Tropical Agricultural Research and Extension 7, 2004

Effect of acorn collection procedure and their characteristics on germination and early seedling growth of ban oak (*Quercus leucotrichophora* A.Camus) in Tehri Garhwal region of Uttaranchal, India.

*Virendra Singh and S.K.Lavania
College of Forestry & Hill Agriculture,G.B.Pant University of Agriculture & Technology, Hill Campus, Ranichauri 249199Tehri Garhwal, India.

Accepted 28th June 2004

ABSTRACT

The effect of acorn collection procedure and their characteristics on germination and early seedling growth in *Quercus leucotrichophora* was studied. The ground collected (freshly fallen) acorns showed 60.75 per cent germination as compared to 47.44 per cent germination of crown collected acorns. The acorns which sank in water resulted in 64.38 per cent and those floated gave only 43.82 per cent germination. The acorns with cups gave 58.82 per cent germination in comparison to 49.38 per cent germination of acorns without cups. The collar diameter, seedling dry weight, seedling vigour index and quality index except sturdiness ratio was significantly higher in sunken acorns. Thus, irrespective of collection methods, sunken acorns should be used to obtain higher germination, dry weight, seedling vigour index and quality index.

Key words : Acorns, Germination, Sturdiness ratio, Seedling vigour, Quality index, Ban oak.

INTRODUCTION

Quercus leucotrichophora is moderate to large evergreen tree with almost round crown. It covers extensive areas in the western Himalayas in moister and cooler aspects. Ban oak chiefly occurs between 1200-2200 m as a climax species and forms gregarious forests between 1800-2000 m (Champion and Seth 1968; Puri *et al.*, 1982). It sometimes descends down to subtropical zone and is reported to occur even at 600 m elevation. In its upper zone, it is found associated with *Cedrus deodara, Quercus floribunda* and *Pinus wallichiana* whereas in its lower zone, it occurs with *Quercus glauca, Quercus lanuginosa* and *Pinus roxburghii*. It is very useful nurse crop to *Cedrus deodara* on hot slopes (Troup 1986). Ban oak plays subsistence role in the economy of rural hill population being used mainly as fodder, fuelwood, for making agricultural implements and charcoal (Singh *et al.*, 1995; Gautam and Bhardwaj 2001). The oak forests are an important component of Himalayan ecosystem from the view of biodiversity, soil and water conservation (Nautiyal *et al.*, 2000).

The trees are lopped extensively and mercilessly for leaf fodder. The uncontrolled and indiscriminate continuous lopping has resulted in almost negligible or absence in natural regeneration of this species. Thus, artificial regeneration remains the only alternative to keep up the area under ban oak cover. For this, pre-requisite is the collection of mature acorns that could produce good quality planting stock. This requires determination of precise procedures (methods) to collect quality acorns from the ban oak forests. The available information on the procedure of acorn collection and their characteristics on germination and seedling growth is not only scarce but fickle. Therefore, investigations on the effect of acorn collection procedure and their characteristics on germination and early seedling growth in ban

*Corresponding author

oak were undertaken.

MATERIALS AND METHODS

The acorns of ban oak were collected from a natural forest in Tehri Range of Tehri Forest Division of Uttaranchal at an altitude of 1800m asl, situated on north aspect between 30° 15' N latitude and 78° 30' E longitude. A total of twenty well developed middle aged trees with full tree crown were selected. The selected trees were having the habit of regular seed bearing. The acorns were collected in the first fortnight of January (Singh and Sah 1994) from standing trees (M_1) as well as freshly fallen acorns from the ground surface (M_2). The polythene sheet was spread beneath the crown of trees to collect the freshly fallen acorns. The acorns so collected were brought to the laboratory immediately and dipped into water to separate into sinkers (S_1) and floaters (S_2). The acorns, which sank or floated were further separated into acorns with cups (C_1) and without cups (C_2).

The seeds were sown at a depth of 2.0 cm (Luna 1996) in January itself into polybag containers of $2.2cm^{-3}$ filled with a mixture of soil, sand and FYM in the ratio of 1:1:1. Due care was given to watering and other cultural practices as required time to time. Each treatment was replicated four times and each replication contained forty polybags. One seed was sown into each polybag. Thus, one hundred sixty acorns were sown in each treatment. Emergence of plumule was taken as the criterion for germination. The germination of acorns started in the first week of April and it was complete by the end of June. The germination percentage in each replication was rounded off to the nearest whole number at the time of calculation. The height and collar diameter of all the surviving seedlings in each replication were measured at the time of termination of experiment in the month of December at a stage when seedlings became six month old. The average height and collar diameter were calculated for each treatment from the data. At the time of termination of experiment, 20 seedlings in each treatment (five seedlings from each replication) were uprooted with utmost care and separated into above ground (shoot) and below ground (root) parts and dry weight of each part for each treatment was calculated after drying the sample at 80° C to a constant weight. The seedling quality indices viz; shoot: root ratio (based on dry weight) and sturdiness ratio (shoot length in cm: collar diameter in mm) were computed. The seedling vigour index (VI) was derived from the formula of Abdul-Baki and Anderson (1973) by multiplying the germination per cent by dry weight of seedling in grams. The Quality index (QI) was calculated by the integrated procedure suggested by Dickson *et al.* (1960) as follows

