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Variation in seed germination and seedling traits of *Quercus leucotrichophora* A. Camus natural populations in Himachal Pradesh

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Abstract

Variability Studies 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 seed germination and seedling traits. The study revealed significant variation among different sites for traits viz., Initiation of Germination, Complete Germination, Germination (%), Germination value, Percentage Seedling Survival, Seedling Length, Collar Diameter, Inter- Nodal Length, Leaves Per Seedling. Over all site S8 (Salooni-Chamba) was found to be superior followed by site S6 (Manikaran-Kullu) for all traits. Diameter class D3 (>60 cm) excelled in seed germination and seedling traits. Study concluded that superiority of S8 (Salooni) and S6 (Manikaran) populations from large diameter class D₃ (>60 cm dbh) for obtaining seed /propagules for further testing and obtaining best results.

Keywords: variability, *Quercus leucotrichophora*, populations, germination, banoak, and seedling traits

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) [13]. 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) [8]. In Himachal Pradesh out of total forest area of 37591 km², 921 km² 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. Plus tree selection and diameter class is fruit and primary step and pioneer approach for tree improvement works. Hence, present study in seed germination and seedling traits is contemplated.

Materials 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 seed and seedling 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.

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.	Solan	Shilly	S ₁	1480 m amsl
		Chail	S ₂	2250 m amsl
2.	Shimla	Taklech	S ₃	1350 m amsl
		Summer Hill	S ₄	2120 m amsl
3.	Kullu	Garsa	S ₅	1190 m amsl
		Manikaran	S ₆	1760 m amsl
4.	Chamba	Sahu	S ₇	1400 m amsl
		Salooni	S ₈	1850 m amsl

Germination and seedling growth Studies Characters and Seedling traits viz., Number of days to initial germination, Number of days for complete germination, Germination per cent, Germination value, seedling survival percentage and Variation seedling traits namely., Seedling length, collar diameter, Inter nodal length, Leaves per seedling etc. were estimated and evaluated and recorded, as per methods suggested by (Bhatt and Ram 2005) [4], (Bimlendra and Toky 1992) [5], and (Boeger *et al.* 2004) [6], (Bagchi and Sharma 1989) [3] and (Jaswal 1992) [7].

Results and Discussion

The variation among the different sites showed non-significant variation with maximum mean days were recorded for site S₆ (22.18) and minimum for site S₁ (20.96). Whereas interaction among the three diameter classes revealed

maximum mean value for D1 (23.90) and minimum for D2 (18.85). D3 (21.16) were found statistically at par with D2. For diameter and site interaction the maximum mean value was showed by S₄D1 (25.15) and minimum value by S₂D2 (17.34). Non-significant interaction was found between diameter classes and different sites.

The variation among the eight sites showed significant variation with maximum mean days were recorded for site S₃ (49.61) and minimum for site S₅ (43.39). S₂ (46.95), S₄ (47.90) S₆ (44.88) and S₈ (46.54) were found significant with the maximum. Whereas interaction among the diameter classes revealed maximum mean value for D1 (52.25) and minimum for D2 (39.78). D3 (46.55) were found statistically at par with D2. Interaction studies between three diameter classes and eight sites showed maximum mean value for S₃D1 (57.33) and minimum value for S₂D2 (36.23). Significant interaction was found between diameter classes and different sites. S₁D1 (54.26), S₂D1 (56.23), S₄D1 (53.46) and S₈D1 (53.22) were found statistically at par with S₃D1.

The variation among eight sites showed non-significant variation with the maximum mean value for germination by site S₈ (66.01) and minimum by S₃ (58.04). Interaction among the diameter classes revealed maximum value for D2 (70.13) and minimum for D1 (56.36). D3 (66.31) were found statistically at par with D1. Interaction studies between three diameter classes and eight sites showed maximum mean value for S₅D2 (75.10) and minimum for S₇D1 (52.97) and significant interaction was found between diameter classes and different sites. S₂D2 (73.44), S₆D2 (74.36), S₇D2 (71.22), S₈D2 (69.49), S₇D3 (68.88) and S₈D3 (69.89) were found statistically at par with S₅D2. Table -1.

