

# EFFECT OF VARIOUS STRATIFICATION TREATMENTS ON GERMINATION BEHAVIOUR OF *RHODODENDRON CAMPANULATUM* D. DON

ROVITA KATOCH, MANISHA THAKUR\*, G. S. SHAMET

Dr. Yashwant Singh Parmar University of Horticulture and Forestry,  
Department of Silviculture and Agroforestry, College of Forestry, Nauli - 173 230, Solan, H.P., INDIA  
e-mail: thakur.monisha011@gmail.com

## KEYWORDS

Rhododendron  
Stratification period  
Germination percent  
Temperature

Received on :  
05.11.2016

Accepted on :  
08.02.2017

\*Corresponding  
author

## ABSTRACT

The present study was conducted to examine effect of stratification treatment on germination of seeds of *Rhododendron campanulatum* D. Don. as the seeds are so minute that it hardly reaches to the soil surface resulting in poor natural regeneration in its habitat. The result showed that significantly maximum germination (72.27%), germination value (6.21) and germination index (2.24) was obtained in control ( $W_1$ ), than other periods used for stratification. However, for temperature effect, the significantly maximum germination (64.53%), germination energy (46.13%), germination value (5.44) and germination index (2.08) were obtained when seeds were kept in outdoor-pit ( $T_3$ ). However, for combined effect ( $W \times T$  interaction), the significantly maximum germination (78.67%), germination value (8.19) and germination index (2.51) resulted when seeds were stratified for 3 weeks at room temperature ( $W_2T_1$ ). The results emphasize the importance of maintaining a good storage environment for *Rhododendron* seed collections which are likely to be short-lived compared with species from other families.

## INTRODUCTION

The main objective of this research was to study the effect of various stratification treatments on the germination attributes of the *Rhododendron* species. The genus *Rhododendron*, family Ericaceae, was founded by Linnaeus (Linnaeus, 1753) is an evergreen shrub or a small tree, reaching upto 6m in height and up to 90cm in girth and mainly native to Northern hemisphere (Cox and Cox, 1997). In India, there are about 80 species (with 10 subspecies and 14 varieties) (Bhattacharyya, 2005) maximum of which are widely distributed in different regions and altitudes in the Himalayas in between 1500 – 5500 m) and in temperate and alpine regions of Northern India from Kashmir to Nagaland at 2400-5200m elevations. *Rhododendron campanulatum* D. Don. grows in mixed forest, along with conifers and other *Rhododendrons*. In Himachal Pradesh, it is chiefly found in Chanshal, Muraldanda, Thamsarbase, Dainasar pastures, Mani Mahesh, Rorag thatch, Shikari Devi in Mandi district, Churdhar in Sirmour district, and Kullu district of Himachal Pradesh between 2800-4200m elevations (Chauhan, 1999). *Rhododendron campanulatum* D. Don. the pink rhododendron is an endangered and rare species of Himalayas and enunciated as the State Flower of Himachal Pradesh. The species prefer well drained sandy loam soil, having pH of less than 6. It thrives well in sun and shade, but warmer the climate, the more shade the species requires. It however, avoids deep shade from large tree and can tolerate harsh climatic conditions of the Himalayas.

The regeneration of rhododendron in nature is through seed

only, its fruits consist of oblong, five-valved, dehiscent capsules that begin to ripen in autumn. The capsules turn from green to brown and split along the sides when ripe (Blazich and Rowe, 2003). Each inflorescence can produce as many as 5000 seeds. The seeds are very small, typically 2-3mm including testa, and easily dispersed by wind. As, the regeneration in nature is through seed only, which is reportedly very low as the seeds are so minute that it hardly reaches the soil surface resulting in poor natural regeneration in its habitat (Grime *et al.* 1981).

A significant number of studies (Baskin and Baskin, 1998) have been carried out by researchers across the globe for assessing and evaluating the regeneration studies of rhododendron; but so far, no long term stratification treatment have been suggested for the seed of rhododendrons, therefore it is important to examine their desiccation response in order to obtain preliminary information for their seed germination and its conservation. Similarly, the literature on propagation through vegetative means is totally lacking. Therefore, keeping in view the ecological and economic value of the species, this study was carried out.

