

Variability and divergence in morphological traits of *Toona ciliata* in provenances

Narendra Singh, Tara Gupta, HP Sankhayan

Department of Tree Improvement and Genetic Resources, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Abstract

With this background the study had conducted with the following objectives. Morphological and seeds characterization of *Toona ciliata* provenances in three states. The aim of the study was to determine genetic seeds germination and seedling performances of *Toona ciliata* collected from different provenances. A variation was observed in mean, germination percent, seeds color seeds, weights, heritability genetic advances, genetic gain and genetic parameters. The variation was observed in all different characteristics behavior among the samples of *Toona ciliata* collected from different provenances. The present study is helpful in selecting good provenances on the basis of good performances such as phenotypic, seeds and seedlings characteristic etc. The significant variation observed among different provenances may probably be influenced by different intensities of natural constraints acting upon these traits in the prevailing geographic conditions.

Keywords: mean, seeds characters, germination, genetic parameters and seedling

Introduction

Toona ciliata M. Roem is one of the best known Indian timber species, popularly known as Toon and Red cedar. Investigation was carried out in three different provenances viz. Himachal Pradesh, Uttarakhand and Uttar Pradesh. Meliaceae is a large family of tropical woody species, comprising of 50 genera with approx.575 species (Pennington and Styles, 1975; Mabberley *et al.*, 1995; Chase *et al.*, 1999) ^[19, 16, 4] and further categorized into four sub-families viz. Melioideae (07 tribes, 35 genera) Swietenioideae (03 tribes, 13 genera) and the monogeneric Quivisanthoideae and Capuronianthoideae, which contain a relatively wide range of floral, fruit and seed morphologies (Pennington and Styles, 1975) ^[19]. *Toona ciliata* is a large deciduous moderate light demanding tree with a spreading crown, commonly attaining a height of 20-30m and a girth of 1.8-3.0m. In India, it is found throughout the sub-Himalayan tract, western-Himalaya and valleys of the outer Himalaya including Himachal Pradesh, Utrakhand and Uttar Pradesh up to an elevation of 1600m amsl. The species also occurs in the plains of Madhya Pradesh, Tamil Nadu, Karnataka, eastern and western Ghats distributed up to elevation of 1200m amsl (rarely 1300m) in western peninsula (Singh, 1982) ^[22]. On moist localities such as ravines, stream banks or swamps (Troup, 1981) ^[24]. Traditional medicine makes uses of various parts of the plant, chiefly the bark and leaves (Lemmens 2008) ^[15]. *T. ciliata* is mostly grown for its versatile timber, which is used for building houses and ships and for high-value goods such as furniture, musical instruments, carvings, and numerous other uses like dyes and tans from flowers and bark respectively (Lemmens, 2008) ^[15]. Traditional medicine makes uses of various parts of the plant, chiefly the bark and leaves (Lemmens, 2008) ^[15]. The leaves are widely used as an animal fodder in India (Edmonds, 1993) ^[7]. The bark is powerful astringent and used in various forms of ulceration, antiperiodic in fever, rheumatism, tonic, beneficial in chronic dysentery, powdered bark externally applied to

ulcer, leprosy, cures fever, headache, blood complaints (Ayurveda) used as cardio tonic, aphrodisiac, good for scabies and expectorant in Yunani medicine (Kertikar and Basu 1995) ^[13]. A more comprehensive research approach should aim to understand which factors limit tree growth, which tree species are more suitable to cope with limited resources, and which mechanisms allow them to adjust to changes in environmental conditions. Information on morphological variations in seed characteristics amongst the provenances of a species will be useful for tree improvement programs. A study on seed morphological, germination and early seedling traits of the different provenances of *Toona ciliata* at nursery stages will help to evaluate the suitability of provenances of *Toona ciliata* from the study areas viz; Himachal Pradesh, Uttarakhand and Uttar Pradesh. In view of the increasing demand for the valuable timber produce by this species, along with other multipurpose uses like medicinal, fodder values and soil conservation in hilly terrains; there is a need to establish a provenances trial, in order to establish the identity of superior provenances across a vast geographical stretch.

