THE RESPONSE TO NITROGEN AND PHOSPHORUS FERTILIZER OF NATIVE PASTURE ON THE BALBIRINI LAND SYSTEM IN NORTH-WEST QUEENSLAND

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ABSTRACT

The response to nitrogen and phosphorus of a mid height grassland vegetation referred to as the bluegrass (Dichanthium *spp.)-browntop* (Eulalia fulva) *plains, and growing on heavy clay soils, was assessed in two field experiments sited* 60 *km south of Normanton in north-west Queensland.*

In the first experiment six levels of phosphorus (nil to 200 *kg P* ha^{-1}*) applied at the beginning of the experiment, failed to increase total dry matter yield when sampled over a 4-year period.*

In the second experiment four levels of phosphorus (nil to 100 *kg P* ha^{-1}*) in a factorial combination with four levels of nitrogen (nil to* 224 *kg N* ha^{-1}*) were applied at the beginning of the experiment. The highest level of nitrogen increased total dry matter yield over the control by* 56 *per cent in the first year and by* 22 *per cent in the second year. Phosphorus application failed to increased total yield and no interaction occurred. Nitrogen increased nitrogen percentage of three native grasses and phosphorus increased phosphorus percentage of these three grasses and of* Rhynchosia minima *when each was sampled in the third year following application of the fertilizer.*

INTRODUCTION

The Balbirini land system is the largest of the five which make up the bluegrass-browntop plains of the Gulf of Carpentaria (Perry 1964). Soils are grey and brown, of heavy texture, and support a mid height grass vegetation regarded as high yielding but of low quality, particularly in the dry season (Perry 1964, Bishop 1973). A large proportion of the beef cattle in north-west Queensland are grazed on this grassland vegetation. Efforts to improve pasture quality through introduction of new pasture species have been unsuccessful (Bishop 1973).

The climate is monsoonal with over 80% of the annual rainfall occurring during the four summer months December to March. Topography is flat to gently undulating with total elevation below 150 m and local amplitude less than 3 m. A detailed description of the region is given by Perry (1964) and Bishop (1973).

To further characterize this grassland vegetation two experiments were conducted to measure the effects of added nutrients on growth and chemical content of the major species.

MATERIALS AND METHODS

The soil is a slightly alkaline (pH 7.7) grey silty clay containing 5 ppm available P, 0.53 m.e.% replaceable K and less than 10 ppm Cl^- in the surface 10 cm. The bulk density of this surface layer is 1.34 g cm^{-3}. A representative site was selected on Milgarra Station 60 km south of Normanton and fenced in December 1967. The pasture was mown to a height of 10 cm.

In experiment 1, six rates of phosphorus were hand broadcast onto 10 m × 5 m plots arranged in a randomized block with four replications. Phosphorus was applied as "Aerophos" (monosodium phosphate) at rates equivalent to nil, 12.5, 25, 50, 100 and 200 kg P ha^{-1}.

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In experiment 2, four rates of phosphorus and four rates of nitrogen were arranged in a factorial design with three replications. Plot size was 10 m × 5 m. Phosphorus was applied as "Aerophos" (monosodium phosphate) at rates equivalent to nil, 25, 50 and 100 kg P ha^{-1} and nitrogen as urea (46 per cent N) at rates equivalent to nil, 56, 112, 224 kg N ha^{-1}. Also for this experiment a basal dressing of 125 kg ha^{-1} muriate of potash, 8 kg ha^{-1} copper sulphate, 8 kg ha^{-1} zinc carbonate, 8 kg ha^{-1} iron chelate, 4 kg ha^{-1} borax and 0.5 kg ha^{-1} ammonium molybdate was applied as an insurance against deficiency of any other elements.

In both experiments fertilizer was applied only once, at the beginning of the experiment, in January 1968 in experiment 1 and January 1969 in experiment 2.

Dry matter yield and botanical composition were determined by hand cutting quadrats and separating into the major species components. Material was oven dried and whole plant samples were retained for chemical analysis.

In experiment 1 harvest dates were March 29 and May 7, 1968; April 11, May 20 and September 4, 1969; April 3, 1970 and May 22, 1971. In experiment 2 it was March 20, May 7, August 30 and November 4, 1969; April 2 and August 19, 1970 and May 21, 1971. Datum area at each harvest varied between 2% and 4% of the plot.

