

***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/m²) was recorded by counting all plants in each 20m² 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/m² (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.

Genus/Species	Accessions/ Cultivar	Blackall	Blackall	Blackall	Isisford	Isisford
		1989	1999	2003	1990	1999
<i>Alysicarpis rugosus</i>	TQ91	13	0	0	0	0
<i>Chamaecrista rotundifolia</i>	cv. Wynn	6	0	0	0	0
<i>Clitoria ternatea</i>	2 accessions	2 – 4*	0	0	0	0
<i>Centrosema pascuorum</i>	CPI 55697	1	0	0	0	0
<i>Macroptilium atropurpureum</i>	2 accessions	1 – 5*	0	0	1 – 2*	0
<i>Stylosanthes scabra</i>	2 accessions	22 – 23*	0	0	2 – 3*	0
<i>S. hamata</i>	7 accessions	0 – 26*	0	0	0 – 4*	0
<i>Vigna trilobata</i>	CPI 13671	6	0	0	6	0
<i>Desmanthus bicornutus</i>	CPI 81337	4	T	T	1	T
<i>D. bicornutus</i>	CPI 84508	9	0	0	1	0.3
<i>D. bicornutus</i>	CPI 90857	4	0	0	0	1.4

<i>D. bicornutus</i>	CPI 91162	17	0	0	2	T
<i>D. covillei</i>	CPI 90311	na	na	na	0	T
<i>D. leptophyllus</i>	TQ87	10	0	0	1	0
<i>D. leptophyllus</i>	TQ88	27	0	0	1	0
<i>D. leptophyllus</i>	TQ90	14	0	T	0	0
<i>D. leptophyllus</i>	CPI 37143	19	0	0	2	0
<i>D. leptophyllus</i>	CPI 38351	13	0	0	3	T
<i>D. leptophyllus</i>	CPI 55719	12	0	0	3	0
<i>D. leptophyllus</i>	CPI 76053	9	T	1	2	0
<i>D. leptophyllus</i>	CPI 92655	16	T	T	3	0
<i>D. leptophyllus</i>	CPI 92746	7	T	0.3	2	T
<i>D. leptophyllus</i>	CPI 92809	15	0	0	2	0
<i>D. pernambucanus</i>	CPI 40071	9	0	0.5	1	T
<i>D. pernambucanus</i>	CPI 49728	7	0.4	0.6	0	T
<i>D. pernambucanus</i>	CPI 83565	10	T	T	0	T
<i>D. pubescens</i>	CPI 92800	4	0	0	0	0
<i>D. pubescens</i>	CPI 92802	6	T	T	1	T
<i>D. pubescens</i>	cv. Uman	5	0	0	1	0
<i>D. pubescens</i>	CPI 92804	4	T	0	4	T

<i>D. sp</i>	CPI 33426	na	na	na	0	0.3
<i>D. sp</i>	CPI 70338	8	T	0.6	2	T
<i>D. tathuyensis</i>	CPI 90362	3	0	0	0	0
<i>D. virgatus</i>	CPI 57960	13	1	1.5	1	0.5
<i>D. virgatus</i>	CPI 67643	28	1.3	1.5	0	1
<i>D. virgatus</i>	cv. Marc	10	3	9	0	0.4
<i>D. virgatus</i>	CPI 78372	11	1	4	0	0.3
<i>D. virgatus</i>	CPI 78382	6	0.8	2	0	0
<i>D. virgatus</i>	CPI 79653	4	1	2	0	0
<i>D. virgatus</i>	CPI 83563	13	0	0	0	T
<i>D. virgatus</i>	CPI 85173	3	1	1	0	0
<i>D. virgatus</i>	CPI 85178	6	2.5	9	0	0.3
<i>D. virgatus</i>	CPI 85182	13	1	0.7	1	0.6
<i>D. virgatus</i>	CPI 90751	6	2.7	5	0	0.5
<i>D. virgatus</i>	CPI 91181	8	2	3.5	0	0.4

* range of plants/m² observed for 2 or more accessions of this species, na = not planted at site, T = trace (<0.3plants/m²)

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/m²) recovered from plots of promising accessions at Blackall and Isisford in 2003.