Materials and Methods

Study sites- This study was carried out between 2018 -2019 Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan India. Phenotypic study- Tree height of the trees was measured by using Christen hypsometer. The diameter was calculated by actually measuring the girth. The crown spread was measured in two directions viz: north – south and east – west by using plumb bob. Spiegel Relaskop was used on 30 m scale for recording clear bole height of each tree as per the method for tree height measurement (Chaturvedi and Khanna 1982) ^[5]. Crown area was calculated on the principal of a triangle, taking crown length and crown width as the vertical and horizontal lengths and was expressed in square meters. Leaf characters - Leaflet area (cm²) was detached from the plant and was measured for their area using leaf area meter (LICOR area

meter Modal 3100). The leaf base was the slightly expanded area where the leaf attaches to the stem. It was worked out with physical observation. Leaf apices were shape of the tip of the leaf furthest from the petiole. Terminal leaflet: the presence or absence of terminal leaflet was being recorded. Flowers characterization- Duration of flowering Time and duration of flowering was recorded from the selecting trees. Number of flowers per inflorescence was studied by taking flower counts for each of the three inflorescences collected per tree. Seeds materials- seeds samples were collected from twelve districts of three states of India. A field survey was carried and samples were collected from twelve districts of three states of India. Mature capsules were collected during (2018-2019) minimum ten selected trees of each provenance. Seed characterizes Seeds weight, germination percentage, Seeds colour of all the trees within provenances was observed by displaying all at on platform for comparative colour observation. Seedling characters - There had to be raised the trial in mist chambers during. Germination energy index (%) was computed as per

(Grouse and Zimer, 1958) [8]. Seedling height (cm) was measured with a scale and meter rod from the polybag ground level to the shoot tip of the seedling. Collar diameter (cm) was measured with a vernier digital caliper Number of leaves per plant was counted. Number of branches per seedling was recorded. Leaf length (cm) was measured with a ruler from the leaf base to its tip. Five representative (fully grown) leaves per seedling were recorded. Leaf length was measured using scale and expressed in centimeters (cm). Seedling survival percent (%): Survival percentage was calculated as the number seedling that survived after it reached 3-4 leaves stage out of number of germinated seedlings and expressed in percentage. Data analysis- Data collected of all parameters was analysed with help Analysis of Variance (ANOVA) and using the SPSS statistical software. This was done to determine the variation among provenances at a 0.05 significant level.

Result and Discussion

Table 1: Variation in morphological character of different provenances

Sr. No.	Provenances	Tree height (m)	Tree diameters (cm)	Crown spread (m)	Clear bole height (m)	Crown area (m)
P ₁	Nauni	28.70	33.05	9.74	2.99	27.44
P ₂	Hamirpur	25.06	32.19	10.14	2.66	30.20
P ₃	Thakurduar	25.75	29.97	10.20	2.62	31.11
P ₄	Ghumarwin	22.38	32.40	11.29	2.87	36.78
P ₅	Nurpur	26.69	31.65	10.09	2.77	29.32
P ₆	Nainikhad	18.47	31.83	10.38	2.57	31.12
P ₇	Una	21.21	31.68	10.14	2.76	29.91
P ₈	Rajpur	24.40	32.69	12.27	2.85	43.71
P ₉	Katghodam	25.54	32.41	12.84	2.54	48.73
P ₁₀	Naini	25.77	33.19	12.24	3.19	43.43
P ₁₁	Nagina	22.63	31.39	12.36	2.75	44.76
P ₁₂	Sarsaba	22.76	31.99	12.14	2.33	40.44
C.D 0.05		3.49	1.28	1.23	0.16	8.35