## MATERIALS AND METHODS

The present study was carried out in the laboratory of Department of Silviculture and Agroforestry, Dr Y S Parmar University of Horticulture and Forestry, Nauli, situated south-east of Solan town of Himachal Pradesh, at 30°51'N latitude and 76°11'E longitude having an altitude of 1250 m above

mean sea level during 2012-14. The experiment was carried out with 3 replications and following treatments *i.e.* A. Stratification period (5)  $W_1$ :Control (no stratification),  $W_2$ :Stratification for 3 weeks,  $W_3$ :Stratification for 6 weeks,  $W_4$ :Stratification for 9 weeks,  $W_5$ :Stratification for 12 weeks

B. Stratification temperature (5)  $T_1$ :Control (room temperature),  $T_2$ :  $3 \pm 1^\circ\text{C}$ ,  $T_3$ : $0^\circ\text{C}$ ,  $T_4$ : $-3 \pm 1^\circ\text{C}$ ,  $T_5$ :Outdoor pit. The seeds were made to germinate on filter papers in petridishes kept under open laboratory condition during April - May, 2013.

Blotter method (de Tempe, 1953) Stratification of seeds was done for 12, 9, 6, 3 and 0 weeks by placing the required number of seeds on two blotting paper fold which were placed in each Petri-dish 9 cm diameter. Sterilized water was used for moisten of the blotter paper. Seeds were placed in each Petri-dish and incubated under different temperatures of  $-3 \pm 1^\circ\text{C}$  (deep freezer),  $0^\circ\text{C}$  (freezer),  $3 \pm 1^\circ\text{C}$  (incubator), room temperature and out-door pit. The percent germination of seeds was calculated weekly. The temperature of out-door pit and control for maximum 90 days period was found to be  $16.73^\circ\text{C}$  and  $19.00^\circ\text{C}$  respectively. The trial was thus, kept under observation for one month so that best stratification treatment could be worked out. Seeds were collected from *Rhododendron campanulatum* stands from Larot forest (below Chanshal thatch) of Rohru Forest Division during Oct-Nov 2012. The seed bearing capsule were brought to laboratory and sieved to remove unwanted foreign material. The observations on seed Germination per cent (g %), Germination energy (ge %), Germination rate / speed, Mean daily germination (mdg), Peak value (pv) Germination index (gi) of *Rhododendron campanulatum* D.Don. were recorded. The data obtained under various experiments were subjected to statistical analysis as per the methods detailed by (Chako,1965), (Misra,1968), (Steel and Torrie,1960) and (Gomez and Gomez,1984). The data were appropriately transformed wherever required before subjecting to ANOVA

for drawing necessary interpretation and conclusions. The obtained results were analyzed statistically using completely randomized design (CRD) following (Snedecor and Cochran,1989).

