AFF Scientific Report

Lens morphology in Australian acacias – implications for germination, propagation, cultivation and conservation

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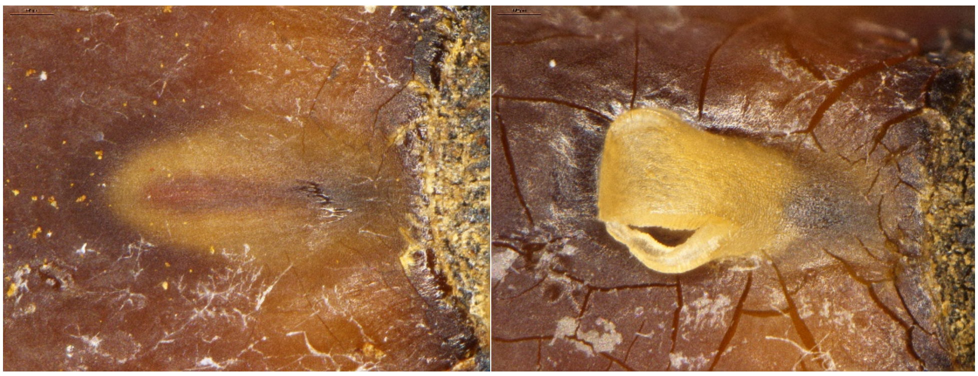

On the left hand side image is the elliptical lens of an untreated *Acacia* seed.

On the right hand side image is the lens of the same seed after a boiling water treatment. Note the lens has 'popped' and there is now a pathway for water to enter the seed.

The small black scale bars (top left of each image are 100 µm). The images are of *Acacia dunnii* which had the largest seeds and largest lenses of the studied species.

Full results of this study are available in two scientific papers:

Burrows, G. E., Alden, R. and Robinson, W. A. (2018). The lens in focus – lens structure in seeds of 51 Australian *Acacia* species and its implications for imbibition and germination. *Australian Journal of Botany* 66, 398-413

http://www.publish.csiro.au/BT/BT17239

If the paper is not available from the Australian Journal of Botany website the first author can be contacted directly for a copy.

Burrows, G. E., Alden, R. and Robinson, W. A. (2019). Markedly different patterns of inhibition in seeds of 48 *Acacia* species. *Seed Science Research* 29, 270-282

https://www.cambridge.org/core/journals/seed-science-research/article/markedly-different-patterns-of-imbibition-in-seeds-of-48-acacia species/24091844ECBAE16B00977B61810CD4A8

This paper is Open Access.

In addition a media release regarding this project is available:

https://news.csu.edu.au/latest-news/research-finds-australian-wattle-seeds-have-a-fire-gauge-and-a-rain-gauge

Overall project summary:

Acacias (the wattles) are the largest genus of Australian plants with over 1000 species. They occur from arid central Australian deserts to coastal rainforest.

Acacia seeds can remain dormant for decades in the bush and will not germinate when provided with the usual conditions of moisture and warm temperatures. The seeds have physical dormancy where the cells of the palisade or macrosclereid layer are so tightly packed that water cannot reach the embryo and start germination. In nature a bushfire is usually needed to break the seed dormancy while in nursery propagation hot or boiling water treatment is usually used.

It is often stated that the fire has 'cracked' the seed coat but the heat of the fire only affects a small part of the coat, the lens.

This study investigated two aspects of acacia seed imbibition and germination:

i) Do all Australian acacia seed have a lens and, if present, is there much variation in this structure?

ii) Once the lens has popped do all acacias have a similar pattern of imbibition.

Structure:

Seed coat structure was examined in 51 *Acacia* species. Most of the species were known to be hard-seeded, but two species (*A. cambagei* and *A. harpophylla*) had been recorded to produce 'soft seeds'. The average seed mass of the 51 species ranged from 3 – 258 mg (median 14 mg), on average the seed coat was 132 µm thick and on average the palisade cells were 42 µm long. All the hard-seeded species had a well-defined lens, while the two soft-seeded species did not have an obvious lens. On average the lens was ¼ mm long and 1/5 mm wide and so is barely visible to the naked eye. After a heat treatment the lens 'pops' up making a small hole in the water impermeable cells so that water can reach the embryo. The popped lenses had a range of morphologies from a mound, a mound with cracks, an open cylinder or pipe and complete detachment.

Imbibition:

The next part of the study looked at how the seeds absorbed water after the lens had popped. In many legume species once the lens has popped the seeds imbibe and germinate within a few days. In some *Acacia* species, after the lens has popped, some seeds germinate almost immediately while others can take many weeks, leading to a slow and progressive increase in germination percentage. Some scientists thought this was because the lens opening was so small that water entered the seed very slowly. If this was the case then most seeds should germinate at much the same time, perhaps a few days after seeds that had been nicked or scarified (treatments that create large areas for water uptake when compared to the minute size of a popped lens).

This study found that seeds of the two soft-seeded species imbibed and germinated rapidly without a heat treatment. The heat treatment used (boiling water poured over the seeds for 1 minute before being poured off) killed the seeds as the very hot water was taken up so quickly. After heat treatment seeds of 10 of the studied Acacia species imbibed rapidly and uniformly. In the remaining species some seeds with a popped lens swelled up with water near the start of the experiment, while others (also with the lens popped) could remain on moist paper towel for days or weeks without absorbing water before (remarkably) suddenly swelling up in less than 24 hours. It appears there is something in the inner seed coat of some seeds that can slow water getting to the embryo in the middle of the seed.

Thus it appears that an *Acacia* seed coat can have two functions –

i) The lens acts as a 'fire gauge' so that germination only occurs in the favourable post-fire conditions

ii) Some other (still to be determined) part of the seed coat (the 'rain gauge') can slow water reaching the embryo in some seeds of a seed batch, thus ensuring not all seeds germinate if there is a small rain event without any follow up rainfall.

The lens is key to understanding the germination of acacias. A brief look at an *Acacia* seed under a good quality stereo microscope to check the condition of the lens, both before and after dormancy breaking treatments, can improve understanding of experimental and nursery propagation results.