



Seed ripening indication in *Quercus leucotrichophora* A. Camus, in Kumaun, Central Himalayan region

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Abstract

Quercus leucotrichophora A. Camus, a dominant tree species in the Uttarakhand Himalaya region. In the present study analysis the various seed characteristic and germination in different ecological setting. Seeds were analyzed for seed size (length & width), seed weight, number of seed 100 gm⁻¹, moisture content and germination. Seeds size were larger at lower elevation compare to higher elevation. The mean seed length across the collection dates varied between 8.45±1.2 and 14.88±2.4 mm. The germination was higher in seeds collected from higher elevation than those from low elevations. The range of seed moisture content (53.8±0.8 to 55.4±1.2%) coincided with maximum germination.

Keywords: *Quercus leucotrichophora*, seed characteristic, seed maturity, germination, Himalaya

Introduction

The Himalayan Mountain is the tallest, most complex and the youngest among the major mountain systems of the world extending for about 2500 km from east to west. The Himalayan range support a variety of forest which vary in species composition from east to west and from low to high elevation. These forests have traditionally played a key role in safeguarding the environment and have provided the long term ecological security to the subcontinent. The tree vegetation is the dominant components of these forests (Singh *et al.*, 2014) [12]. Plants maintain and expand their population over time by the process of regeneration. Regeneration includes seed production and the maturation of seeds so that they readily dispersed (Barnes *et al.*, 1998) [1].

Banj oak (*Quercus leucotrichophora* A. Camus) is the most common broadleaf tree species in the Central Himalayan region. Oak (*Quercus spp.*) occupy most of the area from 1000 to 3000 m altitude in the Central and Western Nepal, Uttarakhand and Himanchal Pradesh (Singh *et al.*, 2000) [14]. Banj oak is the important tree species in temperate and subtropical component of Himalayan ecosystem for biodiversity conservation view point, maintenance of soil fertility and recharge of spring water. *Q. leucotrichophora* is a late succession major forest forming tree species in Uttarakhand Himalaya region. The over exploitation of this species for a long time has led to gradual degradation of its natural stands (Nautiyal *et al.*, 2000) [8]. These forests have been under a tremendous biotic stress as they provided fuel, fodder and leaf litter. Concentration of human settlements in the oak forest areas, lopping and felling and occasional fire spreading from pine forest, have reduce the area under oak forest (Champion and Seth, 1968) [3]. Banj oak is used by the villagers mainly for fuel, fodder, leaf litter and timber. Therefore, one of the immediate ecological problem is this region is revival of the oak forests, which is turn involves vegetational study, evaluation of regeneration status and subsequently the factor influencing the regeneration.

Seed maturation is one of the most important parts of the life cycle in forest trees. Change in maturity period can change germination and growth rate; hence change the structure and composition of a stand in due time course (Bhatt and Ram, 2015) [7]. Thus, seed maturation study is important for conservation, development, growth, management (Bhatt and Ram, 2009) of a species and its adaptation in changing climatic conditions. Further, the time of maturation is also important for the collection, storage and testing of seeds for its better regeneration (Bhatt and Ram, 2015) [7]. Despite the dominance of Banj oak in Uttarakhand Himalaya seed maturity and germination behavior have received little attention. Seeds play an important role in the regeneration of tree species either by natural or artificial means. The objective of the present study was to analyse the seed maturity indices and seed germination of banj oak along the elevation gradient in Himalayan region.

Material and Methods

The study area is located between 29° 8' - 29° 38' N latitude and 79° 20' - 79° 45' E longitude. After a thorough survey two sites were selected namely Bhumiyaadhar (1580 m) and Bhowali (1720 m) in Uttarakhand Himalaya. The study was carried in the year 2012-13. The tree height across the selected trees ranged between 15.6±0.6 and 23.4±1.7 m and mean diameter between 17.2±1.4 and 26.5±2.0 cm at Bhumiyaadhar whereas, at Bhowali the tree height ranged between 17.4±0.8 and 25.3±0.7 m and mean tree diameter between 20.3±0.6 and 27.4±1.2 cm. At both the study site the associated species were *P. roxburghii* and *R. arboreum*. The average rainfall is about 1352 mm and the mean annual temperature is 18.5°C (Singh *et al.*, 2015) [15]. The relative humidity being variable from 30.79% in November to 56.15% in August but very often it crosses the 90% marks when individual days were noted (Bhatt and Ram, 2005) [7].

For seed collection, tree were marked based on characteristics of clear bole, good crown, sufficient number of forest seeds

and diseased free trees. Five averaged sized healthy trees were selected and marked at a distance of about 100 m from each other. Collection of seeds of *Q. leucotrichophora* was started in the second week of December up to the availability of seeds in January from both the sites. For maturity indices seeds collection was made at an interval of one week till the seeds were available. The seeds parameters taken were seed size (length and width), number of nut/acorn 100 gm⁻¹, weight of 100 nut/acorn, moisture content and germination. Weight parameters were recorded with the help of digital electronic balance and the size was recorded with the help of digital calliper.

