Evaluation of pasture plants for use in recharge areas in northern New South Wales

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On the North-West Slopes of NSW, 75% of the agricultural land is permanent pasture, dominated by summer-growing native perennial grasses. Traditionally, arable areas of the region are based on mixed farming enterprises with winter and summer cropping, and grazing by sheep and cattle. Northern NSW has a summer dominant rainfall, with 60% of rain falling from November to March, mainly as high intensity thunderstorms (Clewett *et al.* 2003). With high evaporation rates during summer and high water loss as a result of surface runoff, rainfall effectiveness is low.

The North-West Slopes covers the Namoi, Gwydir and Border Rivers catchments of the upper portion of the Murray Darling Basin. Of these, the Namoi is considered to have the highest salinity risk (National Land and Water Resources Audit 2000; Littleboy *et al.* 2001). In 2000, 2896 ha of land in the Namoi catchment was estimated to have the water table within 2 m of the surface, with the water table estimated to be increasing 0.06 m/year under current land practices. This area is expected to increase to 27,837 ha by 2050 (Littleboy *et al.* 2001).

As yet the extensive mobilisation of salt is not being expressed in the landscape to a large extent, however declines in stream water quality are evident. In 1998, the average monthly water salinity of the Namoi River at Boggabri exceeded 800 EC 20% of the time. This is predicted to increase to 63% by 2100. Similarly, the critical threshold of 1500 EC was exceeded 6% of the time in 1998 and this is expected to increase to 27% by 2100. Further downstream, salinity of the Namoi River at Gunnedah was recorded as 580 EC in 1998 and is expected to increase to 930 EC and up to 1400 EC by 2020 and 2100, respectively (MDBMC 1999).

Red soils, typical of the North-West Slopes, have been identified as having a high salinity hazard (S. Donaldson, pers. comm.), with response rates to management varying from low to high. Most of the ground water flow systems in this region are localised (Sinclair Knight Mertz 2003). Native pastures and annual crops commonly sown in the region typically have roots to about 1.2 m (Lodge and Murphy 2002), with deep drainage estimated to occur mostly in wet winters, and ranging from 0-200 mm/year under native pasture (Lodge *et al.* 2002). Therefore there is an excellent opportunity to use persistent, deep rooted perennials in grazing systems to both increase the length of the growing season and provide a 'dry buffer' to minimise deep drainage.

This paper reports data for the establishment year of a range of perennial legumes and grasses sown at recharge sites in northern NSW, as part of a national field evaluation program within the Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PMDS).

Materials and methods

The recharge sites were located about 12 km west of Manilla, (30.74°S 150.61°E) in the Namoi catchment, on the North-West Slopes of NSW on a Brown Vertosol soil at an elevation of 400 m. Average annual rainfall at Manilla is 650 mm. The experimental area consisted of a paired comparison of a permanent native pasture and a cropped area, typical of the district. In May 2003, perennial legume and grass experiments were sown along with a temperate grass cohort consisting of *Phalaris aquatica* and *Festuca arundinacea* lines (Table 1). Seed was shallow sown in 4 replicates using a 6-row cone seeder (20 cm between rows) in plots 5 m (legumes) and 6 m (grasses) long.

Plant numbers were recorded 6-8 weeks after establishment (60 by 15 cm quadrats) in 3 subplot strata. Herbage mass (as a calibrated visual assessment) was recorded in late spring in each strata and persistence (measured as frequency in a fixed 100 by 50 cm quadrat per plot), was recorded in spring-summer.

Results

Prior to sowing 242 mm rainfall was received from January 2003 (83% of the long term average for the period), with a further 235 mm received (64% of the average for the period) from sowing until December 2003. To assist establishment, 6-8 mm water was applied to all experiments in June 2003. With insufficient rainfall, all experiments on the native pasture site failed to establish, so no data will be presented for these.

