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Studies on Germination of Ban Oak (Quercus Leucotrichophora A. Camus)

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Abstract—*The investigation was carried under nursery conditions with the aim to assess the rate of seed germination. The individual effect of seed size, seed colour and sowing depth was found with the maximum values for germination per cent in large sized (43.89%), dark brown colour seeds (39.44%) when sown at depth 1cm (47.04%), whereas for germination capacity the maximum value was obtained in large sized (59.44%), dark brown colour seeds (53.33%) when sown at depth 1cm (67.04%). Similar trend was observed in other germination parameters. It was found that effect of interaction for large size (S_1) dark brown colour seeds (C_2) sown 1cm deep (D_1) significantly excelled over other categories in terms of germinability parameter viz., number days for initiation of germination (14.67 days) .*

1. INTRODUCTION

Oaks are in the genus *Quercu*s of Fagaceae family (beech family). Oaks constitute an important group of forest trees and occupy a sizeable area in the Himalayas. There are 16 species of oaks growing in India, ten in eastern Himalayas and six in the western Himalayas. *Quercus leucotrichophora* commonly known as ban oak has been a symbol of permanence, strength and courage (Keator and Bazel, 1998)[1]. Besides it harbours a rich faunal diversity and is important for watershed protection and biodiversity conservation in general (Tashi, 2004)[2]. But the replacement of oak by pines has become a common and ever increasing phenomenon (Joshi and Tewari, 2011)[3]. Other than this pressure, oak forests in many parts of the Western Himalayas and in the rest of the world are dwindling due to lack of regeneration, habitat changes and biological invasions. The causes of failure in regeneration include erratic seed production, poor seed viability, defoliation, acorn predation and increased incidences of fire, unfavourable microsites and overgrazing by domestic animals. It is also one of the most over-exploited species and fails to regenerate adequately. Anthropogenic disturbances occur in the form of animal grazing, lopping of trees for fuelwood and fodder, removal of leaf litter and surface burning. The lack of mast seed years and the infestation of acorns by weevil add to the poor regeneration of the species. The amount of oak that regenerates following a harvest or major disturbance is often was less present than in the parent stand which lead to the realization that obtaining adequate oak regeneration is indeed a problem (Smith, 1993)[4].

2. MATERIAL AND METHOD:-

To study the effect of depth, seed colour and seed size on germination attributes of *Quercus leucotrichophora*.

A). Sowing depth: -

D_1: 1.0cm

D_2: 2.5cm

B). Seed Size

S_1: Large

S_2: Medium

S_3: Small

Table 1: Categorization of seed size was done on the basis of weight

Seed Grade	Average Acorn Weight (g)
Large	2.86
Medium	2.58
Small	1.82

C).Seed Colour

C_1**:** Light brown

C_2**:** Dark brown

C_3**:** Greenish Brown

Replications : 3

Design : Factorial (RBD)

treatmentS : 2x3x3 = 18

TREATMENT COMBINATIONS

$D_1C_1S_1$ $D_1C_3S_1$ $D_2C_2S_1$

$D_1C_1S_2$ $D_1C_3S_2$ $D_2C_2S_2$

$D_1C_1S_3$ $D_1C_3S_3$ $D_2C_2S_3$

$D_1C_2S_1$ $D_2C_1S_1$ $D_2C_3S_1$

$D_1C_2S_2$ $D_2C_1S_2$ $D_2C_3S_2$

$D_1C_2S_3$ $D_2C_1S_3$ $D_2C_3S_3$

Seedling growth studies

Three randomly selected seedlings per replication were carefully uprooted without breaking the roots and observations were taken after two months of sowing.

2.1 PARAMETERS CALCULATED

- Germination per cent (%)
- Germination capacity (%)
- Germination energy (%)
- Onset/initiation of germination (number of days of germination**)**

2.1.1 Germination per cent (%)

The per cent germination was calculated by number of seeds in a given sample that actually germinated.

$$\text{Germination (\%} = \frac{\text{Number of seed germinated}}{\text{Total no. of seed kept for germination}} \text{ X } 100$$

2.1.2 Germination capacity (%)

Germination capacity of a seed lot expressed percentage of number of seed which are subjected to the test and represent the full number of viable seed in the sample. It is calculated as the cumulative number of seeds that germinated during the given days of test period plus the number of viable seeds not germinated (using tetrazolium chloride) at the end of the test expressed in percentage.

