PERICARP DELAYS GERMINATION IN *QUERCUS GLAUCA* SEEDS

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RAWAT, D.C.S., THAPLIYAL, P. & NAUTIYAL, A.R. 1998. Pericarp delays germination in *Quercus glauca* seeds. Seed germination and water uptake in *Quercus glauca* were studied in intact, scarified (pericarp ruptured at distal end) and peeled (pericarp completely removed) acorns. Removal of pericarp resulted in an early and high percentage of germination (92%), but scarification led to only partial improvement of germination (22%). The possibilities of pericarp's involvement in delayed germination indicated that pericarp presumably interfered in water uptake by the seed not through disallowing water entry into the seed, but through imposing a mechanical restraint to cotyledon expansion resulting in arrested imbibition and delayed germination.

Key words: Germination - inhibition - pericarp - *Quercus glauca* - imbibition

RAWAT, D.C.S., THAPLIYAL, P. & NAUTIYAL, A.R. 1998. Percambahan tertunda perikarpa dalam biji benih *Quercus glauca*. Percambahan biji benih dan kadar penyerapan air dalam *Quercus glauca* dikaji dalam biji oak yang dalam keadaan baik, melelas (perikarpa yang pecah pada hujung distal) dan menggelupas (perikarpa dibuang semuanya). Pembuangan perikarpa menyebabkan percambahan yang awal dan peratus percambahan yang tinggi (92%) manakala lelasan menyebabkan berlaku hanya sedikit pembaikan dalam percambahan (22%). Kemungkinan penglibatan perikarpa dalam percambahan tertunda menandakan bahawa perikarpa mungkin mengganggu kadar penyerapan air oleh biji benih bukan dengan penyekatan kemasukan air ke dalam biji benih tetapi dengan mengenakan tekanan mekanik ke atas pembesaran kotiledon yang menyebabkan penahanan pendapan dan percambahan tertunda.

Introduction

Quercus glauca Thunb. (subgenus *Cyclobalanopsis*), the blue Japanese oak, known as harinj or phaniat in Uttarakhand region (India), is a highly valued multipurpose tree distributed throughout the outer Himalayan region between 1000 and 2200 m elevation, commonly in moist depressions (Osmaston 1926). Besides its use as fuelwood, the leaves serve as excellent fodder, and the wood is used for making a range of agricultural implements, construction of sledge runners, bridges and houses (Troup 1921, Anonymous 1969, Singh 1982). Owing to its multiple uses, it has been under severe pressure of overexploitation such that pure natural stands are now rare. It is a handsome evergreen tree with a clean bole and dense rounded crown worth cultivating for shade and ornamental purposes. However, the fresh acorns take considerable time to germinate and the germination is not homogeneous as found in a routine study testing germinability of mountain tree seeds in this laboratory. Earlier also, seeds of this species have been reported to germinate after resting on the ground for 5-6 months (Troup 1921). Expansion of what is already known about the involvement of the pericarp in slowing germination in some other species of *Quercus*, e.g. *Q. falcata* (Thompson 1970), *Q. nigra* (Peterson 1983), both belonging to section Labatae, and *Q. robur* (Finch-Savage & Clay 1994) of section Leucobalanus, is required. An attempt was, therefore, made to study the involvement of the pericarp, if any, in impeding germination in *Q.glauca*.

Materials and methods

Mature acorns of *Q. glauca* were collected from its natural forest near Bheeri in District Chamoli (India). The damaged/empty acorns were removed by floating them in water for a few minutes and the healthy ones were taken for study. Acorns were divided into three groups: (1) intact acorns, (2) scarified acorns - in which the pericarp (including seed coat which is firmly attached with the pericarp and difficult to separate) was gently ruptured at the distal end (end with flower remnants from where the radicle emerges), and (3) the peeled acorns - where the pericarp (including seed coat) was completely removed to excise the seeds. One hundred seeds replicated three times from each group were placed for germination in Petri dishes on the top of Whatman No. 1 filter paper and kept in a Seedburo seed germinator at 30 °C. The filter papers were moistened regularly with distilled water and the data on germination were taken daily for 20 days. Radicle emergence attaining 5 mm length was taken as the criterion for germination.

The moisture content of intact acorn, pericarp and excised seed was determined separately by drying these in an electric oven for 48 h at 80 °C. To determine their proportional weight, the acorn was first weighed in intact state, then pericarp and seed were separated and weighed individually. For each determination 10 acorns/seeds were separately used.

To monitor water imbibition in intact, scarified and peeled acorns, ten acorns/seeds from each group were immersed in distilled water and weighed individually at 24-h intervals for 120 h. Subsequently, intact as well as scarified acorns were separated into pericarp and seeds after 120 h of imbibition and weighed separately to determine the amount of water imbibed by the two parts individually.