Perennial legumes

Mean plant count at establishment on the cropped site was 43 plants/m^2. Mean mid-spring herbage mass was 1393 kg DM/ha, ranging from 5398 (*H. carnosum*) to zero kg DM/ha for Wynn Cassia which failed to establish. Herbage mass was highest (P<0.001, Fig. 1*a*) for *H. carnosum* and Sceptre and significantly different to all other cultivars/lines except, *A. suberosus*, *H. coronarium* (Grazing bulk) and Othello. Herbage mass was <500 kg DM/ha for *A. uniflorum*, *A. palaestinus*, *D. pentaphyllum*, *D. rectum*, *L. patens*, *L. uliginosus*, *M. sativa* ssp. *caerula*, *M. suffruticosa*, *P. polystachyus*, *S. minor*, *T. physodes*, and *T. uniflorum*. Plant count at establishment and mid-spring herbage mass were poorly correlated (R^2=0.064).

Of the species that established, the average frequency in early summer was 78.3%. *M. sativa* ssp. *caerula*, *L. glaber* and *L. corniculatus* had 100% frequency, but were not significantly different to all species with a percentage of site mean frequency greater than 105% (Fig. 1*a*). Of those species that established, *D. rectum*, *S. minor* and *P. polystachyus* had the lowest frequencies.

Perennial grasses and herbs

Establishment was varied with the chicory, plantain, native grasses and cocksfoots establishing poorly. In mid-spring, mean plant frequency was 51% and highest (P<0.001, Fig. 1*b*) for Gala, Resolute+AR542 (endophyte), AU Triumph, Australian, Avalon, Holdfast, Grouse, Dundas, Atlas PG, AVH4, Landmaster and Fraydo. Native grasses and cocksfoots had the lowest frequencies.

Of the species that established, mid-spring herbage mass was highest (P<0.001) for Grouse and lowest (P<0.001) for Porto, Currie and Wakefield (Fig. 1*b*), with a mean of 1099 kg DM/ha. Herbage mass of Atlas PG and Holdfast were higher (P<0.001) than those of Australian (1391 kg DM/ha), with Landmaster being intermediate (2098 kg DM/ha). Mean herbage mass of the fescue cultivars (Fraydo, Resolute and AU Triumph) was 697 kg DM/ha and similar to that of the 2 perennial ryegrass cultivars (858 kg DM/ha).

Temperate grasses

Overall mean plant establishment was 95 plants/m^2. In mid-spring, plant frequency was 87.6% and similar for all cultivars and lines (Fig. 1*c*). Mean mid-spring herbage mass was 2562 kg DM/ha. Herbage mass was highest (P<0.001) for Sirocco, CPI19305 and

Table 1. Species sown at recharge sites in northern NSW in autumn 2003

(a) Perennial legumes

1. *Adesmia muricata* 2. *Argyrolobium uniflorum* 3. *Astragalus palaestinus* 4. *Astragalus suberosus* 5. *Chamaecrista rotundifolia* cv. Wynn Cassia 6. *Cicherium intybus* cv. Puna 7. *Coronilla varia* 8. *Dorycnium hirsutum* 9. *D. pentaphyllum* 10. *D. rectum* 11. *Galega officinalis* 12. *Hedysarum boutignyanum* 13. *Hedysarum carnosum* 14. *Hedysarum coronarium* cv. Grassland Aokou 15. *Hedysarum coronarium* (Fodder bulk) 16. *Hedysarum coronarium* (Grazing bulk) 17. *Indigofera patens* 18. *Lotononis bainesii* cv. Miles[^] 19. *Lotus corniculatus* cv. Goldie 20. *Lotus corniculatus* 21. *Lotus creticus* 22. *Lotus cytisoides* 23. *Lotus glaber* 24. *Lotus maroccanus* 25. *Lotus uliginosus* 26. *Medicago sativa* ssp. *caerula* 27. *Medicago suffruticosa* 28. *Onobrychis viciifolia* cv. Othello 29. *Psoralea cinerea* 30. *Ptilotus polystachyus* 31. *Sanguisorba minor* 32. *Trifolium hybridum* 33. *Trifolium physodes* 34. *Trifolium uniflorum* 35. *Medicago sativa* cv. Sceptre

