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Perennial grasses for waterlogging prone, summer dry environments

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RESUME *– "Herbacées pérennes pour des milieux enclins à l'engorgement et secs en été". L'évaluation d'une gamme diverse de cultivars de* Phalaris aquatica, Festuca arundinacea, Lolium perenne, Dactylis glomerata *et* Thinopyrum ponticum *sur un site enclin à l'engorgement en hiver et à la sécheresse en été a démontré que les cultivars de* Phalaris *à port érigé et actifs en hiver, Sirolan, Atlas PG et Holdfast, sont fortement productifs et persistants. L'un des cinq cultivars de* F. arundinacea*, cv. Prosper, était dormant en été et présentait une persistance supérieure par rapport aux autres lignées de* Festuca*. La sélection pour la tolérance à l'engorgement au sein de* D. glomerata *cv. Porto a amélioré la persistance.* Thinopyrum porticum *s'est montré productif spécialement lors des longs printemps humides et frais.*

Mots-clés **:** Phalaris, Lolium, Festuca, Dactylis, Thinopyrum*, production, persistance, dormance d'été.*

Introduction

Many pastures used in the ley farming systems of southern Australia have traditionally been composed of such annual species as subterranean clover (*Trifolium subterraneum)* and annual ryegrass (*Lolium rigidum*). These systems have recently been shown to be unsustainable as the low water use of annual species increases the rate of soil acidification and contributes to the increasing occurrence of soil waterlogging and associated dryland salinity (Ridley *et al*., 2001). In addition many of the soils of southern Australia have a relatively impermeable subsoil causing temporary waterlogging over winter.

Recent research has shown that perennial pasture species reduce the rate of soil acidification and incidence of waterlogging by increasing the use of water. However, winter waterlogging and the hot, dry summers of southern, inland Australia combine to produce an environment in which only certain perennial species can survive. While farmers are now being encouraged to include perennial species in their pastures, there is a shortage of recommended perennial pasture grass cultivars available as the last major developments with these species in inland New South Wales occurred in the 1960's (Oram and Hoen, 1967). This was the motivation for the work described here.

Materials and methods

The experiment, which was established in May 1997, comprised 6 different lines of phalaris (*Phalaris aquatica* L.*)*, cultivars (cv.) Landmaster, Holdfast, Sirolan, Australian, Atlas PG and *P. aquatica, P. arundinacea, P. aquatica* backcross hybrid. Tall fescue (*Festuca arundinacea* Schreb.*)* cv. included Advance, Dovey, Cajan, Au Triumph and Prosper while the varieties Roper, Boomer, Camel and Victorian evaluated developments within perennial ryegrass (*Lolium perenne* L.*).* Three varieties of cocksfoot (*Dactylis glomerata* L.*),* Kasbah, Porto and a waterlogging tolerant selection from within Porto, designated 'Porto WT', (R. Culvenor pers. com.) were included, as were 2 varieties of tall wheatgrass (*Thinopyrum ponticum* Podp.*),* Tyrrell and Dundas. The trial was located at Gerogery, New South Wales (latitude 35° 54' 0'' S, longitude 146° 56' 30'' E, altitude 220 m) on a yellow podzolic soil of pH 4.7. The site was in a depression and was regularly flooded in winter. Test cultivars were sown in pure sward plots and arranged with 3 replications in a randomised complete block design. Phalaris and cocksfoot were sown at 3 kg/ha, whereas tall fescue, tall wheatgrass and perennial ryegrasses were sown at 10, 12 and 15 kg/ha respectively. Fertilization at sowing applied 15 and 13 kg/ha of nitrogen (N) and phosphorus (P) respectively while subsequent annual fertilizer applications consisted of 50 kg/ha of N in spring and 9 kg/ha of P in autumn.

Herbage yields were determined twice a year, in mid winter (July) and at the end of spring (December) and once at the summer end. A total area comprising 0.5 m^2 was harvested from each plot and dry weight then determined. Persistence was calculated by comparing crown frequency in December 1997 with that of June 2001. Frequency was determined using a fixed quadrat of 1 m^2 which was divided into 100 squares each of 100 cm^2. The frequency of presence of a live grass crown in each small square was noted by the value 1. Herbage yield and plant survival data were analysed using linear mixed models (REML - residual estimated maximum likelihood) and ANOVA procedures respectively, both contained in Genstat 5 Version 4.2. The experiment was analysed as a one factor trial with cultivar as the factor.