Table 1: Variation in the Initiation of germination, complete germination and germination (%) of *Quercus leucotrichophora* in three diameter classes among different sites

Sites/Trees	Diameter classes											
	Initiation of Germination				Complete Germination				Germination (%)			
	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 ₁ (Shilly)	24.29	18.28	20.33	20.96	54.26	40.27	45.65	42.96	56.70	68.00	61.25	61.98
S ₂ (Chail)	24.37	17.34	21.36	21.02	56.23	36.23	48.38	46.94	55.18	73.44	61.79	63.47
S ₃ (Taklech)	23.51	17.52	22.56	21.19	57.33	39.09	52.41	49.61	55.73	67.05	51.34	58.04
S ₄ (Summer-Hill)	25.15	19.26	20.56	21.65	53.46	43.54	46.72	47.90	60.87	62.41	55.57	59.61
S ₅ (Garsa)	23.30	18.18	21.62	21.03	48.20	38.59	43.40	43.39	54.66	75.10	62.37	64.04
S ₆ (Manikaran)	22.99	21.21	22.34	22.18	47.96	41.18	45.52	44.88	56.14	74.36	52.98	61.61
S ₇ (Sahu)	23.32	18.99	21.44	21.25	47.33	39.03	44.23	43.53	52.97	71.22	68.88	64.35
S ₈ (Salooni)	24.29	20.06	19.11	21.15	53.22	40.30	46.11	46.54	58.66	69.49	69.89	66.01
Mean	23.90	18.85	21.16	21.30	52.25	39.78	46.55	46.19	56.36	70.13	66.31	64.26

CD(0.05)

Diameter	3.37	1.88	2.49
Site	NS	3.07	NS
Diameter× Site	NS	5.31	7.03

The variation among the sites showed non-significant variation with maximum mean germination value in site S₈ (7.43) and minimum value in S₆ (5.63). Interaction among the diameter classes revealed maximum means value for D3 (7.18) and minimum for D1 (5.97). D2 (6.38) and were found statistically at par with D3. Interaction studies between three diameter classes and eight sites showed maximum mean value for S₂D3 (9.18) and minimum mean value for S₅D1 (4.49). Significant interaction was found between diameter classes and different sites. S₄D1 (7.09), S₈D1 (8.01), S₁D2 (7.10), S₃D2 (7.12), S₅D2 (7.91), S₈D2 (7.75), S₃D3 (8.16) S₄D3

(8.55) and S₇D3 (7.74) were found statistically at par with S₂D3.

The variation among the sites showed significant variation with maximum mean value for Site S₇ (75.83) and minimum mean value for S₁ (69.17). S₈ (75.30) and S₆ (73.35) were found significantly at par with site S₇. Interaction among the diameter classes revealed maximum value for D2 (80.65) and minimum for D1 (63.85). D3 (73.61) and were found significantly at par with D1. Interaction studies among three diameter classes and eight sites showed that maximum mean value for survival percentage was showed by S₇D2 (84.37) and minimum S₁D1 (55.68). Significant interaction was

found between diameter classes and different sites. S2D2 (80.03), S3D2 (79.04), S5D2 (79.46), S6D2 (83.58) and S8D2 (83.74) were found significantly at par with S7D2

The germination and seedling growth characters, viz., number of days for complete germination, seedling survival percentage were recorded significant among various sites. Site S6 (Manikaran-Kullu) recorded maximum mean value for number of days for initial germination and germination percentage. Site S8 (Salooni-Chamba) recorded maximum mean value for germination percentage and S7 (Sahu-Chamba) excelled in seedling survival percentage. With in diameter classes significant variation were recorded for number of days for initiation of germination, number of days for complete germination, germination percentage, germination value and seedling survival percentage. Diameter

class D2 (30-60 cm) excelled in germination percentage and seedling survival percentage.

