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## Biological screening of progeny performance traits in *Quercus leucotrichophora* A. Camus (Banoak) populations

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**Abstract**

Biological screening study in *Quercus leucotrichophora* A. Camus Populations (Banoak) in Himachal Pradesh was carried out for selection of best phenotypes. In order to select best sites for improved genetic gain and quality production of *Quercus leucotrichophora*, eight sites and three D.B.H. classes from Himachal Pradesh were evaluated on the basis of progeny performance traits. The study revealed significant variation among different sites for traits viz., Leaf area of seedling, Fresh leaf biomass of seedling, Root length of seedling, Shoot length of seedling, Root: shoot length ratio, Root fresh weight, Shoot fresh weight, Root: shoot fresh weight ratio, Root dry weight, Shoot dry weight and Root: shoot dry weight ratio. On the basis of overall mean Site S2 (Chail-Solan) excelled over other sites selected in progeny performance traits with index scoring 4.34. With in diameter classes significant variation recorded for characters viz., leaf area of seedling, root length of seedling, root: shoot length ratio and shoot dry weight. Diameter class > 60 cm excelled in progeny performance indicating mean of index score value of 4.33.

**Keywords:** biological screening, *Quercus leucotrichophora*, populations, banoak, and progeny performance traits

**1. Introduction**

With the rapid growing population and industrialization, the increasing demand of oil and fats cannot be met by putting more pressure on arable land which we need for growing food grains. This deficit can be partially met by the utilization of edible fruits, nuts, seeds of trees growing in the forest.

Trees are the largest and among the most complex organisms in the world with millions of diverse life forms (Zobel and Talbert 1984) [19]. Taxonomically the oaks fall under genus *Quercus* in the family Fagaceae (beech family), which includes more than 400 species and is one of the important tree species in temperate and subtropical plant communities (Koul 1985) [10]. In Himachal Pradesh, out of total forest area of 37591 km<sup>2</sup>, 921 km<sup>2</sup> is under the oak covering different species, viz., *Quercus leucotrichophora*, *Quercus glauca*, *Quercus dilatata*, *Quercus semicarpifolia* and *Quercus ilex* (Anonymous, 1991) [2]. *Quercus leucotrichophora* locally called as 'ban oak' is a moderate sized to a large evergreen tree with almost rounded crown attaining a height of 20 m and diameter of 60 cm, rarely reaching 30 m in height and 100 cm diameter. Site specific and plus tree selection and diameter class is the primary step and pioneer approach for tree improvement works. Hence, present study in progeny performance traits was contemplated for biological screening.

**2. Material and methods**

The present investigation entitled, "Variability Studies on *Quercus leucotrichophora* A. Camus Populations in Himachal Pradesh" was carried out to study magnitude of variation in the progeny performance traits, variation in different diameter classes, variation among different sites, interaction between the trees of different diameter classes and sites in the natural forest conditions. An eco-geographical survey of the populations of *Quercus leucotrichophora* was undertaken in jurisdiction of four districts of Himachal Pradesh, viz., Solan, Shimla, Kullu and Chamba areas to identify the sites where species occurs in abundance.

## 2.1 Experimental Details

The main aim of the experiment was to study the variation among the trees in different diameter classes, variation in different sites, interaction between trees of three diameter classes and the sites. From each site nine trees were selected, three from each diameter class, viz., less than 30 cm (D1), 30-60 cm (D2) and more than 60 cm (D3), respectively. These trees were marked properly.

Study Area with Elevation

S. No.	District	Area	Code	Elevation
1.	Solani	Shilly	S <sub>1</sub>	1480 m amsl
		Chail	S <sub>2</sub>	2250 m amsl
2.	Shimla	Taklech	S <sub>3</sub>	1350 m amsl
		Summer Hill	S <sub>4</sub>	2120 m amsl
3.	Kullu	Garsa	S <sub>5</sub>	1190 m amsl
		Manikaran	S <sub>6</sub>	1760 m amsl
4.	Chamba	Sahu	S <sub>7</sub>	1400 m amsl
		Salooni	S <sub>8</sub>	1850 m amsl

