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# Temperature regulated seed germination in *Acer oblongum* Wall. ex DC. (Sapindaceae) – A threatened Himalayan species

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**Abstract**

*Acer oblongum* Wall. ex DC. (Sapindaceae) is a semi-deciduous tree species growing in parts of Central and Eastern Himalaya. The present study aims at understanding the role of temperature and time of collection of diaspores after dispersal in regulating the germination of its seeds. It was seen that maximum germination of seeds occurred when kept at 25 – 30° C. Also the seeds collected in the month of October and November showed more uniform germination and higher longevity in storage. Seeds collected from Nainital (NTL) showed higher seed germination as compared to those collected from Dehradun (DDN).

***Key words***: *Acer oblongum,* Seed germination, Seed longevity, Effect of temperature

## INTRODUCTION

A seed has been defined as a 'mature ovule' or a reproductive unit formed from fertilized ovule, consisting of an embryo, endosperm and a protective seed coat. Seed germination is affected by various climatic and ecological factors. Many environmental factors affect the germination of seeds and the growth of seedlings. Adequate levels of irradiance (Beckage *et al*. 2000), soil nutrients, litter depth, temperature and moisture (Khan & Gulzar 2003) are important factors for the germination and growth of seedlings. Furthermore, the response to variable environmental conditions depends on the species (Taylorson 1987; Chachalis & Reddy 2000; Norden *et al*. 2009). Variation in seed size, physiology and timing of germination allow each species to specialize in its germination requirement, and such variations contribute to the maintenance of species diversity (Grubb 1977). The significance of seed stage in plant population ecology and natural recruitment of species has long been recognised (Harper 1977; Silvertown & Lovett-Doust 1993). Germination and seedling establishment are crucial phases in the life history of plant species since these are associated with high mortality rate. The germination response pattern of seeds is also regarded as a key characteristic in plant's life history strategy (Angevine & Chabot 1979; Mayer & Poljakoff-Mayber 1989). However, seed production and seedling establishment are limited by many other factors *viz*. pollen limitation, precocious or late flowering, resource optimization, and insect infestation of fruits (Ehrlen 1991; Ganeshaiah & Shaanker 1992; Ravishanker *et al*. 1995). The poor quality seeds may have following problems: low germination percentage, slow emergence, low survival rate, poor adaptability to site, susceptibility to diseases and pests, poor growth and low productivity. In a forest ecosystem regeneration pattern of a species depends on population structure, which in turn depends on the presence of adequate number of seedlings. In any forest community, seedling survival may be affected by competition (Chen *et al*. 2014).

*Acer oblongum* Wall. ex DC. (Sapindaceae) is a semi-deciduous tree, 15–18 m tall with its natural distribution in India, China, Nepal and Pakistan (Nayar & Datta 1982). In India, *A. oblongum* occurs mainly in Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Meghalaya, Manipur, Nagaland, Sikkim, Uttarakhand and West Bengal (Lama *et al.* 2015). The species yields timber of commercial value and the leaves are used as fodder (Yadav *et al*. 2016). In *A. oblongum* seeds are of temperate recalcitrant type where the seeds are desiccation sensitive and can be dried to 35 – 50 % moisture content of fresh weight. In a temperate tree species the seeds often do not germinate due to various factors including, excessive low temperature, chilling damage, pest and insect infestation, etc. Such seeds lie dormant in seed bank till the conditions are conducive for growth. On the other hand, the seeds of many species in tropical rain forests do not develop dormancy because conditions are always favourable for growth (Bisht & Ahlawat 1999). It is a species-specific natural phenomenon.

## MATERIALS AND METHODS

Experiments in natural conditions and *in vitro* studies were performed to examine seed germination at different temperature gradients. The study sites (Dehradun: 30°20' N, 077°59' E; and Nainital: 29°22' N, 079°27' E) are located in Uttarakhand state (Central Himalaya), India (Yadav *et al.* 2016). For *in vitro* studies, mature fruits from two different study sites, Dehradun (DDN) and Nainital (NTL) were brought to laboratory and were soaked in water before sowing or putting in seed germinator. Seeds were kept in petriplates lined with moist germination paper and kept in seed germinator at different temperatures (25, 30 and 35° C). A set of 100 seeds each was kept at different temperature gradients. The aim of the present study was to see the role of temperature and time of collection of seeds after the month of dispersal (September) in regulating its germination percentage. Under natural conditions, number of seeds those germinated from the fallen samaras on the ground was studied at the site itself. 1 $m^2$ quadrats were laid down in 10 m radius of the tree. Number of seedlings was counted in each quadrat and was plotted against distance from the tree trunk. Seedling establishment was noticed on consecutive days and months, to record whether the seedlings survive or perish. Other ecological and anthropogenic factors were also considered for germination of seeds *in vivo*.

