Evaluation of new breeding populations of phalaris for the North-West Slopes of New South Wales

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Abstract. *Populations of phalaris bred for improved adaptation to the North-West Slopes were evaluated at two sites west of Manilla from 2004–2007 to determine progress compared with present cultivars and assess their suitability for cultivar release. The persistence of all breeding populations and cultivars declined during the period 2006–07. Nevertheless, the breeding populations as a group were more persistent than the available cultivars with the possible exception of cv. Sirolan. It was decided not to release any of the populations as a cultivar at this stage but to expand testing to lower rainfall areas in southern NSW. The populations are expected to be a valuable breeding resource under a warmer and more drought-prone climate.*

Introduction

Poor persistence of sown temperate perennial grass cultivars on the North-West Slopes of New South Wales points to a clear need for improved cultivars that can increase the profitability of livestock production by filling the winter feed-gap (prevalent on summer-growing pastures), and providing high quality pasture at key times. Phalaris (*Phalaris aquatica*) is one species able to survive the moisture and heat-stress characteristic of the North-West Slopes for limited periods but better-adapted cultivars are needed if it is to be recommended with confidence.

A project to breed a cultivar with improved adaptation commenced in 1998. Relatively summer-dormant populations from north-west Africa with superior persistence compared with present cultivars were identified among a wide range of germplasm during the first phase of the project (Culvenor and Boschma 2005). Two older cultivars, Sirocco and El Golea, were also relatively persistent and are known to be very productive. Four breeding populations incorporating levels of seed retention required by the seed industry were bred from the most persistent lines and developed to the F2 stage following screening of F1 families at Tamworth. These populations plus a fifth based on selections from grazed plots at Tamworth aiming to breed a more grazing-tolerant winter-active cultivar were evaluated at two sites west of Manilla during 2004–2007.

The aim of the experiment was to evaluate progress in breeding for improved persistence and to assess the suitability of the populations for release as locally adapted cultivar.

Methods

The evaluation was conducted at two sites, 'Narrawarra', 30 km west of Manilla (630 mm annual average rainfall (AAR), 500 m altitude) on a brown Chromosol soil, and 'Willow Bend', 10 km west of Manilla (600 mm AAR, 400 m altitude) on a red Chromosol soil. Twelve lines were sown at both sites in 12 m^2 plots in 2004. The site at Willow Bend failed and was resown with 14 lines in 6 m^2 plots in 2005. There were four replicates at each site. Entries at Narrawarra included four breeding populations and five cultivars (Atlas PG, Sirolan, Sirocco, Landmaster, Australian II). The breeding populations were 'Northern Non-retainer' (formed from the most persistent wild accessions identified in Phase 1), 'Northern Retainer' (formed from the most persistent accessions crossed to a relatively persistent seed-retaining population, P×C), '19305 × (P×C)' (CPI19305 was registered after selection as El Golea in 1977) and Tamworth Persistent Winter-active ('TamPWA'). The extra lines at Willow Bend included another breeding population, 'Sirocco × (P×C)', which was 75 per cent derived from cv. Sirocco. The other lines are not discussed in this paper.

Plant frequency (the proportion of 0.1 m × 0.1 m cells containing live base, Brown 1954) was assessed in the autumn–spring period in a 1 m^2 fixed quadrat during 2004–2007. Plant frequency was also measured in four randomly-placed 1 m^2 quadrats at Narrawarra and two quadrats at Willow Bend at the end of the experiment in July 2007. Herbage mass was assessed visually at intervals and calibrated by cutting herbage from 12 quadrats. Narrawarra was grazed intermittently with sheep during 2005–2007 while Willow Bend was defoliated by mowing.