(b) Perennial grasses and herbs

1. *Phalaris aquatica* cv. Australian 2. *P. aquatica* cv. Atlas PG 3. *P. aquatica* cv. Holdfast 4. *P. aquatica* cv. Landmaster 5. *Dactylis glomerata* cv. Currie 6. *D. glomerata* cv. Porto 7. *Festuca arundinacea* cv. Fraydo 8. *F. arundinacea* cv. Resolute+AR542 9. *F. arundinacea* cv. AU Triumph 10. *Lolium perenne* cv. AVH 4 11. *L. perenne* cv. Avalon 12. *Lothopyron ponticum* cv. Dundas 13. *Bromus stamineus* cv. Gala 14. *Plantago lanceolata* cv. Tonic 15. *Cichorium intybus* cv. Grouse 16. *Austrodanthonia fulva* cv. Ligule 179 17. *A. richardsonii* cv. Taranna 18. *Microlaena stipoides* cv. Wakefield 19. *Themeda australis* 20. *Ehrharta calycina* cv. Mission 21. *Panicum maximum*[^] 22. *Setaria sphacelate* cv. Narok[^] 23. *Pennisetum clandestinum* cv. Whittet[^] 24. *Chloris gayana* cv. Katambora[^]

(c) Temperate C_3 grass cohort

1. *F. arundinacea* cv. Fraydo 2. *F. arundinacea* cv. Flecha 3. *F. arundinacea* cv. Resolute+AR542 4. *F. arundinacea* cv. Resolute 5. *F. arundinacea* cv. Prosper 6. *P. aquatica* cv. Atlas PG 7. *P. aquatica* cv. Sirocco 8. *P. aquatica* cv. Australian II 9. *P. aquatica* (140042) 10. *P. aquatica* (CPI 19305) 11. *P. aquatica* (T39) 12. *P. aquatica* (M170) 13. *P. aquatica* (M196) 14. *P. aquatica* (M225) 15. *P. aquatica* (M231) 16. *P. aquatica* (M241)

