Tropical Grasslands (1991) Volume 25, 32-36

Pasture legume evaluation on seasonally flooded soils in the Northern Territory

B.J. ROSS[1] AND A.G. CAMERON
Department of Primary Industry and Fisheries, Darwin, Northern Territory, Australia

Abstract

Fourteen legume accessions were grown for 3 years on a solodic soil and a black cracking clay, both subject to seasonal flooding. Glenn American jointvetch (*Aeschynome americana* cv Glenn) grew well on both soils over 3 years. The twining legume *Macroptilium longipedunculatum* CPI62158 grew and spread well on the solodic soil and is recommended for further evaluation in this situation.

Resumen

Durante 3 años se cultivaron 14 accesiones de leguminosas en un suelo solódico y en uno con arcillas negras agrietables, ambos sujetos a inundaciones estacionales. Glenn American jointvetch (Aeschynomene americana *cv. Glenn) creció bién durante los 3 años en los dos tipos de suelos. La leguminosa voluble* Macroptilium longipedunculatum *CPI62158 creció y se propagó bién en el suelo solódico y es recomendada para evaluaciones futuras bajo estas condiciones.*

Introduction

The floodplains in the 'Top End' of the Northern Territory cover approximately 2.5 million ha. The dominant soil types are solodics and heavy cracking clays. Flooding usually occurs for 3 to 9 months from January to October. These floodplains are mainly used for dry season grazing when cattle and buffalo graze grasses such as the native *Hymenachne acutigluma* or the introduced para grass (Calder 1989). Animal production is limited by the quality of the pasture. This could be improved by the use of legumes if legumes well adapted to seasonal flooding could be identified. Adapted plants must be able to survive 3 months or more of flooding during the growing season.

Centrosema pascuorum accessions established and survived flooding on a solodic soil at Mt Bundey Station, Adelaide River (Cameron and McCosker 1986). *Macroptilium longipedunculatum* CPI62158 and *Aeschynomene americana* cv Glenn also performed well on a seasonally waterlogged solodic soil at Tortilla Flats Research Farm, Adelaide River (G.J. Calder and B.J. Ross, unpublished data). Glenn is tolerant of waterlogging and persists under prolonged wet soil conditions (Bishop *et al.* 1985). In a pot study by Miller and Williams (1981), *A. americana* CPI58522 and *M. longipedunculatum* CPI62158 survived waterlogging for 6 and 3 months, respectively. Other legumes which persisted for up to 7 years in evaluations at Coastal Plains Research Station and Tortilla Flats Research Farm were lines of *Centrosema plumieri* and *C. pubescens* (Cameron *et al.* 1984).

Fourteen accessions from these genera and species were evaluated under cutting over 3 years on 2 soil types to measure establishment, growth, and feed quality, and to select promising lines for grazing evaluation.

Materials and methods

Fourteen legume accessions (Table 1) were sown in randomized complete blocks with 3 replications at Tortilla Flats Research Farm at 13°5'S, 131°14'E, on December 9, 1983, and at Coatal Plains Research Station 12°30'S, 131°25'E, on December 12, 1983. The Tortilla Flats site, average annual rainfall 1270 mm, was a former rice bay on solodic soil (Dy 3.23, Oslen 1982),

Correspondence: Mr A.G. Cameron, NT Department of Primary Industry and Fisheries, PO Box 79, Berrimah, NT 0828, Australia.

[1]Present address: NT Department of Mines and Energy, GPO Box 2901, Darwin, NT 0801, Australia.

while the Coastal Plains site, average annual rainfall 1320 mm, was described as a black cracking clay (Ug 5.21) by Howe (1972) and as a grey cracking clay by Lucas and Czachorowski (1980). Both sites are subject to waterlogging during the wet season and may be flooded to a depth of 10 cm for up to 3 months in an average year and up to 5 months in an exceptionally wet year.

