NUTRIENT RESPONSES ON A CYPRESS PINE SAND

Exploratory investigations conducted on soils of the Kurrawa Association (Thompson and Beckmann 1960), which occur west of the Condamine River on the Darling Downs in south-eastern Queensland, indicated that growth and persistence of a number of subtropical grasses were severely limited by acute mineral deficiencies. One soil, a deep, slightly differentiated, light grey brown sand (Group 10, Thompson and Beckmann) was selected for study and the results of glasshouse experiments are recorded here.

The soil carries a native vegetation dominated by cypress pine (*Callitris sp.*), bull oak (*Casuarina leuhmannii*), species of *Aristida* and species of *Chloris*. Analyses performed on this soil yielded the following data:—

pH	6·0
Total nitrogen	0·02%
Available P_2O_5	44·0 p.p.m.
Total replaceable bases	1·0 m-equiv.%
Exchangeable K^+	0·05 m-equiv.%

These conform closely with the more detailed analyses of Reeve, Thompson, and Beckmann (1960).

Two pot experiments were conducted with soil from 0–9 in. depth, 4 lb of air-dry soil being contained in 6-in. plastic pots lined with polythene. The nutrient treatments in each experiment were as follows:—

Experiment 1

(1) Ca applied as $CaCO_3$ at 0 and 1 ton/ac
(2) N applied as NH_4NO_3 at 0 and 3 cwt/ac
(3) P applied as $NaH_2PO_4 \cdot 2H_2O$ at 0 and 4 cwt/ac
(4) K applied as KCl at 0 and 2 cwt/ac
(5) Mg applied as $MgSO_4 \cdot 7H_2O$ at 0 and 2 cwt/ac
Basal dressing:— $MnSO_4 \cdot 4H_2O$ at 10 lb/ac; H_3BO_3 at 4 lb/ac; $ZnSO_4 \cdot 7H_2O$ at 10 lb/ac; $FeSO_4 \cdot 7H_2O$ at 56 lb/ac; $Na_2MoO_4 \cdot 2H_2O$ at 1 lb/ac; $CuSO_4 \cdot 5H_2O$ at 10 lb/ac.

Experiment 2

(1) Cu applied as $CuSO_4 \cdot 5H_2O$ at 0 and 7 lb/ac
(2) Zn applied as $ZnSO_4 \cdot 7H_2O$ at 0 and 7 lb/ac
(3) B applied as H_3BO_3 at 0 and 7 lb/ac
(4) Mo applied as $(NH_4)_6Mo_7O_{24} \cdot 4H_2O$ at 0 and 1 lb/ac
(5) Mn applied as $MnSO_4 \cdot 4H_2O$ at 0 and 7 lb/ac
Basal dressing:—NH_4NO_3 at 4 cwt/ac; $NaH_2PO_4 \cdot 2H_2O$ at 4 cwt/ac; KCl at 2 cwt/ac.

Each experiment was a 2^5 factorial design confounded into four blocks each of eight pots.

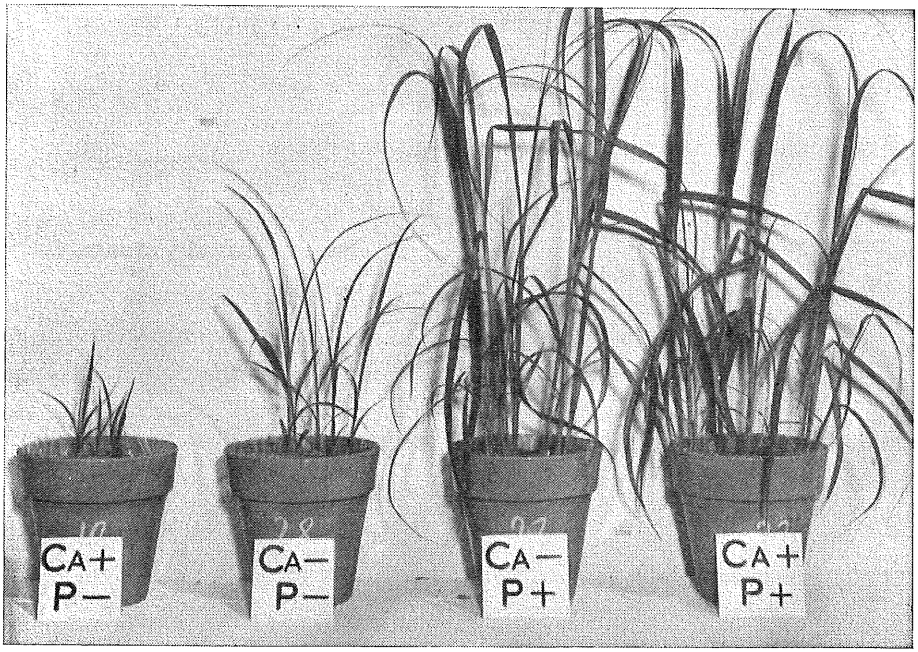

Fig. 1.—Showing depressive effect at first harvest of calcium in the presence of phosphorus.

Nutrients were applied as analytical-grade reagents in solution, except for $CaCO_3$ in Experiment 1, which was thoroughly mixed with the soil. Application rates were calculated on a volume basis per-acre-9 in.

