Desmanthus – a new pasture legume for the dry tropics

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Abstract

The legume genus, *Desmanthus*, comprises many species, some of which may be valuable in western Queensland grasslands where few, if any other sown pasture legumes persist. In the late 1980s, a selection of *Alysicarpus*, *Centrosema*, *Chamaecrista*, *Clitoria*, *Desmanthus*, *Macroptilium*, *Stylosanthes* and *Vigna* genotypes were sown in trials across semi-arid/arid western Queensland on clay soils in the Mitchell Grass Bioregion. In the early 1990s the trials ceased and the sites were abandoned but were reassessed 10 years later. Plant density data are presented for two sites from the establishment phase in 1989/90 to 2003. All genera other than several *Desmanthus* accessions failed in these harsh environments.

Key words

Desmanthus, clay soils, dry tropics, pasture legumes

Media summary

Desmanthus is a pasture legume with the potential to significantly enhance the sustainability and productivity of clay soil production systems in the dry tropics.

Introduction

Queensland's Mitchell Grass Bioregion includes vast open grasslands and large areas of associated acacia ecosystems, which are used extensively for sheep and cattle production. An adapted pasture legume would contribute to the sustainability of the region by improving the quality of nutrition available to livestock as well as sustaining nitrogen levels for associated native and exotic grasses. The soils of the region have a high clay content, rainfall is summer dominant and very variable, mean annual rainfall (MAR) ranges from 250 mm - 550 mm/yr across the region (Orr 1975, Commonwealth of Australia 2001). The region lacks an adapted sown pasture legume. Leslie *et al* (1987) suggested that many of the original productive and palatable native herbaceous legumes of such regions were lost long ago due to grazing. Orr (pers. comm.) found that in similar regions where grazing utilization is > 10%, herbaceous legumes are a minor component of the available pasture. Native legumes also have been lost or reduced in other grasslands such as in Texas (Muir & Pitman 2003). In western Queensland, large areas of the native acacia trees have been cleared for buffel grass monoculture pastures (Butler & Fairfax 2003). Some years after tree clearing and grass pasture establishment, the grasses suffer from a "run down" effect, which is manifested as reducing productivity due to a decline in available soil N (Robertson *et al* 1997).

Methods

In 1989/90 CSIRO/DPI established experiments across Queensland's Mitchell Grass Bioregion aimed at identifying potential pasture legumes for the region. Fifty-four accessions representing 8 legume genera were sown in the trials (Table 1). After initial evaluation, the trials ceased and the sites were abandoned. For several years since being abandoned, they have been unfenced and incorporated into grazed paddocks. Since planting, the sites have experienced periods of severe drought and floods (Table 2), locust plagues, frosts and often heavy grazing. A decade after planting, plot positions were located and plant density and soil seed bank data were collected. These attributes and others will be used as indices of the potential of the accessions for cultivar development. In this paper we focus on 2 sites in semi-arid rangelands: firstly at Blackall, a cleared gidgee (*Acacia cambagei*) light clay buffel (*Cenchrus ciliaris*) pasture with a MAR of 525 mm and secondly, at Isisford, a cleared gidgee very pebbly/stony light clay buffel/mitchell grass (*Astrebla* spp.) pasture, with a MAR of 451 mm. Table 4 describes the key soil attributes of each site.

In 1989/90, 10 grams of seed of each accession were planted into 5m x 4m plots with 3 replications. Seed was inoculated with appropriate rhizobia and seed was broadcast onto uncultivated plots, which were set out in a randomised plot design. Plant density (plants/m^2) was recorded by counting all plants in each 20m^2 plot. In 2003, seed bank data were collected from selected plots by inserting 3 steel cylinders (7cm diameter x 5 cm deep) per plot and washing the resulting soil cores through an Endecott 1mm gauge sieve.

Results

Table 1. Genera and accessions assessed, plants/m^2 (mean of 3 replicates) for the establishment phase and for 10 and 14 years after planting at Blackall and Isisford. Isisford 2003 data is not shown as no plants were observed.