$$\text{Quality Index (QI)} = \frac{\text{Seedling dry weight (g)}}{\dfrac{\text{Height (cm)}}{\text{Diameter (mm)}} + \dfrac{\text{Top weight (g)}}{\text{Root weight (g)}}}$$

All the parameters were statistically analysed in a factorial randomised block design using standard procedures for variance analysis (Snedecor and Cochran 1989). The arc sine transformation of percentage data was carried out before putting to analysis.

RESULTS AND DISCUSSION

The effect of acorn collection procedure and their characteristics on different aspects of germination and early seedling growth is described on:-

Germination

The results of effect of acorn collection method and their characteristics on germination have been presented in Table 1 which indicated that freshly collected acorns from the ground floor resulted in 60.75 per cent germination as compared to 47.44 per cent germination of acorns collected directly from the crown. The germination of acorns collected from ground floor differed significantly at P= 0.05 from the germination of crown collected acorns. The sinkers from ground collection resulted in 71.88 per cent germination as compared to 56.88 per cent from crown collected acorns. Similarly, floaters of ground collection gave 49.63 per cent germination of acorns as compared to 38.00 per

Table 1. Effect of method of acorn collection and their characteristics on germination

Condition of cup	Germination per cent					
	Crown collection (M_1)			Ground collection (M_2)		
	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	56.00 (48.45)*	53.25 (46.87)	54.63 (47.66)	72.25 (58.28)	53.75 (47.18)	63.00 (52.73)
Without cups (C_2)	57.75 (49.47)	22.75 (28.19)	40.25 (39.38)	71.50 (57.76)	45.50 (42.42)	58.50 (50.09)
Mean	56.88 (48.95)	38.00 (38.06)	47.44 (43.54)	71.88 (57.96)	49.63 (47.80)	60.75 (51.21)

Critical Difference (P=0.05)	
Collection methods (M)	5.21
Sinkers/floaters (S)	5.21
With or without cups (C)	5.21
M x S	7.37
M x C	7.37
S x C	7.37
M x S x C	10.48
CV (%)	13.09

* Values in parentheses are the arc sine transformed data

cent germination of crown collected floaters. Thus, the sinkers and floaters from ground collection gave significantly high germination than the sinkers or floaters of crown collection. Irrespective of collection method, the acorns, which sank, gave significantly higher germination of 64.38 per cent as compared to only 43.82 per cent germination of floaters.

Similarly, acorns with cups collected from ground floor gave 63.00 per cent germination whereas the germination of crown collected acorns with cups was only 54.63 per cent. The germination of acorns without cups collected from ground floor and crown was 58.50 per cent and 40.25 per cent, respectively. The germination of acorns with and without cups collected from ground floor and from crown differed significantly. In general, the acorns with cups gave 58.82 per cent germination in comparison to 49.38 per cent germination of acorns without cups that differed significantly at P= 0.05 level. The interactions between M x S, M x C, S x C and M x S x C were also significant at P=0.05 level.

The results of germination obtained from crown and ground collected acorns are in conformity with that of Masilamani *et al.* (2000) in *Tectona grandis* where crown collected drupes did not germinate but ground collected drupes gave 7.5 per cent germination. One of the possible cause of higher germination in ground collected acorns may be attributed to the fact that ground collected (freshly fallen) acorns might be in a best physiological state or maturity, the point at which the seeds have the greatest potential for maximum germination (Delouche 1974). Nappier and Robbins (1989) Delouche 1974). Nappier and Robbins (1989) And Luna (1996) have also recommended the collection of freshly fallen acorns in oak species. The sinkers gave higher germination. It possibly will be due to the fact that sinkers are heavy in weight than floaters. Heavier the seed, more is the reserved food material. The higher germination in sunken seeds can be endorsed to higher reserved food material, which might have provided a more rapid supply of energy at the time of seed germination. The results are in concurrence with that of Teclaw and Isebrands (1986) in *Quercus rubra*, Liou and Kuo (1999)

