

Explaining rapid production of the grasstree inflorescence after fire

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Commonly called grasstrees, the genus *Xanthorrhoea* is a group of palm-like monocotyledons endemic to Australia. The Western Australian species, *Xanthorrhoea preissii*, flowers in early spring in response to fire. The annual vertical growth rate of *X. preissii* has been estimated at 1 - 2 cm (Lamont and Downes 1979). In contrast, the same plant can produce an inflorescence, or spike, in excess of 3 m long in less than 3 months (Fig. 8). **Where does the energy come from to achieve such rapid reproductive growth?**

Foliage and spike as energy sources

As the spike grows beyond the young leaves it becomes green and photosynthetic (D. Korczynskij pers. observ.). The sheer size of this photosynthetic organ suggests that it should significantly contribute to its own growth through the synthesis of carbohydrates.



Fig. 1. *X. preissii* in the banksia woodland with both young spike and foliage covered.

To determine the relative contribution of the foliage and the spike towards spike growth, an experiment was established in the banksia woodland. Twenty grasstrees with small spikes were allocated to four "covering" treatments: no cover, spike cover, foliage cover, and both foliage and spike cover (Fig. 1).

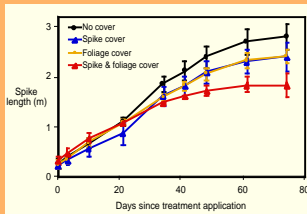


Fig. 2. Spike length over time since the treatment was imposed. Data are mean of 5 plants \pm SE (n = 4, for "Spike and foliage cover").

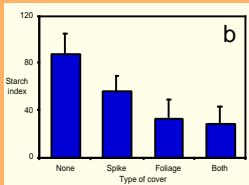
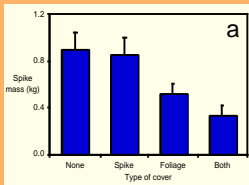


Fig. 3. Spike dry mass (a) and starch index (b) for *X. preissii* subjected to the four covering treatments. Data are mean of 5 plants \pm SE (n = 4 for cover type "Both").

On day 74 (Fig. 2), a marginally significant effect of foliage ($P = 0.053$) and spike cover ($P = 0.050$) on spike length was demonstrated (2-way ANOVA). Spike length and reproductive phase was also recorded.

On day 74 (Fig. 2), a marginally significant effect of foliage ($P = 0.053$) and spike cover ($P = 0.050$) on spike length was demonstrated (2-way ANOVA). Spike dry mass ($P = 0.002$) and starch index ($P = 0.018$, 2-way ANOVA) were only significantly reduced by foliage cover, despite a consistent trend suggesting that the spike does contribute to its own growth. This surprising lack of much energy contribution from the spike places primary importance on the foliage as the source of most energy during reproduction, followed closely by the desmium starch (see "Starch reserves" on this).

Sacrificing leaf production

Carbohydrates synthesised by the foliage on a daily basis are re-directed from production and development of new leaves to inflorescence and fruit production.

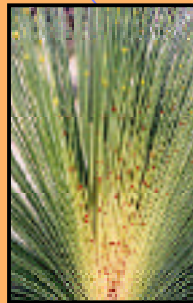


Fig. 4. Leaf production was monitored for flowering and vegetative grasstrees by counting and tagging the innermost leaves on each visit. Spike length and reproductive phase was also recorded.

Leaf production is reduced from the moment spike elongation starts and is maintained until seed release about 5 months later (Fig. 5). The difference in leaf accumulation between vegetative and reproductive plants was 291, representing 44% of the total number of leaves produced annually for grasstrees in the banksia woodland. A similar result was demonstrated for grasstrees in the jarrah forest, a contrasting habitat.

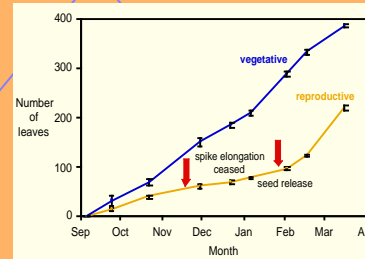


Fig. 5. Leaf accumulation over the reproductive season (1999/2000) for vegetative and reproductive grasstrees in the banksia woodland. Data are means of 6 plants \pm SE.

The cost of reproduction

- ★ Rapid spike growth is primarily supported by the foliage and starch reserves.
- ★ Carbohydrates synthesised by the spike only contribute marginally to its own growth.
- ★ Loss of leaf production and depletion of starch reserves are significant trade-offs associated with reproduction.



Fig. 8. *X. preissii* in flower.

Starch reserves

Some of the carbohydrates synthesised by the foliage of *X. preissii* are converted into starch grains in the desmium of the stem (Fig. 6). A preliminary study revealed a decrease in the amount of starch following reproduction, suggesting that it is available to the plant during reproduction.

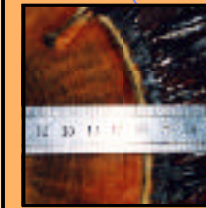


Fig. 6. Transverse section through the stem of a vegetative grasstree. Staining with iodine highlights the location of starch (the black band at the 16 cm mark) in the desmium tissue which separates the leafbases from the inner fibrous core. The width of the starch band multiplied by its colour intensity gives the starch index, a relative measure of starch availability.

Vegetative grasstrees had a significantly higher starch index than reproductive grasstrees ($P < 0.0005$, 2-way ANOVA), over the reproductive season. During reproduction up to 60% of the starch is remobilised in the form of soluble carbohydrates and redistributed to the developing spike, where it is used for early spike elongation and seed production.

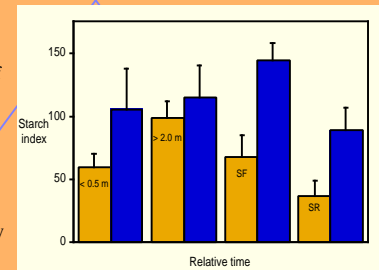


Fig. 7. Starch index for vegetative (blue) and reproductive (yellow) grasstrees over the reproductive season. Labels indicating spike length, SF = swollen fruits and SR = seed release. Data are mean of 4 plants \pm SE.

Reference

Lamont, B.B. & Downes, S. (1979) The longevity, flowering and fire history of the grasstrees, *Xanthorrhoea preissii* and *Kingia australis*. *Journal of Applied Ecology* 16: 893-899.