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Assessment of population structure genetic diversity through morphometric traits in *Dendrocalamus hamiltonii* Nees. in Himachal Pradesh

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Abstract

The present investigation entitled “Assessment of population structure genetic diversity through morphometric traits in *Dendrocalamus hamiltonii* Nees. in Himachal Pradesh.” was carried out in the Department of Tree Improvement and Genetic Resources. Field survey was carried out across the populations of *Dendrocalamus hamiltonii* Nees. in different altitudinal zones of Himachal Pradesh. Flowering and morphometric traits were taken as selection criteria to select well-represented twelve natural populations viz. S₁ (Jukhala), S₂ (Sujanpurtila) S₃ (Kallar), S₄ (Chabutra) S₅ (Sarkaghat) S₆ (Ghumariwn), S₇ (Toni Devi), S₈ (Kuthar) S₉ (Ratti) and S₁₀ (Awah Devi), S₁₁ (Giripul), S₁₂ (Sapri). The clumps having flowering were randomly selected and morphometric traits were studied. The data was analyzed by RCBP revealed that there was small variation observed between natural populations for morphometric traits. The variation observed for morphometric traits did not follow any particular trend with regard to different populations. It is concluded that on altitudinal basis morphometric traits can be used as an effective tool for selecting genotypes for good quality seeds and seedlings from natural populations.

Keywords: Variation, altitude, morphometric traits

1. Introduction

Bamboos are often giant, woody, evergreen, perennial, grasses belonging to the subfamily Bambusoideae of the family Poaceae. Bamboo is native to every continent except Europe and Antarctica and is found from sea level tropics to 4000 m in mountains, their genera and species are widely distributed. It is reported that over 77 genera and 1250 species occur globally, most of which are confined to Southeast Asia. The largest number of species (300) is found in China followed by India (130 species) and are reported to belong to 24 genera, of which 20 are indigenous while 4 are of exotic origin. More than half of the species diversity is recorded from North eastern India. There are 5 genera and 4 species found in the western Himalayas including foothills. In Himachal Pradesh only 8 species namely *Bambusa nutans*, *B. bambos*, *Dendrocalamus hamiltonii*, *D. parishii*, *D. strictus*, *Drepanostachyum falcatum* (syn *Arundinaria falcata*), *Thamnocalamus spathiflorus* (syn. *Arundinaria spathiflora*) and *Phyllostachys bambusoides* are reported. The latter one is the native species of China and was introduced in Himachal Pradesh (Chowdhery and Wadhwa, 1984) [4].

Bamboo's special biological and ecological characteristics and growth habits enable bamboo forests to serve ecological and environmental functions such as land rehabilitation, water conservation and control of soil erosion.

Dendrocalamus hamiltonii Nees. is a large sized solid sympodial bamboo belongs to Family Poaceae, locally known as Maggar bans. It is culm grows at an angle and is greyish white when young and dull green at maturity. The diameter of culm and intermodal length ranges between 30-40 cm and 5-15 cm. Internodes are 30-50 cm long, culm sheath is glabrous, rough with brown hairs on outer side. It flowers sporadically or gregariously. It generally flowers sporadically, gregarious flowering occurs at an interval of 30-40 years. New culms arise from buds on the rhizome during July-August and attain their full length by November-December. New leaves production starts in summer.

2. Materials and Methods

Morphometric parameters studied were Clump height: It was measured with the help of Ravi multimeter, Clump girth: It was measured with the help of tape.

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Number of culms per clump was manually observed and counted, Culm diameter was measured with the help of tape, Culm length was measured with the help of Ravi multi-meter, Branch length: For calculation of branch length from represented culms, three different length branches was selected and an average branch length was calculated, Number of nodes: It was calculated by manual observation and counting, Leaf length (cm): The petiole length was measured with the help of measuring scale and expressed in cm. Leaf width (cm): The petiole length was measured with the help of measuring scale and expressed in cm, Leaf area (cm²): It was measured with the help of Leaf Area Meter. Biomass characters: To estimate the total biomass, three clumps was selected randomly on each site and from each clump, and from each clump one culm of each age class, i.e., < 1 year, 1-2 Year, >2 year was undertaken in the present study. Sampled culms was separated into leaves, branches and stem and rhizome. Fresh weight of components was weighed in the field and then oven dried at 80 °C to constant weight. total dry weight of culm and clump was obtained from sum of the dry weight of stem+ dry weight of branch +dry weight of leaf the biomass was estimated using the following formula

$$\text{Biomass} = \frac{\text{Dry Weight of sample}}{\text{Fresh Weight of Sample}} \times 100$$

3 Result and Discussion

Data pertaining to different morphometric traits viz., Clump height (m), Clump diameter (m), Number of culms in clump, Internodal length (cm), Number of nodes, Culm length (m), Branch length (cm), Leaf length (cm), Leaf width (cm), Leaf area (cm²), Biomass (kg) culm biomass of culms and clumps growing in the study area is depicted in Table 2 and Table 3.

