Seed Research, Vol. 35(1): 48-52, 2007

Seed and Cone Characteristics of Spruce (*Picea smithiana* Wall)

A.H. MUGHAL, M. A. KHAN, S. N. ZAFFAR AND JAVEED MUGHLOO

Division of Forestry, S. K. University of Agricultural Sciences and Technology (K), Shalimar, Srinagar 191 121
ahmughal1@rediffmail.com

ABSTRACT A study in the non monsoon zone of Jammu and Kashmir relating to cone, seed and germination characteristics of *Picea smithiana* revealed significant differences among cone and seed parameters. Cones collected from different trees varied in weight, length, diameter as well as specific gravity. The mean cone weight was 94.5 gm at maturity with mean diameter of 37.20 mm and length of 12.85 cm. Specific gravity an index of maturity recorded a mean of 0.96. Seed weight as well as seed number per cone also varied.Seed number per cone recorded an average of 124.60, which accounted for about 1.53% of total cone weight. Seed weight averaged 11.6 gm/1000. Germination study revealed that freshly harvested seeds have dormancy and the same can be overcome by cold stratification. Cold stratification for varying periods of time from 1 to 5 weeks not only increased germination per cent but germination value also recorded an increase and MGT for completion of germination decreased significantly. In the present study 4 week stratification resulted in all round improvement in germination per cent, germination value and mean germination time. Germination per cent and germination value after 4 week of stratification was 80% and 36.05, an increase of 56.86% and 297% over control respectively. Mean germination time recorded after 4 weeks was 12.7 days recording a fall of 8.16 days over control.

Key words : *Picea smithiana*, stratification, germination value, mean germination time

Picea smithiana Wall. is fairly well distributed all over the western Himalayas up to Nepal between an altitude of 2300-3800 m and it is found both in monsoon and non monsoon zones. The timber of this species is white and fairly hard and is used for planking, making packing cases, including railway sleepers, pulp wood and building construction. With the demand for seed for afforestation and reforestation programme increasing, it becomes imperative to know about the cone characteristics, seed yield from cones and germination characteristics. The yield from a given volume of cones serves as an indicator to both quantity and quality and has a great importance to avoid the collection of low yielding cones [1]. Studies on seed production and germination have already been carried out in species like *Pinus roxburghii* and *Cedrus deodara* [2, 3], but no such information is available with regard to *Picea smithiana*.

The purpose of the paper is to present results of investigations on cone size, cone weight, seed yield per cone and seed weight of *Picea smithiana*. Also, as reported, conifers have an inherent problem of slow and poor germination both in field and laboratory conditions [4, 5] and are also reported to have physiological dormancy. So it is important to standardize pre treatments to overcome slow and poor germination as well as dormancy.

In order to overcome the problem of poor and slow germination normally stratification is recommended. Another advantage of stratification is that the incubation temperature requirement comes down with increase in stratification duration [6, 7]. Physiological dormancy in *Abies alba, A. pindrow, A. procera*, and *Pinus densiflora* can be overcome by cold stratification of varying periods of time from 21-90 days [8, 9, 10]. The present

Received May 2005 Revised June 2006 Accepted December 2006

study besides cone and seed characteristics report the effect of cold stratification on various germination parameters.

MATERIALS AND METHODS

The study was conducted in the year 2003 in the non monsoon zone of J&K in Gulmarg area of Pir Panjal Forest Division with an annual precipitation of about 1300 mm.

Cones were collected in the month of October 2003. Twenty cones each were harvested from 10 trees at least 100 m away from one another and following observations were made on each cone. Cone analysis was performed on cones with no sign of prior seed release or insect damage. Cone length was measured using a measuring tape while a digital calliper was used for recording diameter of cones. Cone specific gravity was determined by water displacement method [11] and value was determined by the ratio of unit weight to unit volume of cone displaced. Cone scales were separated for seed count into three categories (basal, central and apical) before counting. Central axis, which spread apart considerably on cone drying to permit easy removal of seeds were considered fertile. Extracted seeds were separated into filled and empty seeds by flotation method after being dewinged. Empty and sterile seeds were not included in seed count per cone. Seed weight was recorded using 10 replications of 100 seeds each with the help of sensitive top pan balance and finally transformed into 1000 seed weight by multiplying 100 seed weight by a value of 10.

Germination test was conducted using top of paper method immediately after seed extraction. Four replicates of 100 seeds each as devised by ISTA, were used for the test and germinated at 20+1°C. The seeds were counted germinated when radicle emergence was about 0.25 cm. Germination count was taken after 7 days and testing period was 28 days.