Due to the marked seasonal nature of the growing period each harvest date is accepted as an independent estimate of total annual pasture yield. The date of first harvest was governed by the rainfall pattern and pasture maturity. Residual pasture growth was removed prior to each wet season—by accidental fire in 1968 and 1970 and by mowing in 1969.

The major species encountered were bluegrass (*Dichanthium fecundum*), browntop (*Eulalia fulva*), bull Mitchell grass (*Astrebla squarrosa*), hoop Mitchell grass (*A. elymoides*), Flinders grass (*Iseilema* spp.) and the native legume *Rhynchosia minima*. Species of less frequent occurrence were grouped as "other species" and included a wide range which grow on this land system (Bishop 1973).

Rainfall recorded at Normanton 60 km north of the site, is shown for years 1968 to 1971 (Table 1).

RESULTS

The native pasture sampled was highly variable in its pattern of yield and composition. Because of this it was not possible to compare the yield responses of individual species.

In experiment 1 overall pasture yield was unaffected by the application of P fertilizer. Mean yields for the four years were 3 284 kg ha^{-1}, 2 211 kg ha^{-1}, 1 909 kg ha^{-1} and 3 157 kg ha^{-1} respectively.

In experiment 2 N fertilizer at 112 kg ha^{-1} or more increased yield and N % in the first 2 years after application. Phosphorus did not affect yield at any harvest although mean yield in year 1 reached significance between treatments nil and 100 kg ha^{-1} P (Table 2). Interactions between nitrogen and phosphorus were not significant.

A high degree of variability in species distribution is indicated by the figures in Table 3 which show pasture composition expressed as a percentage by weight for the four years in experiment 1.

Nitrogen percentage of the native grasses in experiment 2 was increased by nitrogen application when sampled in the third year following application. (Chemical data for years 1 and 2 were not statistically analyzed due to bulking of replications.) The phosphorus percentage of Mitchell grasses was reduced by nitrogen application but it increased in all species analyzed when phosphorus was applied (Table 4). Interactions between nitrogen and phosphorus were not significant.

In experiment 2 the nitrogen and phosphorus percentages (mean of fertilizer treatments for bulked replications) declined as the year progressed. Between March

TABLE 1

Rainfall (mm) recorded at Normanton 60 km north of the experimental site.*

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1968	298	195	56	89	39	0	2	0	0	1	2	29	711
1969	120	140	162	0	6	5	4	0	0	7	21	221	686
1970	51	93	174	52	0	0	0	0	15	1	3	163	552
1971	47	255	255	83	22	1	0	0	0	20	16	132	831
Mean **(100 years)	259	254	157	32	8	10	4	2	3	9	42	143	923

*Closest detailed rainfall records; Milgarra mean annual rainfall is 710 mm.
**Bureau of Meteorology.

TABLE 2

Total dry matter yield of native pasture in relation to the application of phosphorus and nitrogen fertilizers (Experiment 2).

Treatment	Mean Year 1	Mean Year 2	Year 3 21.v.71
Nitrogen applied			
0 kg ha^{-1}	1676	1671	2883
56 „ „	1905	1704	2521
112 „ „	2141	2013	3026
224 „ „	2614	2037	3243
LSD 5%	327	296	n.s.
Phosphorus applied			
0 kg ha^{-1}	1635	1855	3131
25 „ „	2351	1860	2948
50 „ „	1897	1800	2652
100 „ „	2085	1911	2943
LSD 5%	327	n.s.	n.s.
Mean	2084	1856	2918

TABLE 3

Pasture composition as a percentage by weight of the major species over four years in experiment 1.

Species	Experiment 1			
	Year 1 7.v.68	Year 2 20.v.69	Year 3 3.iv.70	Year 4 22.v.71
Bluegrass/browntop	30	50	25	20
Mitchell grasses	0	15	20	45
Flinders grass	60	0	35	25
Rhynchosia minima	5	30	1	2
Other species	5	5	20	10

20 and May 7, 1969 N% and P% declined as follows—bluegrass browntop 1.49 and 0.19 to 0.78 and 0.10, Mitchell grass 1.91 and 0.24 to 1.00 and 0.13 and *Rhynchosia minima* 3.30 and 0.31 to 1.58 and 0.18 respectively.