## RESULTS AND DISCUSSION

### Effect of stratification periods on germinability attributes of *Rhododendron campanulatum*. D.Don.

The present study revealed that germination was significantly affected by various stratification treatments. The rhododendron seeds were stratified for different periods, viz, control ( $W_1$ ), 3weeks ( $W_2$ ), 6weeks ( $W_3$ ), 9weeks ( $W_4$ ) and 12weeks ( $W_5$ ) at different stratification temperatures like control (room temperature) ( $T_1$ ),  $3 \pm 1^\circ\text{C}$  ( $T_2$ ),  $0^\circ\text{C}$  ( $T_3$ ),  $-3 \pm 1^\circ\text{C}$  ( $T_4$ ), and outdoor-pit ( $T_5$ ). The result in Table 1.concluded that significantly maximum germination of 72.27 per cent resulted when control treatment (no stratification) ( $W_1$ ) was used. (RBG Kew ,2008) also observed high germination rate without stratification, which was followed by 62.67 per cent in stratification period of 3weeks ( $W_2$ ) and 59.33 per cent for 6weeks ( $W_3$ ) treatments. The significantly minimum germination of 48.80 per cent was found for seeds stratified for 9 weeks ( $W_4$ ). Significantly maximum germination energy of 47.33 per cent resulted when seeds were stratified for 6weeks ( $W_3$ ), but being statistically at par with control ( $W_1$ ) giving value of 46.80 per cent. This was followed by seeds stratified for 3weeks ( $W_2$ ) giving value of 44.93 per cent. The significantly least value of 33.47 per cent resulted in seeds stratified for 9 weeks ( $W_4$ ). Germination speed of 1.71 for control ( $W_1$ ) was significantly maximum, but being statistically at par with 6weeks ( $W_3$ ) and 3weeks ( $W_2$ ) stratification giving value of 1.67 and 1.57 respectively in descending order. The significantly minimum germination speed of 1.11 however, resulted for seeds stratified for 9 weeks ( $W_4$ ). Maximum mean daily germination of 2.41 recorded when

**Table 1: Effect of stratification period on germinability attributes of *Rhododendron campanulatum* D.Don. seeds under laboratory condition**

Stratificationperiod	Germination(%)	Germinationenergy (%)	Germination speed	Mean daily germination	Peak value	Germination value	Germination index
$W_1$ :Control	72.27 (58.25)	46.80 (43.15)	1.71	2.41	2.57	6.21	2.24
$W_2$ :3weeks	62.67 (52.57)	44.93 (42.06)	1.57	2.09	2.47	5.28	1.99
$W_3$ :6weeks	59.33 (50.49)	47.33 (43.44)	1.67	1.98	2.31	4.65	1.90
$W_4$ :9weeks	48.80 (44.32)	33.47 (34.76)	1.11	1.63	1.98	3.49	1.60
$W_5$ :12weeks	56.00 (48.54)	38.93 (38.33)	1.28	1.87	2.01	3.91	1.62
SE $\pm$	1.41	0.50	0.08	0.08	0.06	0.28	0.08
CD <sub>0.05</sub>	2.85	1.01	0.15	0.16	0.13	0.57	0.16

Figures in parentheses are arc-sine transformed values

**Table 2: Effect of stratification temperature on germinability attributes of *Rhododendroncampanulatum* D.Don. seed under laboratory condition**

Stratificationtemperature	Germination (%)	Germination energy (%)	Germination speed	Mean daily germination	Peak value	Germination value	Germination index
$T_1$ : Control(roomtemp.)	55.20 (48.20)	35.20 (35.61)	1.27	1.84	2.02	4.23	1.80
$T_2$ : $3 \pm 1^\circ\text{C}$	61.20 (51.67)	42.00 (40.25)	1.52	2.04	2.28	4.82	1.89
$T_3$ : $0^\circ\text{C}$	59.87 (50.82)	42.93 (40.89)	1.31	1.99	2.12	4.34	1.69
$T_4$ : $-3 \pm 1^\circ\text{C}$	58.27 (49.89)	45.20 (42.21)	1.58	1.94	2.41	4.72	1.89
$T_5$ : Out-doorpit	64.53 (53.59)	46.13 (42.76)	1.65	2.15	2.51	5.44	2.08
SE $\pm$	1.41	0.50	0.08	0.08	0.06	0.28	0.08
CD <sub>0.05</sub>	2.85	1.01	0.15	0.16	0.13	0.57	0.16

Figures in parentheses are arc-sine transformed values

**Table 3: Effect of stratification period and stratification temperature interaction (WxT) on germinability of *Rhododendron campanulatum* D.Don. seed under laboratory condition**