For determining the effect of chilling on seed germination, seeds were subjected to chilling for 48 hours in distilled water, thereafter excess water was drained off and then the seeds were wrapped in polythene bags and kept for chilling/ stratification at 4+1°C for varying periods of time of 1, 2, 3, 4 and 5 weeks before being subjected to germination tests. Data recorded on germination was subjected to statistical analysis for computation of germination value (GV) and mean germination time (MGT). Following formulae were used for determining GV and MGT of seeds:

$$GV = \Sigma DGS/N \times (GP \times 10) \quad [12]$$

Where DGS = Daily germination speed = Cumulative germination %/No. of test days

N = Frequency of number of DGS during the test

GP = Germination per cent at the end of test.

MGT = Σ(Daily germination x days)/No. of seeds sown. [13].

Ungerminated seeds at the end of the test were given values of n + 1;

Where n = number of days in the test and these values were included in calculation of the means.

RESULTS AND DISCUSSION

Mean of 10 cone measures of various parameters of cone and seed are depicted in Table 1. Size of cone has been reported to have a direct bearing on seed yield and quality. In the present study cones collected from different trees has varying sizes, and a mean diameter 37.20mm and length of 12.85 cm with a standard deviation of 2.32 and 1.18 respectively was recorded in *Picea smithiana*. Cone size is known to vary within species in many conifers [14]. Specific gravity which is an index of maturity of cones and used for harvest cones at maturity for seed collection ranged between 1.25 and 0.80 with a mean specific gravity of 0.96 and standard deviation of 0.11. Specific gravity in *Abies concolor* was 0.85 at maturity while it was 0.90 for *Abies grandis* and 0.75 for *Abies magnifca* [15, 16]. Franklin [17] reported specific gravity of 0.90 in *Abies procera* at maturity. Weight of cone recorded a mean of 94.50 g with a deviation of 17.64. Seed number per cone recorded an average of 124.60 which accounted for about 1.46 gm per cone. Differences in seed yield per cone could be explained by differences in cone size. Mc Pherson *et al.* [18] reported an average yield of 11 and a

Table 1. Cone and seed parameters of *Picea smithiana*

Cone No.	Cone length (cm)	Cone dia. (mm)	Cone weight (gm)	Specific gravity	Seed no./ cone	1000 seed weight (gm)
1	14	38.93	100	0.90	170	11.9
2	10	38.16	75	1.00	105	12.4
3	13	34.93	100	1.05	100	13.1
4	14	38.80	105	0.84	162	11.4
5	13	40.51	105	0.87	150	11.8
6	10	30.56	50	1.00	100	11.2
7	13	39.03	110	0.91	155	11.3
8	12	38.57	100	0.95	102	11.3
9	14	39.21	120	1.09	154	11.2
10	14	39.89	110	0.84	108	11.3
11	13	36.53	80	0.80	100	11.9
12	13	34.75	100	1.25	101	12.4
13	12	34.63	80	1.00	174	13.1
14	14	38.07	100	0.95	82	11.4
15	14	37.90	120	1.09	105	11.8
16	12	35.97	75	1.07	113	11.2
17	13	35.47	80	0.80	161	11.3
18	13	37.69	100	1.00	170	11.3
19	13	37.68	80	0.80	80	11.2
20	13	36.79	100	1.00	100	11.3
Mean	12.85	37.20	94.50	0.96	124.60	11.69
SE ±	1.18	2.32	17.64	0.11	32.59	0.61

range of 2-28 filled seeds per cone in clonal orchard. Seed yield as calculated was only 1.53 per cent of the total cone weight. Seed yield variations have also been reported by different workers in different species e.g. 3-19 per cent in *Abies concolor* [19], 4 per cent in *Abies magnifica* and 1.1 per cent in *Pinus engelmanii* [20]. Seed weight of 1000 seeds had a mean wt. of 11.69 gm with 0.61 standard deviation.

Germination percentage of seeds without pre-treatment was only 51 per cent although the viability of seeds was 85 per cent as determined by combination of germination and cut test methods, thus indicating dormancy. This dormancy was overcome by cold stratification as 71 per cent of germination was recorded after a week of cold stratification and by 3 week of stratification, germination shot up to 80 per cent, an increase of 56.86 per cent (Fig. 1) over control which was significant at .01 level of significance. *Picea glehnii* required 21-42 days of chilling to over come dormancy [21]. Similarly for other species one month or less of cold stratification was required. *Abies balsamea*, 28 days [22], *Cedrus deodar*, 28 days [7]. In pines, chilling requirement of seeds is met under natural conditions also. The seeds after being dispersed during autumn season remain quiescent on the forest floor till spring season. They imbibe water during rains and get subjected to chilling during snowfall and thus the dormancy gets removed. The seed then start germinating once the spring season sets in.