The legumes were hand broadcast at 10 kg/ha onto 4 m x 4 m cultivated plots with 3 m laneways between plots. *Centrosema* spp. were inoculated with commercial centro inoculant before sowing. Superphosphate (400 kg/ha), potassium chloride (100 kg/ha), zinc sulphate (22 kg/ha), and sodium molybdate (500 kg/ha) were applied at sowing. Superphosphate and potassium chloride were applied with a combine drill while the zinc and molybdenum were sprayed onto the plots.

Establishment counts were made in two 0.25 m^2 quadrats per plot eight weeks after sowing. In subsequent years populations were assessed visually.

Dry matter yield was recorded on May 8, 1984, May 9, 1985 and April 28, 1986. Two 1 m x 0.5 m quadrats per plot were harvested and hand-sorted into sown legume, other legume, grass and weeds. The samples were dried in a forced draught dehydrator at 80 °C and dry weight recorded. The grass and sown legume were analysed for N, P, K, S and Zn each year and Ca, Mg and Cu in the first year.

The plots were cut with a sickle-bar mower each year during the dry season and mown material removed.

Results

Rainfall

Seasonal rainfall during the experiment was above average in 1983/84, below average in 1984/85, and average in 1985/86. In 1984 rainfall was above average in February and March but below average in April, particularly at Tortilla Flats. In 1985 and 1986, rainfall in February and March was considerably below average and only temporary flooding of 7–14 days was experienced during January.

Establishment and yield

Tortilla Flats. Establishment was variable, with one replication having a significantly ($P < 0.05$) lower number, and uneven distribution of plants as a result of seed movement in rainwater runoff. Significantly ($P < 0.05$) higher establishment was recorded for Glenn and *M. lathyroides* CPI58704 while no plants of *C. plumieri* CPI58567 or *Vigna* sp. CPI58476 were counted and there was only one plant/m^2 of *C. pubescens* CPI58575 (Table 1).

In the first year, 3 accessions, *M. lathyroides* CPI50406, *M. longipedunculatum* CPI62158 and Glenn produced more than 4500 kg/ha dry matter despite the first two being grazed by wallabies (Figure 1). The *C. pascuorum* lines were severely trampled and grazed by wallabies, which is reflected in lower yields. The 3 lines which established poorly were not included in the analysis.

Table 1. Establishment of legume accessions sown in December 1983 at Tortilla Flats Research Farm (TFRF) and Coastal Plains Research Station (CPRS), Northern Territory

Species	Accession	Plants/m^2	
		TFRF	CPRS
Aeschynomene americana	cv Glenn	41 a[1]	136 a
Centrosema pascuorum	cv Bundey	4 b	20 bc
	Q9855	9 b	48 bc
	Q10050	8 b	28 bc
	CPI55697	4 b	28 bc
	cv Cavalcade	12 b	15 bc
	11/5	13 b	20 bc
	12/4	8 b	25 bc
Centrosema plumieri	CPI58567	0[2]	8 c
Centrosema pubescens	CPI58575	1 b	28 bc
Macroptilium lathyroides	CPI50406	9 b	44 bc
	CPI58704	45 a	33 bc
Macroptilium longipedunculatum	CPI62158	13 b	88 ab
Vigna sp.	CPI5846	0[2]	11 c

[1] Means in the same column followed by the same letter are not significantly different, P = 0.01. [2] Did not establish.