3.1 Clump height (m)

The culm height of *Dendrocalamus hamiltonii* Nees. At different populations varied from 30.50 m to 23.80 m having a mean value of 26.38 m. The S₁ (Jukhala) population recorded the highest culm height which is statistically at par with populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₄ (Chabutra). The minimum culm height was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was recorded best for clump height with mean value 25.39 whereas elevation range A₄ (1200-1500) recorded least for clump height with mean value 15.10.

3.2 Clump diameter (m)

The clump diameter of *Dendrocalamus hamiltonii* Nees. at different populations varied from 2.10 m to 2.50 m having a mean value of 2.25 m. The S₁ (Jukhala) population recorded the highest clump diameter which is statistically at par with populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₅ (Sarkaghat). The minimum culm diameter was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was recorded best for clump diameter with mean value 2.19 whereas elevation range A₄ (1200-1500) recorded least for clump diameter with mean value 1.57.

3.3 Number of culms in a clump

The Number of culms in a clump in *Dendrocalamus hamiltonii* Nees. at different populations varied from 85.60 to

100 having a mean value of 93.20. The S₁ (Jukhala) population recorded the highest which is followed by populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₄ (Chabutra). The minimum values for Number of culms in a clump was recorded for S₁₂ (Sapri). Elevation range A₁ (300-600 m) was recorded best for Number of culms in a clump with mean value 86.06 whereas elevation range A₄ (1200-1500) recorded least for Number of culms in a clump with mean value 64.93.

3.4 Internodal length (cm)

The internodal length of *Dendrocalamus hamiltonii* Nees. at different populations varied from 25.5 cm to 32.8 cm having a mean value of 29.82 cm. The S₁ (Jukhala) population recorded the highest Internodal length which was statistically at par with populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₅ (Sarkaghat). The minimum Internodal length was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was recorded best for internodal length with mean value 81.74 whereas elevation range A₄ (1200-1500) recorded least for internodal length with mean value 62.20.

3.5 Number of Nodes

The Number of nodes in *Dendrocalamus hamiltonii* Nees. at different populations varied from 25.5 cm to 32.8 cm having a mean value of 29.82 cm. The S₁ (Jukhala) population recorded for highest Number of nodes which was statistically at par with populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₅ (Sarkaghat). The minimum Number of nodes was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was recorded best for Number of nodes with mean value 64.92 whereas elevation range A₄ (1200-1500) recorded least for Number of nodes with mean value 28.74.

3.6 Culm length (m)

The Culm length of *Dendrocalamus hamiltonii* Nees. at different populations varied from 30.40 m to 33.60 m having a mean value of 32.02 m. The S₁ (Jukhala) population recorded the highest clump diameter which is statistically at par with populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₄ (Chabutra). The minimum culm diameter was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600 m) was recorded best for Culm length with mean value 32.36 whereas elevation range A₄ (1200-1500) recorded least for Culm length with mean value 17.47.

3.7 Branch length (cm)

The Branch length of *Dendrocalamus hamiltonii* Nees. at different populations varied from 36.80 cm to 50.20 cm having a mean value of 42.60 cm. The S₁ (Jukhala) population recorded the highest branch length which is statistically at par with populations S₂ (Sujanpur tira), followed by S₃ (Kallar) and S₄ (Chabutra); closely followed by S₆ (Ghumarwin). The minimum branch length was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was recorded best for Branch length with mean value 40.94 whereas elevation range A₄ (1200-1500) recorded least for branch length with mean value 24.50.

3.8 Leaf length (cm)

The Leaf length of *Dendrocalamus hamiltonii* Nees. at different populations varied from 18.60 cm to 20.60 cm having a mean value of 19.92 cm. The S₂ (Sujanpur tira) population recorded the highest leaf length which is followed

by populations and S₃ (Kallar) and S₁ (Jukhala); closely followed by S₄ (Chabutra). The minimum Leaf diameter was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) was

recorded best for Leaf length with mean value 19.82 whereas elevation range A₄ (1200-1500) recorded least for Leaf length with mean value 18.29.