	Accessions/	Blackall	Blackall	Blackall	Isisford	Isisford
Genus/Species	**Cultivar**	**1989**	**1999**	**2003**	**1990**	**1999**
***Alysicarpi**s rugosus*	TQ91	13	0	0	0	0
***Chamaecrista** rotundifolia*	cv. Wynn	6	0	0	0	0
***Clitoria** ternatea*	2 accessions	2 – 4*	0	0	0	0
***Centrosema** pascuorum*	CPI 55697	1	0	0	0	0
***Macroptilium** atropurpureum*	2 accessions	1 – 5*	0	0	1 – 2*	0
***Stylosanthe**s scabra*	2 accessions	22 – 23*	0	0	2 – 3*	0
S. hamata	7 accessions	0 – 26*	0	0	0 – 4*	0
***Vigna** trilobata*	CPI 13671	6	0	0	6	0
***Desmanthus** bicornutus*	CPI 81337	4	T	T	1	T
D. bicornutus	CPI 84508	9	0	0	1	0.3
D. bicornutus	CPI 90857	4	0	0	0	1.4
D. bicornutus	CPI 91162	17	0	0	2	T
D. covillei	CPI 90311	na	na	na	0	T
D. leptophyllus	TQ87	10	0	0	1	0
D. leptophyllus	TQ88	27	0	0	1	0
D. leptophyllus	TQ90	14	0	T	0	0
D. leptophyllus	CPI 37143	19	0	0	2	0
D. leptophyllus	CPI 38351	13	0	0	3	T

D. leptophyllus	CPI 55719	12	0	0	3	0
D. leptophyllus	CPI 76053	9	T	1	2	0
D. leptophyllus	CPI 92655	16	T	T	3	0
D. leptophyllus	CPI 92746	7	T	0.3	2	T
D. leptohyllus	CPI 92809	15	0	0	2	0
D. pernambucanus	CPI 40071	9	0	0.5	1	T
D. pernambucanus	CPI 49728	7	0.4	0.6	0	T
D. pernambucanus	CPI 83565	10	T	T	0	T
D. pubescens	CPI 92800	4	0	0	0	0
D. pubescens	CPI 92802	6	T	T	1	T
D. pubescens	cv. Uman	5	0	0	1	0
D. pubescens	CPI 92804	4	T	0	4	T
D. sp	CPI 33426	na	na	na	0	0.3
D. sp	CPI 70338	8	T	0.6	2	T
D. tatuhyensis	CPI 90362	3	0	0	0	0
D. virgatus	CPI 57960	13	1	1.5	1	0.5
D. virgatus	CPI 67643	28	1.3	1.5	0	1
D. virgatus	cv. Marc	10	3	9	0	0.4
D. virgatus	CPI 78372	11	1	4	0	0.3
D. virgatus	CPI 78382	6	0.8	2	0	0
D. virgatus	CPI 79653	4	1	2	0	0
D. virgatus	CPI 83563	13	0	0	0	T
D. virgatus	CPI 85173	3	1	1	0	0
D. virgatus	CPI 85178	6	2.5	9	0	0.3
D. virgatus	CPI 85182	13	1	0.7	1	0.6
D. virgatus	CPI 90751	6	2.7	5	0	0.5
D. virgatus	CPI 91181	8	2	3.5	0	0.4

* range of plants/m^2 observed for 2 or more accessions of this species, na = not planted at site, T = trace (<0.3plants/m^2)

Table 2 Total annual rainfall for Blackall and Isisford 1989 to 2003. Source: Bureau of Meteorology.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Blackall	698	741	388	410	455	418	345	540	703	756	787	706	480	275	260
Isisford	740	873	397	399	412	313	260	422	522	691	860	546	558	164	284

Table 3 Seed bank (seeds/m^2) recovered from plots of promising accessions at Blackall and Isisford in 2003.