Progeny performance traits viz., Leaf area seedling, Fresh leaf biomass of seedling, Root length, Shoot length of seedling, Root: shoot length ratio, Root fresh weight, Shoot fresh weight, Root: shoot fresh weight ratio, Root dry weight, Shoot dry weight and Root: Shoot dry weight ratio etc. were estimated and evaluated and recorded, as per methods suggested by (Bhatt and Ram 2005) <sup>[4]</sup>, (Bimlendra and Toky 1992) <sup>[5]</sup>, and (Boeger *etal* 2004) <sup>[6]</sup>, (Bagchi and Sharma

1989) <sup>[3]</sup> and (Jaswal 1992) <sup>[9]</sup>. Overall site and diameter index score was calculated computing the mean value of all useful traits under study. The data was analysed statistically by using RBD. ANOVA (Analysis of Variance) for progeny performance traits, as described by Panse and Sukhatme (1967) <sup>[13]</sup> and Chandel (1984) <sup>[7]</sup>.

## 3. Result and Discussion

Variation among the different sites showed significant variations with maximum mean leaf area for S<sub>8</sub> (11.37 cm<sup>2</sup>). S<sub>1</sub> (11.24 cm<sup>2</sup>), S<sub>2</sub> (11.05 cm<sup>2</sup>) and S<sub>3</sub> (10.94 cm<sup>2</sup>) were found statistically at par with S<sub>8</sub>. Interaction among the diameter classes revealed maximum value for D<sub>3</sub> (10.78 cm<sup>2</sup>). For diameter and sites interaction significant interaction was found between three diameter classes and different sites and maximum mean value for leaf area was recorded by S<sub>1</sub>D<sub>1</sub>(12.73 cm<sup>2</sup>). The different sites showed non significant variation with highest mean fresh leaf biomass for S<sub>3</sub> (2.08g). Interaction among the three diameter classes depicted maximum mean fresh leaf biomass value for D<sub>2</sub> and D<sub>3</sub> (2.05). For diameter and site interaction the maximum value was recorded for S<sub>3</sub>D<sub>3</sub> (2.32 g). The different sites showed non significant variation with highest mean root length for S<sub>6</sub> and S<sub>7</sub> (11.95 cm). Interaction among the three diameter classes showed maximum mean value for root length for D<sub>2</sub> (12.04 cm). For diameter and site interaction the maximum value was recorded by S<sub>6</sub>D<sub>2</sub> (13.72 cm) (Table 1).

**Table 1:** Variation in the Leaf area of Seedling (cm<sup>2</sup>), Fresh Leaf Biomass of Seedling (g) and Root Length of Seedling (cm) of *Quercus leucotrichophora* in three diameter classes among different sites.

Sites/Trees	Diameter classes											
	Leaf area of Seedling (cm <sup>2</sup> )				Fresh Leaf Biomass of Seedling (g)				Root Length of Seedling (cm)			
	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean
S <sub>1</sub> (Shilly)	12.73	10.54	10.47	11.24	1.95	1.84	2.24	2.01	11.24	11.39	10.68	11.10
S <sub>2</sub> (Chail)	10.98	11.61	10.57	11.05	2.25	2.09	1.86	2.06	11.56	11.98	11.91	11.81
S <sub>3</sub> (Taklech)	10.17	11.17	11.50	10.94	2.06	1.87	2.32	2.08	11.57	12.65	10.13	11.45
S <sub>4</sub> (Summer-Hill)	10.34	10.87	10.17	10.46	1.80	2.26	2.00	2.02	12.61	10.61	10.03	11.08
S <sub>5</sub> (Garsa)	9.61	10.21	10.56	10.12	2.13	1.96	1.66	1.91	11.43	12.43	11.65	11.83
S <sub>6</sub> (Manikaran)	9.79	9.71	10.61	10.03	1.40	2.24	1.91	1.85	10.06	13.72	12.09	11.95
S <sub>7</sub> (Sahu)	8.32	9.72	11.45	9.83	1.96	1.86	2.19	2.00	10.87	12.69	12.31	11.95
S <sub>8</sub> (Salooni)	11.24	11.94	10.94	11.37	1.58	2.24	2.21	2.01	9.98	10.87	12.20	11.01
Mean	10.40	10.72	10.78	10.63	1.89	2.05	2.05	1.99	11.18	12.04	11.38	11.53

