

THE EFFECTS OF DIETARY NITROGEN AND CALCIUM SUPPLEMENTATION ON *BOS INDICUS* CROSS CATTLE OFFERED LOW P DIETS.

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SUMMARY

Sixteen *Bos indicus* cross steers were fed low phosphorus (P) diets based on barley straw supplemented with nitrogen (N) and calcium (Ca) for a period of 22 weeks. Liveweight change was severely reduced when no N supplement was provided or when supplements of N and Ca were provided together. Under low dietary N conditions plasma inorganic P was elevated in spite of the low P intake. Low N diets were found to have no effect on Ca and P retention but the coefficient of absorption of Ca was affected by the levels of both N and Ca in the diet. The results are discussed in relation to cattle grazing tropical pastures containing *Stylosanthes* legumes.

Keywords: cattle, calcium, nitrogen, phosphorus, deficiencies.

INTRODUCTION

Studies with young sheep (Field *et al.* 1975; Temouth and Sevilla 1990) have shown that under conditions of adequate dietary N, dietary Ca and P concentrations affect food intake and growth. A high Ca diet has been shown to exacerbate the effect of a P deficiency alone on feed intake, liveweight change and plasma P (Field *et al.* 1975).

In cattle and sheep, a N-deficient diet causes an immediate depression of food intake whilst a low P diet results in a depression after 4-8 weeks (McLachlan and Temouth 1985; Bortolussi *et al.* 1988). Reducing dietary N concentration does not change P absorption but reduces Ca absorption (Braithwaite 1978; Tuen *et al.* 1984). The interactions of dietary P, N and Ca have particular relevance to the grazing of improved tropical *Stylosanthes*-dominant pastures in northern Australia (Gilbert *et al.* 1989). This experiment examined the effects of dietary N and Ca on steers fed a low P diet.

MATERIALS AND METHODS

Sixteen *Bos indicus* cross cattle (264 ± 28 kg) were assigned on a random stratified weight basis to the diets of a 2×2 experiment consisting of low (L) and high (H) quantities of Ca and N. The diets consisted of limited daily quantities of sorghum (250 g), formaldehyde-treated cottonseed meal (100 g), mineral mix and N and Ca supplements offered with coarsely hammer milled barley straw [3.87 g N, 0.59 g P and 2.19 g Ca/kg dry matter (DM)] *ad libitum* for a period of 22 weeks. The HN and HCa supplements were urea and limestone included in the diets at daily rates of 70 and 40 g/head respectively. Feed intake was recorded weekly. Blood was collected and the cattle weighed fortnightly, immediately prior to feeding.

Studies of Ca and P balance and kinetics were conducted during weeks 10 and 11. The animals were provided with in-dwelling jugular catheters, infused with approximately 90 MBq of ³²P and ⁴⁵Ca and housed in metabolism cages for 7 days for collection of blood, faeces and urine as described by Temouth and Sevilla (1990) in sheep and Temouth *et al.* (1990) in cattle.

Plasma inorganic P was determined using the method of Little *et al.* (1971) and plasma urea-N using a Boehringer Mannheim diagnostic kit. Feed and faeces were dried at 60°C in an oven for 48 hours to measure dry matter content. Deproteinised plasma and wet digested faecal samples were assayed for radioactivity using Emulisifersafe (Packard) as a scintillant (Temouth and Sevilla 1990). Faecal endogenous Ca and P were estimated as described by Temouth *et al.* (1990).

RESULTS

The steers on the high and low N treatments consumed diets containing 11.1 and 6.2 g N / kg DM respectively whilst those on the high and low Ca had diets containing 4.6 and 2.1 g Ca / kg DM respectively. There were no differences between treatments in dietary P concentration (0.94 g/kg DM).

The LN diets resulted in an immediate and major decrease in feed intake and liveweight gain of the cattle (Table 1, Fig. 1). The cattle offered the LN diets had a higher plasma P but lower plasma Ca and urea N and N balance. There was a negative relationship between plasma urea N and plasma P (Fig. 2). There were no differences between dietary treatments in organic matter digestibility (0.63 g/g). The differences in N intake between the high and low N intakes was reflected in smaller differences in N balance. The cattle offered the low N diets had a negative balance (Table 2).