Tree height recorded from different provenances ranged from (18.47m) to (28.70 m). The maximum height was recorded from P₁ (Nauni) provenances with the mean height as (28.70 m) Minimum tree height was recorded from P₆ (Nainikhad). Tree diameter recorded from different provenances was found to range from (29.05cm) to (33.05 cm). Maximum tree diameter was recorded from P₁₀ (Naini) provenances with the mean value (33.05 cm) Minimum tree diameter was recorded from P₃ (Thakurduar). Crown spread (12.84 m²) of Toon was found maximum in P₉ (Katghodam) provenances. Lowest crown spread (9.74 m²) was observed in P₁ (Nauni). Clear bole height (3.19 m) of Toon was found maximum in P₁₀ (Naini) provenances. On the hand, lowest clear bole height P₁₂ (2.33 m). Crown area (48.73 m) of Toon was found maximum in P₉ (Katghodam) provenances, lowest crown area (27.44 m). Handa (1994) [9] observed such variation in *Alnus nitida* with respect to six morphological characters viz., height, diameter, age crown length, clear bole and taper of tree. 81 CPTs of *Dalbergia sissoo* were selected by Yadav *et al.* (2005) [26] based on the intensive survey in the states of Haryana, Uttar Pradesh and Himachal

Pradesh. They reported wide variation in clear bole height, straightness among selected trees. Sidhu (1997) [21] selected sixteen of *D. sissoo* and recorded the observation on tree height, clear bole height, and diameter. From them, twelve plus trees of shisham were significantly better than baseline trees. Khobragade *et al.* (2013) [12] reported the criteria for efficient selection of *Terminalia chebula* and *T. bellerica* in two sites each in Maharashtra and Madhya Pradesh. Crown volume, girth and clear bole height were given considerable importance for the selection of trees of *T. chebula* whereas in case of *T. bellerica* crown diameter, girth, height were given age. These parameters found to be more in genetic improvement and conservation programme of these species. Paray *et al.* (2017) [18] selected hundred CPTs of *Salix alba* based on the comparison tree method from twenty places across the two selected districts of Kashmir valley. The tree characteristics used were height, bole height, DBH, and crown diameter. Furthermore, the mean values recorded for these dimension were as 12.50 for height, 28.70 cm for DBH, 5.40 m for bole height, and 3.40m for crown diameter respectively.

Table 2: Variation in leaf character of different provenances

Sr. No.	Provenances	Leaf area (cm ²)	Leaf bases	Leaf apices	Terminal leaflet	Leaflet margin
P ₁	Nauni	245.40	Oblique	Attenuate	Lanceolate	Entire
P ₂	Hamirpur	325.11	Oblique	Acuminate	Lanceolate	Wavy
P ₃	Thakurduar	264.26	Oblique	Acuminate	Lanceolate	Wavy
P ₄	Ghumarwin	240.89	Acute	Acuminate	Ovate	Toothed
P ₅	Nurpur	299.20	Rounded	Attenuate	Ovate	Toothed
P ₆	Nainikhad	251.95	Rounded	Attenuate	Ovate	Toothed
P ₇	Una	371.82	Rounded	Attenuate	Inceolate	Wavy
P ₈	Rajpur	238.35	Rounded	Attenuate	Inceolate	Wavy
P ₉	Katghodam	222.58	Oblique	Attenuate	Inceolate	Toothed
P ₁₀	Naini	225.58	Acute	Acuminate	Inceolate	Entire
P ₁₁	Nagina	318.44	Acute	Attenuate	Ovate	Entire
P ₁₂	Sarsaba	338.53	Acute	Acuminate	Ovate	Entire
C.D 0.05		13.86				

Leaf area was recorded from different provenances ranged from (222.58cm²) to (371.82 m). Leaf area (371.82 m²) of Toon was found maximum in p₇ (Una). On the other hand, lowest leaf area (222.58 m²) was observed in p₉ (Katghodam) provenance. Leaf bases Leaf base for different provenances were compared on individual tree basis and comparative numbers failing in each of these leaf base categories (Oblique, Acute and Rounded) were recorded, and presented in table 2. Leaf apices for different provenances were compared on individual tree basis and comparative numbers failing in each of these leaf apices categories (Attenuate and Acuminate) were recorded. Terminal leaflet for different provenances were compared on individual tree basis and comparative numbers failing in each of these Terminal leaflet categories (Lanceolate and

Ovate) were recorded. Leaflet margin for different provenances were compared on individual tree basis and comparative numbers failing in each of these leaflet margin categories (Entire, Toothed and Wavy) were recorded in table 2. Wani (2005) [25] studies reproductive biology and morphological variation in 32 plus tree of *Bauhinia variegata* under house and field conditions. The studies revealed that plus tree progeny of Pinjor, kanddaghath and Giripul exhibited outstanding performances for morphological characters *viz.* Height, diameter, number of branches, leaf area etc., in comparison to all other superior tree progenies under glasshouse. Whereas, Renukaplus tree showed the best performances progeny followed by Subathu, Kunihar and Narag under field conditions for the above characters studies.

