

A plant-physiology approach to a fire-y problem

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Introduction

As vegetation dies, it dries and becomes more flammable. Fire agencies require accurate and timely assessments of curing (the percentage of dead material in the sward) to model grass fire behaviour and calculate fire danger ratings (Cheney and Sullivan 2008). Visual observation is commonplace and the more objective use of the Levy Rod is recommended, although both have drawbacks (Anderson *et al.* 2011). There is great potential for pasture growth models to provide curing estimates to assist with the management of wild grass fires (Gill *et al.* 2010). This PhD project focused on plant physiological characters to populate models that could be used to predict curing assessments for fire management purposes.

Existing pasture growth models

APSIM (McCown 1996), GrassGro (Moore *et al.* 1997) and the SGS Pasture Model (Johnson *et al.* 2003) were used to simulate curing in a number of pastures (*e.g.* Fig. 1) and a wheat crop in SE South Australia. Curing outputs were similar to estimates derived from the Levy Rod technique except in native pastures. However, no single pasture growth model was suited to all grassland situations.

The models varied in the species simulated, the underlying senescence assumptions, and management flexibility. Use of these models is predicated on accurate inputs and robust validation, which is often problematic. Calibration of curing outputs to management practice is also necessary.

Measurement and modelling of leaf turnover rates

Curing is a fire management term encompassing the senescence and death of plant material, which is not well represented in current plant growth models. Leaf growth rates (leaf appearance, elongation, length, and life span) and leaf senescence rates were measured to capture the whole life cycle to ascertain similarities and differences between four C3 grass species (Fig. 2). This study was unique in that it measured all growth and death stages, including an Australian native, and compared grass species of differing growth habits. Generally, the relationship between leaf rates and leaf position could be represented using non-linear models. This work will be useful to model developers who wish to strengthen the algorithms underpinning particularly the senescence routines in existing pasture growth models. In the interim, a standalone model was developed to incorporate the leaf rates into a prototype curing model.

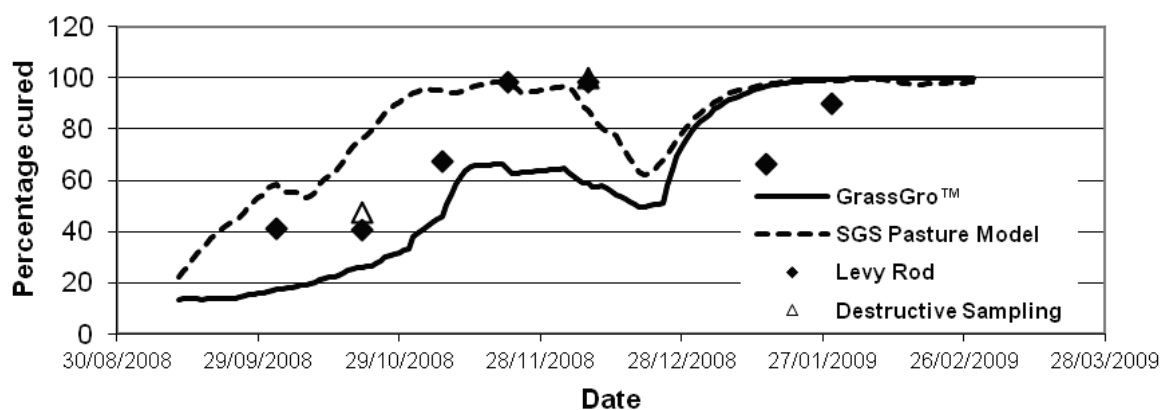


Figure 1. Comparison of field curing assessments with estimates of curing from GrassGro™ and the SGS Pasture Model for phalaris at Struan, SA, during the 2008-2009 fire season.