Table 1: Variation in morphometric traits of *Dendrocalamus hamiltonii* Nees. in natural populations in Himachal Pradesh

Population code	Clump height (m)	Clump diameter (m)	Number of culms in a clump	Internodal length (cm)	Number of nodes	Culm length (m)	Branch length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm ²)	Leaf Biomass (kg)	Branch Biomass (kg)	Culm Biomass (kg)	Biomass (kg)
S ₁ (Jukhala)	26.38	2.25	93.2	85.05	67.34	32.02	42.65	19.92	1.76	26.29	1.08	1.81	30.28	33.17
S ₂ (Sujanpur tira)	24.50	2.17	83.03	80.47	66.08	32.68	43.14	20.02	1.71	26.46	1.05	2.01	34.87	37.93
S ₃ (Kallar)	25.30	2.16	81.96	79.6	61.35	32.40	37.04	19.52	1.60	26.08	1.13	2.21	37.28	40.62
S ₄ (Chabutra)	25.42	1.82	81.48	67.4	60.14	29.27	38.44	18.96	1.70	25.16	1.12	2.24	37.48	40.84
S ₅ (Sarkaghat)	24.90	2.47	78.2	75.39	64.08	26.26	39.93	18.76	1.64	25.63	0.97	1.92	33.42	36.31
S ₆ (Ghumariwn)	24.61	1.85	67.2	74.73	60.34	26.74	41.32	18.63	1.63	25.58	1.08	2.31	35.72	39.11
S ₇ (Toni Devi)	21.14	1.57	70.96	77.37	55.52	24.75	39.07	18.69	1.59	26.07	1.1	2.12	36.16	39.38
S ₈ (Kuthar)	19.55	1.59	72.36	74.22	40.92	22.77	32.98	18.9	1.48	25.31	1.03	2.03	33.81	36.87
S ₉ (Ratti)	17.65	1.59	73.86	62.99	35.52	21.11	33.4	18.76	1.73	23.58	0.93	1.9	31.64	34.47
S ₁₀ (Awah Devi)	16.12	1.7	69.31	64.48	29.75	23.91	21.86	18.48	1.75	23.9	0.75	1.55	26.36	28.66
S ₁₁ (Giripul)	15.96	1.58	66.32	63.25	27.45	16.07	24.55	18.12	1.49	23.42	0.78	1.63	25.81	28.22
S ₁₂ (Sapri)	13.22	1.43	59.18	58.87	29.02	12.44	27.10	18.27	1.42	23.85	0.73	1.92	26.71	29.36
Mean	21.22	1.84	74.755	71.985	49.79	25.03	35.12	18.91	1.62	25.11	0.79	1.97	32.46	35.412
CD _(0.05)	1.86	0.55	6.14	8.63	3.56	1.51	4.56	0.52	0.14	1.26	15.14	11.86	13.17	13.056

Table 2: Altitudinal variation in morphometric traits of *Dendrocalamus hamiltonii* Nees. in Himachal Pradesh

Altitude	Clump height (m)	Clump diameter (m)	No. of culms in clump	Internodal length	No. of nodes	Culm length (m)	Branch length (cm)	Leaf length (cm)	Leaf width (cm)	Leaf area (cm ²)	Biomass (kg)
A ₁	25.39	2.19	86.06	81.74	64.92	32.36	4.94	19.82	1.69	25.59	36.9
A ₂	24.97	2.04	75.62	72.5	61.52	27.22	39.89	18.78	1.65	25.45	35.33
A ₃	19.44	1.58	72.39	71.52	43.98	22.87	34.15	18.79	1.6	24.98	34.87
A ₄	15.1	1.57	64.93	62.2	28.74	17.47	24.5	18.29	1.55	23.72	33.63

3.9 Leaf width (cm)

The Leaf width of *Dendrocalamus hamiltonii* Nees. at different populations varied from 1.50 cm to 2.00 cm having a mean value of 1.76 cm. The S₁ (Jukhala) population recorded the highest leaf width which is followed by populations S₂ (Sujanpur tira) and S₃ (Kallar); closely followed by S₄ (Chabutra). The minimum Leaf width was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) with mean value was recorded best for Leaf width 1.69 with mean value whereas elevation range A₄ (1200-1500) recorded least for Leaf width with mean value 1.55

3.10 Leaf area (cm²)

The Leaf area of *Dendrocalamus hamiltonii* Nees. at different populations varied from 22.10 cm to 28.60 cm having a mean value of 26.29 cm. The S₂ (Sujanpur tira) population recorded the highest leaf area which is populations and S₃ (Kallar) and S₁ (Jukhala); closely followed by S₄ (Chabutra). The minimum Leaf diameter was recorded at S₁₂ (Sapri). Elevation range A₁ (300-600m) with mean value 25.59 was recorded best for Leaf area whereas elevation range A₄ (1200-1500) recorded least for Leaf area with mean value 23.72.

