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# Moderate defoliation improves Mitchell Grass leaf, tiller and inflorescence production

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**Key words**: drought recovery; drought resilience; perennial tussock grass; Astrebla

**Abstract**

The Mitchell grasslands are unique to Australia and make important contributions to grazing, conservation, cultural heritage, and rural socioeconomics.

Previous studies suggest there is an optimal range of 15-20cm defoliation height to promote Mitchell grass (*Astrebla* spp.) leaf, tiller and inflorescence production during average to above average rainfall periods. However, there is evidence that a different defoliation height and frequency is needed to increase the responsiveness of Mitchell grass leading into, during, and exiting drought.

A long-term drought resilience experiment commenced in December 2021 at Longreach, Queensland to determine the interaction between defoliation height and frequency and water stress on Mitchell grass response to rainfall.

Treatments commenced in October 2022 once establishing plants reached maturity. The main effect of water stress is induced through rainfall received or alleviated through supplementary irrigation. Treatment interaction is applied through defoliation height (15cm or 0cm) and frequency (never, annually or biennially) at the end of the dry season (early October). Soil moisture and key plant parameters are monitored monthly and quarterly respectively.

Preliminary findings of plant recovery from the initial two defoliations indicate that cutting: increased end-of-wet-season photosynthetic area at both heights; increased tiller and inflorescence production and canopy area at 15cm height; but reduced tiller and inflorescence production at 0cm.

These early results support previous studies that Mitchell grass responds positively to 'moderate'—but negatively to severe—defoliation. The current study has been during average to above-average rainfall. Further papers will report longer-term results that will begin to reflect drought conditions.

Investment into long-term research is needed to continuously improve our understanding of perennial grass species management as a changing climate brings new challenges through increased temperature and



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rainfall variability. The ultra long-lived (>20 years) *Astrebla* spp. are an excellent model species for this purpose.

**Introduction**

*Astrebla* spp (Mitchell grasses) are tropical tussock grasses which are endemic to Australia. They are very long-lived perennials (>20 year life span, Orr and Phelps 2013), and produce relatively high levels of palatable forage. They grow predominantly on clay soils in arid to semi-arid regions, on naturally tree-less rolling downs and plains. These grasslands make important contributions to pastoralism, conservation, cultural heritage, and rural socioeconomics. Previous studies suggest there is an optimal range of defoliation height and frequency which can increase the responsiveness and resilience of Mitchell grass leading into, during, and exiting drought. Globally, defoliation frequency and height is recorded as impacting photosynthetic capacity (Cullen et al. 2006), tiller dynamics and dry matter yield (Kaufononga et al. 2017), and interacts with drought to increase mortality (Hacker et al. 2006) in perennial grasses. Studies of Astrebla spp can therefore contribute to the international understanding of perennial grass management.

**Methods**

A long-term drought resilience experiment commenced in Longreach in December 2021 to determine the role of defoliation and water stress on *Astrebla lappaecea* (Curley Mitchell grass) response to rain. The main treatment is a) exposure or b) non-exposure to drought water stress, achieved by a) relying on rainfall received or b) supplementary irrigation to match monthly average rainfall. Sub-treatments are annual or biennial clipping to remove a) all tiller nodes (1-2 cm height) b) all but 3-4 tiller nodes (15 cm height) and c) an unclipped control. Clipping occurs at the end of the dry season (October). Plots and plants were allocated randomly with a split-plot design with four replicates. Five plants are arranged in the corners and centre of each of eight 0.7m x 0.7 m sized plots, with a 0.3m access path between each plot.

Forty plants were established over December 2021-March 2022, and irrigated until all plants had reached maturity in October 2022. During this time, heatwaves and insect incursions killed many young seedlings which were replaced with newly germinated seedlings, and set-back the growth of others. Emergent tillers were tagged in control plants during the establishment phase to track survival.

Soil moisture is recorded monthly through a DeltaT PR2 probe, with two access tubes installed per plot and 10 access tubes within walkways to monitor for the possibility of lateral flow from irrigated to non-irrigated plots. Plants are recorded daily, weekly, monthly, quarterly, or biannually depending on the parameter (Table 1). No statistical analysis is reported for these preliminary results.

**Results**

The Longreach region was drought declared from December 2021 to May 2023 (LongPaddock 2024). Heatwaves, high evapotranspiration, and insect incursions killed many of the young seedlings and set-back the growth of others during the establishment phase (Dec. 2021 to Jan. 2022; days 0-90; Fig. 1a). Nevertheless, soil moisture levels were relatively consistent at depth (600-1000mm) and more dynamic in response to rainfall events within the soil cracking zone (0-400mm, Fig. 1b).

