Strategies to enhance perennial ryegrass persistence over summer

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Abstract
Field research is being conducted in northern Victoria, Australia to evaluate how perennial ryegrass genotypes vary in their ability to survive summer drought, and to determine irrigation and grazing management strategies that may enhance perennial ryegrass persistence and production. One experimental site involves 15 perennial ryegrass and tall fescue cultivars and two summer irrigation strategies (full and nil irrigation). Two other experimental sites involve 7 ryegrass cultivars, two summer irrigation strategies (limited and nil irrigation), two summer grazing strategies and an oversowing component. To date, there have been no clear effects of ryegrass genotype and/or genetic background on summer survival at any field site nor any consistent effects of either summer grazing or oversowing in any of the irrigation bays. Ryegrass plant frequency (density) in the following autumn hasn't differed between perennial ryegrass genotypes but has been higher in the irrigation bay that was fully irrigated (grass presence measured at 97% at the Tatura site) compared with the bay where summer irrigation has been restricted (grass presence measured at 72% at the Tatura site). Autumn and winter pasture accumulation has varied across years, sites and irrigation bays, and appears to be related to the amount of residual pasture mass that is present prior to restricting irrigation. Further research is being undertaken to investigate whether the residual pasture mass and water soluble carbohydrate reserves at the start of the dry period impacts either summer survival or subsequent pasture accumulation.

Keywords
Lolium perenne, limited irrigation, summer dormancy, grazing management.

Introduction
In the dairy regions of Australia, the performance of perennial ryegrass over summer can be poor because of a combination of high water demand and high temperatures which limit dry matter production (Vough and Marten 1971). The ability of perennial ryegrass to survive drought conditions is influenced by a range of factors including plant genotype, irrigation and grazing management, as well as the presence of endophyte. Perennial ryegrass cultivars with a north-west Spanish background are believed to have an improved tolerance to summer moisture deficit compared with cultivars with a more European background (Matthew et al. 2012) and may adopt a drought survival strategy. Withholding irrigation water and/or limiting grazing over summer may also affect summer survival (Beattie 1994).

The objectives of this research are to evaluate how perennial ryegrass genotypes vary in their ability to survive summer drought and to determine irrigation and grazing management strategies that may enhance perennial ryegrass persistence and production. This paper reports on the research that commenced in spring 2014 and will continue until June 2017 with the possibility of a further extension.

Methods
This research involves three field sites that have been established in northern Victoria, Australia. One field experiment is located on site at DEDJTR, Tatura Centre and the two other two field sites are located on local dairy farms within a 80 km radius of Tatura.

The first site was established at the DEDJTR, Tatura (36°26' S, 145°15' E, elevation 110 m), 2.5 km east of Tatura in northern Victoria in May 2014. Thirteen perennial ryegrass cultivars (including diploids, , tetraploids and material with north-west Spanish genetics) and two tall fescue cultivars have been established and are being grown under two summer irrigation strategies (fully watered (Full) or no irrigation between late-heading and mid-March (Nil)). The 15 genotypes are replicated four times within each irrigation bay. Data collection includes dry matter (DM) production, heading date, plant density in autumn, and plant stubble carbohydrate reserves. The plots are mown to a height of 5 cm.

Two further field sites have been established on dairy farms at Katunga (35°58' S, 145°24' E) and Rochester (36°22' S, 144°39' E) in March 2015. Each site involves seven ryegrass cultivars (five perennial and two short-lived), two summer irrigation strategies (no irrigation –(Nil) or irrigated once (Limited) between late-heading and mid-March), two summer grazing strategies (grazed once or not grazed) as well as an oversowing component (the five perennials are sown in duplicate plots with one plot oversown and the other not oversown each autumn; the two short-lived cultivars are oversown each autumn). The treatments are replicated three times within each irrigation bay. Data collected includes forage DM removal at each grazing, nutritive characteristics, botanical composition and plant density in autumn.

For each of the three sites, the two irrigation strategies are located in adjacent irrigation bays and are un-replicated; hence they represent separate experiments and can only be compared with each other qualitatively. In all cases, all bays were fully irrigated for the remainder of the irrigation season, i.e. for the spring/early summer and autumn periods. All plots were grazed prior to oversowing in autumn 2016, with both sites being grazed six times from the recommencement of irrigation in autumn 2016 until mid-December 2016.

Results and Discussion

Tatura Site

To date there have been no consistent yield (DM) differences ($P<0.05$) between any ryegrass cultivar within an irrigation bay. Average total harvested yields for the ryegrass cultivars in each bay were 14.6 and 10.4 t DM/ha in Year 1 (17 Jan 2015 to 4 Jan 2016), and 11.1 and 7.0 t DM/ha in Year 2 (4 Jan 2016 to 5 Dec 2016), for the Full and Nil bays, respectively (Figure 1). On a seasonal basis, there were marked differences in DM yields between the bays during the non-irrigated summer period in both Year 1 and Year 2. For the next three harvests after the non-irrigated summer period, (the autumn/winter period), there was a minimal difference between the irrigation bays in Year 1 (3.4 vs 3.0 t DM/ha) but a large difference in Year 2 (3.0 vs 1.5 t DM/ha) such that the total DM yield from 4 January to 12 August 2016 (Year 2) in the Nil bay was only 1.7 t DM/ha. For the final four harvests of each year (August to December) the growth rates were similar in both bays.