## RESULT

Germination of seeds in *A. oblongum* does not require any pre treatment. *In vitro* germination was undertaken in the laboratory with seeds collected after different months of diaspore dispersal. Seeds were grown in seed germinator at different temperatures viz. 25, 30, and 35° C and were germinated in the double door seed germinator in replicates of 100. Germination of seeds in seed germinators took two weeks for the cotyledons to expand and seedlings to emerge. At different temperatures, rate of germination of seeds varied and it was observed that maximum germination took place when the temperature was kept between 25 and 30° C. Beyond this, higher the temperature lesser the seed germination. Variation in temperature and time of collection of seeds may result in difference in percentage of seed germination, and it was found that maximum germination of seeds took place in October and November at 25° C with germination percentage ranging between 55 and 57 % (Figure 1). Seed germination failed at temperature above 35° C and only few seeds were seen germinating at 35° C (Figure 2). Seeds started germinating on seventh day and on $14^{th}$ day almost all the seeds kept for germination in seed-germinator were germinated. On $14^{th}$ day seedlings were 7 – 9 cm long. Seed germination per cent was maximum when kept at 25° C (Figure 2). *In vitro* germination of seeds was higher in

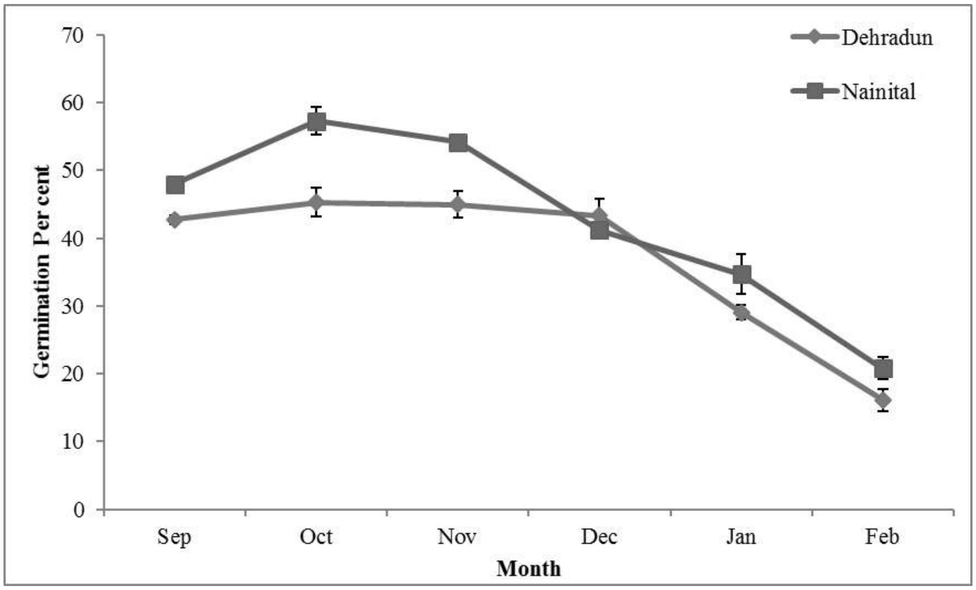


**Figure 1.** *In vitro* germination of seeds of *Acer oblongum* collected from two different sites in different months after seed dispersal (dispersal month – September 2013).

**Table 1.** Natural regeneration of *Acer oblongum* in randomly placed 1m$^2$ quadrats

| **Quadrat number ($1\ m^2$)** | **Distance from focal tree** | **No. of seedlings recorded in early spring season (end of February)** | | **No. of seedlings recorded at end of spring ( end of April)** | |
|---|---|---|---|---|---|
| | | 2013 | 2014 | 2013 | 2014 |
| **1.** | (under tree canopy area) | 58 | 71 | 0 | 2 |
| **2.** | (0-2 m ) | 62 | 57 | 3 | 0 |
| **3.** | (3-4 m) | 28 | 33 | 2 | 2 |
| **4.** | (5-6 m) | 17 | 19 | 1 | 3 |
| **5.** | (7-10 m) | 12 | 15 | 0 | 2 |
| **6.** | (11-20 m) | 13 | 17 | 0 | 2 |
| **7.** | (up to 50 m) | 11 | 9 | 0 | 3 |
| **8.** | (up to 100 m) | 1 | 3 | 0 | 0 |
| **9.** | (up to 500 m) | 2 | 0 | 1 | 0 |
| **10.** | (up to 1000 m) | 0 | 0 | 0 | 0 |
| | Total | 204 | 224 | 7 | 14 |

seeds collected from Nainital (NTL) populations where the number of individuals was far more as compared to Dehradun (DDN). Also, there was difference in number of seeds per fruit. At NTL, there were often two seeds per fruit/ samara, but at DDN fruits were only one seeded.

