Length, Number of Culms /Clump, Clump Girth, Clump Height, variations in various species of bamboo.



**Fig 2:** Mean Leaf Length, Leaf Width, Leaf Area variations in various species of bamboo

## Discussion

The probable reason for variation in growth parameters among 15 bamboo species may be due to the genetic make-up of the species or due to the wide range of rainfall, temperature, altitude, soil type in relation to habitat. Secondly, it may be due to positive relation and adaptability of the species with the rainfall, temperature, altitude, soil type in relation to habitat (Amlani, 2015). These results are in close proximity with the earlier findings of Annapurna *et al.* (2015) [1] in 14 candidate plus clumps (CPCs) of bamboos originated from different regions and revealed variability; Tewari *et al.* (2014) [27] found *B. balcooa*, *B. nutans* and *B. vulgaris* performed better in terms of survival and growth among different species of bamboo; Adhikari and Shrestha (2008) got significant differences in phenotypic characters of *B. nutans*, giving a clue of significant genetic differences which leads to variation among plants; Nath *et al.* (2008) reported similar phenological pattern in *B. balcooa* and *B. vulgaris* and their difference with *B. cacharensis* reflects differential ecological adaptability among the species growing under the same environmental condition; Nath *et al.* (2007) [13] studied culm characteristics and population structure of Dolu bamboo (*Schizostachyum dullooa*); Nath *et al.* (2004) studied different phenology and culm growth of *Bambusa cacharensis*; Qiu *et al.* (1999) found growth variation in *Phyllostachys pubescens* collected from nine Chinese provenances; Kochar *et al.*

(1994) [7] observed a wide range of variation in growth parameters among bamboo germplasm.

It is concluded from the present investigation that there was variation for growth parameters among different species of bamboos in South Gujarat conditions. Among the growth parameters bamboo species with the maximum value found were as in *Bambusa bambos* for culm diameter at breast height (7.75 cm); *Bambusa vulgaris* (Green) for culm height (17.73 m) and clump height (18.80 m); *Bambusa polymorpha* for internodal length (86.25 cm); *Schizostachyum dullooa* for culms per clump (105); *Melocanna bambusoides* for clump girth (10.80 m) and leaf area (76.31 cm<sup>2</sup>); *Bambusa balcooa* for leaf length (23.73 cm) and leaf width (4.61 cm).

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