

# Potential of *Desmanthus* spp. in northern New South Wales

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## Abstract

Temperate legumes have been the traditionally sown phase legumes for the northern New South Wales (NSW) cropping zone. Northern NSW has a summer dominant rainfall pattern which also makes it potentially suitable for tropical legumes, however there have been few studies to test species in this region. This paper reports data for two experiments sown on a Black Vertosol soil site near Moree in northern NSW to: (1) evaluate herbage mass and persistence of six species in an ungrazed experiment and, (2) confirm the potential of *Desmanthus* spp. under grazing. In experiment 1, 32 cultivars and experimental lines (collectively called entries) representing four *Desmanthus* spp, *Glycine latifolia* and *Medicago sativa* were evaluated over a five-year period. The most productive and persistent entries with average or higher than average leaf-stem dry weight ratio included *G. latifolia* (experimental line 15), *D. leptophyllus* (38820) and (38351), and *D. pernambucanus* (40071). *D. virgatus* (78372) also performed well. In experiment 2, eight entries representing four *Desmanthus* spp. were sown in plots and grazed by sheep. In the final summer of the experiment, *D. bicornutus* (91162) was the most productive. *D. virgatus* (Q9153) was also productive and had the highest plant frequency in the 5th year following seedling recruitment the previous spring. These studies highlighted *Desmanthus* spp. as having potential in northern NSW and indicated that the ability to set seed and regenerate was important to ensure longer term persistence. The need for further testing across a wider range of soil types and in mixtures with tropical grasses was recommended.

## Key Words

*Desmanthus virgatus*, herbage production, seed set

## Introduction

Pasture legumes are important in both grazing and farming systems – by increasing diet quality of grazing animals and providing nitrogen (N) for the following crop. As fertiliser N costs increase, pasture legumes have an increasingly important role, providing a more affordable and sustainable source of N. Northern New South Wales (NSW) has traditionally been dependent on temperate legumes, but the region has summer dominant rainfall making it also potentially suitable for tropical legumes. Moylan and Crocker (2000) evaluated a range of tropical pasture legumes and identified *Desmanthus virgatus*, *Macroptilium* spp. and *Lablab purpureus* as having potential in northern NSW.

*Desmanthus* is a mimosoid legume and perennial species of the genus are of interest for use as phase legumes for the northern cropping zone. The Australian Tropical Crops and Forages Collection (ATCFC), Biloela contains a collection of >300 entries of *Desmanthus*. This collection was classified using the random amplified polymorphic DNA method in 1999 (Pengelly and Liu 2001) and together with the taxonomic treatment of the genus by Luckow (1993), a group of representative entries from a range of species was selected for initial field evaluation at six sites in central and southern Queensland and northern NSW. A number of these entries were then advanced to evaluation under grazing.

This paper reports data for experiments sown at one site in northern NSW – the initial evaluation of entries described above (experiment 1) and a subsequent experiment evaluating a subset under grazing (experiment 2).

## Methods

These studies were conducted at a site located on a commercial property near Terry Hie Hie, 50 km southeast of Moree (29.418°S 150.108°E; elevation 240 m) on a Black Vertosol with an annual average rainfall of 670 mm at Gravesend, the nearest town.

Experiment 1 was sown in December 1998 and consisted of 32 cultivars and experimental lines (collectively called entries, Table 1) representing four *Desmanthus* spp., *Glycine latifolia* and *Medicago sativa* (lucerne). Plots were 3 x 2 m and the experiment was a randomised complete block design with three replicates. Two

kg/ha viable seed, inoculated with rhizobia, was broadcast by hand in pure swards into a prepared, weed-free seedbed and the surface raked to cover the seed. Single superphosphate [8.8% phosphorus (P), 11% sulfur (S)] was applied at 250 kg/ha in the first year of the study and 150 kg/ha in each subsequent spring. Assessments were conducted over a five-year period and included plant height, herbage mass, leaf-stem dry weight (L-S) ratios and plant frequency. The experiment was not grazed, but slashed in June at the end of the growing season and herbage removed from the plots. In this paper, L-S ratio in March 2000, plant frequency in June 2002, and herbage mass in March 2003 are described.