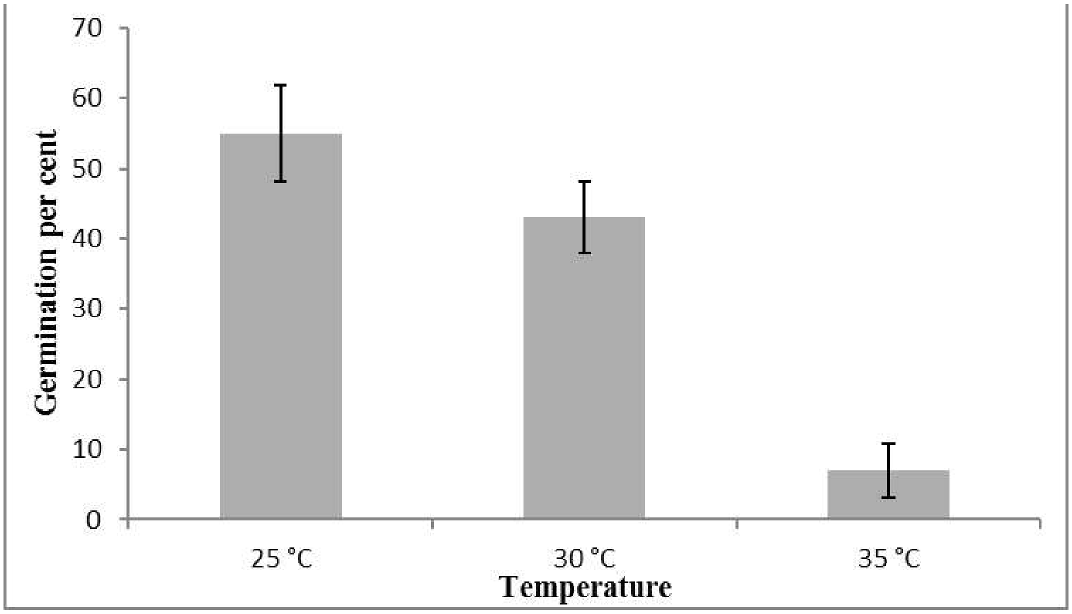


**Figure 2.** *Acer oblongum*: *In vitro* seed germination rate at different temperatures

In the field under natural conditions, the diaspores those have fallen on the ground start germinating toward the end of winter (end of February). The seeds of *A. oblongum* do not require any pre-treatment as the seeds start germinating as soon as the diaspore is dispersed from the parent tree. However, following colder winter months (December, January, early February) the seeds remain dormant and as soon as the ambient temperature becomes moderate germination begins. It was observed that temperature plays an important role in regulating seed germination in the field too. Cold winter months after the dispersal period do not allow the fallen seeds to germinate on the forest floor. During this period trees at higher altitudes remain completely or partially leafless to enhance dispersal of diaspores. Seed germination is of epigeal type. During March 2 – 3 cm long seedlings were seen in wild, both at Nainital and Dehradun study sites. Seed germination was noticed more beneath the parent canopy (Table 1). Seedling survival rate and establishment was higher at Dehradun and a few 13 – 18 months old saplings were seen at Dehradun site where there was less human intervention as the area was protected. One or two 15 months old saplings were seen growing at a distance of 10 – 20 m from the focal tree.

## DISCUSSION

The *in vitro* germination of seeds of *A. oblongum* was carried out to know the barriers to seed germination if any. Time of collection of seeds after dispersal month and temperature at which the seeds germinate play important role in *in vitro* seed germination. Time of collection of seeds has been determined to be critical with some other maples too (Toth & Garrett 1989). In the present study it is seen that mature seeds collected during the peak phase (October – November) give more uniform germination and show higher longevity in storage. Previous studies indicated that *in vitro* seed germination in *A. oblongum* was ~50 % or less (Bisht & Ahlawat 1999; Sathyakumar & Viswanath 2003). In the present study, seed germination in laboratory ranged between 50 – 55 % depending upon time of collection. Also some site specific variation was seen in case of germination of seeds. It was observed that seeds collected from NTL, where the number of individuals in the population was far more than in the population of DDN, showed better germination in terms of seedling emergence and seedling length. Fruits from NTL often contain two seeds per samara and these seeds are more vigorous in terms of size and germination compared to those collected from DDN population. Although the rate of seed germination is above 30 % in wild, the seedling survival is poor because of low soil moisture retention, high insect infestation, thick litter layer on the forest floor and human intervention in dry summer months. A recent study carried out in Europe on two *Acer* species by Caron *et al*. (2015) concluded that in the upcoming years by the end of this century, impact of warming and changes in precipitation may likely affect all phases of life cycle of plants, but plant reproduction has been suggested to be especially sensitive including seed germination and seedling establishment.

In case of natural recruitment of seedlings and their establishment on forest floor, it has been observed in the present study that in areas with less human intervention (e.g., reserved forests or botanical gardens), seedlings and a few saplings grow under or away from tree canopy. However, in forest areas where human intervention is more, as was observed in oak forest of NTL, often seedlings were found to be absent from forest floor. For conservation of this threatened tree species, reserve areas with less human intervention should be established for seedling survival so that in future this tree species could be prevented from becoming extinct. As for any other largely wind-pollinated species, the trees of *Acer oblongum* need to be growing in a certain density for effective pollination. The samaras too require less disturbed conditions for their regeneration.

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