Treatment	Germination (%)	Germination energy (%)	Germination speed	Mean daily germination	Peak value	Germination value	Germination index
W <sub>1</sub> T <sub>1</sub>	72.67 (58.53)	48.00 (43.84)	1.76	2.42	2.77	6.74	2.42
W <sub>1</sub> T <sub>2</sub>	74.67 (59.77)	49.33 (44.60)	1.85	2.49	2.69	6.70	2.39
W <sub>1</sub> T <sub>3</sub>	72.00 (58.07)	45.33 (42.30)	1.65	2.40	2.41	5.80	2.08
W <sub>1</sub> T <sub>4</sub>	72.67 (58.47)	47.33 (43.45)	1.69	2.42	2.49	6.04	2.23
W <sub>1</sub> T <sub>5</sub>	69.33 (56.39)	44.00 (41.54)	1.60	2.31	2.49	5.75	2.08
W <sub>2</sub> T <sub>1</sub>	78.67 (62.49)	54.00 (47.28)	1.92	2.62	3.12	8.19	2.51
W <sub>2</sub> T <sub>2</sub>	72.00 (58.07)	47.33 (43.45)	1.56	2.40	2.45	5.88	2.13
W <sub>2</sub> T <sub>3</sub>	52.67 (46.52)	37.33 (37.65)	1.14	1.76	1.78	3.12	1.41
W <sub>2</sub> T <sub>4</sub>	56.67 (48.88)	42.67 (40.77)	1.61	1.89	2.62	4.96	1.95
W <sub>2</sub> T <sub>5</sub>	53.33 (46.90)	43.33 (41.15)	1.60	1.78	2.37	4.22	1.96
W <sub>3</sub> T <sub>1</sub>	52.67 (46.51)	43.33 (41.15)	1.44	1.76	1.94	3.41	1.66
W <sub>3</sub> T <sub>2</sub>	49.33 (44.60)	38.67 (38.42)	1.59	1.64	1.93	3.22	1.55
W <sub>3</sub> T <sub>3</sub>	69.33 (56.47)	51.33 (45.75)	1.68	2.31	2.61	6.05	2.08
W <sub>3</sub> T <sub>4</sub>	64.00 (53.27)	54.67 (47.66)	1.92	2.13	2.60	5.57	2.15
W <sub>3</sub> T <sub>5</sub>	61.33 (51.58)	48.67 (44.22)	1.73	2.04	2.44	5.03	2.05
W <sub>4</sub> T <sub>1</sub>	31.33 (33.88)	12.00 (20.22)	0.49	1.04	0.95	1.03	1.04
W <sub>4</sub> T <sub>2</sub>	41.33 (39.93)	25.33 (30.16)	1.03	1.38	1.91	2.71	1.59
W <sub>4</sub> T <sub>3</sub>	55.33 (48.06)	43.33 (41.15)	0.95	1.84	2.00	3.70	1.54
W <sub>4</sub> T <sub>4</sub>	45.33 (42.30)	38.00 (38.04)	1.38	1.51	2.28	3.46	1.63
W <sub>4</sub> T <sub>5</sub>	70.67 (57.44)	48.67 (44.22)	1.69	2.36	2.76	6.56	2.20
W <sub>5</sub> T <sub>1</sub>	40.67 (39.59)	18.67 (25.58)	0.72	1.36	1.31	1.78	1.36
W <sub>5</sub> T <sub>2</sub>	68.67 (55.97)	49.33 (44.60)	1.58	2.29	2.43	5.57	1.81
W <sub>5</sub> T <sub>3</sub>	50.00 (44.98)	37.33 (37.65)	1.12	1.67	1.81	3.02	1.32
W <sub>5</sub> T <sub>4</sub>	52.67 (46.51)	43.33 (41.15)	1.32	1.76	2.03	3.58	1.49
W <sub>5</sub> T <sub>5</sub>	68.00 (55.62)	46.00 (42.69)	1.65	2.27	2.47	5.62	2.13
SE <sub>±</sub>	3.16	1.12	0.17	0.174	0.14	0.63	0.17
CD <sub>0.05</sub>	6.37	2.25	0.34	0.351	0.28	1.28	0.35

