EFFECT OF PHOSPHOROUS FERTILISER ON THE COMPETITION BETWEEN TWO TROPICAL GRASSES AND TWO TROPICAL LEGUMES

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ABSTRACT
The effect of P fertiliser on the competition between grass and legume in four grass-legume mixtures : *Urochloa mosambicensis* cv. Nixon/ *Stylosanthes hamata* cv. Verano; Nixon/*S.scabra* cv. Seca; *Bothriochloa pertusa* cv. Bowen/Verano and Bowen/Seca were studied. Each mixture was grown in a low P, low N soil, in pots. A standard replacement series design with two P levels (0 and 10 kg/ ha equivalent) and 3 replicates were used. Seventy days after sowing, Nixon mixtures outyielded Bowen mixtures, and Verano mixtures outyielded Seca mixtures. P increased top and root yields of all mixtures but there was no significant ($p>0.05$) effect on botanical composition. In pure stands, root yield of the grasses increased with P, but root yield of the legumes did not.

KEYWORDS
Fertiliser, competition, grass/legume mixture, *Stylosanthes*, *Urochloa*, *Bothriochloa pertusa*

INTRODUCTION
The amount of P available to grass/legume pastures in northern Australia is a most important determinant of yield and botanical composition (Jones, 1990). However, the outcome of improving the P nutrition of grass/legume pasture through fertilisation is complex and depends on many other contributory factors especially soil fertility, the pasture species present and grazing pressure (Coates *et al.*, 1990; Jones, 1990). The objective of this paper was to measure the effects of P application on competition in four tropical grass/ legume mixtures in the establishment phase and to relate these to the poorer compatibility of Verano with Bowen in a field study (Jones and Kerr, 1993).

METHODS
A pot experiment was carried out in a glasshouse and a replacement series experimental design (de Wit, 1960) was used. This involved the use of 4 grass/legume mixtures x 2 fertiliser treatments ((+P and control (without P)) x 5 legume : grass ratios. The treatments were randomised within 3 replicate blocks. Two grasses: *Urochloa mosambicensis* cv. Nixon (Nixon) and *Bothriochloa pertusa* cv. Bowen (Bowen); and two legumes *Stylosanthes hamata* cv. Verano (Verano) and *Stylosanthes scabra* cv. Seca (Seca) were used to form four mixtures: Nixon/Verano, Nixon/Seca, Bowen/Verano and Bowen/Seca. The P treatment used sodium dihydrogen orthophosphate ($NaH_2PO_4.2H_2O$) (19.9% P) dissolved in water and was applied to the pots at the equivalent of 10 kg P/ha. Each pot was filled with 1.25 kg soil. The soil used was the top 10 cm of a yellow earth/podzolic intergrade. Pots were watered to field capacity. The plants were harvested by cutting at ground level 70 days after sowing. All pots (120) were then washed and sieved to recover roots.

RESULTS
There were no significant ratio x P treatment effects and so only the means of the ratios 0.25, 0.5 and 0.75 are presented for the various mixtures. Overall, P increased mean total pot yield by about 50%. Both grasses and legumes responded to P. Nixon mixtures outyielded Bowen mixtures and Verano mixtures outyielded Seca mixtures (Table 1). Bowen was more responsive to P than was Nixon. Nixon/ Verano gave a significantly higher yield than Bowen/Verano or Bowen/Seca ($p<0.05$) (Table 1). The grass yields were in the order: Nixon with Seca > Bowen with Seca ($p>0.05$) > Nixon with Verano ($p<0.05$) > Bowen with Verano ($p<0.01$) (Table 1). Verano was more responsive to P than was Seca. In mixtures, Seca was lower yielding than Verano ($p<0.05$) (Table 1). The legume percentage in mixtures did not differ greatly ($p>0.05$) between +P soil and the control soil. However, Verano percentage was higher than Seca in both mixtures ($p<0.01$). Verano percentage was lower when mixed with Nixon than with Bowen. Seca percentages were similar when grown with either Nixon or Bowen (Table 1). Root yields generally followed the pattern of top growth yields, but significant response to P only occurred with Nixon/Verano. However, root yields for the pure legume pots were not increased with P fertiliser as were root yields of the pure grass pots (Table 2.)