Results and discussion

Rainfall received over the duration of the trial varied greatly with annual totals of 413, 551, 804 and 793 mm being recorded for 1997, 1998, 1999 and 2000 respectively.

Herbage yield results from 6 successive growth periods are presented in Fig. 1. Over winter 1998, Sirolan phalaris was significantly more productive than any other cultivar and it was followed by 2 other phalaris lines, Atlas PG and Holdfast. These 2 cv. comprised the second highest productivity group. In spring 1998 the results were that Tyrrell tall wheatgrass and Holdfast phalaris were the most productive lines with the second most productive group comprising the 5 phalaris cv., Holdfast, Sirolan, Australian, Atlas PG and the hybrid together with Prosper tall fescue. Quite contrasting results to the previous 2 seasons were obtained at the end of summer (March) 1999, insofar as the summer active cv. of tall fescue, tall wheatgrass and perennial ryegrass were the most productive. The level and range in productivity were not as great in this season indicating probable super-optimal growth temperatures and moisture deficit. The most productive cultivar group comprised 4 tall fescues, Au Triumph, Cajan, Advance and Dovey, the waterlogging tolerant selection of Porto cocksfoot and Dundas tall wheatgrass. The inclusion of a summer harvest in the trial has allowed the contrast in seasonal productivity between the various lines to be well expressed. As an example the difference in productivity of Porto WT and Kasbah cocksfoots between winter and summer demonstrates one component of the effect conferred by the summer dormancy trait. Production results in winter 1999 were comparable to those in the winter 1998 with similar cultivars, Sirolan, Kasbah, Atlas PG and Holdfast ranked in the top four. The almost complete change in productivity order of cultivars between winter and summer is noteworthy.

Two harvests were performed during spring 1999, one in September, the other in early December. After pooling of the data, results indicated that the most productive cultivar group comprised 5 phalaris's, the hybrid, Atlas PG, Holdfast, Sirolan and Australian, the tall wheatgrasses, Dundas and Tyrrell, the perennial ryegrasses Victorian, Roper and Boomer and Porto WT cocksfoot. The final harvest occurred in spring (December) 2000. No harvest occurred in winter 2000 because cattle invaded the trial and removed all herbage. Dundas tall wheatgrass was the most productive cultivar with 9532 kg/ha. The other point of interest was the virtual disappearance of the cocksfoot cultivar Kasbah by this time as it had not survived the waterlogging well and was not competitive against annual grass weeds which had a longer period of growth over spring.

Cultivar persistence, expressed as the proportion of crowns present in June 2001 compared to December 1997 is presented in Table 1.

All six phalaris cv., both tall wheatgrasses and Prosper tall fescue persisted well and even increased their presence. The superior persistence of cv. Prosper in comparison to the other tall fescues suggests that summer dormancy is a trait necessary for improving persistence in this species particularly as summer drought was a major limitation at the site. Noteworthy, also is the improvement in persistence of Porto WT in comparison to Porto indicating that selection for waterlogging tolerance helped improve persistence of cocksfoot. However, results still indicated a slow decline in the population of Porto WT although, as the site suffered especially severe waterlogging this cocksfoot may be useful for less wet landscapes. All perennial ryegrasses and summer active tall fescues had poor persistence and although yields of these cultivars were satisfactory in spring 2000 the very hot and dry summer of 2001 killed many plants indicating the poor adaptation of these cultivars and the utility of the summer dormancy trait where present in these species.