Site	<i>Desmanthus</i> 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

	Textur e % clay	pH (1:5 water)	Organi c Carbo n %C	Nitrate Nitroge n mg/kg	Phosphor us (Colwell) mg/kg	Potassiu m (Amm.Ac.) meq/100 g	Electrical conductivi ty dS/m	Sodium (Amm.Ac) meq/100 g	CEC meq/100 g
Black all	35	8.5	0.6	8.3	26	1.1	0.15	0.45	35.0
Isisfor d	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/m² 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 & St?r 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/m² 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/m² and up to 15 plants/m² 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/m² with up to 3.25 plants/m² 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/m² (mean of 696) at Blackall and 87 to 522 seeds/m² (mean of 238) at Isisford. Elsewhere, Rangel & Gardiner (1996) found a mean *Desmanthus* seed bank of 729 seeds/m² and Jones (1998) a mean of 1125 seeds/m², while Burrows & Porter (1993) found a mean of 300 seeds/m². 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, hardseededness, 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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References

Burrows DM and Porter FJ (1993). Regeneration and survival of *Desmanthus virgatus* 78382 in grazed and ungrazed pastures. *Tropical Grasslands* **27**, 100-107.

Butler DW & Fairfax RJ (2003). Buffel grass and fire in a Gidgee and Brigalow woodland: A case study from central Queensland. *Ecological Management & Restoration?* **4**(2), 120-125.

Commonwealth of Australia (2001). Mitchell Grass Downs. Australian Natural Resource Atlas http://audit.ea.gov.au/ANRA/rangelands/rangelands_frame.cfm?region_type=NT®ion_code=MGD

Cook BG, Graham TW, Clem RL, Hall TJ, & Quirk MJ (1993). Evaluation and development of *Desmanthus virgatus* on medium to heavy textured soils in Queensland. *Proceedings of the XVII International Grassland Congress*, Rockhampton, 1993. 3, 2148 – 2149.

Horne PM & St?r WW (1999). *Developing forage technologies with farmers – how to select the best variety to offer farmers in SE Asia*. ACIAR Canberra.

- Jones RM (1998). Evaluation of a range of tropical legumes on two clay soils in SE inland Queensland. *Tropical Agriculture Technical Memorandum no.2*. CSIRO.
- Jones RM, Bishop HG, Clem RL, Conway MJ, Cook BG, Moore K and Pengelly BC (2000). Measurements of nutritive value of a range of tropical legumes and their use in legume evaluation. *Tropical Grasslands* **34**, 78-90.
- Leslie JK, Mungomery VE, Cameron DG & Hogarth DM (1987). Plant genetic constraints in tropical agriculture. 57th ANZAAS Congress, James Cook University 24-28 August 1987.
- Muir JP & Pitman WD (2003). Establishing bundleflowers in bumuda and switchgrass. Forage research in Texas 2003. CPR 5267. <http://forageresearch.tamu.edu/2003/2003%20desmanthus%20establishment.pdf>
- Ocuppaugh WR, Kuntz D, Rahmes J, Martinez D, Grichar J, Hussey M, Reilly J, Abrameit A, Owens K, Reed R, Muir JP, & Bade D (2003). *Desmanthus bicornutus*: a new summer-growing perennial shrubby legume for south Texas and Mexico. *Proceedings of the American Forage and Grassland Council*. Vol. 12.
- Orr DM (1975). A review of *Astrebla* (Mitchell Grass) pastures in Australia. *Tropical Grasslands* **9**, 21-36.
- Pengelly BC & Conway MJ (1998). The evaluation of tropical legumes for use in ley pastures in central and southern Queensland. *Proceedings of the 9th Australian Agronomy Conference*, Wagga Wagga, 1998. <http://www.regional.org.au/au/asa/1998/1/278pengelly.htm#TopOfPage>
- Rangel JH deA & Gardiner CP (1996). Effect of fire and heat on the seed germination of *Desmanthus virgatus* accessions. *Proceedings of the International symposium on the future of the tropical savannas*, Townsville 1994.
- Robertson FA, Myers RJ & Saffigna PG (1997). Nitrogen cycling in brigalow clay soils under pasture and cropping. *Australian Journal of Soil Research* **35**, 1323 – 1339.
- Schlink AC & Burt RL (1993). Assessment of the chemical composition of selected tropical legume seeds as animal feed. *Tropical Agriculture* **70**, 169-173.