Variation among the different sites showed non-significant variation with maximum mean length of 25.24 cm in sites S4 and minimum value for the same was recorded in S1 (23.04 cm). Interaction among the three diameter classes depicted maximum mean value for the diameter class D3 (24.96 cm) and minimum for D1 (22.83 cm). D2 (24.89 cm) and were found statistically at par with D3. Interaction studies between diameter classes and different site showed maximum mean value for S2D3 (27.48 cm), whereas S6D1 (19.98 cm) recorded the minimum mean value. Non-significant interaction was found between diameter classes and different sites Table -2.

Table 2: Variation in the Germination value, Percentage Seedling Survival and Seedling Length (cm), of *Quercus leucotrichophora* in three diameter classes among different sites.

Sites/Trees	Diameter classes											
	Germination value				Percentage Seedling Survival				Seedling Length (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 ₁ (Shilli)	5.91	7.10	5.18	6.06	55.68	75.99	75.85	69.17	20.95	23.38	24.81	23.04
S ₂ (Chail)	6.05	4.84	9.18	6.69	58.59	80.03	77.49	72.03	22.23	25.56	27.48	25.09
S ₃ (Taklech)	4.67	7.12	8.16	6.65	61.88	79.04	71.85	70.92	22.49	24.13	23.67	23.43
S ₄ (Summer-Hill)	7.09	6.39	8.55	7.34	63.15	78.98	74.83	72.32	26.05	23.86	25.82	25.24
S ₅ (Garsa)	4.49	7.91	6.35	6.25	68.85	79.46	69.72	72.67 (58.60)	24.04	25.60	23.64	24.42
S ₆ (Manikaran)	6.07	5.07	5.77	5.63	66.56	83.58	69.93	73.35	19.98	25.75	25.22	23.65
S ₇ (Sahu)	5.46	4.87	7.74	6.02	69.29	84.37	73.83	75.83	22.41	24.90	24.48	23.93
S ₈ (Salooni)	8.01	7.75	6.54	7.43	66.77	83.74	75.40	75.30	24.50	25.89	24.53	24.97
Mean	5.97	6.38	7.18	6.51	63.85	80.65	73.61	72.70	22.83	24.89	24.96	24.22

CD(0.05)

Diameter	0.93	1.89	1.14
Site	NS	3.09	NS
Diameter × Site	2.63	5.36	NS

Variation among the different sites showed non-significant variations with maximum mean collar diameter for site S7 (0.30 cm each) and minimum value for S6 (0.25 cm). Variation among the three diameter classes was significant and maximum mean value was recorded by D3 (0.35 cm) and minimum for D1 (0.23 cm). D2 (0.26 cm) were found statistically at par with D1. Interaction between three diameter classes and eight sites showed maximum value for S7D3 (0.46 cm) and minimum value for S8D1 (0.20 cm). Non significant interaction was found between diameter classes in different sites.

Variation among the sites showed non-significant variation with maximum mean height by site S6 (2.99 cm) and minimum value by site S1 (2.22 cm). Interaction among the three diameter classes recorded maximum mean value for the diameter class D3 (3.03 cm) and minimum for D1 (2.04 cm). D2 (2.72 cm) were found statistically at par with D1.

Interaction between three diameter classes and eight sites showed maximum mean value for S6D3 (3.72 cm) while S5D1 (1.79 cm) recorded the minimum mean value. However, non significant interaction was found between diameter classes and different sites.

Variation among the sites showed non-significant variations with maximum mean leaves per seedling by site S4 (10.60) and minimum value by site S3 (8.98). Variation among the diameter classes was significant and maximum mean value was recorded by D2 (10.31) and minimum by D1 (8.56). D3 (10.01) were found statistically at par with D2. Interaction between three diameter classes and eight sites showed maximum mean value for S4D2, S8D2 and S2D3 (11.42) and minimum value for S1D1 (7.25). Non significant interaction was found between three diameter classes and different sites Table -3.