The preliminary trends for plant recovery from a single defoliation indicate that clipping: increased end-of-wet-season photosynthetic area at both heights; increased tiller production, basal area and canopy area at 15cm height but; reduced tiller production and basal area at 0cm. In contrast with other studies, defoliation did not increase inflorescence production. Drought exposed plants tended towards reduced photosynthetic area compared with non-exposed (irrigated) plants within every clipping sub-treatment (Fig. 2).

Table 1. Frequency of plant parameter measurements.

| Frequency | Parameter | Method |
|---|---|---|
| Daily-weekly | Visual overview | Photographic record |
| Weekly-monthly | Plant height | Direct measurement (cm) |
| Monthly-quarterly | Photosynthetic area | Number of green leaves, direct measurement of representative leaf length and width (mm) |
| | Tiller number (primary and axillary) | Direct count |
| | Inflorescence number (primary and axillary) | Direct count |
| | Rhizome emergence | Direct count |
| | Canopy area | Direct measurement of perpendicular widths (leaf tip to leaf tip, cm) |
| Quarterly-biannually | Basal area | Direct measurement of perpendicular widths (mm) |
| | Node number per tiller | Direct count of 10 random tillers |
| | Tiller lifecycle | Direct estimate of live, senescent and dead tillers; counts of tagged tillers emerged in first year |
| | Leaf lifecycle | Direct estimate of live, senescent and decaying leaves |
| Annual- biennial | Biomass | Weight of harvested material (dry matter, g) |

One of the 1-2 cm height clipped plants has died, and all have greatly reduced basal area (data not presented). One of the unclipped control plants is dominated by dead tillers and leaves, with very little new growth. Other control plants are starting to show similar signs of reduced vigour. Tagged tiller mortality reached 46% after 11 months, and 93% by 29 months after emergence. By April 2024, the majority (60%) of control plants' total primary tillers were dead.

**Discussion**

High mortality of seedlings during the summer establishment phase suggests that mid-summer conditions may not be conducive to *Astrebla* seedling establishment. This potentially contradicts earlier findings that seedling recruitment occurs any time during the wet season (Orr and Phelps 2013) but may also reflect the drought and heatwave conditions experienced over the 2021-22 summer at Longreach.

The early results of clipping support previous studies that Mitchell grass responds positively to 'light'—but negatively to severe—defoliation. Despite challenging drought conditions during the establishment phase of this experiment, subsequent average to above-average rainfall conditions have led to relatively reliable soil moisture and a lack of exposure to drought since the initiation of clipping.

Further papers will report longer-term results that include drought and hence water stress conditions. The key question that remains to be answered is whether there is an optimal defoliation height and frequency which increases the responsiveness and resilience of Mitchell grass during and exiting drought.

The high mortality of the first years' tagged tillers in unclipped control plants, supported by high overall primary tiller mortality, suggests old tillers will dominate the demographics of clipped plants. This is likely to reduce the potential for recovery compared with tiller demography dominated by younger tillers. Clipping to 1-2cm height forced regrowth as primary tillers from the crown, as all nodes that could initiate growth are removed. Clipping to 15cm height retains 3-4 nodes where leaves and axillary tiller growth can initiate from. It remains to be seen if clipping to force consistently younger primary (annual or biennial 1-2cm clipping) or axillary (annual or biennial 15cm clipping) tillers will promote growth during drought recovery, or if reduced basal area and reduced overall tiller number will impede growth.

Investment into long-term research is needed to continuously improve our understanding of Mitchell grass as a changing climate brings new challenges through increased temperature and potentially more variable rainfall conditions.