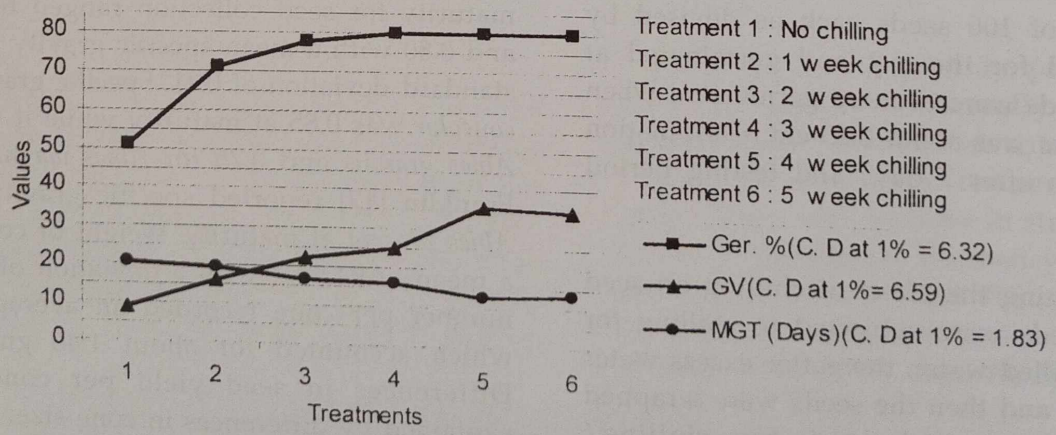

Fig. 1. Effect of stratification on germination (%), GV and MGT of *Picea smithiana* seeds

A period of moist stratification at low temperature or pre soaking in cold water for a periods of few hours to 2 days sometimes increased germination energy without influencing germinative capacity [23, 24]. In the present study germination value, which is related to the expected seedling survival in the field or nursery also recorded significant increase due to moist chilling and maximum value of 36.05 was recorded after 4 week chilling thereby showing an increase of 297 per cent over control. All the chilling treatment differed significantly from the control. Germination value recorded for 4 and 5 week of chilling was at par.

Mean germination time which gives the speed of germination decreased significantly from 20.95 days in control to 12.79 days after 4 week of chilling thus recording a decrease of 8.16 days. Again the MGT recorded after 4 and 5 week of chilling was at par. MGT recorded after 2 and 3 week was 17.05 and 16.09 days and was also at par with one another. Jinks and Jones [25] reported in *Picea sitchensis* that pre-chilling increased the rate of total germination compared to untreated seeds. Edwards [26, 27] reviewed chilling requirements of Abies in western North America and noted that 30 days chilling resulted in rapid and complete germination for most species. Stratification definitely speeds up germination in many pine species and probably most in Abies seed lots [28, 29]. Pfister [30] reports that in most cases total germination is also increased due to chilling.

The present study is in conformity with previous studies and revealed that in order to over come dormancy and slow germination in *Picea smithiana* moist stratification for 4 weeks was most effective in germination improvement, germination value and mean germination time.