Experiment 2 was sown in February 2001. It consisted of eight entries (Table 2) representing four *Desmanthus* spp. chosen from analysis of performance of entries in experiment 1 sown at all six sites from central Queensland to northern NSW. Three entries were consistent with experiment 1: *D. leptophyllus* (38820); *D. virgatus* (78372) and *D. leptophyllus* (63453) which performed well, average and poorly, respectively. The experiment was sown in a randomised complete block design with three replicates. Two kg/ha viable inoculated seed was broadcast by hand into plots (8 x 4 m) as pure swards into a pre-prepared, weed-free seedbed. Plots were lightly harrowed to cover the seed with soil. Single superphosphate was applied at the same rates as experiment 1. Plant counts were recorded in March 2001 and herbage mass assessed from December 2001. Grazing with sheep commenced in February 2002 and the experiment was grazed for ~1-week when the average height of entries reached ~0.3 m. The experiment was grazed at the same time as the rest of the paddock. Data collected included post-grazing assessment of herbage mass, percentage of leaf present, percent ground cover, sward height, frost damage, seedling recruitment and plant frequency. Data reported in this paper are herbage mass in summer each year (2002–04), plant height (January 2002), seedling regeneration (March 2003) and plant frequency (November 2003).

Data from both experiments were analysed with Genstat 13.3 following transformation after examination of residuals indicated that they were not normally distributed.

## Results and discussion

Total annual rainfall was above the long-term average (LTA) in all years, except 2002. Rainfall was variable as is characteristic of the region, with summer rainfall being below the LTA every year except 2000–01, while spring rainfall was above average (ranging from 40–306 mm above the LTA) every year. Winter rainfall was below average in most years that the experiments were conducted. This trend continued throughout 2000–2009 (Lodge and McCormick 2010) and climate change models have predicted that rainfall distribution in the future may increase in spring and decrease in autumn (Watterson et al. 2007). These patterns together with the predicted increase in temperatures favour the establishment and growth of tropical species.

*Experiment 1* – In June 2002 at the end of the third year of assessment, *G. latifolia* (15) had the highest plant frequency, but was not significantly different to *G. latifolia* (6) and *D. leptophyllus* (38351) (Table 1). Based on species groups, the native legume *G. latifolia* had highest plant frequency, but *D. pubescens* had the highest proportion of leaf (i.e. highest L-S ratio) (Table 1). *D. leptophyllus*, *G. latifolia* and lucerne groups had average L-S ratios. The *D. virgatus* and *D. pernambucanus* groups had the lowest average L-S ratio and the range within *D. virgatus* was large. Herbage mass in autumn 2003 at the end of the experiment was highest for *G. latifolia* (15), but not significantly different to *D. virgatus* (78372) and (67643), *D. leptophyllus* (38820) and (38351), *D. pernambucanus* (83565) and (40071), and *D. pubescens* (92805) (Table 1). In general, entries with L-S ratios <30 tended to have average or above average herbage mass, while those with high L-S ratios (>55) had below average herbage mass, indicating that stem weight may have been a large contributor to the total herbage mass of some entries. Entries with L-S ratios of 40–50 had the full range of herbage mass. Observations of *Desmanthus* spp. in this and other experiments have shown persistence of entries for >5 years (G. Crocker and W. McDonald, pers. comm.). Entries with above average plant frequency, herbage mass and average or above average L-S ratios included *G. latifolia* (15), *D. leptophyllus* (38820) and (38351), and *D. pernambucanus* (40071). *D. virgatus* (78372) also had above average herbage mass and average density, but below average L-S ratio. *D. pernambucanus* tended to act as an annual at other sites (B. Pengelly, pers. comm.).