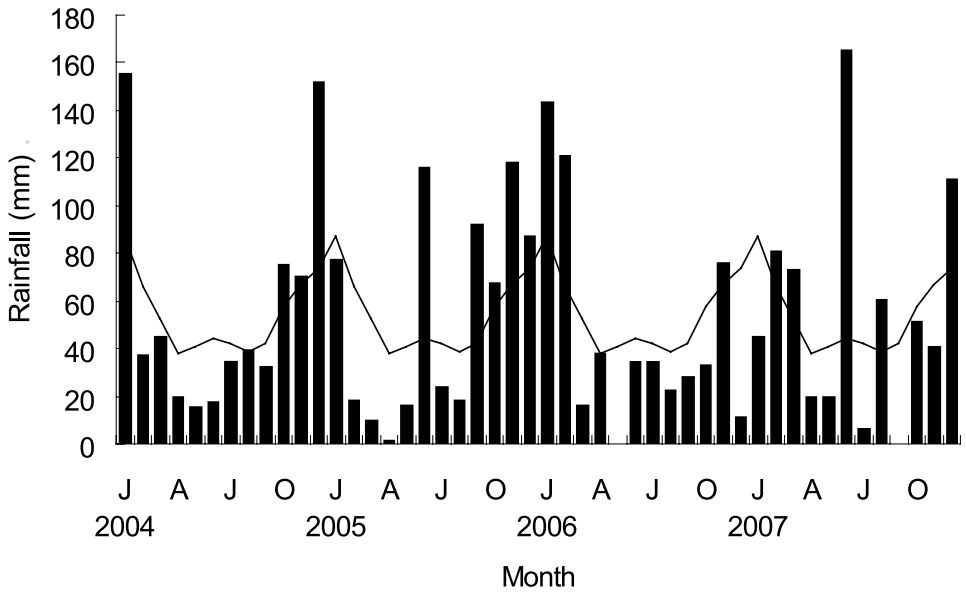

Figure 1. Actual monthly rainfall (mm, bars) and long term average (mm, 122 years, line) recorded near Willow Bend from 2004–2007.

Results and discussion

Plant frequency increased up to 2006 at both sites but declined sharply between early spring 2006 and autumn 2007 under the stress of drought conditions (Figure 1). Plant frequency in fixed quadrats at Narrawarra declined from 81% to 39% and at Willow Bend from 84% to 27% over this period, all lines showed a similar response. Within-site variation in the data was high at Narrawarra probably due to unknown soil factors increasing variation at that site. Nevertheless, correlations between sites were significant for plant persistence (ratio of plant frequency between 2006 and 2007) in fixed quadrats (r=0.6, P<0.05) and final plant frequency in random quadrats (r=0.7, P<0.01).

Long periods of moisture deficit have been common throughout this entire program (since 1998) and could be considered common on the North-West Slopes. An analysis of long-term rainfall records is required to see how typical this period has been. It is possible that temperate grasses such as phalaris will struggle to adapt to environments similar to where the study was conducted, particularly in association with a summer-dominant rainfall pattern. Phalaris still performs well in the higher rainfall, cooler summer-dominant rainfall environment of the Northern Tablelands.

Persistence in fixed quadrats ranked lines similarly to frequency in random quadrats at the end of the study (Figure 2).

The high ranking of Northern Non-retainer at both sites confirmed the relatively high persistence of the

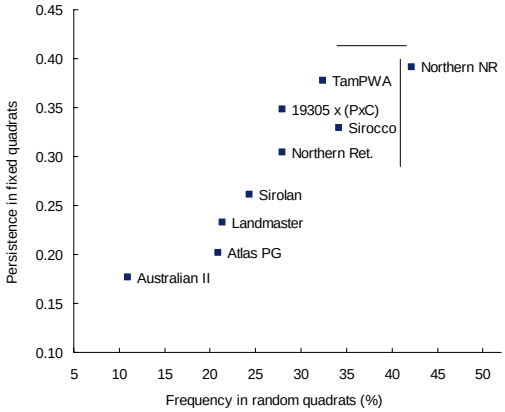

Figure 2. Relation between frequency in random quadrats in 2007 across the two sites and persistence (ratio of plant frequency in 2007 to 2006) in fixed quadrats. Values are best linear unbiased predictors (BLUPs) derived by mixed models spatial analysis. The bars indicate twice the average standard error of differences between BLUPs.

