PASTURE SPECIES ARE SUITABLE FOR REVEGETATING DEGRADED GRANITIC SOILS OF HERVEY RANGE MILITARY TRAINING AREA IN NORTH QUEENSLAND

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ABSTRACT

Twelve pasture species were evaluated for their ability to regenerate eroded shallow granitic soil supporting a Eucalyptus *woodland in the Hervey Range military training area, with grazing excluded.* Bothriochloa insculpta *(Hatch creeping bluegrass) and* Melinis minutiflora *(molasses grass) were the most successful colonizing grasses; they maintained a dense sward for 3 seasons following rough cultivation and fertilization.* Bothriochloa pertusa *(Indian bluegrass) showed potential to give a low ground cover for camp sites. The legumes,* Stylosanthes hamata *(Verano) and* Macroptilium atropurpureum *(Siratro), persisted but their foliage covers were too low to control erosion. Hatch creeping bluegrass was the most promising grass for erosion control.*

RESUMEN

Doce especies de pastos fueron evaluadas por su habilidad de regenerar suelos graníticos superficiales y erosionados, soportando un bosque de Eucalyptus *en la area de entrenamiento militar Hervey Range, excluyendo pastoreo.* Bothriochloa insculpta *(Hatch creeping bluegrass) y* Melinis minutiflora *(molasses grass) fueron los pastos colonizantes de más éxito manteniendo un césped denso durante 3 estaciones después de una áspera preparación de suelo y fertilización.* Bothriochloa pertusa *(Indian bluegrass) mostró un bajo potencial para dar cubrimiento. Las leguminosas,* Stylosanthes hamata *(Verano) y* Macroptilium atropurpureum *(Siratro) persistieron, pero su capacidad de cobertura fue demasiado baja para controlar la erosión. Hatch creeping bluegrass fué el pasto más prometedor para el control de erosión.*

INTRODUCTION

The Hervey Range area of the Great Dividing Range in North Queensland is used for cattle grazing and military training. The area supports open *Eucalyptus drepanophylla* and *E. intermedia* woodland with a native grass cover of *Themeda triandra* (kangaroo grass) and *Heteropogon contortus* (black speargrass) growing on shallow granitic soils. Frequent use by military vehicles, and overgrazing, destroys the surface cover, which leads to soil loss through sheet and gully erosion. Subsequent regeneration is restricted by poor water penetration into the clay subsoil.

In the military training area, vigorous grasses are needed to control erosion at camping sites, on tracks and roadside verges, areas of earth-works and target areas. Vigorous and persistent grasses are also required to replace the palatable native species destroyed by heavy grazing in pastoral country surrounding the training area. This experiment evaluated pasture species for their suitability for revegetation in this area. Dry matter yield and N and P contents of tops were measured to provide data for potential evaluation under grazing.

MATERIALS AND METHODS

A degraded site was chosen in a hilly to strongly undulating area at Camp Guilfoyle in the High Range Military Training Area (19°24′S, 146°30′E, 561 m altitude), in the Leichhardt land system (Christian *et al.* 1950) 36 km south-west of Townsville. The soil was a granitic, sandy surfaced, yellow duplex (Dy 3.41; Soloth) with surface (0-10 cm) pH of 6.0, bicarbonate extractable P of 1 ppm, extractable K of

TABLE 1

Plot foliage cover (%) and dry matter yield (kg/ha) of sown grass and total herbage in years 1, 2 and 3.

Species	Foliage Cover			Sown grass yield			Total herbage yield		
	1	2	3	1	2	3	1	2	3
		(%)				(kg/ha)			
Bothriochloa pertusa Indian bluegrass (Bowen strain)	53	77	60	1280	2460	2870	1930	3320	4920
Bothriochloa insculpta cv. Hatch (creeping bluegrass)	90	97	90	3350	5730	7070	3520	5730	7131
Urochloa mosambicensis cv. Nixon (Sabi grass)	70	73	63	1560	1940	1990	2070	2480	3560
Urochloa mosambicensis CPI 46876	60	78	50	1850	2030	3130	1980	2180	3930
Cenchrus ciliaris cv. Gayndah (buffel)	87	72	17	1530	1240	1160	1530	1770	4210
Cenchrus ciliaris cv. Biloela (buffel)	63	75	33	2940	3860	2480	2940	4250	5030
Cenchrus setiger (Birdwood grass)	10	—	—	—	—	—	830	1280	—
Chloris gayana cv. Callide (Rhodes grass)	100	92	63	2890	4090	3130	2890	4110	3440
Chloris gayana cv. Pioneer (Rhodes grass)	77	93	60	2490	2870	2860	2490	2950	3500
Melinis minutiflora (molasses grass)	93	98	80	3640	4330	5700	3640	4330	6240
Indian bluegrass + *Stylosanthes hamata* cv. Verano	63	92	53	1020	2390	2940	1940	2940	6510
Indian bluegrass + *Macroptilium atropurpureum* cv. Siratro	68	60	53	510	1880	2120	1050	2670	5430
U. mosambicensis CPI 46876 + Verano	93	92	67	1340	2290	3610	2210	2650	4460
U. mosambicensis CPI 46876 + Siratro	80	93	87	1690	2180	3720	2090	2780	4760
Verano + Siratro	87	52	37	—	—	—	1510	2060	5530
L.S.D. (P = 0.05)	41	NS	35	1540	NS	2830	1590	2500	2170