Site	*Desmanthus* seeds/m^2 in seed bank (mean of 3 cores/plot)				
Accession	78373	85178	85182	90751	90857

Blackall	1044	261	-	783	-
Isisford	522	-	174	174	87

Table 4 Soil properties of bulked top soil (0-10 cm) for the Blackall and Isisford sites

	Texture % clay	**pH (1:5 water)**	**Organic Carbon %C**	**Nitrate Nitrogen mg/kg**	**Phosphorus (Colwell) mg/kg**	**Potassium** (Amm.Ac.) **meq/100g**	**Electrical conductivity dS/m**	**Sodium (Amm.Ac.) meq/100g**	**CEC meq/100g**
Blackall	35	8.5	0.6	8.3	26	1.1	0.15	0.45	35.0
Isisford	34	8.8	0.7	44.5	20	1.0	0.20	1.75	44.0

Discussion

Of the species evaluated in this study, only *Desmanthus* genotypes remained in the trial plots 10 years after planting. Table 2 shows the extreme variability of the rainfall at the sites, including periods of severe drought. At Isisford for example, only 164 mm of rainfall was recorded in 2002 compared with 873 mm in 1990. The two sites have similar soil properties (Table 4) except that soil at the Isisford site has higher nitrogen and sodium levels and it also has a very pebbly/stony soil mantle.

Desmanthus is known to be nutritious (Schlink & Burt 1993; Jones *et al* 2000), palatable, productive, drought tolerant and adapted to clay soils (Cook *et al* 1993; Pengelly & Conway 1998). However, no *Desmanthus* cultivar has been released specifically for western Queensland where in fact, no suitable sown legumes are available and where an adapted legume would contribute to the productivity and sustainability of the grasslands. Elsewhere, *Desmanthus* cultivars have been released, for example in southern Queensland, a composite cultivar named Jaribu, made up of cvv Bayamo, Marc and Uman (Cook *et al* 1993) is available. Of these, Marc and Uman were included in our studies but of these only Marc survived and ranked highly at Blackall (Table 1) with 9 plants/m^2 in 2003. A composite cultivar, which includes *D. bicornutus* CPI 90857, has been released in Texas, USA (Ocumpaugh *et al* 2003). *D. illinoensis* cv Sabine is used in temperate USA (Muir & Pitman 2003) and *D. pernambucanus* cv Chaland is used in SE Asia (Horne & Stür 1999).

Assessment at the establishment phase of the trial indicated that *Stylosanthes* accessions (Table 1) were potential new cultivars for the region. However ten years later, only *Desmanthus* remains, demonstrating the value of long-term evaluation. In southern Queensland, Jones (1998) studying *Desmanthus* observed < 0.2 to 5 plants/m^2 and suggested that it has promise for permanent pastures. In our trials, at Blackall, the superior accessions were all *D. virgatus* genotypes, including the Argentine lines, cv Marc (CPI 78373), and CPI 78372, and the Mexican lines, CPI 85178 and 90751, CPI 85178 had a mean plant density of 9 plants/m^2 and up to 15 plants/m^2 in one replicate in 2003. At Isisford in 1999, on the drier and stonier site, *D. bicornutus* CPI 90857 had a mean plant density of 1.4 plants/m^2 with up to 3.25 plants/m^2 in one replicate. This particular site will be a further test of the resilience and adaptation of *Desmanthus* in response to drought.

The 2003 seed bank data (Table 3), taken 2 years into very severe drought (Table 2), revealed *Desmanthus* seed banks ranging from 261 to 1044 seeds/m^2 (mean of 696) at Blackall and 87 to 522 seeds/m^2 (mean of 238) at Isisford. Elsewhere, Rangel & Gardiner (1996) found a mean *Desmanthus* seed bank of 729 seeds/m^2 and Jones (1998) a mean of 1125 seeds/m^2, while Burrows & Porter (1993) found a mean of 300 seeds/m^2. Due to the severe 2002/03 drought (Table 2) at Isisford, all local grasses and forbs were dead by mid 2003. However, given the density of *Desmanthus* in 1999, the size of the seed bank and the current 2004 wet season *Desmanthus* is expected to regenerate as it did after the 1994/5 drought. *Postscript: Desmanthus* did indeed have recruitment in the 2004 wet season and was the sole sown legume to recover from the drought.

Conclusion

The data suggest that the population density of *Desmanthus* fluctuates considerably over time, illustrating the resilience of the genus and the importance of seedset, hardseedeness, seed bank longevity and recruitment. Of the 8 genera investigated, *Desmanthus* offers the best prospect for the development of cultivars adapted to dry tropical western Queensland clay soil environments. Selection and seed increase of the most promising accessions has commenced.

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