To study the possible involvement of pericarp in delaying the process of germination, peeled acorns were tested for germination under different treatments using 50 seeds replicated three times and following the same procedure as described above. In one experiment the peeled acorns were germinated in continuous darkness and the leachate was used as germination medium in another. Leachate was obtained by immersing the pericarp in boiling water (15 g in 100 ml) for 15 min and subsequently allowing it to cool for 24 h.

The significance of differences between means of different treatments was tested by Duncan's Multiple range test.

Results and discussion

Germination of the acorns of *Q. glauca* in the three states – intact, scarified and peeled – is presented in Figure 1. Acorns in the peeled and scarified states commenced germination 3 days after sowing and accomplished 10% germination within the next 5 days. Subsequently an exponential increase in percentage germination in the peeled acorns reaching 80% after 9 days was followed by a plateau showing a gradual increase with ultimate 92% germination. Contrary to this, progress of germination was very slow in the scarified acorns and only 22% germination was recorded in these after 15 days. The intact acorns completely failed to germinate within this period. These data indicate that presence of pericarp delayed/inhibited germination in these seeds, which could be mediated through interference in water uptake, disallowing gas exchange or light to enter the seed, posing mechanical restraint to embryo growth or presence of inhibitor in the pericarp (Bewley & Black 1982). To examine these possibilities individually, the pericarp was ruptured at the distal end in one set (scarified) which would facilitate water entry into the seed, gas exchange and radicle emergence while the peeled acorns tested for germination in total darkness and in the presence of pericarp leachate would fail to germinate if these are the causal factors for inhibition of germination in these seeds. The latter has been indicated as a possible inhibitor (Thapliyal & Nautiyal 1989, Thapliyal & Naithani 1996).

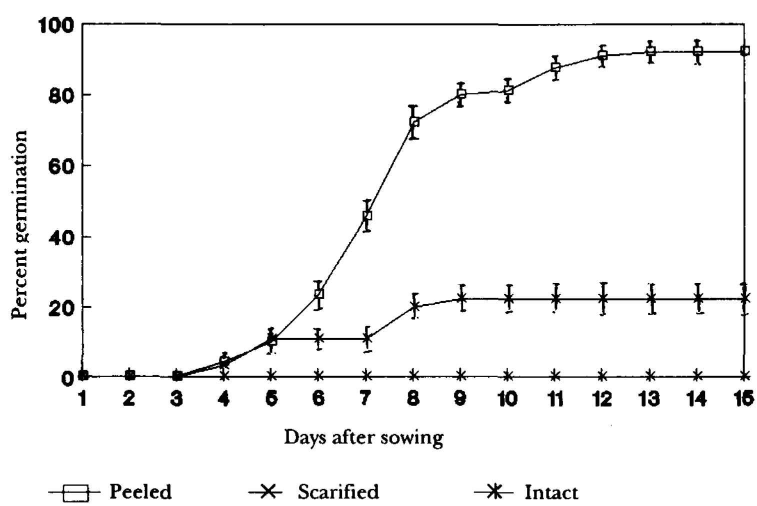

Figure 1. Pattern of germination in intact, scarified and peeled acorns of *Quercus glauca*

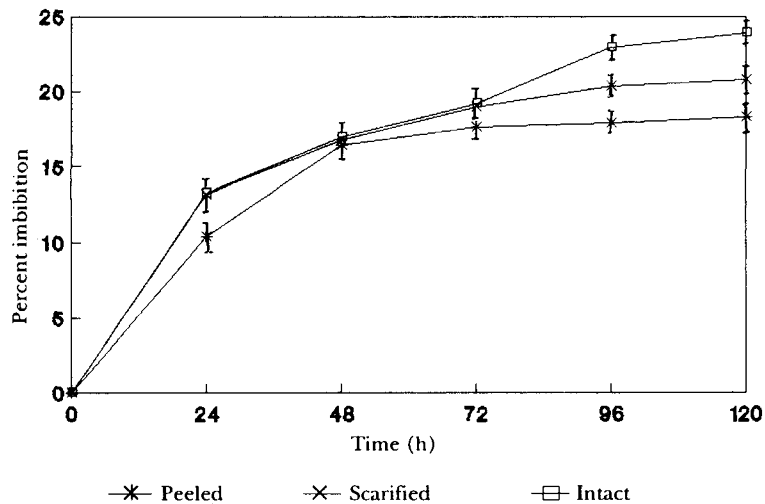

Figure 2. Pattern of imbibition in intact, scarified and peeled acorns of *Quercus glauca*