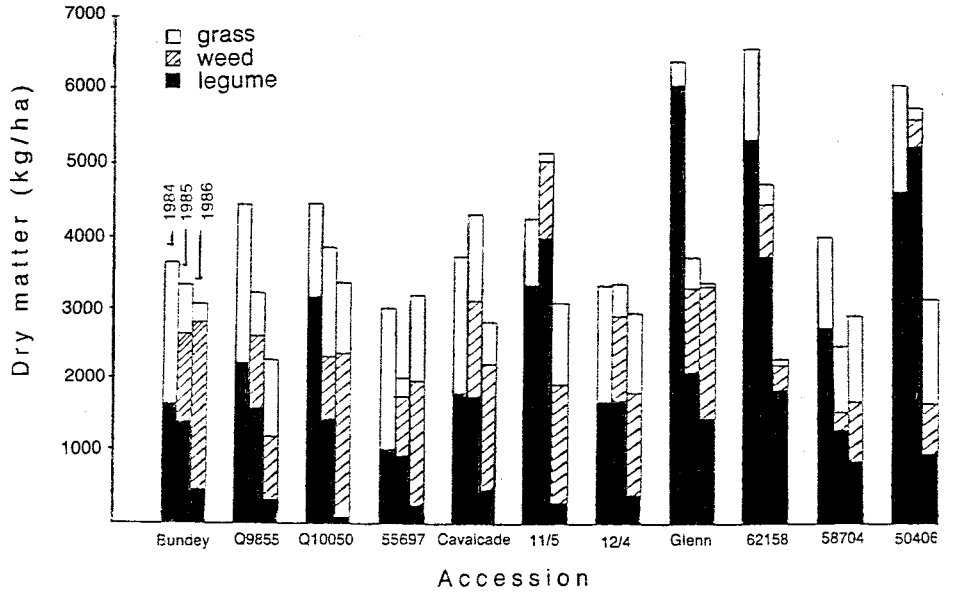

Figure 1. Dry matter yield of sown legumes, grass, and weed at Tortilla Flats Research Farm, Northern Territory. LSD, P = 0.05, for legume: 1984 = 2610; 1985 = 1900; 1986 = 1245.

In the second year, *M. lathyroides* CPI50406, *M. longipedunculatum* CPI62158 and *C. pascuorum* 11/5 again produced high yields (Figure 1). *M. longipedunculatum* CPI62158 spread into adjacent plots.

In the third year few plots remained as pure stands of the original sown legume, with Glenn, *M. longipedunculatum* CPI62158, and *M. lathyroides* CPI50406 spreading more than the other legumes. The "weed" component of total yield shown in Figure 1 was largely comprised of these 3 legumes. These lines also yielded the highest of the sown legumes. The highest yield was from *M. longipedunculatum* CPI62158 with 1881 kg/ha, but with considerable leaf litter left unsampled on the soil surface. *Vigna* sp. CPI58476 was the only legume not present in 1985/86.

Grass yields ranged from 50–2000 kg/ha in any of the 3 years (Figure 1) but no significant differences occurred.

Coastal plains. Initial plant establishment was adequate (> 10 plants/m^2), although seedling density was again variable. The highest density was recorded for Glenn and *M. longipedunculatum* CPI62158, and the lowest for *Vigna* sp. CPI58476 and *C. plumieri* CPI58556 (Table 1).

Dry matter yield of all lines was low and variable and bore little relationship to seedling counts. In 1984 Glenn significantly ($P < 0.01$) outyielded the other legumes (Table 2). Cavalcade grew well in 2 out of 3 replications, recording second highest yield. *Macroptilium longipedunculatum* CPI62158 grew poorly despite good establishment (Table 1).

In 1985 all the sown legumes except Cavalcade and Glenn comprised less than 20% of the total dry matter. These two lines yielded more than 1000 kg/ha which was more than 60% of the total dry matter (Table 1).

Table 2. Dry matter yield of sown legume at the Coastal Plains Research Station in 1984 and 1985

Accession	Yield 1984	1984
	(kg/ha)	
Glenn	2270 a[1]	1990 a
Bundey	670 bc	180 a
Q9855	910 bc	180 a
Q10050	490 bc	360 a
CPI55697	240 c	240 a
Cavalcade	1330 b	1290 a
11/5	690 bc	430 a
12/4	460 bc	320 a
CPI50406	210 c	190 a
CPI58704	380 c	100 a
CPI62158	224 c	130 a

[1] Means in the same column followed by the same letter are not significantly different, P = 0.01.

