QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

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EFFECT OF FERTILIZER NITROGEN ON YIELD, NITROGEN CONTENT AND ANIMAL PRODUCTIVITY OF BRACHIARIA DECUMBENS CV. BASILISK ON THE WET TROPICAL COAST OF NORTH QUEENSLAND

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SUMMARY

Responses to fertilizer nitrogen in *Brachiaria decumbens* cv. Basilisk were studied in one cutting and two grazing experiments between 1962 and 1971 at South Johnstone (3 200 mm mean annual rainfall) in north Queensland.

In the cutting experiment the optimum annual nitrogen application rate was 365 kg N ha^{-1} in terms of dry matter yield and efficiency of use. The main increases in herbage yield from fertilizer nitrogen were recorded during the cool and dry season months (August to January).

In the first grazing experiment a mean annual liveweight gain of 950 kg ha^{-1} was obtained at a stocking rate of 0·22 ha per head with 196 kg N ha^{-1} yr^{-1} applied only during the June to December period. This compared with 716 kg ha^{-1} liveweight gain at a stocking rate of 0·29 ha per head with similar nitrogen fertilization or 572 kg ha^{-1} without applied nitrogen.

In the second grazing experiment optimum use of applied nitrogen was recorded between September and February in those paddocks with 112 kg N ha^{-1} when stocked at 0·2 ha per head or with 196 kg N ha^{-1} at 0·13 ha per head. From March to August, optimum use of applied nitrogen occurred with 84 kg N ha^{-1} when stocked at 0·2 ha per head.

It is suggested that the main role of nitrogen fertilized *B. decumbens* pastures is to complement grass/legume pastures over the cool and dry season when they are poorly productive.

I. INTRODUCTION

Signal grass (*Brachiaria decumbens*) cv. Basilisk (Mackay 1974) is an aggressive stoloniferous grass, suited to all but flooded and waterlogged soils in high rainfall areas of north Queensland (Teitzel, Abbott and Mellor 1974). In cutting experiments at South Johnstone its dry matter production has been superior to that of other grasses tested (Schofield 1944; Grof and Harding 1970), including pangola grass (*Digitaria decumbens*), particularly over the winter period (Teitzel, Abbott and Mellor 1974). Signal grass is well adapted to intensive utilization as it withstands heavy stocking and trampling (Walsh 1959; Appleman and Dirven 1962).

This paper presents the results of three experiments conducted on pure signal grass swards at the South Johnstone Research Station (146° 10′ E, 17° 36′ S), in which the effects of fertilizer nitrogen on dry matter production, nitrogen content and the performance of grazing animals were studied.

II. EXPERIMENTAL

The experiments were located on the lower slopes of the Basilisk Range, where drainage is a problem during prolonged periods of heavy rain. The experimental area was on a metamorphic soil (Um 6.33) and originally supported sclerophyll-mesophyll vine forest. Mean annual rainfall is 3 200 mm, with about 80% received between January and June; the dry season component is still significant for plant growth but is less reliable. Mean maximum and minimum temperatures range from 23·6°C and 13·7°C respectively in July to 30·8°C and 21·8°C respectively in January. Detailed descriptions of soils and climate are given by Teitzel and Bruce (1971).

Details of individual experiments are shown in table 1.

In grazing experiments, new drafts of commercial store steers (18 to 24-month-old Brahman crossbreds) were held on grass/legume pastures for about 6 weeks before being introduced to the experimental pastures at around 300 kg liveweight. The drafts were replaced when most steers were judged to be in finished condition at approximately 430 kg liveweight. Finished steers were sold to the local trade for slaughter.

Initial and final liveweights were obtained by taking the mean of three consecutive daily weighings off pasture, with interim liveweights obtained by weekly weighing (before 9 a.m.) without fasting. Experiment 2 was interrupted for 2 months in early 1967 because suitable cattle were not available; during this period the experimental area was grazed and it was mown before introducing new animals.