Biloela buffel grass (*Cenchrus ciliaris*) was sown and seedlings thinned to seven per pot. Pots were watered regularly with distilled water to field capacity. Plants were harvested approximately seven weeks after emergence, when increases in plant height had ceased. In Experiment 1, nitrogen treatments were refertilized with NH_4NO_3 at 3 cwt/ac after harvest and the regrowth harvested after a further eight weeks. Plant material was dried at 105°C for 24 hr and weighed. Plant height (height of longest leaf) was measured weekly.

The pertinent yield data are shown in Tables 1 and 2, and some indication of responses is given in Figures 1 and 2.

TABLE 1
RESPONSES TO N, P AND K
Oven-dry Plant Yield (g per pot)

		O	N	O	K	Necessary Differences for Significance	
						5%	1%
1st Harvest, March 31, 1959	O	0·65	0·91	0·80	0·76	0·62	0·86
	P	1·59	7·28	3·94	4·93		
2nd harvest, May 27, 1959 ..	O	0·30	0·92	0·61	0·61	0·65	0·91
	P	0·26	2·57	1·43	1·40		

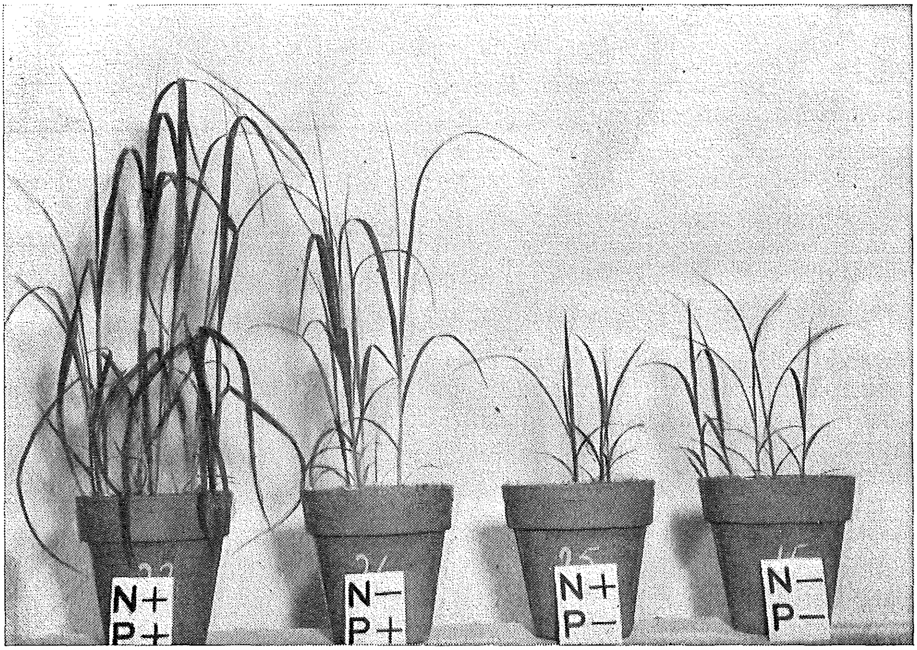

Fig. 2.—Showing typical response at first harvest to phosphorus and to nitrogen in the presence of phosphorus.

At the first harvest, phosphorus gave the greatest yield response; but nitrogen and potassium produced yield responses in the presence of applied phosphorus. With regrowth, nitrogen deficiency became acute and the nitrogen/phosphorus interaction persisted. The potassium response did not recur with regrowth. It would seem unlikely that the initial application of this element had been fully utilized or that its availability had been reduced by exchange mechanisms. It is possible that potassium is present in marginally deficient levels.

Calcium carbonate tended to produce a yield depression in the presence of nitrogen and absence of phosphorus. This depression became more marked in the regrowth, when the response to phosphorus was most pronounced in the presence of calcium. The positive interaction between calcium and phosphorus approached significance. For the first stage of Experiment 1, the depressive effect of calcium in the absence of phosphorus was seen in a significant reduction ($P<0\cdot01$) on average growth rate computed according to the formula:—

Average growth rate $= 1/10\ (2l_5 + l_4 - l_2 - 2l_1)$, where $l =$ plant height (in.) and subscript $=$ age in weeks.

This formula provided a satisfactory representation of the height/time curves.

Plant yields were increased by applications of copper, zinc and manganese, and the responses to these elements were additive.

No responses were obtained to magnesium, boron or molybdenum.

TABLE 2

RESPONSES TO CU, ZN, AND MN

Oven-dry Plant Yield (g per pot)

	O	Zn	O	Mn		O	Mn
O	1·58	2·38	1·40	2·56	O	1·54	2·66
Cu	2·62	3·68	2·74	3·56	Zn	2·60	3·46

Necessary difference for significance { 5% 0·38; 1% 0·54 }

Copper-deficient plants displayed a whitening of the leaf lamina, while plants suffering the triple deficiency of zinc, copper and manganese exhibited leaf-tip necrosis and ceased growth after four weeks. The whitening associated with copper deficiency has been observed in the field on Biloela buffel grass treated with a 5:13:5 fertilizer.

In these experiments the soil has been found acutely deficient in nitrogen, phosphorus, copper, zinc and manganese and slightly deficient in potassium and calcium. It is probable, though not certain, that responses to the same elements would be obtained in the field.

On this assumption, and from field observations, it would seem that future developmental work on this soil would be best directed at nematode-resistant leguminous species which do not respond to applied nitrogen, and which would persist under low-fertility conditions.

REFERENCES

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