*Experiment 2* – All entries established similarly (14–20 seedlings/m<sup>2</sup>,  $P>0.05$ ), except *D. virgatus* (Q9153) and (78372) which had <10 seedlings/m<sup>2</sup> and were readily grazed. Sward height of entries varied, with *D. glandulosus* (90319A), *D. leptophyllus* (38351) and *D. virgatus* (Q9153) being the tallest (0.75–0.81 m)

**Table 1. Leaf-stem ratio in March 2000, plant frequency (%) in June 2002 and herbage mass (square-root transformed (in brackets) and back-transformed (kg DM/ha) to assist interpretation) in March 2003 of all legume entries in experiment 1 sown in December 1998. (\*LSD is for the transformed data)**

Legume entry	Leaf-stem ratio	Frequency (%)	Herbage mass (kg DM/ha)
<i>D. leptophyllus</i> (38820)	54.5	48.3	(90.0) 8107
<i>D. leptophyllus</i> (38351)	45.7	51.8	(84.9) 7205
<i>D. leptophyllus</i> (AC10)	38.0	40.2	(64.5) 4159
<i>D. leptophyllus</i> (AC11)	47.6	48.5	(59.3) 3511
<i>D. leptophyllus</i> (87860)	47.5	35.9	(37.3) 1391
<i>D. leptophyllus</i> cv. Bayamo	53.5	39.9	(35.2) 1236
<i>D. leptophyllus</i> (92818)	49.6	33.2	(24.8) 614
<i>D. leptophyllus</i> (63453)	42.9	17.8	(20.3) 410
<i>D. pernambucanus</i> (40071)	45.5	40.2	(87.5) 7653
<i>D. pernambucanus</i> (83565)	40.4	41.2	(74.5) 5553
<i>D. pubescens</i> (92805)	45.9	33.2	(70.3) 4942
<i>D. pubescens</i> (92804)	42.7	32.9	(43.7) 1913
<i>D. pubescens</i> (92829)	60.4	30.6	(30.7) 945
<i>D. pubescens</i> (92809)	72.7	38.0	(26.3) 691
<i>D. pubescens</i> cv. Uman	56.4	29.6	(24.6) 603
<i>D. virgatus</i> (78372)	26.8	36.3	(93.0) 8640
<i>D. virgatus</i> (67643)	44.2	35.3	(68.6) 4699
<i>D. virgatus</i> (73467)	17.3	36.7	(65.2) 4250
<i>D. virgatus</i> (33220)	46.6	35.6	(61.7) 3811
<i>D. virgatus</i> (90759)	25.3	35.3	(49.8) 2476
<i>D. virgatus</i> (73465)	49.7	32.6	(47.9) 2294
<i>D. virgatus</i> (76055)	30.6	34.1	(47.0) 2213
<i>D. virgatus</i> (78379)	45.2	31.0	(44.6) 1989
<i>D. virgatus</i> (79653)	35.5	26.5	(43.6) 1897
<i>D. virgatus</i> (85184)	63.3	38.4	(41.7) 1742
<i>D. virgatus</i> (91181)	47.9	29.4	(39.9) 1595
<i>D. virgatus</i> (65947)	58.4	23.8	(26.3) 691
<i>D. virgatus</i> (91491)	58.8	29.2	(9.7) 95
<i>G. latifolia</i> (15)	46.2	56.5	(95.5) 9126
<i>G. latifolia</i> (6)	46.2	53.9	(50.6) 2563
<i>M. sativa</i> cv. Aurora	46.2	30.5	(33.6) 1127
<i>M. sativa</i> cv. Aquarius	46.2	36.4	(19.2) 369
LSD (P=0.05)	25.29	7.87	27.91*

