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EFFECT OF SULPHUR ON THE PRODUCTIVITY OF A NATIVE PASTURE CONTAINING MEDICAGO MINIMA, ON THE EASTERN DARLING DOWNS, QUEENSLAND

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SUMMARY

Fertilizers were applied to a degraded native pasture on a gravelly basaltic ridge on the eastern Darling Downs containing naturalized woolly burr medic (*Medicago minima*).

A single application of 67 kg S ha^{-1} gave a continuing but decreasing dry matter yield response in medic over 3 years. Additional annual applications of 22 kg S ha^{-1} maintained this response. Yields of native grass measured in the fifth and sixth summers increased with sulphur application. The nitrogen content of both medics and grass was increased by sulphur fertilization.

Nitrogen application of 56 kg ha^{-1} had little effect on the dry matter yield of native grass but nitrogen concentration was increased.

There was no response to phosphorus.

I. INTRODUCTION

Lloyd (1970) described the current native pasture in the mountain coolibah (*Eucalyptus orgadophila*) open woodland of the eastern Darling Downs as a complex of grass species including pitted blue (*Bothriochloa decipiens*), Queensland blue (*Dichanthium sericeum*), yabila (*Panicum queenslandicum*), plains (*Stipa aristiglumis*), and white spear (*Aristida leptopoda*).

Grazing has encouraged colonization of the pasture by woolly burr medic (*Medicago minima*); however, this potentially valuable cool season legume produces little forage under natural conditions in the region.

Commercial application of superphosphate gave improved growth of medic on a site with adequate available soil phosphorus. This suggested sulphur as the deficient element.

At commencement of this trial in 1966 no local record of phosphorus or sulphur response in annual *Medicago* spp. was available, but Hilder and Spencer (1954) had recorded a response of *M. polymorpha* to sulphur on a basaltic soil in New South Wales.

This paper reports results of applications of nitrogen, phosphorus and sulphur to a degraded native grass pasture colonized by woolly burr medic on a site adjacent to where medic responded to superphosphate.

II. MATERIALS AND METHODS

The trial site was a cleared ridge situated 6 km west of Cambooya township (27°42′S, 151°52′E). The shallow basaltic soil was a Kenmuir gravelly clay loam (Thompson and Beckmann 1959). Chemical analysis disclosed a pH of 6·9, acid extractable P>120 p.p.m., and an extractable K level of 1·15 m-equiv. %. The area had not previously been cultivated or fertilized.

Fertilizer was broadcast onto 4 m × 5 m plots on 8 August 1966 in a 2^3 complete factorial layout with three randomized blocks. The initial fertilizer treatments were a factorial combination of:—

1. Nitrogen (N), as urea, at 0 (N_0) and 56 (N_1) kg N ha^{-1}.
2. Phosphorus (P), as monosodium phosphate, at 0, (P_0) and 34 (P_1) kg P ha^{-1}.
3. Sulphur (S), as flowers of sulphur, at 0 (S_0) and 67 (S_1) kg S ha^{-1}.

From 1967, treatments were applied annually to one-half of each original plot as follows:—

1. Nitrogen (N) as ammonium nitrate, at 0 (N_0) and 56 (N_1) kg N ha^{-1} applied in the spring.
2. Phosphorus (P) at 0 (P_0) and 11 (P_1) kg P ha^{-1} applied in autumn.
3. Sulphur (S) at 0 (S_0) and 22 (S_1) kg S ha^{-1} applied in autumn.

Two histories of fertilizer application were therefore:—

1. An initial application only.
2. An initial application plus annual applications.

Sampling for dry matter yields of medic was carried out on 31 October 1966, 8 November 1968 and 14 November 1969. In 1967 depredations of hares precluded effective sampling although a dry matter response to sulphur was obvious. The stock fence was subsequently improved to exclude all animal predators. After an apparent response to fertilizer treatments, native grass production was measured on 17 November 1970, 12 May 1971, 11 January 1972 and 7 June 1972.