CD (0.05)

Diameter NS NS NS

Site 0.90 NS NS

Diameter × Site 1.56 NS NS

The different sites showed significant variation with highest shoot length mean value for S<sub>8</sub> (13.95 cm). Interaction among the three diameter classes found maximum mean value for D<sub>3</sub> (13.58 cm). For diameter and sites interaction the maximum value was recorded by S<sub>4</sub>D<sub>3</sub> (15.80 cm). However variation among the different sites showed non significant differences with maximum root: shoot length ratio for S<sub>6</sub> (1.03). Whereas interaction among the diameter classes revealed maximum value for D<sub>1</sub> (0.99). Interaction studies among the three diameter classes and eight sites showed maximum mean value

for S<sub>1</sub>D<sub>1</sub> (1.16). Non significant interaction was found between diameter classes and different sites. The sites showed significant variation with highest mean value for root fresh weight for S<sub>5</sub> (2.84 g). Interaction among the three diameter classes found maximum value for D<sub>3</sub> (2.46 g). Interaction between three diameter classes and eight sites showed maximum mean value for S<sub>5</sub>D<sub>1</sub> (2.96 g) Significant interaction was found between three diameter classes and different sites (Table 2).

**Table 2:** Variation in the Shoot Length of Seedling (cm), Root: Shoot Length Ratio and Root Fresh Weight (g) of *Quercus leucotrichophora* in three diameter classes among different sites

Sites/Trees	Diameter classes											
	Shoot Length of Seedling (cm)				Root: Shoot Length Ratio				Root Fresh Weight (g)			
	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean
S <sub>1</sub> (Shilli)	9.71	11.99	14.13	11.94	1.16	0.98	0.76	0.96	2.42	2.67	2.28	2.45
S <sub>2</sub> (Chail)	10.58	13.58	15.57	13.24	1.11	0.90	0.79	0.93	2.17	2.42	2.42	2.33
S <sub>3</sub> (Taklech)	10.92	11.49	13.54	11.98	1.08	1.11	0.76	0.98	2.40	2.52	2.43	2.45
S <sub>4</sub> (Summer-Hill)	12.44	13.25	15.80	13.83	0.95	0.83	0.65	0.81	2.80	2.36	2.39	2.51
S <sub>5</sub> (Garsa)	12.60	13.18	11.99	12.59	0.92	0.98	1.00	0.96	2.96	2.69	2.87	2.84
S <sub>6</sub> (Manikaran)	9.91	12.03	13.13	11.69	1.02	1.15	0.94	1.03	1.31	2.92	2.40	2.21
S <sub>7</sub> (Sahu)	11.54	12.21	12.17	11.97	0.97	1.05	1.02	1.01	1.78	1.48	2.21	1.82
S <sub>8</sub> (Salooni)	14.52	15.02	12.33	13.95	0.71	0.73	0.99	0.81	1.74	1.22	2.71	1.89
Mean	11.65	12.84	13.58	12.69	0.99	0.97	0.86	0.94	2.20	2.28	2.46	2.31

CD (0.05)

Diameter 1.07 NS NS

Site 1.74 NS 0.49

Diameter× Site NS NS 0.85

The eight sites showed non significant variation with highest mean shoot fresh weight for S<sub>1</sub> and S<sub>3</sub> (2.40 g). Interaction among the three diameter classes found maximum mean value for D<sub>3</sub> (2.38 g). For diameter and site interaction the maximum value was recorded for S<sub>3</sub>D<sub>3</sub> (2.69 g). Significant interaction was found between diameter classes and different. Variation among the eight sites showed significant differences with maximum mean root: shoot fresh weight ratio value for S<sub>5</sub> (1.34). Whereas interaction among the three diameter classes revealed maximum value for D<sub>3</sub> (1.06). Interaction between three diameter classes and eight sites showed

maximum mean root: shoot fresh weight ratio for S<sub>5</sub>D<sub>3</sub> (1.42). Non significant interaction was found between diameter classes and different sites. The sites showed significant variation for root dry weight with highest mean value for S<sub>3</sub> (1.18 g). Interaction among the three diameter classes found maximum value for D<sub>3</sub> (1.05 g). Interaction studies between three diameter classes and eight sites showed maximum mean value for S<sub>3</sub>D<sub>3</sub> (1.31 g). Non significant interaction was found between diameter classes and different sites (Table 3).

