Thesis Report for NCAARF Honours Grant

Temperature impacts on grassland seedling survival during spring drought

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Seedling recruitment is critical for population stability and expansion. It enables the maintenance of species richness and diversity within a community. How species recruitment processes will respond to climate change is largely unknown. The current predictions for southeastern Australia include warming and a decrease in spring and summer rain. Several studies in Mediterranean grassland recruitment predict climate change, particularly increased temperatures and drought, will have a detrimental effect on seedling recruitment. Grasslands are poorly reserved within Australia and the world, despite their great economic and ecological value and knowledge on recruitment is critical for their preservation. Seedling surveys over the last six years at the TasFACE Climate Change Facility, show that warming of 2 °C, reduces seedling emergence and establishment. The warming is predicted to increase evaporation and transpiration, thus limited water availability is reducing seedling recruitment. The longevity of the seedlings surveyed that did not become established, was not significantly influenced by warming but was by seedling age, suggesting that the warm, dry summers were limiting seedling recruitment.

This experiment aimed to determine if different emergence times and warming would ameliorate the impact of the projected earlier spring drought on seedling establishment. To test this, five grassland species seedlings where germinated in two groups, a month between each and grown under three controlled temperatures: ambient, ambient + 2 °C and ambient + 4 °C. They were also subjected to three watering regimes: control, current spring drought and projected earlier spring drought. The soil water potential of the drought was controlled with different concentrations of polyethylene glycol 6000 (PEG), enabling the decoupling of temperature impacts and drought impacts. The water availability during the two drought treatments was the same, just the timing of the droughts changed.

Results showed that warming did not have a significantly negative impact on seedling growth ($P=0.29$). The early germinated group was not significantly more established or larger than the later germinated group at the completion of the experiment ($P= 0.55$) and the temperature treatment had no significant impact on growth overall. This suggests that early germination and warmer temperatures do not result in larger plants. Species had a significant effect ($P<0.0001$) on all water relationship parameters; fresh above ground biomass, dry AGB, water content and relative water content (RWC). This demonstrated different species had different tolerances to drought, with different allocation patterns. The drought treatments only significantly reduced fresh AGB ($P<0.0001$) and RWC ($P=0.031$) and the control treatment plants

contained significantly more water (mean = 2.61 g) than the current drought treatment both germination groups (mean = 1.98 g).

The photosynthetic efficiency (Fv:Fm), a measure determined by how much available light a plant makes use of, did not change dramatically over the experiment. The variance of the mean Fv:Fm was quite small, ranging from Fv:Fm = 0.829 to Fv:Fm = 0.624 (excluding the Fv:Fm values of 0 for the nine dead individuals). The drought treatments alone did significantly increase senescence of seedlings ($P<0.0001$) and the current drought timing was more detrimental than the projected earlier spring drought. Under most temperature regimes the seedlings also show a significant increase in senescence with an increase in drought severity ($P<0.0001$). Thus, the timing of drought in regards to the seasonal temperature could influence the impacts of drought and through senescence and plant-water relations the seedlings maintained photosynthetic efficiency.

A small competition experiment between two Tasmanian native grass species planted together and separately, demonstrated gemination time did impact species successes under competition but did not significantly alter drought success. The total biomass production when both species were planted together was significantly higher than when planted separately and the total RWC of all biomass separated into treatments demonstrated that the control had a significantly higher value than the drought treatment ($P = 0.002$) but this was not affected by the planting regime. There was no significant difference between the drought treatments planted together (mean= 16.7±2.3 SE) and separately (mean 24.2±2.4 SE) but there was a difference between the drought the control treatments

The overall health of the seedlings in this simple representation of Tasmanian grasslands suggests that under the stress of warming and drought this system is resilient, compounding stressors most likely result in low recruitment. The seedlings are able to maintain photosynthetic efficiency and RWC by partial senescence regardless of temperature, germination time and competition. Management plans recommendations drawn from this study are:

- Native species do not need to be planted earlier than exotics to ensure establishment under drought conditions, increased growth time did not decrease the impact of drought.
- Management of the compounding controllable stressor such as grazing, may minimise grassland destruction, due to the compounding impacts of climate change.
- Senescing plants must not be removed as partial senesces appears to be a mechanism for coping with drought, particularly when enhanced by warming. Further studies may demonstrate winter regeneration of senesced plants.