PAstures and Climate Extremes Newsletter

Autumn 2018
Editors: Amy Churchill and Sally Power

Website: https://www.westernsydney.edu.au/hie/facilities/PACE_pasture_climate_extremes

Introducing the PACE Team

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Research at PACE

Welcome to our first edition of the Pastures in Climate Extremes (PACE) Newsletter! We are a group of research scientists at the Hawkesbury Institute for the Environment within Western Sydney University who are investigating the consequences of extreme climate conditions, including heatwaves and seasonal droughts, for a range of pasture species that underpin the success of Australia's livestock and dairy industries. Our research is centred on a large-scale field facility where we are exposing pasture grasses and legumes to elevated temperature and winter/spring drought, in line with future climate predictions for SE Australia. By undertaking detailed study of above- and belowground responses to warming and drought treatments, we hope to provide new insight into the mechanisms that determine climate sensitivity and resilience in key pasture species. The field facility was constructed in mid 2017 and since then we have focused on establishing healthy swards of our target species. In April 2018 we turned on the heating lamps for the warming treatments (**Figure 1**); our drought treatments start at the beginning of winter (June 1st, to be precise). So, as we ready ourselves to launch the experimental plots into new climate space, we thought it timely to share this update with you!

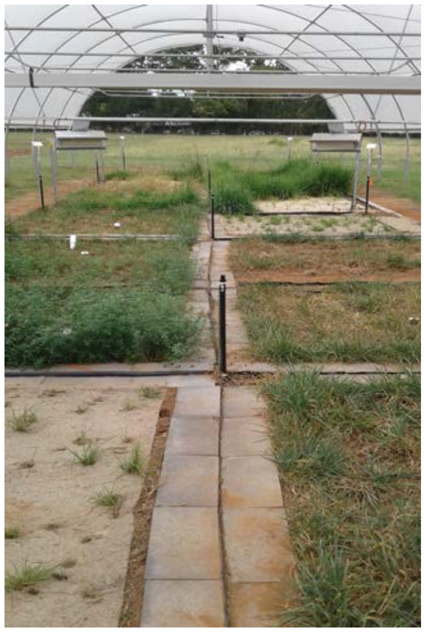

Figure 1. Inside a field shelter at PACE, showing our plot-level controlled watering and heating arrays and sub-plots of many different pasture species.

Pasture establishment and productivity

A diverse range of pasture grasses and legumes are grown across temperate Australia and our field facility has been designed to evaluate the performance of multiple species and species combinations growing under standardised conditions. At PACE we have established swards for nine single species plots (**Figure 2**), as well as an additional three mixed-species combinations (grass-legume or grass-grass) giving us a total of ten pasture species in this first phase of the project. Species selection was informed by input from industry stakeholders and includes a range of cool and warm season dominants to incorporate pasture seasonality within the broader context of responses to climate extremes. Our species also represent a range of traits believed to be important for determining plant responses to drought and warming conditions such as rooting depth and drought-tolerance strategies, allowing us to determine plant characteristics associated with pasture resilience in the face of changing environmental conditions.

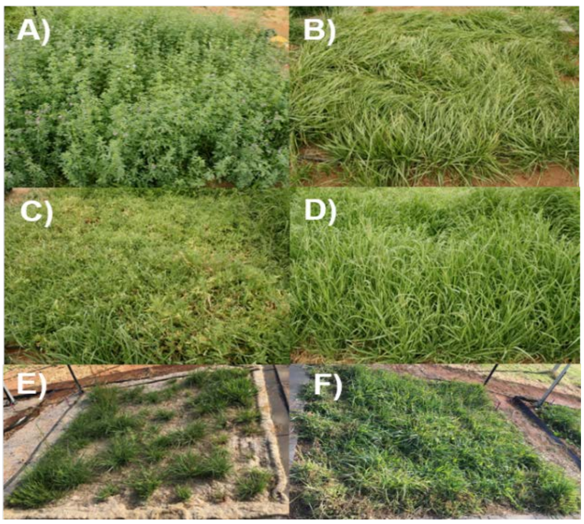

Figure 2. Examples of established swards grown at the PACE experimental facility: A) Lucerne, B) Fescue, C) Biserrula, D) Rhodes grass, E) Kangaroo grass, and F) Digit grass. Other species being grown at PACE include Rye grass, Phalaris, Sub-clover and Wallaby grass.