Table 2. Effect of method of acorn collection and their characteristics on collar diameter

	Collar diameter (cm)					
	Crown collection (M_1)			Ground collection (M_2)		
Condition of cup	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	0.36	0.33	0.34	0.33	0.31	0.32
Without cups (C_2)	0.34	0.33	0.34	0.33	0.30	0.32
Mean	0.35	0.33	0.34	0.33	0.31	0.32

Critical Difference (P=0.05)	
Collection methods (M)	NS
Sinkers/floaters (S)	0.01
With or without cups (C)	NS
M x S	NS
M x C	NS
S x C	NS
M x S x C	NS
CV (%)	8.17

in *Lithocarpus lepidocarpus*. The acorns with cups also showed higher germination in *Quercus rubra* (Teclaw and Isebrands 1986).

Seedling survival

There was no discernible significant difference in survival percentage of seedlings obtained from crown collected or ground collected acorns, sinker or floaters and acorns with cups or without cups.

Seedling collar diameter

The data on collar diameter indicated that the seedlings obtained from crown collected acorns and ground collected acorns gave the measurement of 0.34 cm and 0.32 cm of collar

Table 3. Effect of method of acorn collection and their characteristics on seedling dry weight

	Seedling dry weight (g)					
	Crown collection (M_1)			Ground collection (M_2)		
Condition of cup	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	4.64	3.52	4.08	4.54	3.16	3.85
Without cups (C_2)	3.94	3.40	3.67	3.66	3.26	3.46
Mean	4.29	3.46	3.87	4.10	3.21	3.66

Critical Difference (P=0.05)	
Collection methods (M)	NS
Sinkers/floaters (S)	0.75
With or without cups (C)	NS
M x S	NS
M x C	NS
S x C	NS
M x S x C	NS
CV (%)	27.02

diameter respectively. The difference in collar diameter between the two was statistically non significant. The collar diameter of seedlings obtained from crown collected sinkers was 0.35 cm and that of ground collected sinkers was 0.33 cm. The collar diameter of crown collected sinkers was significantly more from the collar diameter of ground collected sinkers (Table 2).

Similarly, the crown collected floaters resulted in 0.33 cm collar diameter and ground collected floaters gave 0.31 cm collar diameter again a significant difference (P=0.05) like that of crown and ground collected sinkers. The collar diameter of seedlings obtained from crown collected acorns or ground collected acorns but with cups intact was 0.34 cm and that of acorns without cup was 0.32 cm under both the conditions. The acorns with or without cups and collected from crown or ground had no significant difference in collar diameter of resulted seedlings.

Seedling dry weight

The seeding dry weight from crown collected acorns was 3.87 g and from ground collected acorns was 3.66 g. The sinkers from crown collected and ground collected acorns yielded 4.29 g and 4.10 g seedling dry weight. Similarly floaters from crown collected and ground collected acorns attributed 3.46 g and 3.21 g seedling dry weight respectively. The dry weight of seedlings with cups from crown collection and ground collection acorns was 4.08 g and 3.85 g. In the same way, acorns without cups from crown and ground collection resulted in the 3.67 g and 3.46 g seedling dry weight. The perusal of data in Table 3 clearly indicated that there was no significant difference in seedling dry weight between sinkers of crown collection and ground collection acorns or floaters of crown collection and ground collection acorns. Similar was the case with acorns with cups or without cups collected either from the crown or ground. However, the sinkers collectively yielded 4.20 g seedling dry weight against 3.40 g of floaters, a significant difference at P=0.05 level but acorns with cup or without cup showed no such discernible difference.

Table 4. Effect of method of acorn collection and their characteristics on sturdiness ratio

	Sturdiness ratio					
	Crown collection (M_1)			Ground collection (M_2)		
Condition of cup	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	3.40	3.56	3.48	3.51	4.11	3.81
Without cups (C_2)	3.46	3.91	3.68	3.42	3.86	3.64
Mean	3.43	3.74	3.58	3.46	3.98	3.72

Critical Difference (P=0.05)	
Collection methods (M)	NS
Sinkers/floaters (S)	0.28
With or without cups (C)	NS
M x S	NS
M x C	NS
S x C	NS
M x S x C	NS
CV (%)	10.39

Table 5. Effect of method of acorn collection and their characteristics on seedling vigour index

	Seedling vigour index					
	Crown collection (M_1)			Ground collection (M_2)		
Condition of cup	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	259.84	187.44	223.64	328.02	169.85	248.94
Without cups (C_2)	227.54	77.35	152.45	261.69	148.33	205.01
Mean	243.69	132.40	188.05	294.86	159.09	226.98
					3.98	
Critical Difference (P=0.05)						
Collection methods (M)		NS				
Sinkers/floaters (S)		44.73				
With or without cups (C)		44.73				
M x S		NS				
M x C		NS				
S x C		NS				
M x S x C		NS				
CV (%)		29.18				

Shoot: root ratio

The shoot: root ratio when compared between crown collected and ground collected acorns or between sinkers and floaters or between acorns with or without cups did not vary significantly with each other.