prior to grazing in summer 2002 ( $P < 0.05$ ). *D. virgatus* cv. Jaribu was the shortest (0.34 m), but was not significantly different to several other entries (Table 2). *Desmanthus* cv. Jaribu was released in 1991 as a composite of three cultivars; *D. virgatus* cv. Marc, *D. leptophyllus* cv. Bayamo and *D. pubescens* cv. Uman (Cook et al. 1993). Marc was the shortest and earliest flowering and tended to be more persistent (Pengelly and Conway 2000). In contrast, *D. bicornutus* was an erect shrub that grew to 1.5–3 m. The lack of height of some species in this experiment may have been due to the grazing protocol and/or the natural pruning of these legumes by frosts over winter. Herbage mass assessed each summer showed a change in ranking of entries over time (Table 2). In summer 2002, *D. glandulosus* (90319A) had the highest herbage mass, but was not significantly different to five other entries. In 2003, *D. bicornutus* (91162) had the highest herbage mass, and was not significantly different to *D. glandulosus* (90319A) and *D. leptophyllus* (38820). By 2004, *D. bicornutus* (91162) again had the highest herbage mass and was not significantly different to *D. virgatus* (Q9153). Interestingly, *D. virgatus* (Q9153) had the lowest herbage mass of all entries at all previous assessments, however it had the highest seedling regeneration in 2003 ( $P < 0.05$ ). Entries with the lowest regeneration seedling densities were *D. bicornutus* (91162), and *D. leptophyllus* (38351) and (63453) ( $P < 0.05$ ). *D. virgatus* (Q9153) was a short, fine-stemmed early flowering entry that set large quantities of seed. Plant frequency in the final year of the experiment was highest for this entry and lowest for *D. leptophyllus* (38351) and (63453) ( $P < 0.05$ ), reflecting the importance of *Desmanthus* spp. to be able to regenerate from seed. Seedling recruitment at this and other sites suggested that *D. virgatus* (Q9153) may

have softer seed levels than other entries, which could be beneficial in ley systems. All species in these studies produce hard seed, which appeared to be an important characteristic to allow development of a seed bank for regeneration in subsequent years. Tolerance to frost may also be an important characteristic for long-term persistence. The ATCFC contains entries collected from frost-prone regions and evaluation of these may identify entries with greater cold/frost tolerance and allow plants to have a longer growing season and/or greater persistence.

**Table 2. Summer herbage mass (2002–2004), plant height, seedling regeneration and plant frequency of *Desmanthus* entries. Data in brackets are square-root transformed and have been back-transformed to assist interpretation. LSD is for the transformed data (\*entries within an assessment).**

Species	Herbage mass (kg DM/ha)			Height (m)	Regeneration (seedlings/m <sup>2</sup> )		Frequency (%)
	2002	2003	2004				
<i>D. bicornutus</i> (91162)	(72.27) 5223	(51.70) 2673	(77.98) 6081	0.52	(0.0) 0	(5.83) 34	
<i>D. glandulosus</i> (90319A)	(76.96) 5923	(46.91) 2201	(57.97) 3361	0.81	(6.7) 45	(5.97) 36	
<i>D. leptophyllus</i> (38351)	(76.89) 5912	(34.49) 1190	(27.32) 746	0.80	(1.9) 4	(3.48) 12	
<i>D. leptophyllus</i> (38820)	(70.08) 4911	(39.58) 1567	(42.20) 1781	0.55	(6.7) 45	(5.08) 26	
<i>D. leptophyllus</i> (63453)	(67.59) 4568	(24.64) 607	(17.00) 289	0.49	(1.1) 1	(1.76) 3	
<i>D. virgatus</i> (78372)	(38.75) 1502	(14.74) 217	(43.49) 1891	0.35	(5.9) 35	(4.82) 23	
<i>D. virgatus</i> (Q9153)	(64.40) 4147	(33.48) 1121	(67.34) 4535	0.75	(21.5) 461	(8.47) 72	
<i>D. virgatus</i> cv. Jaribu	(55.09) 3035	(29.76) 886	(33.31) 1110	0.34	(4.9) 24	(4.03) 16	
LSD (P=0.05)	14.949*	14.949*	14.949*	0.203	2.58	1.782	

## Conclusion

These studies highlighted *Desmanthus* spp. as having potential in northern NSW. Although the majority of the species and entries tested were perennial, the ability to regenerate from seed appeared to be important to ensure longer term persistence. This needs to be confirmed and the performance of *Desmanthus* spp. assessed across a wider range of soil types and in mixtures with tropical perennial grasses.

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