2.1.3 Germinative energy (%)

Germination energy is a measure of speed of germination and hence is the indicator of the vigour of seed and of seedling. Germination energy was calculated on the basis of the percentage of the total number of seeds that had germinated when the germination reached at its peak generally taken as the highest number of germination in 24 hours period.

$$\text{Germination energy (\%)} = \frac{\text{Number of seeds germinated upto time of peak germination}}{\text{Total number of seeds sown}} \text{ X } 100$$

2.1.4 Onset/Initiation of germination (number of days of germination

It is the time taken for the commencement of germination. The day from trial to the day for first germination was recorded and expressed as onset/initiation of germination (number of days of germination).

3. RESULTS AND DISCUSSION

The results obtained are statistically analyzed and being tested at 5 per cent level of significance.

3.1 Germination Study

The significantly highest germination with large and heavy seeds of various tree species has been reported by various workers (Singh *et. al*., 1973[5]; Kandya, 1978[6]; Santon, 1985[7]; Kackar *et. al.*, 1986[8] and Manga and Sen, 1996[9]).

3.1.1 Effect of sowing depth, seed size, seed colour and their interactions on per cent germination

It is evident from the data presented in table 2 that among three seed size categories large sized seeds (S_1) exhibits maximum germination per cent (43.89%) while the minimum per cent germination (19.44%) was recorded for small sized seeds (S_3). Among seed colour categories, dark colour seed (C_2) exhibits maximum germination per cent (39.44%). Irrespective of seed size and seed colour, sowing depth exerted a significant effect on the per cent germination. The higher germination was found in the seeds sown at depth 1cm (D_1) with the value of 47.04% whereas significantly low under sowing depth D_2 (17.14%).

3.1.2 Effect of sowing depth, seed size, seed colour and their interactions on germination capacity

It can be inferred from the given table 3 that all three factors have significant effect on germination capacity. Among three seed sizes, large sized seed (S_1) exhibits maximum germination capacity (59.44%) and among seed colours, dark brown colour (C_2) was recorded with maximum of germination (53.33%).

The higher of germination capacity was found in the seeds sown at depth 1cm (D_1) with the value of (67.04%) whereas quite low under sowing depth D_2 (28.15%).

3.1.3 Effect of sowing depth, seed size, seed colour and their interactions on germination energy

The perusal of data in table 4 significantly reveals that large sized seeds (S_1) recorded highest of germination energy (29.44%) while the minimum germination energy (14.44%) was recorded for small sized seeds (S_3). Dark brown colour (C_2) seeds were recorded with maximum germination capacity (29.44%) while minimum was found (16.67%) for greenish brown (C_3). Sowing depth exerts significant effect on germinative energy, at depth 1cm (D_1) germinative energy was found to be (32.60%) whereas under sowing depth D_2, it was found to be (11.85%). The findings for germination paprameters are in line with Chauhan and Verma (1994)[10] for *Quercus leucotrichophora* who reported higher and quicker germination as well as growth rate for the larger seeds than the other two categories (medium and small).

3.1.4 Effect of sowing depth, seed size, seed colour and their interactions on onset of germination (number of days)

The content of the table 5 revealed that sowing depth (D) and seed colour (C) have significant effect on the number of days

taken to initiate germination. It has been noticed that the large sized seeds (S_1) took minimum number of days (22.61 days) to start germination as compared to medium sized S_2 (23.72 days) and small sized (24.83 days) seed categories. Among seed colour, dark brown seeds (C_2) took minimum numbers of days (21.78 days) to initiate germination as compared to light brown (21.83 days) and greenish brown (27.56 days). Irrespective of seed size and seed colour, sowing depth exerted a significant effect on the time taken to initiate germination. Under depth 1cm (D_1) number of days found for germination was 19.18 days whereas it was found 28.30 days under depth 2.5cm (D_2). The results are in line with the finding of Yuyama and Siqueira (1999)[11] for seeds of *Myrica dubia* and Adebola *et. al.* (1999)[12] for cashew nuts (*Anacardium occidentale*). Similar findings has been reported by Ghosh *et. al.*, (1976)[13] who ascribed that the seed sowing at 1.0 cm resulted into best germination in *Pinus patula*, *Pinus caribea* and *Pinus elliottii*. Similar observations in *Mallotus philippinensis* has also been reported by Bhaguna & Lal (1996)[14] for medium sized seeds when worked on the depth of sowing.