**Table 3:** Variation in the Shoot Fresh Weight (g), Root: Shoot Fresh Weight Ratio and Root dry Weight (g) of *Quercus leucotrichophora* in three diameter classes among different sites.

Sites/Trees	Diameter classes											
	Shoot Fresh Weight (g)				Root: Shoot Fresh Weight Ratio				Root dry Weight (g)			
	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean
S <sub>1</sub> (Shilli)	2.30	2.32	2.58	2.40	1.08	1.26	0.89	1.07	1.09	1.15	1.04	1.09
S <sub>2</sub> (Chail)	2.58	2.16	2.15	2.29	0.86	1.14	1.13	1.04	0.93	1.08	1.16	1.05
S <sub>3</sub> (Taklech)	2.26	2.25	2.69	2.40	1.12	1.12	0.92	1.05	1.07	1.16	1.31	1.18
S <sub>4</sub> (Summer-Hill)	2.15	2.66	2.33	2.38	1.38	1.07	1.05	1.16	1.14	1.04	1.03	1.07
S <sub>5</sub> (Garsa)	2.41	2.17	2.09	2.22	1.35	1.26	1.42	1.34	1.25	1.21	1.06	1.17
S <sub>6</sub> (Manikaran)	2.08	2.42	2.23	2.24	0.68	1.25	1.09	1.00	0.88	1.23	0.80	0.97
S <sub>7</sub> (Sahu)	2.40	2.17	2.45	2.34	0.77	0.68	0.92	0.79	0.80	0.64	0.92	0.78
S <sub>8</sub> (Salooni)	2.00	2.52	2.50	2.34	0.87	0.52	1.08	0.82	0.76	0.47	1.05	0.76
Mean	2.27	2.33	2.38	2.32	1.01	1.04	1.06	1.03	0.99	1.00	1.05	1.01

CD (0.05)

Diameter NS NS NS

Site NS 0.27 0.25

Diameter× Site 0.43 NS NS

The eight sites showed non significant variation with highest mean value for S<sub>3</sub> (1.10 g). Interaction among the three diameter classes found maximum mean value for D<sub>3</sub>(1.06 g). Interaction studies between three diameter classes and eight sites showed maximum mean value for S<sub>3</sub>D<sub>3</sub> (1.25 g). However, Significant interaction was found between three diameter classes and different sites. Variation among the different sites showed significant differences with maximum

mean value for root: shoot dry weight ratio for S<sub>5</sub> (1.34). Whereas interaction among the diameter classes revealed maximum mean value for D<sub>3</sub> (1.06). Interaction studies between three diameter classes and eight sites showed maximum mean value for root: shoot dry weight ratio by S<sub>4</sub>D<sub>1</sub> (1.38). Non significant interaction was found between diameter classes and different sites (Table 4).

**Table 4:** Variation in the Shoot dry Weight (g) and Root: Shoot Dry Weight Ratio and overall site and diameter index score of *Quercus leucotrichophora*.