Figures in parentheses are arc-sine transformed values

seeds were kept as control (W<sub>1</sub>). This was followed by mean daily germination of 2.09 in stratification of 3 weeks (W<sub>2</sub>) and 1.98 in 6 weeks (W<sub>3</sub>). The significantly least value of 1.63, however resulted for seeds stratified for 9 weeks (W<sub>4</sub>). Peak value of 2.57 for control (W<sub>1</sub>), but being statistically at par with seeds stratified for 3 weeks (W<sub>2</sub>) (2.47). The significantly minimum peak value of 1.98 resulted for seeds stratified for 9 weeks (W<sub>4</sub>), but being statistically at par with seeds stratified for 12 weeks (W<sub>5</sub>) giving value of 2.01 (Ghyare, 2005).

The table revealed that germination value was significantly maximum 6.21 for control treatment (W<sub>1</sub>). The significantly minimum germination value of 3.49 resulted when seeds were stratified for 9 weeks (W<sub>4</sub>), but being statistically at par with seeds stratified for 12 weeks (W<sub>5</sub>) giving value of 3.91.

Results of the data in table 1. reported that germination index was significantly maximum (2.24) when control (W<sub>1</sub>) treatment was used. This was followed by seeds stratified for 3 weeks (W<sub>2</sub>) and 6 weeks (W<sub>3</sub>) giving value of 1.99 and 1.90 respectively in descending order. The significantly least value of 1.60 was however, obtained in seeds stratified for 9 weeks (W<sub>4</sub>), but was statistically at par with seeds stratified for 12 weeks (W<sub>5</sub>) giving value of 1.62.

#### Effect of stratification temperature on germinability attributes of *Rhododendron campanulatum*. D.Don.

Table 2. showed that significantly maximum germination of 64.53 per cent resulted when seed were kept in outdoor-pit (T<sub>3</sub>). This was, however statistically at par with 61.20 per cent obtained for stratification temperature of 3 ± 1°C (T<sub>2</sub>) and 59.87

per cent of 0°C (T<sub>3</sub>) (Baskin and Baskin, 1988). The significantly minimum germination of 55.20 per cent was found for seeds stratified at control (room temperature) (T<sub>1</sub>), but being statistically at par with seeds stratified at -3 ± 1°C (T<sub>4</sub>) and 0°C (T<sub>5</sub>) giving value of 58.27 per cent and 59.87 per cent respectively. It is clear from the given data that significantly maximum germination energy of 46.13 per cent and germination speed (1.65) resulted when seeds were stratified in outdoor-pit (T<sub>5</sub>), but being statistically at par with seeds stratified at -3 ± 1°C (T<sub>4</sub>). The significantly least value of 35.20 per cent and germination speed of 1.27 was obtained for seeds stratified at control (T<sub>1</sub>).

An overview of the data in Table.2 revealed that significantly maximum mean daily germination of 2.15 and peak value of 2.51 resulted when seeds were kept as outdoor-pit (T<sub>5</sub>). The significantly least value of 1.84 was observed for seeds stratified at control (room temperature) (T<sub>1</sub>), but being statistically at par with seeds stratified at -3 ± 1°C (T<sub>4</sub>) and 0°C (T<sub>5</sub>) giving value of 1.94 and 1.99 respectively. The significantly minimum peak value of 2.02 was obtained for control (T<sub>1</sub>), but found to be statistically at par with seeds stratified at 0°C (T<sub>5</sub>) giving value of 2.12.

Germination value was significantly maximum (5.44) when seeds were kept as outdoor-pit (T<sub>5</sub>). This was followed by value of 4.82 at stratification temperature of 3 ± 1°C (T<sub>2</sub>). The significantly minimum germination value of 4.23 was obtained in control (T<sub>1</sub>), but being statistically at par with stratification temperature of -3 ± 1°C (T<sub>4</sub>) and 0°C (T<sub>5</sub>) giving value of 4.34 and 4.72 respectively. The value of germination index was

significantly maximum (2.08) when outdoor-pit ( $T_3$ ) was used. This was followed by stratification temperature of  $3 \pm 1^\circ\text{C}$  ( $T_2$ ) and  $-3 \pm 1^\circ\text{C}$  ( $T_4$ ) giving value of 1.89 each (Campbell, 1985). The significantly least value of 1.69 was obtained for stratification temperature of  $0^\circ\text{C}$  ( $T_3$ ), but being statistically at par with control ( $T_1$ ) giving value of 1.80.