0.17 m.eq. %, total N of 0.04 %, electrical conductivity of 0.063 mS/cm and Cl^- level of 27 ppm. There was 58% coarse sand, 18% fine sand, 9% silt and 15% clay. Its A-horizon had eroded following intense activity by vehicles.

Twelve pasture grasses and legumes (Table 1) were sown (5 kg untreated seed/ha) into plots (5 × 10 m) in a randomised block design with 3 replications. A commercial mixed fertilizer (5.1% N, 6.0% P, 4.9% K, 12.4% S, and 12.4% Ca) was hand-broadcast (400 kg/ha) with the seed, on January 15, 1980. The site had been ripped to 15 cm producing a rough, coarse surface, but the seed was not covered.

Species performance over 3 growing seasons was determined by recording plot foliage cover (%) by visual estimation, dry matter yield (from clipping 2 quadrats 0.5 or 1 m^2 at the end of each growing season), plant height and leaf color (rating, 1 = pale yellow-green, to 5 = dark healthy green), and analysing leaf tips and whole plant tops for nitrogen and phosphorus concentrations. Foliage cover has a close negative relationship with erosivity, and yield is used as a measure of persistence. Yield also indicates how well adapted the species is to the site.

The experiment was fenced to eliminate cattle grazing, but it was not possible to control grazing by rabbits.

Rainfall was 973 mm, 1777 mm and 913 mm in the 3 years 1979-80 to 1981-82 respectively.

RESULTS

Callide Rhodes, molasses grass, Hatch creeping bluegrass and Gayndah buffel colonized rapidly and achieved a high plot cover in the first year (Table 1). The legumes established readily, but they only assisted in producing a dense surface cover in association with *Urochloa mosambicensis* CPI 46876. Indian bluegrass was slow to establish. Its seed had 2% germination in 20 days and 47% dormancy at sowing. Few plants of Birdwood grass established.

The mean height of the swards (67 and 82 cm) and colour rating (4.2 and 3.6) in years 1 and 2 respectively, show that the species were vigorous and healthy, and indicate soil moisture was satisfactory during the first 2 seasons.

The persistence and effectiveness of the species as surface cover for erosion control is shown by the plot cover rating in years 2 and 3 (Table 1). Hatch creeping bluegrass was the most persistent grass over the first 3 years; it maintained a cover of 90%. Molasses also kept good surface cover, although dead material accumulated in the sward. The Rhodes and buffel grasses declined whereas the *Urochloa* lines maintained a cover intermediate between the best and worst cultivars.

Molasses (3 640 kg/ha), Hatch creeping bluegrass, Callide Rhodes and Biloela buffel grew rapidly in the establishment year (Table 1). The accumulated production of Hatch (7 070 kg/ha) and molasses grass by the third year shows their continued vigour. Indian bluegrass and *U. mosambicensis* CPI 46876 increased their production over the 3 seasons.

Native species yielded poorly in the first year after disturbance, but if competition from sown grasses was low, their yield increased in the second and third years. Native grasses made negligible growth in the dense sward of Hatch creeping bluegrass, but when growing only with legumes they yielded 3 580 kg/ha by the third season.

Over the 3 years, mean yield of sown legumes was 700 kg/ha with a companion grass and 1 540 kg/ha without. Siratro and Verano yields were similar, although Verano seemed to attract more rabbit grazing. Up to half of the Verano grown may have been eaten by rabbits.

Other species in the experimental area were mainly grasses (*Rhynchelytrum repens*, *Dactyloctenium radulans*, *Digitaria ciliaris*, *Setaria* sp., *Chloris* sp., *Sporobolus* sp. and *Eriachne* sp.) and some forbs (*Crotalaria* sp., *Sida* spp., and *Cyperus* spp.).

All sown species, except molasses grass and Gayndah buffel, had set seed by April 29, 1981.

Nitrogen and phosphorus concentrations of sown grasses varied between species and declined with time (Table 2). In the third year, mean nitrogen and phosphorus yields of sown grasses were 21.9 kg/ha and 3.5 kg/ha, respectively. Hatch creeping bluegrass had the highest yields of both nutrients (36.7 kg N/ha and 5.7 kg P/ha).