Sturdiness ratio

The sturdiness ratio (shoot length in cm: collar diameter in mm) of the seedlings of crown collected acorns was 3.58 and that of ground collected acorns was 3.72 (Table 4).The difference in the sturdiness ratio between the two methods of acorns collection was not much more different with each other. The sinkers of crown collected acorns illustrated a ratio of 3.43 while the sinkers of ground collected acorns gave a ratio of 3.46. The ratio of crown and ground collected floaters was 3.74 and 3.98. Similarly, acorns with cups and that collected from crown gave 3.48 and those collected from ground gave 3.81 sturdiness ratio. The crown and ground collected acorns but without cups showed a ratio of 3.68 and 3.64. The difference between sinkers or floaters or acorns with cups or without cups and collected either from crown or ground showed no significant difference. The difference in the sturdiness ratio of acorns with cups and without cups being 3.65 and 3.66, was also non significant. But the sinkers altogether gave 3.45 sturdiness ratio which was less than the sturdiness ratio of 3.86 obtained from floaters and the difference between the two was significantly different with each other at P=0.05 level.

Seedling vigour index

The seedling vigour index of crown collected acorns was 188.05 and that of ground collected acorns was 226.98. However, the difference between the two was non significant.

The ground collected sinkers gave seedling

Table 6. Effect of method of acorn collection and their characteristics on quality index (QI)

	Quality index					
	Crown collection (M_1)			Ground collection (M_2)		
Condition of cup	Sinkers (S_1)	Floaters (S_2)	Mean	Sinkers (S_1)	Floaters (S_2)	Mean
Cups intact (C_1)	1.17	0.83	1.00	1.09	0.60	0.84
Without cups (C_2)	0.97	0.76	0.86	0.90	0.70	0.80
Mean	1.07	0.80	0.93	0.99	0.65	0.82
Critical Difference (P=0.05)						
Collection methods (M)		NS				
Sinkers/floaters (S)		0.18				
With or without cups (C)		NS				
M x S		NS				
M x C		NS				
S x C		NS				
M x S x C		NS				
CV (%)		27.54				

vigour index of 294.86 as compared to 243.69 from crown collected sinkers, showing a significant difference between the two. The seedling vigour index of ground and crown collected floaters was 159.09 and 132.40 and showed no significant difference between the two. The ground collected acorns with and without cups showed 248.94 and 223.64 seedling vigour index again a non significant difference. The seedling vigour index of acorns without cups from crown gave a seedling vigour index of 152.45 and that of ground collected acorns gave 205.01 and the difference was statistically significant. The sinkers and floaters as a whole gave a seedling vigour index of 269.28 and 145.75. The difference was statistically significant (Table 5). Similarly, the seedling vigour index of acorns with cups was 236.29 and that of without cup was 178.13 and the index between the two differed significantly with each other like that of sinkers and floaters.

Quality index

The quality index that involves an integrated procedure was 0.93 for crown collected acorns and 0.82 for ground collected acorns. The quality index of sinkers of crown collected and ground collected acorn was 1.07 and 0.99 and that of crown collected floaters and ground collected floaters was 0.80 and 0.65, respectively. The difference was statistically non significant. However, the quality index of sinkers and floaters as a whole was 1.03 and 0.73 respectively and the difference was statistically significant. The acorns collected from crown and ground and with cups intact resulted in a quality index of 1.0 and 0.84 and without cups 0.86 and 0.80, respectively. The acorns with cups and without cups resulted in a quality index of 0.92 and 0.83, a non significant difference. The Table 6 evidently pointed out that sinkers had influenced the quality index significantly.

The results of collar, seedling dry weight, seedling vigour index and quality index insinuated clearly that the values of these parameters were higher in sunken seeds being

heavier in seed weight and consequently with more reserve food materials. The sturdiness ratio was significantly higher in floater seeds and may be due to less growth of collar diameter, thus increasing the sturdiness ratio. The seedling vigour index was significantly higher in sunken seeds but with cups intact. These results are in agreement with those of Singh *et al.* (1990) in *Picea smithiana*, Singh and Sah (1992) in *Abies pindrow*, Bhagat *et al.* (1993) in *Aesculus indica* and Singh (1998) in *Quercus dilatata* where heavier seeds significantly affected the seedling growth. It has been observed that heavier seeds resulted not only in higher biomass but also significantly higher vigour (Gomez and Piedrahita 1994).