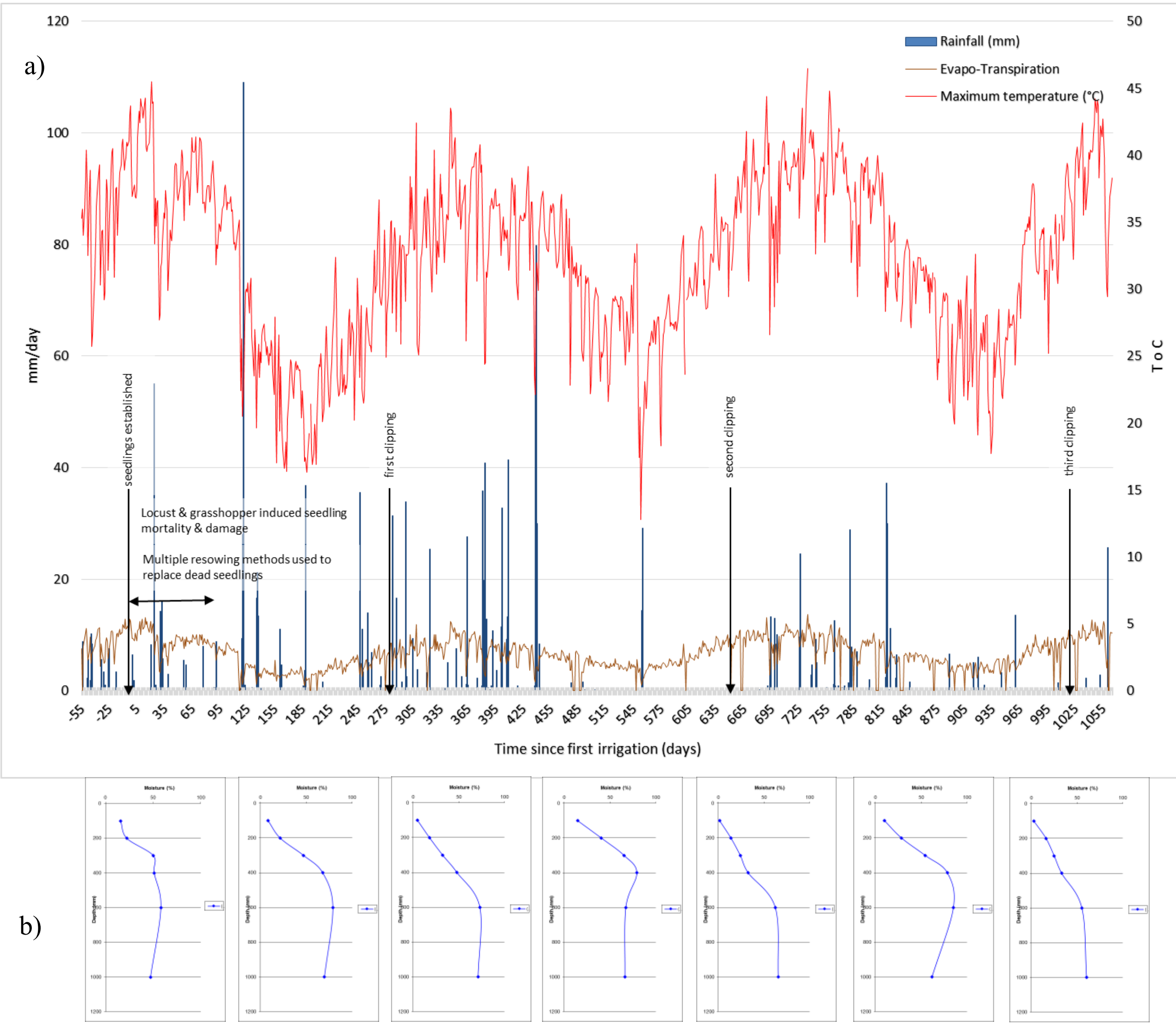


Fig. 1. a) Seedling establishment phase and clipping events in relation to maximum temperature, evapotranspiration and insect incursions throughout the experiment; b) plot level soil moisture levels at days 7, 140, 315, 444, 686, 825, and 1027.



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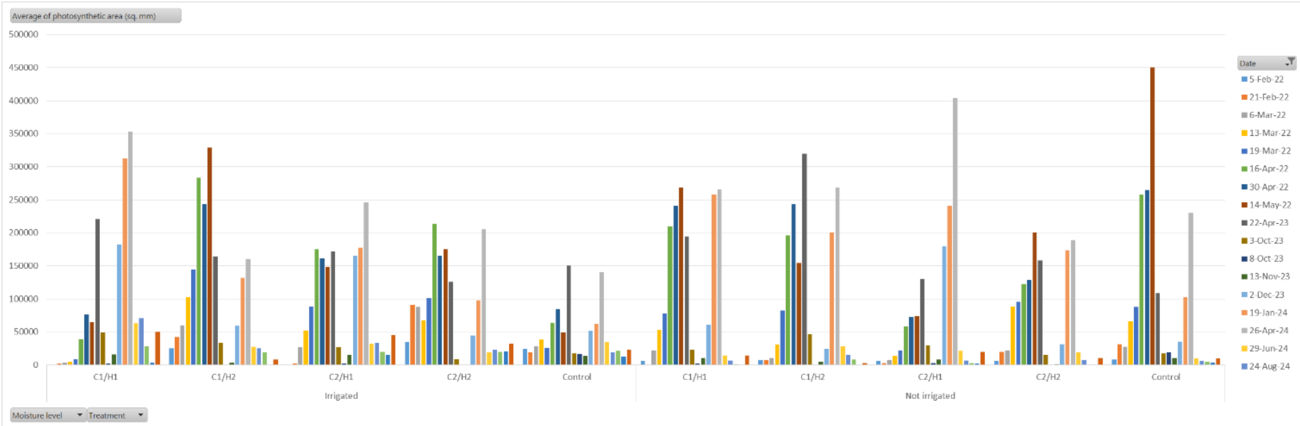


Fig. 2. Photosynthetic area (sq mm/plant) over time under drought and non-drought conditions and at five clipping intensities.

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