Table 3: Variation in the Collar Diameter (cm), Inter-Nodal Length (cm) and Leaves Per Seedling of *Quercus leucotrichophora* in three diameter classes among different sites

Sites/Trees	Diameter classes											
	Collar Diameter (cm)				Inter-Nodal Length (cm)				Leaves Per Seedling			
	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 ₁ (Shilli)	0.26	0.29	0.32	0.29	1.83	2.50	2.33	2.22	7.25	9.95	9.88	9.02
S ₂ (Chail)	0.28	0.22	0.34	0.28	1.83	2.55	2.81	2.39	8.22	8.64	11.42	9.42
S ₃ (Taklech)	0.22	0.31	0.33	0.28	2.11	2.72	2.59	2.47	8.47	10.13	8.34	8.98
S ₄ (Summer-Hill)	0.27	0.23	0.38	0.29	2.17	2.25	3.14	2.52	10.56	11.42	9.83	10.60

S ₅ (Garsa)	0.23	0.28	0.31	0.27	1.79	3.02	3.45	2.75	10.00	10.22	9.99	10.07
S ₆ (Manikaran)	0.21	0.25	0.31	0.25	2.31	2.94	3.72	2.99	8.31	10.34	10.87	9.84
S ₇ (Sahu)	0.21	0.23	0.46	0.30	1.95	2.79	3.31	2.68	7.27	10.35	9.53	9.05
S ₈ (Salooni)	0.20	0.30	0.34	0.28	2.34	3.02	2.90	2.75	8.40	11.42	10.23	10.01
Mean	0.23	0.26	0.35	0.28	2.04	2.72	3.03	2.59	8.56	10.31	10.01	9.62

CD (0.05)

Diameter	0.04	0.38	0.93
Site	NS	NS	NS
Diameter× Site	NS	NS	NS

Various seedling traits like Seedling recorded significant differences among various sites. The site S₄ (Summer Hill-Shimla) excelled in seedling length, collar diameter, number of leaves per seedling and shoot length whereas site S₆ (Manikaran – Kullu) excelled in inter-nodal length, root length, root: shoot length ratio. With in diameter classes significant variation recorded for characters, viz., seedling height, collar diameter, inter-nodal length, number of leaves per seedlings and shoot length. Diameter class > 60 cm excelled for maximum of the characters viz., seedling length, collar diameter, inter-nodal length, 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. Ngulube (1989) in *Gliricidia sepium* provenances reported significant differences in seedling growth between provenances. Mohapatra (1996) [9] studied the variation in seedling traits in *Acacia catechu* and recorded that significant differences exist in the seedling growth and biomass traits under nursery as well as under field condition. Anand (2003) [1] in *Bauhinia variegata* recorded significant variation for seedling length and leaf area. Rana *et al.* (2009) [10] studied the progenies of *Toona ciliata* under nursery condition and they recorded significant difference for Seedling length, collar diameter, number of leaves under nursery condition. Sankhyan *et al.* (2008) [11] studied the morphological variation in *Grewia laevigata* and they recorded that some of the characters like number of leaves per seedling, nodal length, leaf length and leaf area exhibited variation between the sites. The seed source and provenance variation in nursery and field is essentially genetic in origin (Sniezko and Stewart, 1989) [12].

Jaswal (1992) [7] revealed that the growth parameters in *Grewia optiva* seedlings for height, collar diameter, leaf area, length and dry weight of root and shoot and their respective ratio showed significant variations among seed sources.

Study concludes that sites differed significantly for germination traits, viz., number of days for complete germination and seedling survival percentage. Whereas, with in the diameter classes significant variation was recorded for characters viz., number of days for initiation of germination, number of days for complete germination, germination (%), germination value and seedling survival percentage. Site S₆ (Manikaran-Kullu) excelled for maximum germination traits followed by Site S₈ (Salooni-Chamba). Diameter class D₂ (30-60 cm) excelled in germination (%) and seedling survival percentage.

Site S₄ (Summer Hill- Shimla) excelled in maximum traits followed by Site S₆ (Manikaran – Kullu). With in diameter classes significant variation recorded for characters viz., seedling length, collar diameter, inter-nodal length, number of leaves per plants and shoot length. Diameter class > 60 cm excelled for maximum characters.

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