Table 1. The effects of dietary N and Ca supplementation (HN and HCa) of a low P roughage diet on feed intake, liveweight gain and plasma concentration of Ca, P and urea N

	HNHCa	HNLCa	LNHCa	LNLCa	s.e.m.	Significance of effect		
						N	Ca	N x Ca
<i>Feed intake (g/kg LW.day)</i>								
Weeks 1–8	21.8	22.3	17.6	17.9	0.72	***	n.s.	n.s.
Weeks 9–16	21.0	22.6	17.3	16.4	0.79	***	n.s.	n.s.
Weeks 17–22	18.9	19.7	16.8	16.7	0.88	*	n.s.	n.s.
Overall mean	20.8	21.7	17.3	17.1	0.54	***	n.s.	n.s.
<i>Liveweight change (g/day)</i>								
Weeks 8–0	83.9	455.4	–112.5	–280.4	72.1	***	n.s.	**
Weeks 16–8	214.3	267.9	–8.9	–101.8	83.2	***	n.s.	n.s.
Weeks 22–16	–90.5	59.5	–119.0	119.0	114.8	***	n.s.	n.s.
Overall mean	84.4	279.2	–76.6	–105.8	51.6	***	n.s.	n.s.
<i>Plasma concentration (mg/dL)</i>								
Ca	11.69	11.67	11.19	11.57	0.13	*	n.s.	n.s.
P	4.36	5.05	6.74	6.54	0.16	***	n.s.	*
Urea N	8.14	6.99	3.18	2.63	0.53	***	n.s.	n.s.

P* < 0.052; *P* < 0.01; ****P* < 0.001; n.s., not significant.

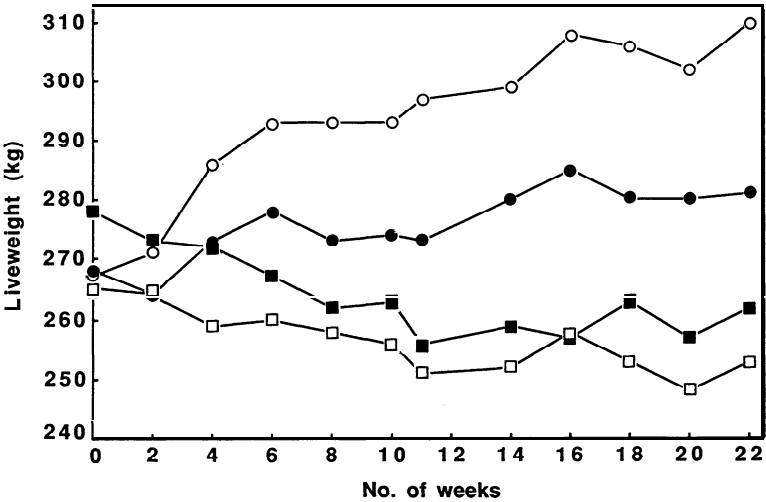


Fig. 1. The effects of feeding diets containing high and low levels of Ca and N on liveweight change of Brahman cross steers. ○ high N, low Ca; ● high N, high Ca; ■ low N, high Ca; □ low N, low Ca.

There were no differences between the Ca treatments in feed intake or liveweight gain nor in plasma Ca, P or urea N. Although there was no dietary interaction for feed intake, plasma Ca or urea N, there was an interaction between N and Ca for plasma P. Overall, there was a trend towards an interaction between treatment in liveweight gain (*P* = 0.052). The HNLCa treatment had the highest liveweight gain and the LNLCa the lowest.

There were large differences in Ca intakes between the high and low Ca diets and these were associated with differences in the coefficient of absorption so there were no differences in the Ca balances. A significant N x Ca interaction was found for the Ca absorption coefficient, with the cattle

Table 2. Dry matter intake and nutrient balances of cattle offered diets containing high (H) and low (L) concentrations of Ca and N and low levels of P

	HNHCa	HNLCa	LNHCa	LNLCa	s.e.m.	Significance of effect		
						N	Ca	N x Ca
DM intake (kg /day)	5.14	6.10	4.30	3.86	0.26	***	n.s.	*
N intake (g /day)	58.73	62.33	25.72	24.11	0.94	***	n.s.	*
balance (g /day)	6.95	5.98	-0.63	-0.64	2.03	***	n.s.	n.s.
Ca intake (g /day)	22.84	11.32	21.30	7.18	0.49	***	n.s.	n.s.
balance (g /day)	2.78	-0.47	-0.95	1.66	1.44	n.s.	n.s.	n.s.
absorp. coefficient	0.33	0.36	0.16	0.66	0.06	n.s.	***	**
P intake (g /day)	4.63	5.24	4.72	4.41	0.16	*	n.s.	*
balance (g /day)	0.16	0.21	0.28	0.68	0.28	n.s.	n.s.	n.s.
absorp. coefficient	0.78	0.81	0.83	0.81	0.04	n.s.	n.s.	n.s.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; n.s., not significant.