[^] Species sown December 2003

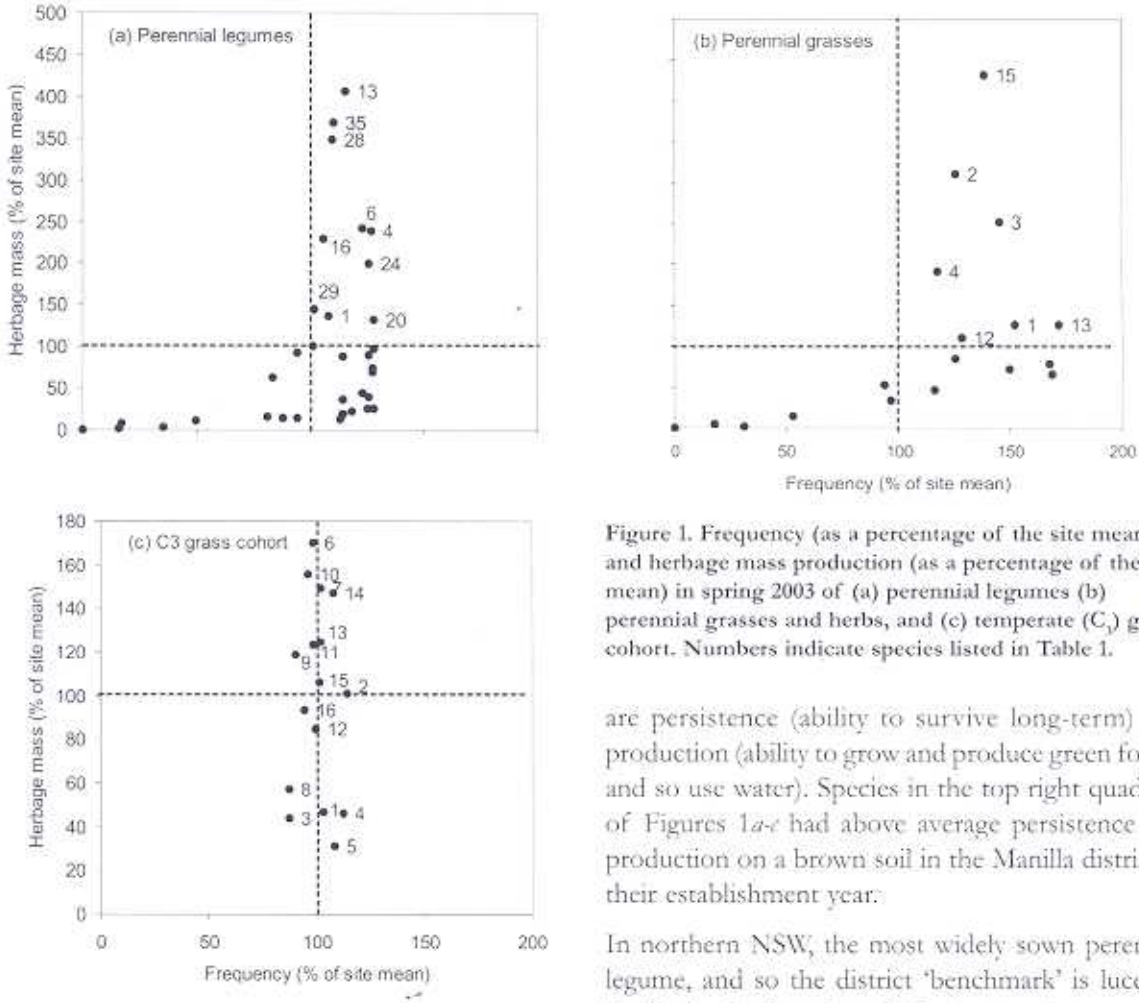

Figure 1. Frequency (as a percentage of the site mean) and herbage mass production (as a percentage of the site mean) in spring 2003 of (a) perennial legumes (b) perennial grasses and herbs, and (c) temperate (C_3) grass cohort. Numbers indicate species listed in Table 1.

M225, compared with all of the fescue cultivars (except Grasslands Flecha), Australian II and M170. Among the fescues, Grasslands Flecha had the highest ($P<0.001$) herbage mass, while for the phalaris cultivars and lines Australian II had the lowest ($P<0.001$) herbage mass (1473 kg DM/ha). Prosper had the lowest ($P<0.001$) mean mid-spring herbage mass (810 kg DM/ha), but it was not significantly different for those of Fraydo, Resolute and Resolute+AR542 (Fig. 1*c*).

Discussion

In northern NSW, it is likely that more pasture plants tend to die in the harsher summer period than in the winter months when rainfall is more effective. The data presented in this paper indicated that most of the species sown in 2003 established well. Persistence monitored over the next 2 years (measured spring and autumn each year) will highlight species that are persistent and which seasons are most detrimental to their survival. To minimise ground water recharge 2 important perennial pasture species characteristics are persistence (ability to survive long-term) and production (ability to grow and produce green forage and so use water). Species in the top right quadrant of Figures 1*a-c* had above average persistence and production on a brown soil in the Manilla district in their establishment year.

In northern NSW, the most widely sown perennial legume, and so the district 'benchmark' is lucerne. Similarly, the benchmark for temperate perennial grasses is phalaris. Lucerne is well adapted to areas with relatively deep, neutral to slightly alkaline soils, but there are problems with bloat and poor ground cover. Phalaris is the most persistent introduced temperate grass (Lodge 2002), particularly cultivars Atlas PG and Landmaster (S.P. Boschma and R.A. Culvenor, unpublished data). Only *H. carnosum* had higher production and plant frequency in the establishment year than lucerne, while no grass species/lines had higher production and frequency than phalaris. For a perennial legume or temperate grass to be widely sown it would need to exceed the performance of the benchmark species or complement them in a mixture.

Establishment failure of species at the permanent pasture site highlighted the difficulties faced by producers sowing into these areas. Often in these areas direct drilling allows better soil-seed contact and water entrapment and infiltration. However, with our equipment we were unable to break the soil surface, and with low and irregular rainfall following sowing, the soil surface did not remain moist long enough

for germination. These experiments will be re-sown in 2004.

Conclusion

Perennial legume and grass species sown in a recharge area on the North-West Slopes of NSW established on a traditionally prepared seedbed, but failed to establish when surface sown in an adjacent permanent pasture. Most species at the cropping site had good persistence 4-6 months after sowing, and will be monitored over the next 3 years. The range in mid-spring herbage production highlighted the range in form (prostrate *vs.* erect) of the different species. Evaluation will continue until 2006.

Acknowledgments

These studies are conducted as part of the national plant evaluation program funded by NSW Agriculture, the Grains Research and Development Corporation and the CRC for Plant-Based Management of Dryland Salinity. We thank Brian Roworth for his technical assistance.

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