Table 3: Variation in flowers character of different provenances

Sr. No.	Provenances	Duration of flowering	Number of flowers per inflorescences
P ₁	Nauni	April to May	474.65
P ₂	Hamirpur	April to May	376.22
P ₃	Thakurduar	April to May	439.02
P ₄	Ghumarwin	April to May	460.12
P ₅	Nurpur	April to May	487.08
P ₆	Nainikhad	April to May	435.60
P ₇	Una	March to April	411.32
P ₈	Rajpur	March to April	460.01
P ₉	Katghodam	March to April	433.88
P ₁₀	Naini	May to June	491.61
P ₁₁	Nagina	February to March	430.33
P ₁₂	Sarsaba	March to April	497.14
C.D			24.76

Duration of flowering Duration of flower for different provenances were compared on individuals tree basis and compared numbers failing in each of these duration flower (April to May, March to April, May to June) were recorded, and presented in table 3. Number of flowers per inflorescences recorded from different provenances ranged from (376.22) to (497.14). The maximum number of flowers per inflorescences was recorded from P₁₂ (Sarsaba) with mean number of flowers per inflorescences as (376.22) minimum number of flowers per inflorescences were recorded from P₇ (Una). Wani (2005) [25] studies reproductive biology and morphological variation in 32 plus tree of *Bauhinia variegata* group under house and field conditions. The studies revealed that plus tree progeny of

Pinjor, Kandaghat and Giripul exhibited outstanding performances for morphological characters *viz.*, height, diameter, number of branches, leaf area etc., in comparison to all other superior tree progenies under glasshouse, whereas, Renuka plus tree showed the best performances progeny followed by Subathu, Kunihar and Narag under field conditions for the above characters studied. Singh and Gupta (2017) [23] studied reproductive biology of Toon trees at Solan district of Himachal Pradesh and they observed flower bud initiation from third week of March to second week of April and floral bud and inflorescence development from second week of April to last week of May, with 503.5 mean numbers of flowers per inflorescence.

Table 4: Variation between provenances in seed traits

Provenances		100 Seeds weight (gm)	Seed germination (%)	Seed storage and viability (%)		Seed colour		
Code	Location			3-month	6-month	Depicted in decreasing proportion		
P ₁	Nauni	0.28	81.67	59.67	33.00	Brown	Light brown	Dark brown
P ₂	Hamirpur	0.23	74.33	54.00	47.67	Light brown	Dark brown	Brown
P ₃	Thakurduara	0.27	71.33	56.67	44.00	Brown	Light brown	Dark brown
P ₄	Ghumarwin	0.26	78.33	68.00	37.00	Dark brown	Brown	Light brown
P ₅	Nurpur	0.25	75.67	62.00	51.00	Dark brown	Brown	Brown
P ₆	Nainikhad	0.31	64.67	38.33	34.00	Light brown	Light brown	Brown
P ₇	Una	0.24	66.33	46.00	36.33	Light brown	Dark brown	Dark brown
P ₈	Rajpur	0.32	67.33	42.33	40.00	brown	Brown	Light brown
P ₉	Katghodam	0.29	46.67	40.67	36.33	Light brown	Dark brown	Dark brown
P ₁₀	Naini	0.30	68.00	50.00	34.67	Brown	Brown	Light brown
P ₁₁	Nagina	0.29	70.67	42.67	40.00	Brown	Brown	Light brown
P ₁₂	Sarsaba	0.27	69.00	51.00	31.67	Light brown	Light brown	Brown
Mean		0.28	69.47	51.78	38.81	-	-	-
CD _{0.05}		0.01	10.14	7.89	3.33	-	-	-

