

EFFECT OF FERTILISER AND SUPPLEMENTARY PHOSPHORUS ON THE INTAKE AND DIGESTIBILITY OF THE LEGUME *Desmodium intortum*

T. R. Evans¹, J. C. P. Severo, D. J. Minson² and J. H. Ternouth³

CSIRO Division of Tropical Crops and Pastures, 306 Carmody Road
and The University of Queensland, St Lucia, Brisbane
Queensland 4067, Australia

Summary

The application of fertiliser P to *Desmodium intortum* at 40, 60 and 100 kg/ha resulted in the P content of the legume regrowth being 0.10, 0.13 and 0.16% on a dry matter basis. When the forages were fed alone to sheep in metabolism pens the corresponding voluntary intakes by sheep of the three forages were 27.3, 42.7 and 54.3 g/W_{kg}^{0.75}, respectively. Provision of additional P by rapid infusion into the rumen each morning before any fresh food was offered depressed the voluntary intake of all three feeds. It is suggested that the adverse effect of supplementary P was probably caused by an induced deficiency of either Ca or Mg and led to a reduction in microbial activity in the rumen. (Key Words: Phosphorus, Voluntary Intake, Digestibility, *Desmodium intortum*)

Introduction

The voluntary intake of forages low in phosphorus (P) can usually be increased by feeding P supplements or raising the level of P in the forage by applying P fertilisers (Minson, 1990; Winter et al., 1990). However, where the forage contains adequate levels of P, feeding a P supplement may have an adverse effect on voluntary intake. The voluntary intake *Digitaria decumbens* containing 0.26% P was depressed 6% by oral supplementation with monosodium phosphate (Rees and Minson, 1982) whilst the intake of lucerne was unaffected (Milton, 1984). Similarly, continuous infusions of monosodium phosphate resulted in reductions in the intake of chopped barley straw but not chopped lucerne (Milton, 1984). It was hypothesised by Rees and Minson (1982) that this adverse effect on grass diets may have been caused by a reduction in the Ca:P ratio and a reduction in the level of available Ca below the critical level required by the

microorganisms in the rumen. The feeding of phosphorus supplement should have no adverse effect on the voluntary intake of leguminous forages which contain approximately three times as much calcium as grasses (Minson, 1990).

This paper describes the effect of phosphorus fertiliser and supplementary phosphorus on the voluntary intake and digestibility of the tropical legume *Desmodium intortum* (greenleaf desmodium) when dried and fed to sheep in pens.

Materials and Methods

Forage

Desmodium intortum (greenleaf desmodium) was established in 1970 as a pure sward at the Beerwah Pasture Research Station on land cleared of Eucalyptus forest and which had not previously been sown to pasture or fertilised. The soil was classified as a Beerwah soil type 5-Gleyed podzolic (Thompson, 1958); Dy 5.41 (Northcote, 1971). Before the pasture was sown, fertiliser was applied at the levels recommended by Andrew and Bryan (1955) except that in the present study three levels of phosphorus (P) were applied as monoammonium phosphate: 40, 60 and 100 kg P/ha. In the establishment year, the pastures were cut and fed to cattle to determine the effect of treatment on diet selection. The results clearly indicated a selection for herbage fertilised at the higher P levels. On this basis a pen feeding study

¹Present address, Miers Road, Ocean View, Dayboro, Queensland 4521, Australia.

²Address reprint requests to Dr D. J. Minson, CSIRO Division of Tropical Crops and Pastures, 306 Carmody Road, St Lucia, Brisbane, Queensland 4067, Australia.

³The University of Queensland, St Lucia, Brisbane, Queensland 4067, Australia.

Received August 27, 1992

Accepted December 4, 1992

was established to further explore these responses. Early in the following growing season (spring) the pastures were topped and 10 weeks later the regrowth was cut with a reciprocating mower, chopped into approximately 3 cm lengths, dried for 24 hours in a batch drier at an inlet temperature of 100°C (Minson, 1981), weighed and stored in hessian sacks until fed. Samples of the legume were manually separated into leaf and stem to determine the proportion of leaf.

Animals and feeding regime

Eighteen 2 year-old Polwarth wether sheep, with an initial liveweight between 40 and 53 kg, were used to measure voluntary intake and digestibility in three periods each with a 7-day preliminary period and a 10-day measurement period. Each forage was offered *ad libitum* to a group of six sheep so that after completing the three periods each forage was fed to a total of 18 sheep. The sheep were not fed any grain supplement.