REFERENCES

1. MAHESHWARI, P & R. N. KONNAR (1971). Pinus. Botanical Monograph No. 7 CSIR, New Delhi, 130 pp.
2. SAAGAWAL, S.S. (1984). Studies on seed production from individual cones of Chir pine (*Pinus roxburghii* Sarget). *The Indian J. Forestry*, **7**(1): 4-6.
3. SINGH, V., V.K. SAH & A.K. SINGH (1992). Effect of cone diameter on seed yield, moisture content and germination in Himalayan Cedar (*Cedrus deodara* Royleex D. Don). *Indian J. Forestry*, **15**(4): 335-338.
4. SCHOPMEYER, C. S. (1974). Seeds of woody plants in the United States, USDA For Serv. Agric. Hand Book No. 450.
5. YOUNG, J.A. & C.G. YOUNG (1992). In: *Seeds of Woody Plants of North America*, Dioscorides Press, Portland, Oregon.
6. JUNTTILA O. (1976). Seed germination and viability in five Salix species. Universities for laget. Tromso Norway, **9**: 19-24.
7. MUGHAL, A.H. & R.C. THAPLIYAL (2004). Effect of chilling temperature, chilling duration and incubation temperature on seed germination characteristics of *Cedrus deodara*. [(G. Don) D. Don)] Proc. 27th ISTA, *Seed Symposium*, Budapest, Hungary, May 17th-19th.
8. EDWARDS, G. (1962). The germination requirements of Abies species. *Proc. Int. Seed Test. Assoc.*, **27**: 142-180.
9. SINGH, V. & R.V. SINGH (1984). Seed dispersal, seed germination and seedling establishment in natural forests of silver fir and spruce. II Seed germination and seedling establishment. *The Indian Forester*, **110**: 632-639.
10. BARTON, L.V. (1930). Hastening the germination of some coniferous seeds. *Am. J. Bot.*, **17**: 88-115.
11. BARNETT, J.P. (1979). Maturation of tree seeds. In: *Proc. Flowering and seed development in trees*. A symposium, 272-280. South For. Exp. Stn. Miss. State Univ., IVFRO.
12. DJARANSHIR, K. & H. POURBEIK (1976). Germination value - a new formula. *Silra Genetica*, **25**: 79-83.
13. BONNER, F.T. (1983). Germination responces of loblolly pine to temperature differentials on a two-way thermogradient plate. *J. Seed Technol.*, **8**(1): 6-14.
14. ELIASON, E.J. & C.E. HEIT (1940). The size of Scotch pine cones as related to seed size and yield. *J. Forestry*, **38**: 65-66.
15. OLIVER, W.W. (1970). USDA. Forest Service. Pac. Southwest *Forest and Range Exp, Stn*. Redding, Calif.
16. REDISKE, J.H. & D. NICHOLSON (1964). Maturation of noble fir seed - a biochemical study, *Weyerhaeuser. For. Pap.*, **2**: 15.

17. FRANKLIN, J.F. (1964). Douglas squirrels cut Pacific silver fir cones in the Washington Cascades. USDA. *Forest Service Res. Note* PNN-15, pp 3.

18. Mc PHERSON, J.A., E.K. MORGENSTERN & B.S.P. WANG, (1982). Seed production in grafted clonal orchards at longlad, Ontario. *For. Chron.*, **58**: 31-34.

19. FOWELLS, H.A. & G.H. SCHUBERT (1956). Seed crops of forest trees in the pine region of California. *U.S. Deptt. Agric. Tech. Bull.*, **1150**: 1-48.

20. READ, A.D. (1932). The testing of forest seeds during 25 years 1887-1912, 91 pp. Langkjaars Bogtrykkeri, Copenhagen. (c.f. *USDA, Agricultural Hand Book*, 450).

21. SAFFORD, L.O. (1974). Picea, A. Dietra. Spruce. In: *Seeds of woody plants in the United States.* (C.S. Schopmeyer, Tech. Coord.) USDA *Forest Service Agriculture Hand book No.* **450**: 587-597.

22. FRANKLIN, J.F. (1974). Abies. Mill. Fir. In: *Seeds of woody plants in the United States*, USDA. *Forest Service Agriculture Hand Book*, No. **450**: 168-183.

23. JENESEN, A. (1967). The influence of stratification on germination and chemical contents of immature seeds of *P. abies* and *P. sitchensis*, *For. Res. Inst.* West Norway Rep. No. **43**: 171-187.

24. KARLBERG, S. (1953). Treatment of pine and spruce seeds to stimulate germination. *Bull. R. Sch. For. Sweden*, **11**: 39.

25. JINKS, R.L. & S.K. JONES, (1996). The effect of seed pre-treatment and sowing dates on the nursery emergence of Sitka spruce (*Picea sitchensis*) seedlings. *Forestry Oxford.*, **60**(4): 335-345.

26. EDWARDS, D.G.W. (1982). Collection, processing, testing and storage of true fir seeds - a review of true fir in the Pacific North west. *Proc. Symp.* On Biology and Mgt. C.D. Oliver and R. M. Kanady (Eds.) USDA. Pacific North west Forest and Range Exp.Sta. Univ. of Washington. pp 113-137.

27. EDWARDS, D.G.W. (1986). Special prechilling techniques for tree seeds. *J. Seed Technol.*, **10**: 151-171.

28. EDWARDS, D.G.W. (1969). Investigations on the delayed germination of noble fir. Ph.D thesis, pp 213 Univ. Wash., Seattle (unpublished).

29. WANG, B.S.P. (1960). The effects of stratification and incubation temperatures on the germination of grand fir (*Abies grandis* (Dougl) Lindl.) seed. *Master thesis*. Univ. Brit. Colombia, Cancouver. (Unpublished).

30. PFISTER, R.D. (1966). Artificial ripening of grand fir cones. *North West Sci.*, **40**: 103-112.