CONCLUSION

The findings of present study indicated that ground collected (freshly fallen) acorns gave higher germination than the crown collected acorns. Irrespective of the method of collection, sunken acorns resulted in significantly higher collar diameter, seedling dry weight, vigour Index and quality index. Therefore, the sunken acorns, irrespective of collection methods, should invariably be separated to get higher germination, dry weight, seedling vigour index and quality index.

REFERENCES

Abdul Baki AA and Anderson JD 1973 Vigour determination in soybean seed by multiple criteria. Crop Sci. 13: 630-632.

Bhagat Sarjan, Singh Ombir and Singh Virendra 1993 Effect of seed weight on germination, survival and initial growth of horse chestnut (*Aesculus indica* Colebr). Indian Forester. 119(8): 627-629.

Champion HG and Seth SK 1968 A revised survey of the forest types of India. Government of India Publications, New Delhi. pp 404.

Delouche J C 1974 Maintaining soybean seed quality. In: Soybean: Production, marketing and use. Muscle Shoals, Ala., NFDC, TVA, Bull. Y-69: 46-62.

Dickson A, Leaf A L and Hosner J E 1960 Quality appraisal of white spruce and white pine seedling stock in nurseries. Forestry Chronicle. 36: 10-13.

Gautum J and Bhardwaj SD 2001 Effect of seed size and presowing treatments on germination of ban oak (*Quercus leucotrichophora*). Indian J. Forestry. 24(3): 311-315.

Gomez RML and Piedrahita CE 1994 Heteromorphism in seeds of *Acacia melanoxylon*. Cornica Forestal y del Medio Ambiente. 9: 9-24.

Liou SW and Kuo SR 1999 Changes of seed characters of native *Lithocarpus lepidocarpus* collected at different maturation stages. J Exp. Forest of National Taiwan University. 13(4): 295-302.

Luna RK 1996 Plantation Trees. International Book Distributors, Dehra Dun. pp 624 - 628.

Masilamani P, Singh BG, Manimuthu L and Singh GB 2000 Influence of collection methods and treatments of seed on the germination and seedling vigour of teak. Bangladesh Journal of Forest Science. 27(2): 138-140.

Nappier I and Robbins Marcus 1989 Forest seeds and nursery practice in Nepal. Forestry Research Division, Department of Forestry and Plant Rresearch, Kathmandu.

Nautiyal AR, Rawat DCS and Prasad P 2000 Physiological aspects of seed source variation in seed germination of *Quercus leucotrichophora* A.Camus. Indian Forester. 126(3): 269-273.

Puri GS, Mehar- Homji VM, Gupta RK and Puri S 1982 Forest Ecology Vol I. 2nd edn. Phytogeography and Forest Conservation. Oxford & IBH Publishing Company, New Delhi. pp 549.

Singh Ombir 1998 Effect of seed weight on germination, survival and initial growth of *Quercus dilatata* in the nursery. Indian Forester. 124(11): 959-963.

Singh Virendra, Bana OPS and Sah VK 1995 Influence of seed size and GA_3 treatment on

the germination and growth of banj oak (*Quercus leucotrichophora* A.Camus). Indian J. Forestry. 18(1): 66-73.

Singh Virendra, Bhagat, Sarjan and Singh, Ombir 1990 Effect of seed weight on Germination and initial seedling growth in spruce (*Picea smithiana* Wall. Boss.). Indian Forester. 116(5): 403-406.

Singh Virendra and Sah VK 1992 Effect of seed weight on germination and seedling growth in silver fir (*Abies pindrow* Spach). Van Vigyan. 30(2): 104-106.

Singh Virendra and Sah V K 1994 Effect of collection dates on germination and seedling growth in west Himalayan banjoak (*Quercus leucotrichophora* A.Camus). Van Vigyan. 32(4): 75-79.

Snedecor GW and Cochran WG 1989 Statistical methods, 8th ed., East-west Press Pvt. Ltd., New Delhi.

Teclaw RM and Isebrands JG 1986 Collection procedures affect germination of northern red oak (*Quercus rubra* L.) acorns. Tree Planter's Notes. 37(3): 8-12.

Troup RS 1986 The Silviculture of Indian Trees. Vol III. (reprinted). International Book Distributors, Dehra Dun.