At sampling, three 1·00 m × 0·40 m randomly selected quadrats per plot were cut at a height of 1 cm above ground. These samples were dried for 16 h at 80°C, weighed, and dry matter yields of medic and native grass determined. Sub-samples of dried forage were taken for Kjeldahl nitrogen determination.

Before fertilizer application and following sampling, plots were mown to sampling height and the cut material was removed from the experimental area.

Average annual rainfall for Cambooya for the 30-year period 1940-69 is 708 mm, of which two-thirds falls between October and March (Thompson and Beckmann 1959). Annual rainfall from 1966 to 1972 inclusive did not deviate from the average by more than 10% whereas fluctuations between winter and summer growing seasons (May–October and November–April) were slightly greater.

III. RESULTS

Dry matter yields of medic in the first season (October 1966), show increases due to sulphur (table 1). In 1968, sulphur gave a large increase in yield and nitrogen concentration of medic for both histories of application. The effect was much larger where annual applications were made (table 1).

Annual applications of 22 kg S ha^{-1} following initial application of 67 kg S ha^{-1} in 1966 increased dry matter yield and nitrogen concentration of medic in 1969. Where an initial application only of 67 kg S ha^{-1} was applied no dry matter yield or nitrogen concentration response was measured in 1969 (table 1).

Annual applications of 22 kg S ha^{-1} following an initial application of 67 kg S ha^{-1} in 1966, increased dry matter production of native grass in the 1970–71 and 1971–72 seasons (table 2). Both histories of sulphur application increased the nitrogen concentration in native grass at each sampling (table 2).

TABLE 1

MEAN DRY MATTER YIELDS (kg ha^{-1}) AND PER CENT NITROGEN (IN PARENTHESIS) OF MEDIC IN THREE YEARS FOR TWO LEVELS OF SULPHUR APPLIED EITHER ONCE (INITIALLY) OR INITIALLY PLUS ANNUALLY.

Date of Harvest	Initial Only			Initial plus Annual		
	S_0	S_1	Sig. level	S_0	S_1	Sig. level
31 October 1966	1 569 (ND)	3 307 (ND)	P<0·01 ..	.. ..	.. ..	.. ..
8 November 1968 ..	686 (2·0)	1 767 (2·8)	NA NA	692 (1·9)	3 206 (3·0)	NA NA
14 November 1969 ..	1 414 (1·7)	1 808 (1·7)	NS NS	1 542 (1·7)	3 001 (2·4)	P<0·01 P<0·01

ND data not available
NA statistical analyses not available
NS not significantly different

TABLE 2

MEAN DRY MATTER YIELDS (kg ha^{-1}) AND PER CENT NITROGEN (IN PARENTHESIS) OF NATIVE GRASS ON FOUR DATES FOR TWO LEVELS OF SULPHUR APPLIED EITHER ONCE (INITIALLY) OR INITIALLY PLUS ANNUALLY.

Date of Harvest	Initial Only			Initial plus Annual		
	S_0	S_1	Sig. level	S_0	S_1	Sig. level
17 December 1970 ..	1 698 (1·54)	1 671 (1·65)	NS NA	1 562 (1·70)	1 935 (2·05)	P<0·05 NA
12 May 1971	1 536 (0·58)	1 460 (0·68)	NS P<0·01	1 601 (0·76)	1 565 (0·91)	NS P<0·01
11 January 1972	1 314 (1·06)	1 588 (1·19)	P<0·05 P<0·05	1 339 (1·42)	2 116 (1·67)	P<0·01 P<0·01
7 June 1972	1 295 (0·77)	1 477 (0·87)	P<0·05 P<0·01	1 222 (1·09)	1 962 (1·39)	* *

NA statistical analyses not available
NS not significantly different
* significant N x S interaction (P < 0·01)

Nitrogen application had little effect on dry matter yield of native grass but nitrogen content was increased (table 3).

There was no response to phosphorus in either medic or grass.