wild accessions on which it was based, but its tendency to shed seed rapidly would hinder commercial seed production and it was overlooked for cultivar release. Breeding for improved seed production characteristics in this population would be worthwhile. TamPWA and Sirocco also ranked high at both sites. Averaged across sites (Figure 2), they were grouped with 19305 × (P×C) and Northern Retainer, but the latter were only intermediate or moderately high at Narrawarra, where within-site variability affected the integrity of the data. Both were similar to Sirocco in persistence and frequency at Willow Bend. Sirocco × (P×C) was

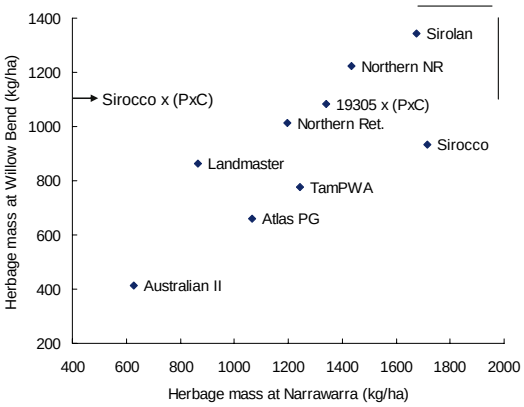

Figure 3. Relation between herbage mass in winter 2005 at Narrawarra and the cumulative herbage mass of three harvests from June to September 2006 at Willow Bend. The extra population tested at Willow Bend only is shown by an arrow on the y-axis. Values are derived from spatial analysis. The bars indicate approx. lsd (*P*=0.05).

not significantly different from Sirocco at Willow Bend (not shown). It is noteworthy that Sirocco was popular and widely sown in lower rainfall areas (Meakins 1973) before seed production ceased and Sirocco × (P×C) could be developed as a seed-retaining replacement. As a group, the currently available cultivars were generally ranked lower than the breeding populations although Sirolan was relatively persistent at Narrawarra and had moderately high plant frequency at Willow Bend. The summer-dormant, seed-retaining cultivar Atlas PG, was expected to be more persistent than the other commercial cultivars in this environment but performed poorly.

Seedling vigour (assessed as herbage mass 3–4 months after sowing) is an important attribute for sown grasses, particularly in weedy situations and in environments with short growing seasons or when sowing is late. Averaged across sowing events, seedling vigour was highest ($P<0.05$) for Sirolan and Sirocco (610 kg/ha), followed by Atlas PG (480 kg/ha), 19305 × (P×C) and Northern Retainer (415 kg/ha), TamPWA, Landmaster and Northern Non-retainer (345 kg/ha) and Australian II (144 kg/ha). Ranking of lines was similar for sward herbage mass in the second year before plant frequency declined (Figure 3) with the exception that Atlas PG was lower and Northern Non-retainer higher relative to their seedling vigour. Sirocco and Sirolan had the highest herbage mass during winter at Narrawarra (Figure 3) and Willow Bend (data not shown), but Sirocco was less productive than Sirolan in cumulative herbage mass over three harvests from June to September 2006 at Willow Bend (Figure 3) because of lower spring yield. Sirocco × (P×C) had similar herbage mass to Sirocco.

Conclusions

The project to improve adaptation of phalaris to the North-West Slopes has developed several productive, seed-retaining populations that differ in genetic background and show promise of better persistence compared with currently available cultivars. However, the large decline in persistence in the last year of the study, the similarity in performance of the candidate populations plus the high within-site variation at Narrawarra have resulted in a decision not to release any of the populations as cultivars at this stage. Because tolerance of moisture-deficit appeared to be the major determinant of persistence on the North-West Slopes, and the most persistent populations are relatively summer-dormant and early flowering, we have decided to extend the target environment to low rainfall areas further south and evaluation in that region is planned. Finally, the North-West Slopes could be a valuable screening environment for the predicted warmer, more drought-prone climate in presently cooler, moister districts. These populations are therefore a potentially valuable resource for southern Australian grass breeding.

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