Table 3: Variation in Culm biomass in *Dendrocalamus hamiltonii* Nees. in Himachal Pradesh

Population code	Leaf Biomass (kg)	Branch Biomass (kg)	Culm Biomass (kg)	Biomass (kg)
S ₁ (Jukhala)	1.08	1.81	30.28	33.17
S ₂ (Sujanpur tira)	1.05	2.01	34.87	37.93
S ₃ (Kallar)	1.13	2.21	37.28	40.62
S ₄ (Chabutra)	1.12	2.24	37.48	40.84
S ₅ (Sarkaghat)	0.97	1.92	33.42	36.31
S ₆ (Ghumariwn)	1.08	2.31	35.72	39.11
S ₇ (Toni Devi)	1.1	2.12	36.16	39.38
S ₈ (Kuthar)	1.03	2.03	33.81	36.87
S ₉ (Ratti)	0.93	1.9	31.64	34.47
S ₁₀ (Awah Devi)	0.75	1.55	26.36	28.66
S ₁₁ (Giripul)	0.78	1.63	25.81	28.22
S ₁₂ (Sapri)	0.73	1.92	26.71	29.36
Mean	0.79	1.97	32.46	35.412
CV	15.14	11.86	13.17	13.056

3.11 Biomass (kg)

The Biomass of *Dendrocalamus hamiltonii* Nees. at different populations varied from 28.22 (kg) to 40.84 (kg) having a mean value of 35.41 (kg). The S₄ (Chabutra) population recorded for highest leaf area which is statistically at par with

populations S₃ (Kallar); closely followed by S₂ (Sujanpur tira). Culm biomass makes major proportion of entire culm biomass whereas least proportion of entire culm biomass was contributed by leaf biomass. The minimum biomass was recorded at S₁₁ (Giripul). Elevation range A₁ (300-600m) with

mean value 36.90 was recorded best for Biomass whereas elevation range A₄ (1200-1500) recorded least for Biomass with mean value 33.63. similar studies were conducted by Bakshi and Rasool (2015) studied variability on the basis of culm characteristics in 20 accessions of *D. strictus* and found significant differences (0.1%) for most of the quantitative characteristics. The morphological diversity data among the 14 Candidate Plus Clumps (CPCs) originated from different regions revealed variability in terms of culm height, diameter, internodal length, no. of culms/clump and solid and hollowness of the culms. Highest culm diameter and number of culms/clump were recorded in PS-27. Bhandari *et al.* (2016) [2] evaluated fourteen species of bamboos for estimation of coefficient of variation heritability and genetic advance and revealed adequate genetic variability among species for most of the traits studied over the years. Pooled analysis indicated predominance of additive gene effects for fodder quality parameters likes biomass, inter-nodal length, dry matter digestibility, crude fibre, crude protein content and dry matter percentage as they displayed high heritability coupled with high to moderate genetic advance.

4. Conclusion

The culm height of *Dendrocalamus hamiltonii* Nees. at different populations varied from 30.50 m to 23.80 m having a mean value of 26.38 m. The clump diameter of *Dendrocalamus hamiltonii* Nees. at different populations varied from 2.10 m to 2.50 m having a mean value of 2.25 m. The Number of culm in a clump in *Dendrocalamus hamiltonii* Nees. at different populations varied from 85.60 to 100 having a mean value of 93.20. Maximum biomass was obtained from altitudinal zone 1 and in seed source S₁ (Jukhala) followed by S₂ and S₃. The internodal length of *Dendrocalamus hamiltonii* Nees. at different populations varied from 25.5 cm to 32.8 cm having a mean value of 29.82 cm. The Leaf area of *Dendrocalamus hamiltonii* Nees. at different populations varied from 22.10 cm to 28.60 cm having a mean value of 26.29 cm. The Biomass of *Dendrocalamus hamiltonii* Nees. at different populations varied from 28.22 (kg) to 40.84 (kg) having a mean value of 35.41 (kg). This study suggests that best genotypes in terms of morphological parameters were from S₁ (Jukhala), S₂ (Sujanpurtila), S₃ (Kallar) and can be used for further breeding and conservation programmes.

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