TABLE 2

Nitrogen and phosphorus concentrations (%) of leaf tips and plant tops of sown grasses in April of years 1 and 3.

Species	Nitrogen			Phosphorus		
	Tips	Plant tops		Tips	Plant tops	
	1	1	3	1	1	3
			(%)			
Sown grasses:						
Indian bluegrass	1.20	0.75	0.65	0.22	0.12	0.08
Hatch creeping bluegrass	1.78	1.00	0.52	0.24	0.13	0.08
Nixon Sabi	1.67	0.75	0.77	0.20	0.11	0.13
U. mosambicensis CPI 46876	1.15	0.55	0.52	0.17	0.14	0.10
Gayndah buffel	0.87	0.86	0.59	0.38	0.15	0.12
Biloela buffel	2.00	1.25	0.59	0.20	0.10	0.12
Birdwood	1.85	1.45	—	0.19	0.12	—
Callide Rhodes	1.85	1.22	0.68	0.16	0.10	0.11
Pioneer Rhodes	1.45	0.86	0.80	0.12	0.10	0.10
Molasses	1.42	1.08	0.40	0.21	0.20	0.09
Indian bluegrass (+ Verano)			0.60			0.10
Indian bluegrass (+ Siratro)			0.83			0.09
CPI 46876 (+ Verano)			0.62			0.09
CPI 46876 (+ Siratro)			0.75			0.09
Mean	1.52	0.98		2.06	0.13	
L.S.D. (P = 0.05)			0.23			0.03
Native grasses:						
Dactyloctenium sp.		1.50			0.10	
Setaria sp.		2.40			0.17	

DISCUSSION

The rapid establishment, high production and good persistence of Hatch creeping bluegrass and molasses grass show that these species are the most suited to regenerating degraded areas on the shallow granitic soils of Hervey Range. Hatch is known for its ease of establishment, hardiness and tolerance of low soil nitrogen (Bisset and Graham 1978). It gives good erosion control because it has upright stems and runners that root at the nodes. The high production and persistence of molasses grass in this experiment contrasts with its failure in the second season in dry tropical environments (Edye 1975), and could reflect the higher rainfall, lower temperature and negligible grazing experienced at Hervey Range.

Callide Rhodes gave a quick cover initially, but the decline in cover by the third year reduces its effectiveness for long-term erosion control. Sowing legumes without a companion grass is not recommended, but the superior cover maintained by *U. mosambicensis* CPI 46876 with a sown legume indicates they could be included in an initial species mixture. These legumes may be less effective with the more dense and vigorous grasses, such as Hatch creeping bluegrass or molasses grass, unless the swards are grazed. Verano would presumably be less damaged by rabbit grazing in larger sown areas.

The commercial fertilizer mixture (Q5) at 400 kg/ha was enough to establish and maintain these species for 3 years. In the second year, extra nitrogen may have improved sown grass performance. When sown grasses were not competitive, the establishment and yield of native species after cultivation and fertilization, show that areas not susceptible to serious erosion can regenerate naturally, although it may take several years. Revegetation will be more successful if seeding and fertilizing of sown grasses begin before all the A-horizon has been eroded. Traffic should be excluded until sown species are well established.

Indian bluegrass showed slower establishment, possibly because of poor seed quality, than either Hatch creeping bluegrass or molasses grass, but it should be more tolerant of lower than average rainfall. It has already shown good erosion control ability by rapidly colonizing degraded country in the Bowen hinterland since 1970 (Bisset 1980).

Indian bluegrass had low ground cover and was the most promising lawn-type tested. It has potential to replace black speargrass around permanent camp sites. However, Indian bluegrass may need several years and suitable management (such as periodic slashing) to establish and to spread into these areas. It could also reduce the fire hazard around camp buildings compared with the taller, high yielding black speargrass, and Indian bluegrass seeds are not as troublesome.

By April 26 of the third year, all grasses had low levels of nitrogen which may reduce intake by cattle (Milford and Minson 1966), and marginal to deficient concentrations of phosphorus (Little 1982). Edye (1975) reported similar low concentrations of these nutrients in buffel, Rhodes and *U. mosambicensis* on solodic and red earth soils in the dry tropics of north Queensland.

Hatch creeping bluegrass was the best species for revegetating these soils, and its high productivity and quality indicate it warrants evaluation under grazing as a pasture grass in this environment. It is also well adapted to many drier environments in north Queensland (McIvor *et al.* 1982), but is not widely used. Under grazing, its sward density may be reduced, allowing Verano to survive as a companion legume. In Central Queensland, creeping bluegrass has successfully combined with Siratro and Townsville stylo in grazed pastures (Bisset and Graham 1978). Verano is more tolerant of heavy grazing than is Siratro in north Queensland. Siratro grows well and may be suitable for erosion control in a grass-legume sward, although not where considerable grazing is contemplated.

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