4. FIGURE AND TABLES

Fig. 1: Seed Sowing in polythene bags

Fig. 2: Seed germination after two month of sowing

Table 2: Effect of sowing depth, seed colour, seed size and their interactions on germination percentage (%):

	Depth (D)			**Seed Colour (C)**			
Size (S)	D_1	D_2	Mean	C_1	C_2	C_3	Mean
S_1	58.89 (50.39)	28.89 (31.99)	43.89 (41.18)	45.00 (41.91)	55.00 (48.05)	31.67 (33.60)	43.89 (41.18)
S_2	52.22 (46.26)	13.33 (20.97)	32.78 (33.62)	35.00 (34.98)	40.00 (38.05)	23.33 (27.82)	32.78 (33.62)
S_3	30.00 (33.06)	8.89 (15.24)	19.44 (24.15)	16.67 (19.57)	23.33 (28.17)	18.33 (24.70)	19.44 (24.15)
Mean	47.04 (43.24)	17.41 (22.73)		32.22 (32.15)	39.44 (38.09)	24.44 (28.71)	
Colour				Figures in parentheses indicate the arc sine transformed values			
C_1	48.89 (44.21)	15.56 (20.09)	32.22 (32.15)				
C_2	56.67 (49.05)	22.22 (27.13)	39.44 (38.09)				
C_3	35.56 (36.44)	13.33 (20.97)	24.44 (28.71)				
Mean	47.04 (43.24)	17.41 (22.73)					

Table 3: Effect of sowing depth, seed colour, seed size and their interactions on germination capacity (%):

	Depth (D)			**Seed Colour (C)**			
Size (S)	**D_1**	**D_2**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
SS_{1S}	78.89 (63.16)	40.00 (39.00)	59.44 (51.08)	60.00 (51.37)	66.67 (55.90)	51.67 (45.98)	59.44 (51.42)
S_2	68.89 (56.50)	25.56 (29.91)	47.22 (43.21)	46.67 (42.87)	56.67 (49.41)	38.33 (37.34)	47.22 (43.21)
S_3	53.33 (47.06)	18.89 (25.49)	36.11 (36.27)	36.67 (36.77)	36.67 (36.87)	35.00 (35.17)	36.11 (36.27)
Mean	67.04 (55.57)	28.15 (31.45)		47.78 (43.67)	53.33 (47.40)	41.67 (39.50)	
Colour				Figures in parentheses indicate the arc sine transformed values			
C_1	65.56 (54.48)	30.00 (32.86)	47.78 (43.67)				
C_2	72.22 (59.24)	34.44 (35.55)	53.33 (47.40)				
C_3	63.33 (53.00)	20.00 (25.99)	41.67 (39.50)				
Mean	67.04 (55.57)	28.15 (31.45)					

Table 4: Effect of sowing depth, seed colour, seed size and their interactions on germination energy (%):

	Depth			Seed Colour			
Size (S)	**D_1**	**D_2**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
S_{1S}	42.22 (40.32)	16.67 (21.06)	29.44 (30.69)	28.33 (29.52)	40.00 (38.45)	20.00 (24.09)	29.44 (30.68)
S_2	35.56 (36.08)	10.00 (17.28)	22.78 (26.68)	23.33 (27.82)	30.00 (29.98)	15.00 (22.24)	22.78 (26.68)
S_3	20.00 (26.00)	8.89 (15.24)	14.44 (20.61)	10.00 (14.99)	18.33 (24.60)	15.00 (22.24)	14.44 (20.61)
Mean	32.60 (34.13)	11.85 (17.86)		20.56 (24.11)	29.44 (31.01)	16.67 (22.86)	
Colour (C)							
C_1	31.11 (33.40)	10.00 (14.83)	20.56 (24.11)				
C_2	44.44 (41.30)	14.44 (20.73)	29.44 (31.01)				
C_3	22.22 (27.70)	11.11 (18.02)	16.67 (22.86)				
Mean	32.60 (34.13)	11.85 (17.86)					

Figures in parentheses indicate the arc sine transformed values

Table 5: Effect of sowing depth, seed colour, seed size and their interactions on onset of germination (number of days):

	Depth (D)			Seed Colour (C)			
Size (S)	**D_1**	**D_2**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
S_1	20.11	25.11	22.61	22.83	18.50	26.50	22.61
S_2	17.67	29.78	23.72	20.17	22.67	28.33	23.72
S_3	19.78	29.89	24.83	22.50	24.17	27.83	24.83
Mean	19.18	28.30		21.83	21.78	27.56	
Colour (C)							
C_1	17.56	6.11	21.83				
C_2	18.44	25.11	21.78				
C_3	21.56	33.56	27.56				
Mean	19.18	28.30					

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