Sites/Trees	Diameter classes								Overall Site Index Score
	Shoot dry Weight (g)				Root: Shoot Dry Weight Ratio				
	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	D1 (<30 cm) Mean	D2 (30-60 cm) Mean	D3 (>60 cm) Mean	Mean	
S <sub>1</sub> (Shilli)	1.04	0.83	1.13	1.00	1.08	1.26	0.89	1.07	4.21
S <sub>2</sub> (Chail)	1.05	0.89	0.95	0.96	0.86	1.14	1.13	1.04	4.34
S <sub>3</sub> (Taklech)	1.06	1.00	1.25	1.10	1.12	1.12	0.92	1.05	4.24
S <sub>4</sub> (Summer-Hill)	0.98	1.22	1.06	1.08	1.38	1.07	1.05	1.16	4.32
S <sub>5</sub> (Garsa)	1.02	1.06	0.90	0.99	1.35	1.26	1.42	1.34	4.30
S <sub>6</sub> (Manikaran)	0.91	1.09	0.85	0.95	0.68	1.25	1.09	1.00	4.08
S <sub>7</sub> (Sahu)	1.02	0.93	1.24	1.06	0.77	0.68	0.92	0.79	4.03
S <sub>8</sub> (Salooni)	0.91	1.07	1.13	1.03	0.87	0.52	1.08	0.82	4.25
Mean	1.00	1.01	1.06	1.02	1.01	1.04	1.06	1.03	
Overall Diameter Index Score	D1 (<30) 4.05 D2 (30-60 cm) 4.30 D3 (>60 cm) 4.33								

CD (0.05)

Diameter NS NS Site NS 0.31

Diameter× Site 0.24 NS

Various progeny performance traits like leaf area, shoot length, root fresh weight, root: shoot fresh weight ratio, root dry weight, root: shoot dry weight ratio recorded significant differences among various sites. The site S<sub>2</sub> (Chail- Solan) excelled in Leaf area seedling, Fresh leaf biomass of seedling, and Shoot length. With in diameter classes significant variation recorded for characters, viz., Leaf area seedling, Fresh leaf biomass of seedling, and shoot length. Diameter class > 60 cm excelled for maximum of the characters viz., leaf area, shoot length, root fresh weight, shoot fresh weight, root: shoot fresh weight ratio, root dry weight and shoot dry weight.

Similar findings have also been observed by different workers in other species namely., Ngulube (1989)<sup>[12]</sup> in *Gliricidia sepium* provenances, Mohapatra (1996)<sup>[11]</sup> studied the variation in seedling traits in *Acacia catechu*, Anand (2003)<sup>[1]</sup> in *Bauhinia variegata*, Rana *et al.* (2009)<sup>[14]</sup> studied the progenies of *Toona ciliata*, Sankhyan *et al.* (2008)<sup>[16]</sup> studied the morphological variation in *Grewia laevigata*. The seed source and provenance variation in nursery by (Sniezko and Stewart, 1989)<sup>[16]</sup>. Rehman *et al.* (1988)<sup>[15]</sup> observed differences among the seed source of *Acacia* spp. and *Prosopis* spp. Veerendra and Sharma (1990)<sup>[18]</sup> revealed that characters like collar diameter, root length, shoot length and number of leaves per seedling varied significantly among different seed sources of *Santalum album*, Bimlendra *et al.* (1992)<sup>[5]</sup> studied details related to root and shoot growth in many species including *Melia azedarach* and Jaswal (1992)<sup>[9]</sup> revealed that the growth parameters in *Grewia optiva* seedlings. Dhillon *et al.* (2009)<sup>[8]</sup> conducted study by raising 11 tree progenies of *Melia azedarach* and Rehman *et al.* (1988)<sup>[15]</sup> observed differences among the seed source of *Acacia* spp. and *Prosopis* spp.

Study concludes that sites differed significantly for progeny performance traits, viz., leaf area of seedling, fresh leaf biomass of seedling, root: shoot length ratio, shoot fresh weight, root dry weight and root: shoot dry weight ratio. Whereas, with in the diameter classes significant variation was recorded for characters viz., leaf area of seedling, fresh leaf biomass of seedling, root: shoot length ratio, shoot fresh weight, root dry weight and root: shoot dry weight ratio. Site S<sub>2</sub> (Chail-Solan) excelled for maximum root length of seedling.

In case of progeny performance traits, leaf area of seedling, shoot length, root fresh weight, root: shoot fresh weight ratio,

root dry weight, root: shoot dry weight ratio recorded significant variation among various sites. On the basis of overall mean Site S<sub>2</sub> (Chail-Solan) excelled over other sites selected for progeny performance traits with overall index scoring 4.34. With in diameter classes significant variation recorded for characters viz., leaf area of seedling, root length of seedling, root: shoot length ratio and shoot dry weight. Diameter class > 60 cm excelled in progeny performance indicating mean of index score value of 4.33.

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