#### Effect of stratification period and temperature interaction ( $W \times T$ )

It is evident from the data given in Table 3 that significantly maximum germination of 78.67 per cent resulted when seeds were stratified for 3 weeks at room temperature ( $W_2T_1$ ). This was, however statistically at par with  $W_1T_2$  (74.67%),  $W_1T_1$  and  $W_1T_4$  (72.67% each),  $W_1T_3$  and  $W_2T_2$  (72.00% each),  $W_4T_5$  (70.67%) and  $W_1T_5$  (69.33%) combinations. The significantly minimum germination of 31.33 per cent was found for  $W_4T_1$  (9 weeks x control), but being statistically at par with  $W_5T_1$  and  $W_4T_2$  combinations giving value of 40.67 per cent and 41.33 per cent respectively in this regard. On the other hand, significantly maximum germination energy of 54.67 per cent was obtained when seeds were stratified for 6 weeks at  $-3 \pm 1^\circ\text{C}$  ( $W_3T_4$ ), but being statistically at par with  $W_2T_1$  and  $W_3T_3$  combinations giving value of 54.00 per cent and 51.33 per cent respectively in descending order. The significantly least value of 12.00 per cent was however, obtained in  $W_4T_1$  combination (Dogra, 2003). The germination speed was significantly maximum when seeds were stratified for 3 weeks at room temperature ( $W_2T_1$ ) or found to be for 6 weeks at  $-3 \pm 1^\circ\text{C}$  ( $W_3T_4$ ) giving value of 1.92 each. This was, however statistically at par with  $W_1T_2$  (1.85),  $W_1T_1$  (1.76),  $W_3T_5$  (1.73),  $W_1T_4$  and  $W_4T_5$  (1.69),  $W_3T_3$  (1.68),  $W_1T_3$  and  $W_5T_5$  (1.65 each),  $W_2T_4$  (1.61),  $W_1T_5$  and  $W_2T_5$  (1.60 each) and  $W_3T_2$  (1.59) combinations.

The significantly minimum germination speed of 0.49 was obtained for seeds stratified for 9 weeks at room temperature ( $W_4T_1$ ), but being statistically at par with  $W_5T_1$  giving value of 0.72 in this regard. An overview of the data in the table 14 revealed that significantly maximum mean daily germination of 2.62 resulted in  $W_2T_1$  (3 weeks and control) combination, but being statistically at par with  $W_1T_2$  (2.49),  $W_1T_1$  and  $W_1T_4$  (2.42 each),  $W_1T_3$  and  $W_2T_2$  (2.40 each) and  $W_4T_5$  (2.36) combinations. The significantly least value of 1.04 was however, observed for  $W_4T_1$  (9 weeks and control) combinations, but being statistically at par with  $W_5T_1$  and  $W_4T_2$  combinations giving value of 1.36 and 1.38 respectively in this regard. Similarly, significantly maximum peak value of 3.12 resulted for seeds stratified for 3 weeks at room temperature ( $W_2T_1$ ). This was followed by  $W_1T_1$  and  $W_4T_5$  combination giving value of 2.77 and 2.76 in descending order. The significantly least value of 0.95 was, however observed in  $W_4T_1$  (9 weeks and control) combination.

Similarly, the significantly maximum germination value of 8.19 was obtained for  $W_2T_1$  (3 weeks and control) combination which was followed by  $W_1T_1$  and  $W_1T_2$  combination giving value of 6.74 and 6.70 in this regard (Baskin and Baskin, 1988). The significantly least value of 1.03 was observed in  $W_4T_1$  (9 weeks and control) combination, but being statistically at par with  $W_5T_1$  giving value of 1.78.