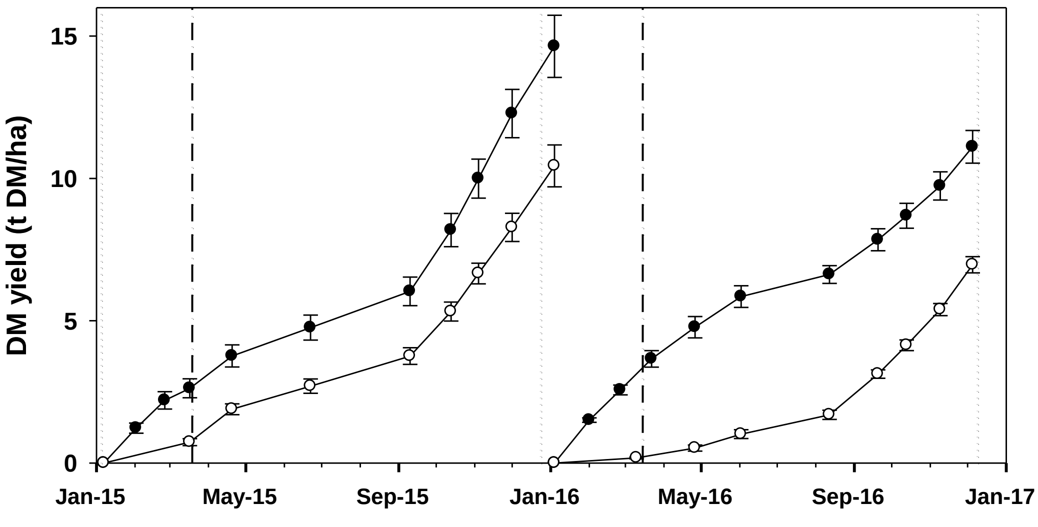

Figure 1. Mean cumulative annual dry matter yields across all perennial ryegrass cultivars in the Full (●) and Nil (○) summer irrigation bays over the period January 2015 to December 2016. The dashed vertical lines in January 2015 and 2016 refer to when irrigation was stopped each summer and the dashed vertical lines in late March in 2015 and 2016 refer to when irrigation recommenced. Error bars indicate standard deviations based on average cultivar yields.

In March 2016 there were no significant differences in plant frequency between perennial ryegrass genotypes within either irrigation bays (Figure 2), however, the ryegrass plant frequency was much higher in the Full bay (97 % cells) compared with the Nil bay (72 % cells).

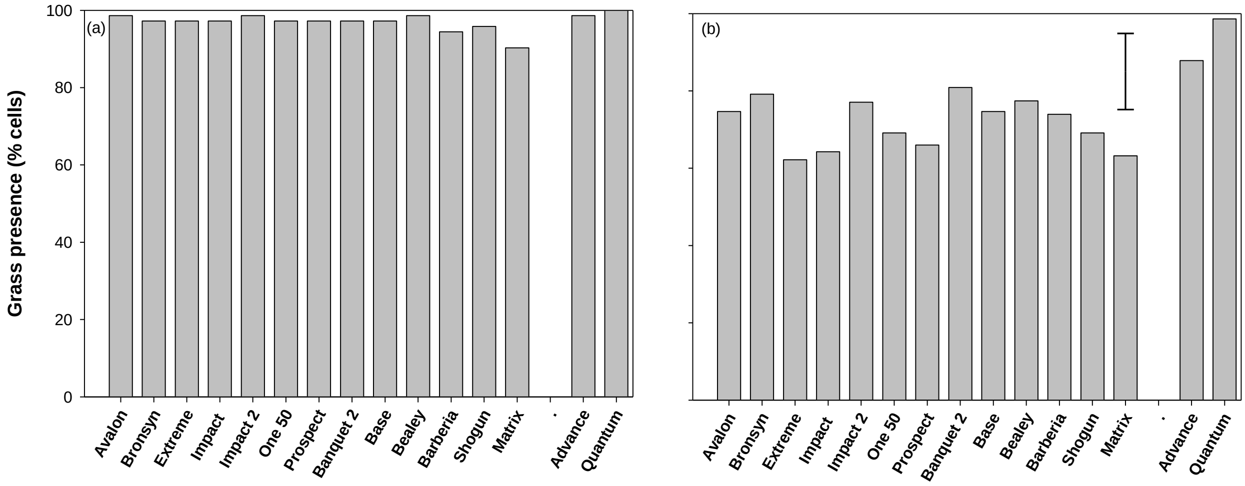

Figure 2. Grass presence as a percentage of quadrat cells in the (a) full irrigation bay and (b) no summer irrigation bay, on the 30 March 2016. Results for (a) are not significant, vertical bar in (b) is l.s.d. (P=0.05). Note that the 13 ryegrass cultivars are on the left and the 2 tall fescue cultivars are on the right.

Katunga and Rochester Sites

There were no significant differences in cumulative DM removal between ryegrass genotypes at either of the commercial dairy field sites from May to December 2015 which averaged between 8.3 and 8.6 t DM/ha for the two bays at Katunga, and 4.7 and 7.9 t DM/ha for the two bays at Rochester (data not presented). To date, there has been no consistent effect of either summer grazing or oversowing in any of the irrigation bays at either site.

Conclusion

There have not been any clear effects of ryegrass genotype and/or genetic background on summer survival of perennial ryegrass at any field site – to date. In the screening study at the Tatura site, there were no differences in autumn / winter / spring pasture accumulation between the two bays with different summer irrigation strategies in Year 1 (2015). However, in Year 2 (2016), autumn and winter pasture accumulation in the bay with limited summer irrigation was 30% less than in the bay that was fully irrigated over summer (Figure 1). This difference is potentially related to water soluble carbohydrate reserves at the start of the dry period which may impact on tiller survival over summer and re-growth after irrigation has been recommenced in autumn. Measurements of soluble carbohydrate reserves in tiller stubble have commenced over the summer / autumn of 2016/17 to investigate the impact of these reserves on summer survival and subsequent pasture accumulation.

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