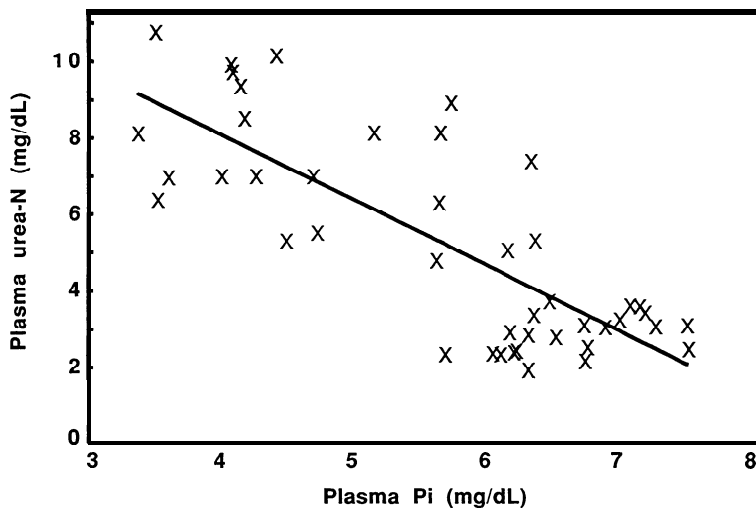


Fig. 2. The relationship between plasma urea N (PUN) and plasma inorganic P in N and Ca supplemented steers. The equation of the line is:

$$\text{PUN} = 14.91 - 1.704(\pm 0.208) \text{ P} \quad (\text{r.s.d.} = 1.69; \text{d.f.} = 42; P < 0.01).$$

fed the LNLCa diet having a high coefficient and the LNHCa a very low coefficient. The mean faecal endogenous Ca was 13.95 mg/kg LW with an absorption coefficient of 0.35.

Although there were small differences in P intake, there were no differences in P intake, absorption or balance. The mean endogenous P loss was 12.95 mg/kg LW and the absorption coefficient was 0.81.

DISCUSSION

The changes in plasma P, liveweight and feed intake over the experimental period in the 2 HN diets were similar to those reported by Field *et al.* (1975) in which the high Ca intake amplified the effect of the low P intake (Boxbeld *et al.* 1983). The existence of a N x Ca interaction for liveweight change and plasma P suggests there is an unsatisfied requirement for P under conditions of high dietary N and Ca. The P absorption coefficients were high in all 4 treatments. These results suggest that when *Stylosanthes* spp. growing on low P soils are grazed there is the need to supplement the animals with P to balance the effects of high dietary N and Ca (Gilbert *et al.* 1989; Winter *et al.* 1990).

The amounts of dietary Ca and P that were absorbed were unaffected by the dietary N deficiency. When the LNHCa diet was fed, the Ca absorption coefficient was reduced as reported earlier by

Braithwaite (1978) and Tuen *et al.* (1984). However, when the LNLCa diet was fed, the absorption coefficient increased. The reason for this is yet to be established.

The low N diets resulted in a reduction in feed and P intake. The secretion of salivary P might be expected to be reduced under these conditions resulting in a lower endogenous loss of P (Temouth 1989). However, the endogenous loss was unchanged between the 4 diets, probably due to the higher concentration of plasma P in the cattle fed the LN diets. The effect of a dietary N deficiency was to mask the effects of a P deficiency on plasma P so that care is required when using this parameter to assess P intake since consideration must be given to the effect of other dietary factors, particularly N.

ACKNOWLEDGMENTS

The authors would like to thank the Meat Research Corporation for funding this research project. We would also like to thank the staff of Mt Cotton Research Farm for their assistance with the trial and Mrs D. Burling for her laboratory assistance.

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