The pattern of germination in the seeds germinated in darkness and in the aqueous extract of the pericarp followed a trend almost similar to that of the peeled acorns shown in Figure 1 and Table 1. Thus, involvement of pericarp in interfering with the light entry to the seed does not seem to be the reason for failure of intact acorns to germinate as the peeled acorns germinated equally and identically in the light as well as in darkness indicating that these seeds do not require light for their germination. Similarly, presence of the pericarp's aqueous extract as substrate did not hinder germination and 90% seeds germinated. This ruled out the possibility of presence of any inhibitor in the pericarp which would inhibit germination in intact seeds like in *Fraxinus micrantha* (Thapliyal & Nautiyal 1989) and in *Nyctanthes arbor-tristis* (Thapliyal & Naithani 1996). Piercing of pericarp at the distal end would also facilitate gas exchange, radicle emergence as well as water entry into the seed if these were causal factors for delayed germination. But only partial improvement of germination took place in the scarified acorns ending in 22% germination which was considerably low in comparison with the peeled acorns. This indicated association of a more complex mechanism of the pericarp's involvement in delaying/ inhibiting seed germination in intact *Q. glauca* seeds than merely disallowing water entry or radicle emergence.

Highest uptake of water was recorded in the peeled acorns followed by the scarified, and lowest by the intact acorns (Figure 2). However, the trend was not linear in respect to the period of imbibition. The peeled and scarified acorns had almost equal water uptake for the first 72 h, but subsequently they drifted apart, and while scarified acorns failed to imbibe beyond 72 h, the peeled ones continued to resulting in a widening gap between these two, the differences being statistically significant ($p \leq 0.05$). At the 48-h interval, even intact acorns exhibited a water uptake almost similar to that of scarified and peeled acorns, but beyond this stage they also failed to imbibe. The differences between water uptake by the seeds in the three states were not significant statistically until 72 h but subsequently the differences were significant at $p \leq 0.05$. Thus, during early hours of imbibition there seems to be no difference in water uptake by these seeds irrespective of the presence or absence of pericarp, but the subsequent pattern of water uptake differentiated the three seed states.

Table 1. Final percentage germination in acorns of *Quercus glauca* under different treatments after 20 days. Data are means ± standard deviation.

Treatment	Percentage germination
Intact acorns	0.0
Scarified acorns	22.0 ± 5.0 a
Peeled acorns	92.0 ± 4.0 b
Peeled acorns in dark	90.0 ± 6.5 b
Peeled acorns in leachate	89.0 ± 6.0 b

Means followed by the same letter are not significantly different at p = 0.05 level of significance.

Rapid water uptake in the first 24 h was followed by a gradual and ultimately almost no uptake, the latter stage being reached at 48 h in intact, 72 h in scarified and even up to 120 h in peeled acorns indicating arrest of imbibition first in intact then in scarified and probably late in peeled acorns. This indicates that water uptake by the seed was restricted by the presence of pericarp even in the scarified state where piercing of pericarp would have allowed free entry of water into the seed. Had the arrest of water uptake by the seed in intact and scarified states not taken place, the pattern of water uptake in these two states would have been similar to that in the peeled acorns and they too would have attained ultimate imbibition levels similar to the latter. The rapid uptake of water by the intact and scarified acorns during the early hours of imbibition could be due to the pericarp imbibing more water than the seed as the former is a drier part than the latter (Table 2). This is also supported by the changed proportional weight of the two parts before and after imbibition both in intact and scarified states (Table 2). Had the uptake of water by the entire acorn (seed with pericarp) been homogeneous, the proportional weight of the two parts would have remained unchanged. Pericarp thus seems to restrict water imbibition by the seeds even in the scarified state possibly through posing a mechanical restraint to cotyledon expansion as in *Quercus nigra* seeds (Peterson 1983) wherein restriction of cotyledon expansion by pericarp impeded water uptake and germination. This seems to be the major reason for the delayed/inhibited germination in *Q. glauca*. As mentioned earlier, in nature, acorns of *Q. glauca* are reported to commence germination in 5-6 months after resting on the ground (Troup 1921). During this intervening period the pericarp is likely to be softened by microbial action or scarification by other means facilitating normal water uptake, cotyledon expansion and germination.

Table 2. Percentage moisture content in the pericarp and seed of *Quercus glauca* and their proportional weights before and after imbibition (mean ± standard deviation)

	Moisture content (%)	Proportional weight (%)		
		Before imbibition	After 120 h imbibition	
			Intact	Scarified
Pericarp	21.48 ± 2.51	17.90a ± 1.49	27.03b ± 3.39	28.48b ± 5.38
Seed	40.96 ± 6.70	82.08a ± 1.49	72.44b ± 3.66	71.24b ± 5.01

Means followed by the same letter in a line are not significantly different at p = 0.05 level of significance.

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