In 1986 re-establishment was poor. There were insufficient plants of *Centrosema pascuorum* lines Q9855, Q10050, 55697 and 11/5, and *M. lathyroides* CPI50406 for harvest, and no plants of *Vigna* sp., *C. pubescens* or *C. plumieri*. The highest yield in this third year was from Glenn with 1460 kg/ha, with all other plots yielding less than 200 kg/ha of the sown legume. There was a severe beanfly (*Ophyomyia phaseoli*) attack on *M. lathyroides* CPI50406. Cavalcade had poor re-establishment in the third year.

Grass yield averaged 2440 kg/ha in 1984, 1520 kg/ha in 1985 and 1800 kg/ha in 1986.

Nutrient concentration

For the 3 years at Tortilla Flats mean nutrient concentrations of most of the legume (whole plant samples) were in the ranges: 1.2–1.9% N, 0.08–0.13% P, 0.08–0.15% S, 0.7–1.4% K, 0.5–0.8% Ca, 0.13–0.26% Mg, 3–6 ppm Cu, and 23–40 ppm Zn, while at Coastal Plains the ranges were: 1.4–2.9% N, 0.09–0.13% P, 0.15–0.36% S, 1.1–1.9% K, 0.7–1.1% Ca. .31–.40% Mg, 5–9 ppm Cu, and 23–35 ppm Zn.

Nitrogen concentration of the grass component showed a marked increase in the second year, from 0.9% to 1.3% in 1984 at Tortilla Flats, and from 0.6% to 1.8% at Coastal Plains, presumably as a result of the nitrogen input of the sown legumes (Whiteman 1980). Grass N levels declined to an average 1% at Tortilla Flats in the third year of the experiment with some plots as low as 0.6%.

Discussion

Glenn was the only legume to perform satisfactorily on the black soil plain at Coastal Plains. It continued to grow into the dry season, producing green leaf in June. Later maturing perennial *A. americana* accessions are needed on this type of soil as Glenn becomes tall and stemmy when access is limited during the wet season, when grazing would lead to soil and pasture damage.

Glenn also performed well on the solodic soil at Tortilla Flats. *Macroptilium longipedunculatum* CPI62158 also grew well and spread. *M. lathyroides* CPI50406 yielded well but is susceptible to beanfly attack.

The *Centrosema pascuorum* lines did not perform as well as expected, particularly Bundey, which is recommended for sowing on flooded soils (Stockwell 1985b). The low April rainfall in 1984 would have favoured the seed production of the early flowering lines Cavalcade, 11/5 and 12/4. The main reason for the decline in yield of *C. pascuorum* lines at Tortilla Flats was the invasion by the three legumes Glenn, *M. longipedunculatum* and *M. Lathyroides* CPI50406 (Figure 1) which were more aggressive and competitive on the solodic soil. The invasion may have been compounded by uncontrolled grazing by wallabies, which seemed to prefer *C. pascuorum*.

The cause of the poor re-establishment and growth at Coastal Plains is not known. Grass competition which prevented legume re-establishment may have contributed to the decline in legume yield with time at this site. A combination of early flowering and high seed yield (Stockwell 1985a) may have favoured Cavalcade during the first two years. Glenn also produces large quantities of seed (Bishop *et al.* 1985) with a high content of hard seed (A.G. Cameron, unpublished data) and this may have led to a greater number of seeds germinating under favourable weather conditions and in niches favourable for establishment.

Soil and plant characteristics discussed by Humphreys (1981) which can affect establishment and performance on clay soils are moisture availability, seedling emergence of small seeded species, deep cracks causing root sheer stress, loss of legume nodules on drying, soil surface seals, soil surface structure, seedling competition and adaptation of particular plants to specific soil types. As most of these reasons do not seem to apply in this case, specific adaptation may be the most criticial factor. This may also apply to the good performance of *Macroptilium longipedunculatum* on the solodic soil.