It was also evident from the data that germination index was significantly maximum 2.51 in  $W_2T_1$  (3 weeks and control)

combination, being statistically at par with  $W_1T_1$ ,  $W_1T_2$ ,  $W_1T_4$  and  $W_4T_5$  combinations giving value of 2.42, 2.39, 2.23 and 2.20 respectively in that order. The significantly minimum value of 1.04 resulted in  $W_4T_1$  (9 weeks and control), but was statistically at par with  $W_5T_3$  and  $W_5T_1$  combinations giving value of 1.32 and 1.36 respectively (Baskin and Baskin, 1998).

In conclusion, it can be stated that significantly maximum germinability resulted when seeds were stratified for 3 weeks at room temperature ( $W_2T_1$ ).

## REFERENCES

- Baskin, C. C. and Baskin, J. M. 1988.** Germination ecophysiology of herbaceous plant species in a temperate region, *American J. Botany*. **75**: 286-305.
- Baskin, C. C. and Baskin, J. M. 1998.** Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. *San Diego: Academic Press*. p. 666.
- Bhattacharyya, D. 2005.** Revision of the genus *Rhododendron* L. (Ericaceae) in India. *University of Calcutta, Kolkata, Ph.D. Thesis*. (Unpublished).
- Blazich, F. A. and Rowe, D. B. 2003.** *Rhododendron* L. In: Seeds of Woody Plants in the United States, USDA Agriculture Handbook No. 450, 2nd ed. U.S. Dept. Forest Service, Washington, DC.
- Butola, J. S. and Badola, H. K. 2004.** Seed germination improvement using chemicals in *Heracleum candicans* Wall, a threatened medicinal herb of Himalaya. *Indian Forester*. **130(5)**: 565-572.
- Campbell, H. M. 1985.** Germination, emergence and seedling growth of *Hypericum perforatum* L., *Weed Research*. **25**: 259-266.
- C. Linnaeus, 1753.** "Species Plantarum," Vol. 1, London, 1753. p. 392.
- Chacko, V. J. 1965.** *A manual of sampling technique for forest surveys*. Manager Publications, New Delhi, India. p. 172.
- Chauhan, N. S. 1999.** Medicinal and aromatic plants of Himachal Pradesh. *Indus Publishing Company*, New Delhi. pp. 355-357.
- Cox, P. A. and Cox, K. N. E. 1997.** The Encyclopaedia of *Rhododendron* Species. *Glendoiik Gardens Ltd., Perth, Scotland*. p. 396.
- De Tempe, J. 1953.** The blotter method of seed health testing. *Proc. Int. Seed Test. Assoc.* **21**: 133-151.
- Dogra, S. 2003.** Effect of stratification and plant bio-regulator on the germination of fir and spruce, M.S.c Thesis, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni-Solan, India.
- Ghyare, B. P. 2005.** Effect of gibberellic acid on germination of five timber species. **131(6)**: 844-846.
- Gomez, K. A. and Gomez, A. A. 1984.** *Statistical Procedures for Agricultural Research* (2<sup>nd</sup> ed.), J. Wiley and Sons Inc, New York, USA, p. 680.
- Grime, J. P., Mason, G., Curtis, A. V., Rodman, J. and Band, S. R. 1981.** A comparative study of germination characteristics in a local flora, *J. Ecology*. **69**: 1017-1059.
- Misra, R. 1968.** *Ecology work book*. Oxford and IBH Publishing, New Delhi, India. p. 241.
- RBG Kew, Royal Botanic Gardens Kew. 2008.** Seed Information Database (SID). *The Ecoscan* Version 7.1. Available from: <http://data.kew.org/sid/> [jan-mar 2013]
- Steel and Torrie, J. H. 1960.** Principles and practices of statistics with special reference to the biological sciences. *Mc Graw. Hill, London*. p. 473.
- Snedecor, G. and Cochran, W. 1989.** *Statistical Methods* (8th edition) The Iowa State University Press. *The Ecoscan*.