Half the sheep fed each diet in each period were given rapid oral infusions of 54 ml of a monosodium phosphate (MSP) solution containing 1.1 g P daily prior to feeding. The unsupplemented sheep were drenched with 54 ml of sodium chloride solution containing the same quantity of sodium. No sheep received the same supplement in successive periods. The sheep were randomly allocated to the treatments and kept in metabolism pens (Minson and Milford, 1968).

Determination of voluntary feed intake

Voluntary intake was determined by feeding

about 250 grams of feed in excess of the expected voluntary intake (and maintaining this level of excess feed) throughout the experimental period (Minson, 1990). Feed residues from each animal were removed, dried and weighed at the end of the 10-day measurement period. Voluntary intake was expressed as a function of metabolic size ($g/W_{kg}^{0.75}$).

Digestibility

Faeces were collected each day in canvas bags attached to the sheep (Weston, 1959) during the 10 days in which voluntary intake was measured, dried overnight at 100°C and stored. At the end of the 10-day period, all the faeces were redried and weighed.

Chemical analysis

Ground samples of the feed were analysed for N by the Kjeldahl method and minerals by emission spectroscopy (Johnson and Simons, 1972).

Results

Composition of the diets

Applying higher levels of P fertiliser increased the P level in the forage (table 1). High levels of phosphorus fertiliser also increased the level of most other elements other than sodium although most of these increases were relatively small. Thus, while 100 kg/ha of fertiliser P increased the P concentration of the legume by 60%, compared with 40 kg/ha fertiliser, nitrogen (N) was increased by only 28%, sulphur (S) by 25%

TABLE 1. COMPOSITION (%) OF THE DRIED *Desmodium intortum* OFFERED TO SHEEP

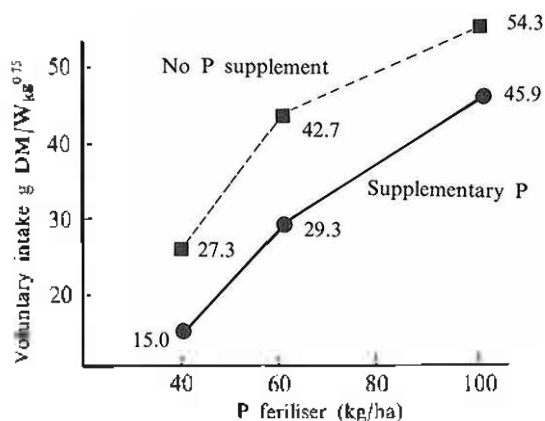
	Fertiliser P (kg/ha)			Maintenance allowance (Minson, 1990)
	40	60	100	
Leaf	60.4	63.3	57.5	—
P	0.10	0.13	0.16	0.09
N	1.52	1.81	1.94	1.60
S	0.12	0.15	0.15	—
K	0.65	0.70	0.73	—
Na	0.03	0.03	0.03	0.13
Cu	0.51	0.51	0.56	0.11
Mg	0.20	0.21	0.23	0.09
Ca : P	5.1 : 1	3.9 : 1	3.5 : 1	—
N : S	13 : 1	12 : 1	13 : 1	—

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and there were even smaller increases in potassium (K), calcium (Ca) and magnesium (Mg). There were no significant differences in the concentration of sodium or the proportion of leaf.

Voluntary intake

The voluntary intake of desmodium by the sheep was increased from 21 to 50 g/W $\text{kg}^{0.75}$ by applying higher levels of P fertiliser ($p < 0.001$). This increase in voluntary intake with increasing levels of P occurred whether or not P supplement was fed (figure 1). Although increasing the level of fertiliser improved voluntary intake, feeding a P supplement depressed the voluntary intake of all three feeds. There was no interaction between the effects of fertiliser and supplement ($p > 0.05$).



Least significant difference (fertiliser P)

$$p < 0.01 = 8.7$$

Least significant difference (supplementary P)

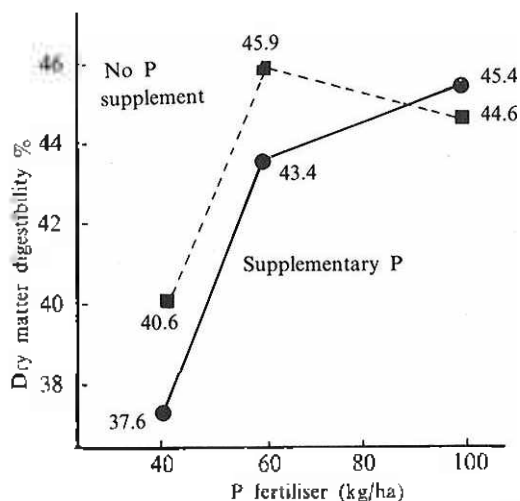
$$p < 0.01 = 7.7$$

Figure 1. The voluntary intake by sheep of desmodium grown with three levels of P fertiliser and fed with and without P supplements.