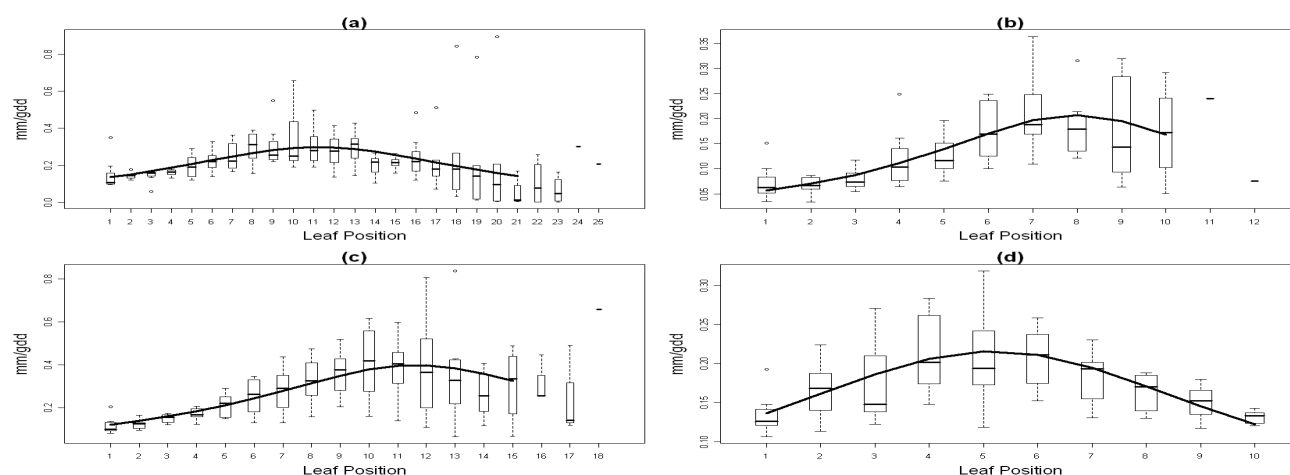


Figure 2. Observed (boxplot) and modelled (line) LSR ($10^1 \times \text{mm/gdd}$ ($T_{\text{base}} = 0^\circ\text{C}$)) with leaf position: (a) annual ryegrass; (b) wallaby grass; (c) phalaris; (d) wheat.

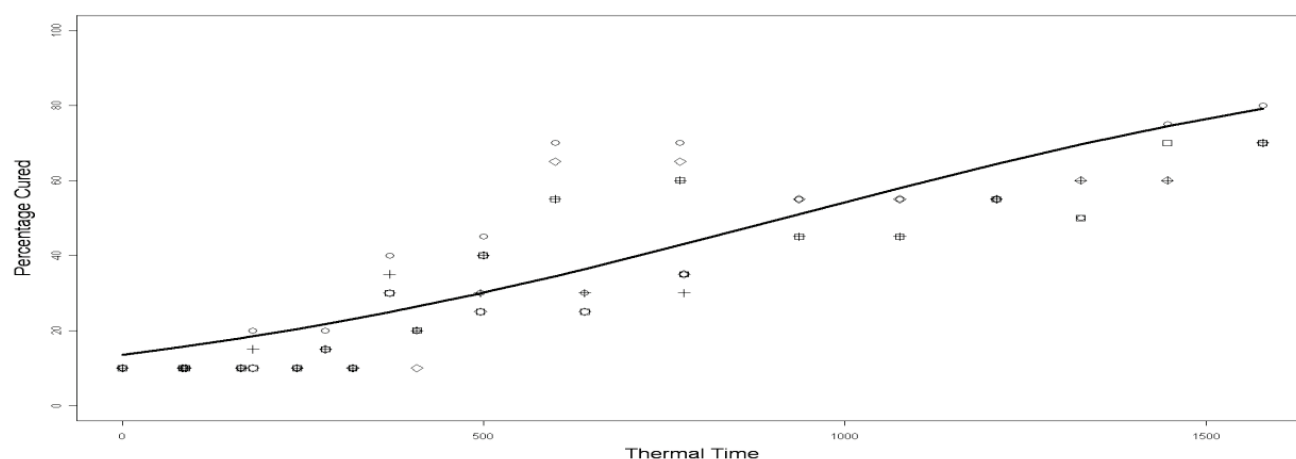


Figure 3. Logistic curve based on the Bayesian model for phalaris (line) fitted against visual curing observations from four sub-districts of the Naracoorte Lucindale Council over thermal time (gdd ($T_{\text{base}}=0^\circ\text{C}$) in the 2009-2010 and 2010-2011 fire seasons: ○) Frances; +) Avenue; □) Callendale; ◇) Wrattontully.

Bayesian curing model

The models of individual leaf turnover rates were incorporated into a Bayesian model, to determine the accumulation of green leaf material, as could the progression of curing over time. The Bayesian model for phalaris sufficiently predicted curing in one region (SE of SA) over two fire seasons (Fig. 3).

Conclusion

This project has improved the prediction of curing by applying a plant physiology perspective to what is essentially a plant flammability problem arising from plant senescence and death. This knowledge can be applied to enhance existing tools, or to create new ones from the prototypes developed here.

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