Appendix 1: Adapting to increases in mean daily temperature by increasing the heat tolerance of perennial ryegrass

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Abstract

Climate projections for Australia suggest that there will be a general increase in daily temperatures of 0.4 to 1.8oC by 2030 and 2.2 to 5oC by 2070 (CSIRO and BoM, 2007). Climate change impact modelling based on future climate scenarios, created by direct scaling of historical climate data, can be used to examine the effect of increased temperature on pasture production and potential adaptation approaches, while maintaining the inherent climate variability. The biophysical model DairyMod (Johnson et al. 2008) was used to simulate mean annual pasture yields for the three Australian dairying regions of Elliott (North West Tasmania), Ellinbank (South East Victoria) and Terang (South West Victoria), which heavily rely on perennial ryegrass (Lolium perenne L.) to support dairy production.

Five climate files for each region were created by direct scaling the historical baseline climate file (1971 to 2008) by 0, 1, 2, 3, 4 and 5oC with corresponding atmospheric CO2 concentrations of 380, 435, 535, 640, 750 and 870 ppm, respectively. The highest mean annual yield for Elliott, Ellinbank and Terang resulted from scaling to 3oC/640 ppm (a 27.2% increase above the baseline climate data), 1oC/435 ppm (1.7% increase) and 2oC/535 ppm (10.1% increase), respectively. At Elliott, increases in temperature with corresponding increases atmospheric CO2 concentration increased annual pasture yields. At Ellinbank and Terang, increasing temperature and CO2 concentrations to and above 2oC/535 ppm and 4oC/750 ppm respectively, resulted in lower annual yields than those produced using the baseline climate data.

The effect of exposure to periods of extreme high temperatures on the growth of perennial ryegrass was then explored using nine variations of high temperature tolerance, in conjunction with the scaled increases in temperature and atmospheric CO2 concentrations described above. Three onset and full temperature combinations (28/35oC, 29/36oC and 30/37oC) were examined across three critical T-sums (20, 35 and 50oC). The onset temperature represents the temperature at which a reduction in plant function commences due to heat stress, the full temperature represents the upper temperature at which plant function ceases, and the critical T-sum represents the recovery period required following exposure to heat stress. Increasing the high temperature tolerance of perennial ryegrass was able to alleviate the negative effects on annual pasture up to 5oC of warming at Terang and up to 4oC warming at Ellinbank. This highlights the relative benefit of exploring and introducing more heat tolerant perennial ryegrass cultivars to the regions used in this study.

References

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