DISCUSSION
The above-ground yield response by all species to P fertiliser when grown in mixtures, resulting in no change in botanical composition, indicates that there was no clear competitive advantage for grasses over legumes and vice versa. Neither was there any evidence that Nixon was more compatible with Verano than was Bowen as occurred in a grazing experiment (Jones and Kerr, 1993). Mclvor (1984a) reported that all four species (Nixon, Bowen, Verano and Seca) responded to phosphorus application, especially in the P range from 0 to 20 kg/ha. Nixon, however, was more responsive to phosphorus than Bowen, and the grasses were more responsive than the legumes. However, N may not have been limiting in the experiment of McIvor since N concentration in Nixon was over 2.5% (McIvor, 1984a and b) compared with 0.8% in this experiment. This may well explain the different results we obtained.

In the field, increasing rates of P fertiliser led to grass dominance over time in Nixon/Verano mixtures (McIvor, 1984a and b). However, in the first year of that experiment the Nixon response to P was overall small, but there was a large response in later years. Similar results were obtained by Coates *et al*. (1990) in grazed pastures. This may be associated with increasing N in the system from N fixation by the legume and/or an increased response to P by the grass when soil N availability has been improved. Additionally, increased grass root yields relative to legume root yields may have improved the competitive ability of the grass over time and in periods of moisture stress. Verano gave more than double the yield of Seca with both grasses and at the two P levels (Table 1.). This fast early growth of Verano may be associated with its more annual habit and larger seeds. This trend may be reversed in well established pasture since Seca is a deep rooted drought-resistant perennial (Williams and Gardener 1984) and is known to increase in dominance over time in grazed pastures (Jones *et al*., 1996).

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Table 1

Dry matter yields for the components of the four grass/legume mixtures (means of the 0.25, 0.5 and 0.75 ratios)

Yield (g/pot)	**TREATMENTS**							
	Nixon				Bowen			
& legume %	with Verano		with Seca		with Verano		with Seca	
	control	+ P	control	+ P	control	+ P	control	+ P
Total	7.78A	10.50B	6.91A	9.72B	5.46A	9.33B	5.11A	9.15B
Grass	4.26a	5.16a	5.37A	7.65B	2.49a	3.95a	3.82A	7.02B
Legume	3.52a	5.34b	1.54a	2.07a	2.97A	5.38B	1.29a	2.13a
Legume%	45.2a	50.1a	24.8a	20.3a	55.2a	57.5a	24.1a	22.1a
Mean (total)	9.14a		8.31ab		7.40b		7.12b	
Mean (grass)	4.71a		6.51b		3.22c		5.42ab	
Mean(legume)	4.43a		1.81b		4.18a		1.71b	
Mean %legume	47.7a		22.6b		56.4a		23.1b	

A and B are significantly different ($p<0.01$); a, b and c are significantly different ($p<0.05$) between P treatments within a mixture, and across mixtures for mean values.

Table 2

Effects of +P fertiliser on DM root yields (g/pot) in mixtures (mean of three grass:legume ratios) and in pure stands

	Treatment	
Mixture & Pure stand	Control soil root DM	+ P soil root DM
Nixon/Verano	2.57a	3.11b
Nixon/Seca		
.		
.. 2.45a	2.89a	
Bowen/Verano	2.22a	2.45a
Bowen/Seca	1.66a	1.85a
Nixon pure stand	1.79A	2.51B
Bowen pure stand	1.24a	1.64b
Seca pure stand	1.70a	1.84a
Verano pure stand	2.77a	2.80a

A and B significantly different ($p<0.01$); a and b are significantly different ($p<0.05$) between P treatments.