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Measuring pasture phenology

In addition to wanting to know how climate extremes affect the overall quantity and quality of pasture species' biomass, understanding how drought and warming affect the timing of projection is a fundamental issue we are tackling in our experimental field facility. PACE is equipped with 48 remotely controlled cameras (**Figure 3A**) connected to our data network, enabling us to document changes in canopy conditions in real time for each species and treatment combination (**Figure 3B**). We are using daily images to examine a variety of important plant responses to the climate treatments, including relative greenness (linked to production and nutrition), recovery of plants following a harvest (**Figure 3C**), seasonality of growth for different species, timing of flowering, and physiological responses to frost or heatwave events (**Figure 3D**).

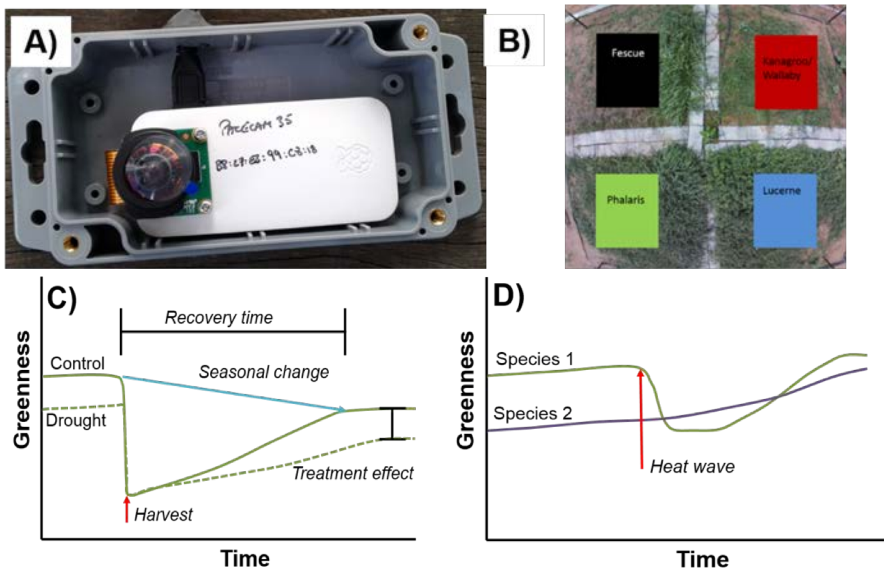

Figure 3. A) Configuration of the Raspberry Pi computer and camera with wide-angle lens. B) Plot level image using the mounted camera, with identified areas in each subplot for examining changes in four different species. C) Schematic representation of predicted changes in greenness between control and droughted plots following a plant harvest (simulated grazing or cut and carry event). The drought plot starts with a lower greenness index, and then recovers more slowly than the control plot. D) Simulation of species differences in susceptibility to a short-term heatwave event, as captured using daily phenocam imaging.

Glasshouse experiment: Drought and warming

Figure 4. Glasshouse experiment exposing Lucerne and Fescue to warming and drought.

A second component of the PACE project involves the use of controlled, glasshouse experiments. Using a glasshouse design enables us to test key mechanistic linkages associated with patterns that we observe in the field study, in a more closely controlled environment. This first glasshouse experiment aims to quantify how warming and drought affect plant hydraulic, physiological and nutritional performance and resilience for two of the pasture species (Lucerne and Fescue) that are being grown in the field facility. Plant responses to warming and drought are predicted to be strongly influenced by the nature of their mutualistic associations with microbial symbionts, especially nitrogen-fixing bacteria and arbuscular mycorrhizal fungi. These symbionts provide limiting resources such as water, phosphorus and nitrogen to the plant in exchange for photosynthetically derived carbohydrates. However, we understand very little about how extreme events can disrupt this give-and-take relationship between plants and their microbial symbionts.