DISCUSSION

The data obtained indicate a pasture of great variability in the pattern of species distribution and in their contribution to total dry matter yield between years.

The annual fluctuations in botanical composition or contribution to total dry weight by various species is probably related to the annual rainfall received and its distribution (Perry 1964). Blake (1938) refers to this unstable nature of the native vegetation as a "fluctuating climax". Rainfall data for the actual site are not available and therefore a relationship could not be established for this experiment. However, higher total yields were recorded in 1968 and 1971 when rainfall was closer to the average and a lower yield was recorded in 1970 when rainfall was considerably below average. It is likely that in above average rainfall years some other species, not recorded as major species in this study (for example *Sorghum* spp.), may become more prominent. Fertilizer application has had no effect on composition.

TABLE 4

Nitrogen and phosphorus percentages of three grasses and one legume sampled in the third year (21.v.71) following the application of nitrogen and phosphorus fertilizers (Experiment 2).

	Mitchell grass		Bluegrass/browntop		Flinders grass		*Rhynchosia minima*	
Treatment	% N	% P	% N	% P	% N	% P	% N	% P
Nitrogen applied								
0 kg ha^{-1}	0·63	0·14	0·56	0·13	0·46	0·17	1·64	0·11
56 kg ha^{-1}	0·68	0·15	0·59	0·13	0·50	0·18	1·80	0·13
112 kg ha^{-1}	0·76	0·13	0·62	0·13	0·62	0·19	1·72	0·13
224 kg ha^{-1}	0·93	0·09	0·75	0·11	0·75	0·19	1·58	0·15
LSD 5%	0·05	0·02	0·07	n.s.	0·08	n.s.	n.s.	0·02
Phosphorus applied								
0 kg ha^{-1}	0·77	0·08	0·64	0·07	0·57	0·08	1·63	0·10
25 kg ha^{-1}	0·73	0·14	0·62	0·12	0·57	0·18	1·74	0·12
50 kg ha^{-1}	0·77	0·14	0·63	0·13	0·60	0·22	1·77	0·15
100 kg ha^{-1}	0·73	0·14	0·64	0·16	0·58	0·24	1·61	0·14
LSD 5%	n.s.	0·02	n.s.	0·03	n.s.	0·02	n.s.	0·02

A mean yield of 2 800 kg ha^{-1} for the control over four years, in experiment 1, is considered moderately high for such inherently infertile soil and moderate rainfall. This is comparable to the yield of *Themeda-Sorghum* native pastures growing on Tippera clay loam soils in the Katherine area of the Northern Territory (Norman 1962), with a similar latitude and annual rainfall to this area. The response to applied nutrients in the present study was, however, considerably less than that recorded by Norman. The highest level of applied nitrogen increased total yield over the control by 56 per cent in the application year whereas at Katherine much lower rates of N and P fertilizers increased total yield over the control by 105 per cent.

The residual effect of added nutrients on the N and P percentages of the pasture species (Table 4) indicates that very strong responses in pasture quality may be expected in the year of application.

The N content of the native legume *Rhynchosia minima* was not altered by the application of either nitrogen or phosphorus while they raised phosphorus content only slightly. This is in keeping with the generally low response of the Australian native legumes to added nutrients (Begg 1963, Norris 1972).

At Katherine, Norman (1963) explained the decrease in the N and P percentages for native species as the year progresses as being mainly due to translocation of nitrogen and phosphorus from the above ground to the below ground parts rather than by loss of seed and leaf to the ground.

The information from this study suggests that the native pasture growing on the Balbirini land system has evolved a survival mechanism of low nutrient requirements. The grass and legume species investigated do not respond to added phosphorus and the grasses respond only slightly to added nitrogen. Any increase in production from this grassland vegetation, brought about through improved agronomic measures, would have to involve complete species replacement to take advantage of associated improvement in nutritional status of the system. The present grassland vegetation is best suited to an extensive open range grazing system.

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