Moisture content of seeds was expressed on a fresh weight (FW) basis, were determine for each collection date using three replicates of 25 seeds oven dried at 103±2°C for 16±1 hrs (ISTA, 1981) and then reweighed. For germination 3 replicates of 25 seeds each were initiated within one day of collection. The germination of the seeds was carried at 25±1°C in a dual chambered seed germinator with 8 hrs. of light for each collection date. Germination test was made on at top of the paper in petri-dishes. Germination was counted when visible radical developed in 1 mm long. Germination was monitored for 28 days. Germination percent was calculated as the total number of germinated seeds out of tested seeds within the test period. Data were analyzed using two way ANOVA (Snedecor and Cochran, 1967) [16] to determine differences in collection sources, seed

characteristics, moisture content and germination.

Result and Discussion

Seed Characteristics

At Bhumiyaadhar site the seeds length varied from 15.2±0.8 and 19.3±0.6 mm and seed width 9.5±2.2 and 16.9±0.3 mm. The seed character from initial to final collection changed in seed length was 4.1 mm and in seed width was 7.4 mm at Bhumiyaadhar site. At Bhowali site the seeds length varied from 10.4±0.4 and 15.3±0.6 mm and seed width 12.5±1.7 and 18.4±1.1 mm. The changes in seed length were 4.9 mm and in seed width 5.9 mm. The longer seeds were found at Bhowali site comparatively to Bhumiyaadhar site and vice-versa in width. ANOVA showed that seed length and width varied significantly across site and collection date (p<0.01). The interaction between site and collection dates was as also significantly different for seed length and seed width (p<0.05) (Table 1).

The changes in seed weight per 100 seeds Bhumiyaadhar were 29 g and at Bhowali it was 12 g. The seeds of Bhumiyaadhar were heavier than Bhowali. Weight of 100 seeds varied significantly across site (p<0.01) and dates (p<0.05) (Table 1). At Bhumiyaadhar the changes in number of 100 seeds were 73 and at Bhowali it was 57. The number of seed in 100 g were more at Bhumiyaadhar than Bhowali. Number of seed 100 gm⁻¹ were also significantly different across site and date (p<0.01) (Table 1).

Table 1: Effect of collection dates on seed characteristics of *Q. leucotrichophora*

Date	Seed length (mm)	Seed width (mm)	Wt. of 100 seeds (g)	No. of seeds 100 gm ⁻¹
Bhumiyaadhar				
17 December	15.2±0.8	9.5±2.2	55±0.9	193±0.6
24 December	16.2±0.7	12.8±0.5	65±0.8	186±0.2
31 December	17.7±1.4	13.1±0.8	82±0.3	160±0.2
07 January	18.6±0.7	15.5±1.3	83±0.9	140±2.6
14 January	19.3±0.6	16.9±0.3	84±1.3	120±1.3
Bhowali				
17 December	10.4±0.4	12.5±1.7	101±1.3	166±0.8
24 December	10.2±1.8	16.2±0.5	103±0.7	146±1.5
31 December	13.6±1.6	16.5±0.8	106±0.6	126±2.1
07 January	14.8±0.7	17.0±1.3	109±1.2	120±1.4
14 January	15.3±0.6	18.4±1.1	115±1.7	109±1.7
Site F Value	*	*	*	*
CD at 5%	-	-	3.54	3.76
Date F Value	**	**	*	*
CD at 5%	1.64	1.67	0.80	0.76
Site * Date				
F Value	**	**	NS	NS
CD at 5%	0.84	0.88	-	-

± = Standard Error, * = Significant at 1%, ** = Significant at 5%, NS = Non-Significant

Germination

For all collection dates, seed from both sites completed their germination in 12 to 28 days. The seed collected on 17th December has 1.9±1.4% mean germination at Bhumiyaadhar and 3.5±1.3% germination at Bhowali, when seed moisture content was 81.4±0.9 and 75.8±0.9% respectively. The peak mean germination was 50.4±0.8 and 66.7±0.3% at

Bhumiyaadhar and Bhowali when seed moisture content was 55.4±1.2 and 53.8±0.3% at both the site respectively. Maximum seed germination was earlier at Bhowali compare to Bhumiyaadhar (Table 2). ANOVA showed that moisture content of seed varied significantly across site and date (p<0.01). Whereas germination varies significantly only across date (p<0.05) (Table 2).

Table 2: Effect of moisture content on seed germination of *Q. leucotrichophora* across the collection dates

Date	Bhumiyaadhar		Bhowali	
	Seed Moisture (%)	Germination (%)	Seed Moisture (%)	Germination (%)
17 December	81.4±0.9	1.9±1.4	75.8±0.9	3.5±1.3
24 December	77.6±0.7	15.7±0.9	68.3±0.5	11.5±0.8
31 December	69.4±0.8	31.8±1.8	63.9±0.8	36.8±1.5
07 January	68.7±1.3	42.4±0.5	60.5±1.3	51.3±0.8
14 January	55.4±1.2	50.4±0.8	53.8±0.8	66.7±0.3
	Seed Moisture		Germination	
Site F Value	*		NS	
CD at 5%	2.87		-	
Date F Value	*		*	
CD at 5%	1.22		2.56	
Site * Date				
F Value	NS		NS	
CD at 5%	-		-	