The data pertaining to variations in seed traits viz., hundred seed weight, seed germination (%), seed viability (%) after three and six months of storage and seed colour were given in Table 4. 100 seeds weight (gm) of 100 seeds were found to differ significantly among different provenances and ranged from 0.23 gm to 0.32 gm. The maximum seed weight was recorded from P₈ (Rajpur) provenances with mean value of (0.32 gm), However, minimum seed weight (0.23 gm) was recorded in P₂ (Hamirpur). Seed germination (%) - seed germination (%) were found to differ significantly among different provenances and ranged from (81.67%) to (46.67%). The maximum seed germination (%) was recorded from P₁ (Nauni) provenances with mean seed germination as (81.67%), minimum seed germination (%) was recorded from P₉ (46.67%). Seed had been stored for a period of 3 and 6 months and seed viability was estimated, which were presented in Table 4. Seed viability after 3-months storage- Seed viability after 3 months of storage was recorded from different provenances which were ranged from 38.33 to 68.00 %. The maximum seed viability was recorded from P₄ (Ghumarwin) with mean value of (68.00 %) minimum seed viability was recorded from P₆ (Nainikhad) with mean value of (38.33%). Seed viability after 6-months storage: Seed storage and viability recorded from different provenances which varied from 31.67 to 51.00 %. The maximum viability was recorded from P₅ (Nurpur) with mean value of (51.00 %) minimum viability was recorded from P₁₂ (Sarsaba) with mean value of (31.67%). Seed colour: Seed colour for different provenances were compared on individual tree basis and comparative numbers falling in each of these colour categories (brown, light brown and dark Brown) were recorded, and is presented in Table 4. It is clear from the results that the nature and extent of observation for traits under consideration was large. The variation observed, might have occurred due to climatic and microclimatic conditions as this species grows over the wide range of climatic conditions. Seed weight depends on the reserve food material (endosperm) formed as a result of double fertilization which is controlled by the traits, and is also affected by the nutrient availability during seed setting and other geoclimatic conditions. Harpar *et al.* (1970) [10] reported that seed characters may vary due to external (environmental) and internal conditions. Baker (1972) [12] observed that variation in seed germination percentage may be due to seed coat hardness/sensitivity of different sources

as reported in differential germination percentage for hardness of seed and the factors responsible were environmental conditions, place of origin, degree of maturation of seeds etc. seed size and seed weight can vary according to seed to seed source Heavy and large seed contain more food reserve than smaller seeds, which is helpful in germination by providing more energy. Seed characters may also affect germination behavior and early seedling growth in the nursery (Howkins, 1998) [11]. The effect of seed characters on germination behavior is variable and somewhat controversial (Chaisurisriera, 1992; Reich *et al.*, 1994) [3, 20]. Dhiman (2018) [6] collected seeds from 36 plus trees of Toon in Punjab and Himachal Pradesh and observed 100 seeds weight and seed germination, mean value of these parameters ranged from 0.704 and 0.843 gm and 27.00 to 67.25 %, respectively. Medeiros *et al.* (2015) [17] reported high first count of germination of Toon seeds in the 24hours photoperiod (13.77 %) and in the sand substrate (12.16 %). Arya and Toky (2006) [11] evaluated of 50 plus trees of *Acacia nilotica* collected from five states at Hisar and found wide variability in seed weight, seed germination, and collar diameter. Chand (1994) reported rapid loss of Toon seed viability (75 %) when stored for three months in polythene bags at room temperature, while seeds stored for one year in polythene bags at 0.0 ± 1.0 °C temperature retained 93 % viability

Conclusion

It emerged from the present study that a large variability exist in the *Toona ciliata* growing naturally in Himachal Pradesh, Utterakhand and Utter Pradesh. The variability of different characters could be utilized for selection of genotypes suitable for plantation and utilization. In this study the wide diversity and variability observed among the provenances. Significant differences between climatic conditions for all the traits were obtained. Morphological characterization is influenced by environmental conditions and observed variability and diversity on the traits measured. This study helps to identify the better provenances of *Toona ciliata* having better yield therefore, the best provenances selected may improve the poor sites for agroforestry system and furniture industry in the best land. The present study is helpful in selecting a good source of *Toona ciliata* for healthy seedlings in plantation programmers in near future.

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