TABLE 3

MEAN DRY MATTER YIELDS (kg ha^{-1}) AND PER CENT NITROGEN (IN PARENTHESIS) OF NATIVE GRASS ON FOUR DATES FOR TWO LEVELS OF NITROGEN APPLIED EITHER ONCE (INITIALLY) OR INITIALLY PLUS ANNUALLY.

Date of Harvest	Initial Only			Initial plus Annual		
	N_0	N_1	Sig. level	N_0	N_1	Sig. level
17 December 1970 ..	1 633 (1·57)	1 736 (1·62)	NS NA	1 740 (1·85)	1 757 (1·89)	NS NA
12 May 1971	1 427 (0·56)	1 570 (0·70)	NS $P<0·01$	1 518 (0·68)	1 649 (0·99)	NS $P<0·01$
11 January 1972	1 360 (1·12)	1 542 (1·14)	NS NS	1 745 (1·17)	1 710 (1·91)	NS $P<0·01$
7 June 1972	1 340 (0·78)	1 432 (0·86)	NS $P<0·05$	1 485 (0·93)	1 699 (1.55)	* *

NA statistical analyses not available
NS not significantly different
* significant N x S interaction ($P < 0·01$)

IV. DISCUSSION

This investigation has shown that annually broadcast applications of 22 kg S ha^{-1} to a native grass pasture containing annual medic on a shallow basaltic soil of the eastern Darling Downs increased dry matter yields and nitrogen concentration of medic and native grass over several years of near average rainfall. Since the establishment of this trial, Jones (1970) recorded dry matter response in annual medic to sulphur application on a basaltic soil of the eastern Darling Downs while Loader (1974) also reported increased nitrogen content. Anderson and Spencer (1950) showed that dry matter yields and percentage nitrogen of subterranean clover (*Trifolium subterraneum*) were reduced by sulphur deficiency.

Dry matter response of grass to sulphur application has been recorded by Andrew *et al.* (1952) Young and Hirst (1964) and Loader (1974), but in the latter two cases a positive interaction also occurred with nitrogen addition. Anderson and Spencer (1950) have shown the importance of sulphur to legumes in the symbiotic fixation of nitrogen. It is not known if the increase in dry matter and nitrogen concentration of native grass following annual sulphur applications in this experiment was due to sulphur *per se* or to a greater soil nitrogen supply resulting from higher legume production with sulphur fertilizer, or an interaction between the two. Increased nitrogen concentration of native grass in the absence of increased dry matter production with nitrogen fertilization is similar to that obtained by Loader (1974) and suggests sulphur deficiency in native grass.

Increased nitrogen concentration of both native grass and medic is important for the nutrition of animals grazing this pasture type. It is notable that the largest percentage increase in dry matter production of medic occurred in 1968, a season of below average rainfall for its growing period.

The non-response of annual medic to applied phosphorus was in keeping with the soil analysis from the site and also with the results of Hilder & Spencer (1954), Jones (1970) and Loader (1974). Dark soils of the basaltic uplands are generally high in both total and available phosphorus (Thompson and Beckmann 1959). High analysis sulphur fertilizer is generally recommended commercially.

The residual effect of the initial application of 67 kg S ha^{-1} on medic dry matter yield and nitrogen concentration declined annually to the fourth season. However, additional annual applications of 22 kg S ha^{-1} to the initial treatment maintained dry matter yields and nitrogen concentration of medic at the level of response to the initial 67 kg S ha^{-1}.

It is not known if 22 kg S ha^{-1} $year^{-1}$ was the optimum level of sulphur fertilization as no other rates were tested and because of the removal of cut material from the trial site. However, data published by Hilder and Spencer (1954) suggest that a lower rate of sulphur may be adequate while Jones (1970) showed that a rate higher than 22 kg S ha^{-1} may be the optimum. Commercial applications of 34 kg S ha^{-1} $year^{-1}$ following an initial application of 67 kg S ha^{-1} have generally been found to give optimum results.

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