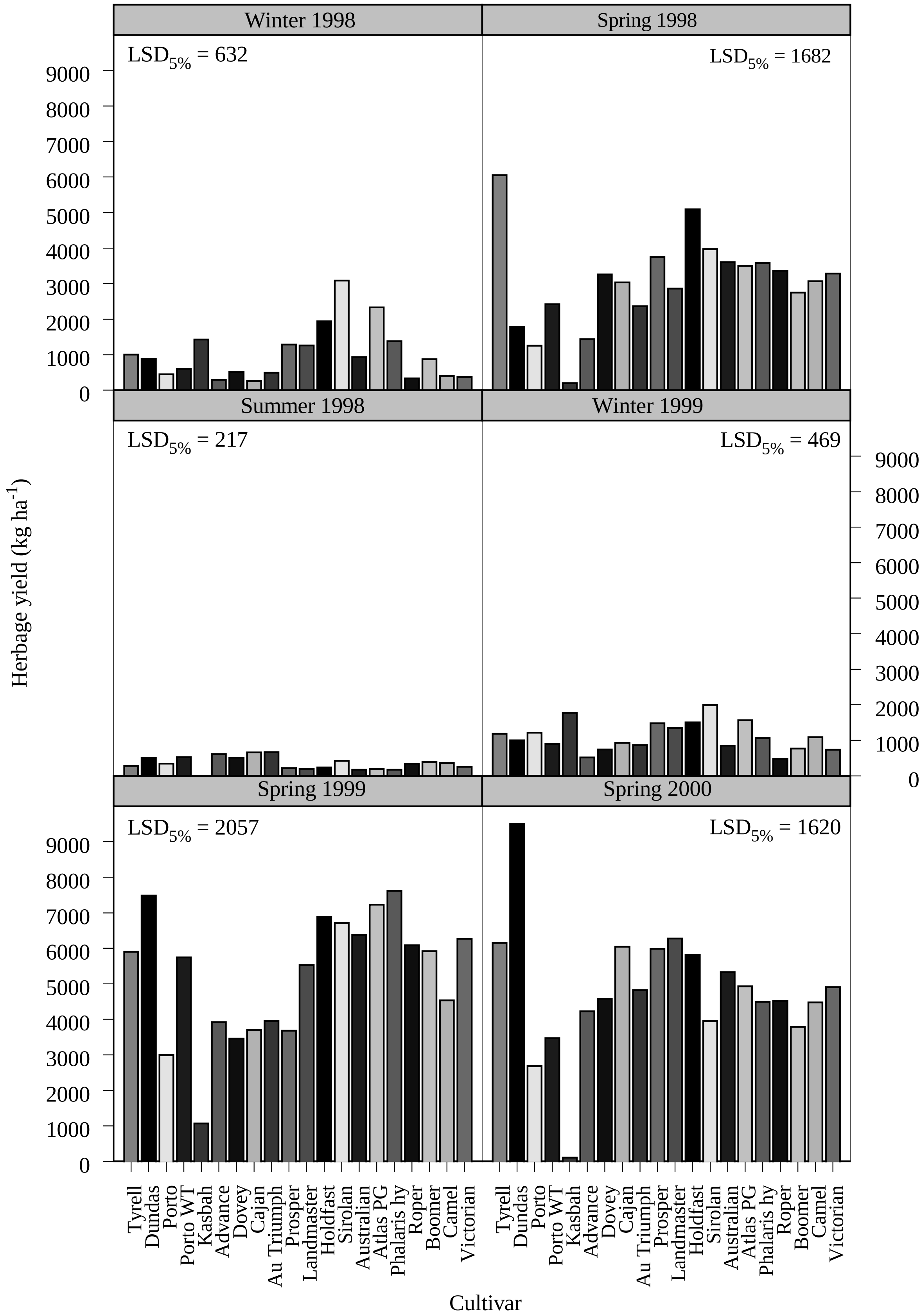

Fig. 1. Herbage production of a range of perennial pasture grasses over the period from Winter 1998 to Spring 2000, at Gerogery, New South Wales, Australia.

Table 1. Proportion of crowns of grass cultivars present in June 2001 compared to December 1997 at Gerogery, NSW, Australia. Different cultivars (P = 5%) have different superscripts

Sirolan[a]	1.97	Australian[bc]	1.46	Camel[f]	0.47	Cajan[fgh]	0.25
Atlas PG[ab]	1.73	Dundas[bc]	1.45	Porto[fg]	0.37	Victorian[gh]	0.17
Hybrid[b]	1.66	Tyrrell[cd]	1.19	Au Triumph[fg]	0.36	Boomer[gh]	0.15
Landmaster[b]	1.56	Prosper[d]	1.11	Dovey[fg]	0.32	Advance[gh]	0.12
Holdfast[b]	1.51	Porto WT[e]	0.79	Roper[fgh]	0.29	Kasbah[h]	0.02

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