± = Standard Error, * = Significant at 1%, NS = Non-Significant

A significant variation was observed in seed germination behavior collected from Bhumiyaadhar and Bhowali on same collection dates. Singh *et al.*, (2010) [13] have also found such differences in *A. butyracea*. The germination for the seeds from these two sites was maximum in higher elevation comparison to the elevation wise. This indicates that the seeds of *Q. leucotrichophora* mature earlier in higher elevation. The germination percentage were high as compared to the values reported by (Bhatt and Ram, 2005) [6] for *Q. leucotrichophora*. Such differences may be due to variations in seed weight (Fox *et al.*, 1994) [4] and seed moisture content (Pandit *et al.*, 2002) [9]. Moisture play a critical role in maturation and change in cone scale and seed moisture and specific gravity of cone or fruit content were strong manifestation that ripeness is progressing (Rediske, 1961) [10]. Moisture content in *Q. leucotrichophora* seeds decreased from 81.4±0.9 to 55.4±1.2% at Bhumiyaadhar and 75.8±0.9 to 53.8±0.8% at Bhowali. The maximum germination occurred when moisture content at both the sites were between 55.4±1.2 and 53.8±0.8%. Seeds at Bhowali (1720 m elevation) mature (maximum germination) compare to Bhumiyaadhar (1580 m elevation) for this difference the climatic variations may be responsible for different degree of physiological stages of seeds at different elevations.

Seed attained full size prior to maturity as no clear trends was observed among the collection dates. This indicates seed size has no bearing in the maturation. Seeds lose their fresh weight as the collection progressed (Bhatt and Ram, 2015) [7]. Seed moisture content and seed germination was negatively correlated. The present study showed that seed maturation period and germination percentage varied significantly between the sites. The seed maturity period lies in between 1st and 2nd week of January and seed germination depends on sound seed production.

References

- Barnes PW, Archer SR. Tree-shrub interactions in a subtropical savanna parkland: competition or facilitation? *J Veg. Sci.* 1988; 1:525-536.
- Bhatt J, Ram J. Ecology and regeneration of *Carpinus viminea* Wall; A lesser known tree species of the Himalaya, *Indian Forester.* 2009; 135:559-570.
- Champion HG, Seth SK. A revised survey of the forest types of India. Govt. of India press. Nasik, India. 1968.
- Fox JED, Barrett DR, Brand JE, Effendi M. Germination in *Santalum album* L.; Recent Research in Western Australia and a protocol for Timor, Indonesia. *Int. J Ecol. Environ. Sci.* 1994; 14:245-58.
- ISTA. Moisture content and equipment Wkg Group. In: Report of Forest Tree Seed Committee. *Seed Sci. Tech.* 1981, 9.
- Bhatt J, Ram J. Seed Characteristics and Germination in *Quercus leucotrichophora* A. Camus Along the Elevation Gradient in the Uttaranchal Himalaya; *Ecology and Environmental Management, New Delhi.* 2005; 15:207-213.
- Bhatt J, Ram J. Seed maturity indices in *Carpinus viminea* (Himalayan hornbeam) along altitudinal gradients in relation to climate change; *International Journal of Recent Scientific Research.* 2015; 6(20):40-50.
- Nautiyal AR, Rawat DCS, Prasad P. Physiological aspects of seed source variation in seed germination of *Quercus leucotrichophora*. *Indian Forester.* 2000; 126(3): 269-273.
- Pandit A, Pant K, Ram J. Effect of collection date on capsule moisture content and germination of *Populus ciliata* Wall. Ex. Royle from Central Himalaya. *New Forest.* 2002; 23:121-130.
- Rediske JH. Maturation of Douglas Fir seed A biochemical study. *For. Sci.* 1961; 7:204-213.
- Singh JS, Singh SP. Structure and function of Central Himalayan oak forests. *Proc. Indian. Sci. (Plant Sci.).* 1986; 96:443-455.
- Singh N, Tamta K, Tewari A, Ram J. Studies on Vegetational Analysis and Regeneration status of *Pinus Roxburghii*, *Roxb* and *Quercus leucotrichophora* Forests of Nainital Forest Division; *Global Journal of Science Frontier Research: Biological Science.* 2014; 14(3):41-48.
- Singh RP, Tewari A, Shah S, Tewari B. Seed maturity indices in *Aisandra butyracea* - A multipurpose tree species of lower Himalaya, *Journal of Environmental Biology.* 2010; 31:297-299.
- Singh SP, Tewari A, Singh SK, Pathak GC. Significance of phonologically synchronous populations of the central

- Himalayan oaks in drought adaptation. *Current Science*. 2000; 79:353-357.
15. Singh N, Ram J, Tewari A, Yadav RP. Phenological events along the elevation gradient and effect of climate change of *Rhododendron arboreum* Sm. in Kumaun Himalaya, *Current Science*. 2015; 108(1):106-110.
 16. Snedecor GW, Cochran WG. *Statistical Methods*. 6th Edn. Oxford and IBH publishing Co., New Delhi, 1967.