Digestibility

When the desmodium fertilised with 60 kg P/ha was fed to unsupplemented sheep the dry matter digestibility (DMD) was 45.9%, 5.6% higher ($p < 0.01$) than for forage fertilised with 40 kg P/ha (figure 2). Increasing the level of fertiliser to 100 kg P/ha caused a small, non-significant decrease in DMD. Feeding a P supplement decreased DMD by 3.0 and 2.5%

for forage fertilised with 40 and 60 kg P/ha respectively ($p < 0.05$) but slightly increased ($p > 0.05$) the DMD of forage fertilised with 100 kg P/ha (figure 2).



Least significant difference (fertiliser P)

$$p < 0.01 = 4.0$$

Least significant difference (supplementary P)

$$p < 0.01 = 3.3$$

Figure 2. The digestibility of dry matter in sheep of *Desmodium intortum* grown with three levels of P fertiliser fed with and without P supplementation.

Intake of digestible dry matter

Applying 100 kg P/ha increased the intake of digestible dry matter (IDDM) from 8.36 g/W $\text{kg}^{0.75}$ for 40 kg P/ha to 22.21 g/W $\text{kg}^{0.75}$, a rise of 160%. Conversely, feeding a P supplement depressed the IDDM of all three diets with a mean difference of 14%.

Discussion

Increasing the quantity of fertiliser P from 40 to 100 kg/ha led to large increases in the voluntary intake of desmodium. This result is in agreement with previous studies with mixed pasture containing *Trifolium subterranean* and *Vulpia myuros* (Ozanne et al., 1976) and pastures of *Stylosanthes humilis* and *Heteropogon contortus* (Playne, 1972). Fertiliser P had little effect on the

voluntary intake of *Digitaria decumbens* (Rees and Minson, 1982), due to either the higher level of P or the lower level of N (0.9-1.0%). The *Digitaria decumbens* contained more than 0.16% P compared with 0.10% P in the desmodium described in this paper that was fertilised at the lower level. The increase in the concentration of S with P fertilisation in the desmodium may have influenced food intake, even though the diet appeared to contain sufficient of the nutrient to satisfy the requirements of the ruminal microbes.

Theiler et al. (1924) showed that the voluntary intake by cattle of hay containing 0.07% P could be increased by 40% by feeding bonemeal (84 g/d), a conclusion confirmed in many other studies (Minson, 1990). In contrast to these studies, feeding supplementary P in the present study depressed the voluntary intake of desmodium grown at all three levels of P fertiliser. This unexpected effect of supplementary P on the voluntary intake was associated with a small non significant depression ($p > 0.05$) in DMD of forage produced at two of the three levels of fertilisation. The cause of this depression in voluntary intake is unknown but may possibly have been associated with the way the P supplement was fed. The P supplement was given each morning as a rapid infusion before any fresh food was offered. The rapid ruminal infusion of a variety of electrolytes before feeding is known to increase osmolality and water intake but they commonly decrease food intake (Ternouth and Beattie, 1971; Milton, 1984). However, infusions of 1.8-5.2 g P as sodium dihydrogen phosphate before feeding had no effect on food intake (Milton, 1984). In the present study the quantity of food in the rumen at the time of infusion would have been relatively small so the P supplement may have precipitated a large portion of the calcium and magnesium in the rumen. The low levels of available calcium and/or magnesium would reduce microbial growth in the rumen and lead to the reduction in digestibility and voluntary intake. It has previously been shown that the appetite of sheep is depressed where the diets are deficient in calcium (Field et al., 1975) or magnesium (Martin et al., 1964).

The DMD of desmodium was increased by applying higher levels of fertiliser P, a result in agreement with results found with a grass-legume mixture (Thornton and Minson, 1973). This

improvement was associated with the increase in P concentration in the forage and hence the P available to the microflora in the rumen. This increase in DMD was unexpected since no improvement was reported in any previous study (Minson, 1990).

It was concluded that increasing the level of P in desmodium by applying P fertiliser improved voluntary intake and digestibility. The relatively small difference in P concentration in desmodium (0.10 to 0.16% DM) increased voluntary intake by 100%, in the absence of a P supplement, which could have a substantial effect on animal response to forages containing these low levels of P concentration. However, supplying additional P as a supplement before feeding should be avoided in pen feeding studies since it has an adverse effect on the voluntary intake of forage.

Acknowledgements

The authors wish to thank A. D. Johnson, R. Needham and P. G. Tuckett for assistance with these studies. The data presented in this paper were collected as part of a study by J. C. P. Severo in partial fulfilment of the requirements for a M. Sc. Agr. at the University of Queensland.

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