The mineral nutrient status of most lines was adequate to meet the nutrient requirements of growing ruminants (ARC 1980; Little 1980; Little 1983). The exceptions were copper which was low in all lines at both sites, phosphorus which was consistently low in Glenn at both sites (0.06–0.10% P) (Little 1980) and in *M. lathyroides* CPI50406 (0.04–0.10% P) at Tortilla Flats and sulphur which was consistently low in *M. lathyroides* CPI50406 and CPI58704 (0.08–0.10% S), and low in two years in Glenn (0.09% S). These lines have a high proportion of stem, and nutrient concentration of the leaf fraction would be considerably higher than that measured in whole tops. This was reported by

Bishop *et al.* (1985), with Glenn plants harvested in June containing 16% and 6% crude protein and 0.12% and 0.03% phosphorus in the leaf and stem, respectively.

At Coastal Plains, plant sulphur concentrations of 0.15–0.36% S were unusually high for pasture legumes in the 'Top End' (A.G. Cameron, unpublished data).

This experiment has shown that *Aeschynomene americana* cv Glenn is well adapted to seasonally flooded clay and solodic soils in the Northern Territory, while *Macroptilium longipedunculatum* and *M. lathyroides* are better adapted only to seasonally flooded solodic soils. Later maturing perennial *A. americana* lines warrant testing on these flooded soils and *M. longipedunculatum* CPI62158 should be further evaluated to determine if it should be released as a pasture cultivar.

Acknowledgements

The technical and field assistance of J. Koomen, B. Beumer, and K. Grenfell is gratefully acknowledged. The Chemistry section conducted the plant analyses.

References

ARC (1980) *The Nutrient Requirements of Ruminant Livestock*. Technical review by an Agricultural Research Council Working Party. (CAB: Farnham Royal, UK.)

BISHOP, H.G., LUDKE, D.H. and RUTHERFORD, M.T. (1985) Glenn jointvetch: A new pasture legume for Queensland coastal areas. *Queensland Agricultural Journal*, **111**, 241–245.

CALDER, G.J. (1981) *Hymenachne acutigluma* in the Northern Territory. *Technical Bulletin No. 46, Department of Primary Production, Darwin*.

CAMERON, A.G. and MCCOSKER, T.H. (1986) Introduced pasture species screening on Mount Bundey Station, NT 1979–1983. *Technical Bulletin No. 97, Department of Primary Production, Darwin*.

CAMERON, A.G., MILLER, I.L., HARRISON, P.G., and FRITZ, R.J. (1984) A review of pasture plant introduction in the 600–1500 mm rainfall zone of the Northern Territory. *Technical Bulletin No. 71, Department of Primary Production, Darwin*.

HOWE, D.F. (1972) Land Units of the Beatrice Hill Experiment Station. *Technical Bulletin No. 7, Animal Industry and Agriculture Branch, Department of the Northern Territory, Darwin*.

HUMPHREYS, L.R. (1981) *Environmental Adaptation of Tropical Pasture Plants*. (MacMillan: London.)

LITTLE, D.A. (1980) Observations on the phosphorus requirement of cattle for growth. *Research in Veterinary Science*, **28**, 258–260.

LITTLE, D.A. (1982) Utilization of minerals. In: Hacker, J.B. (ed) *Nutritional Limits to Animal Production from Pastures*. pp 259–283. (CAB: Farnham Royal, UK.)

MILLER, I.L., and WILLIAMS, W.T. (1981) Tolerance of some tropical legumes to six months of simulated waterlogging. *Tropical Grasslands*, **15**, 39–43.

OLSEN, C.J. (1982) The soils of part of the Upper Adelaide River floodplain. *Technical Report No. 4, Conservation Commission of the Northern Territory, Darwin*.

STOCKWELL, T.G.H. (1985a) Cavalcade: a twining tropical legume bred for the Territory. *Agnote 85/4, Department of Primary Production, Darwin*.

STOCKWELL, T.G.H. (1985b) Bundey: a twining tropical legume for the Northern Territory. *Agnote 85/5, Department of Primary Production, Darwin*.

WHITEMAN, P.C. (1980) *Tropical Pasture Science*. (Oxford University Press: New York.)

(Received for publication, November 11, 1988; accepted December 28, 1990)