Experiment 1

METHODS. A 6-year-old pasture of 'Basilisk' was mown to approximately 3 cm high and the first of 26 four-weekly applications of urea applied on 19 February 1962. Dry matter yield was determined every 4 weeks (immediately prior to urea application) from one 4 m^2 quadrat per plot cut 3 cm above ground level. The remainder of the plot was then mown and all material removed. The cutting cycle was discontinued for a time in 1963. Nitrogen contents were determined on oven-dried (95°C) subsamples of herbage bulked for each treatment. A basal dressing of 36 kg P ha^{-1} (as superphosphate) and 63 kg K ha^{-1} (as muriate of potash) was applied at the end of the first year.

RESULTS. Annual dry matter yield was significantly increased by applications of 365 kg N ha^{-1} yr^{-1} when compared with nil-nitrogen application (table 2). Higher rates of nitrogen produced no further increase (table 2). Nitrogen percentage and yield, however, continued to increase above this level. Percentage recovery of applied nitrogen and dry matter produced per unit of applied nitrogen were highest at 365 kg N ha^{-1} in both years.

Dry matter production was highest in mid-summer, lowest in autumn, and variable in winter and spring (figure 1). The greatest responses to fertilizer nitrogen occurred from late winter to early summer (August–December) in 1962 and during spring and summer (September–February) in 1963–64; however, at rates above 365 kg N ha^{-1}, additional yield increases occurred only in September of 1962 and 1963. There was no yield increase during autumn; reductions were recorded in February 1962, and (for rates above 365 kg N ha^{-1} yr^{-1}) in March/April 1964.

At almost every harvest, nitrogen percentage increased with the rate of fertilizer nitrogen. This increase was greatest from June to January 1962–63 and lowest in March/April 1962 and June 1963 (figure 1).

TABLE 1

DETAILS OF INDIVIDUAL EXPERIMENTS

Experiment	Season	Plot Size	N applied (kg ha^{-1} yr^{-1})	Stocking Rate (ha per Head)	Number of Cattle per Treatment	Grazing Cycle	Design
1	1962–63 and 1963–64	20 m^2	0 365 730 1 460	Cutting only			4 treatments (N rates) x 5 replicates in randomized blocks
2	1965–66 and 1967–68	0·3 ha per paddock	0 196 196	0·29 0·29 0·22	3 3 4	1 week in and 2 weeks out	3 treatments (2 N rates and 2 stocking rates in incomplete factorial) each with 3 paddocks replicated per treatment arranged in randomised blocks
3	1969–71	0·2 ha per paddock	196 336 336 532	0·2 0·2 0·13 0·13	4 4 6 6	1 week in and 1 week out	4 treatments (3 N rates and 2 stocking rates in incomplete factorial) each with 2 paddocks per treatment by 2 replicates in randomized blocks

TABLE 2

EFFECT OF RATE OF NITROGEN APPLICATION ON DRY MATTER YIELD AND NITROGEN CONTENT OF SIGNAL GRASS CUT EVERY 4 WEEKS (EXPERIMENT 1)

Year	1962–63					1963–64				
Annual N Application (kg ha^{-1})	Dry Matter Yield (t ha^{-1})	N%	N Yield (kg ha^{-1})	N Recovery (%)	Dry Matter Produced per kg of Applied N (kg)	Dry Matter Yield (t ha^{-1})	N%	N Yield (kg ha^{-1})	N Recovery (%)	Dry Matter Produced per kg of Applied N (kg)
0	21·3	1·23	261	..	..	10·3	1·70	173	..	..
365	26·7	1·73	461	54·8	14·8	17·6	1·81	320	40·3	20·2
730	27·5	2·21	608	47·5	8·5	16·3	2·40	398	29·6	8·3
1 460	26·1	2·80	733	32·3	3·3	16·0	2·74	434	17·8	3·9
L.S.D.										
P = 0·05	3·0		74			2·8		57		
P = 0·01	4·2		103			4·0		80		

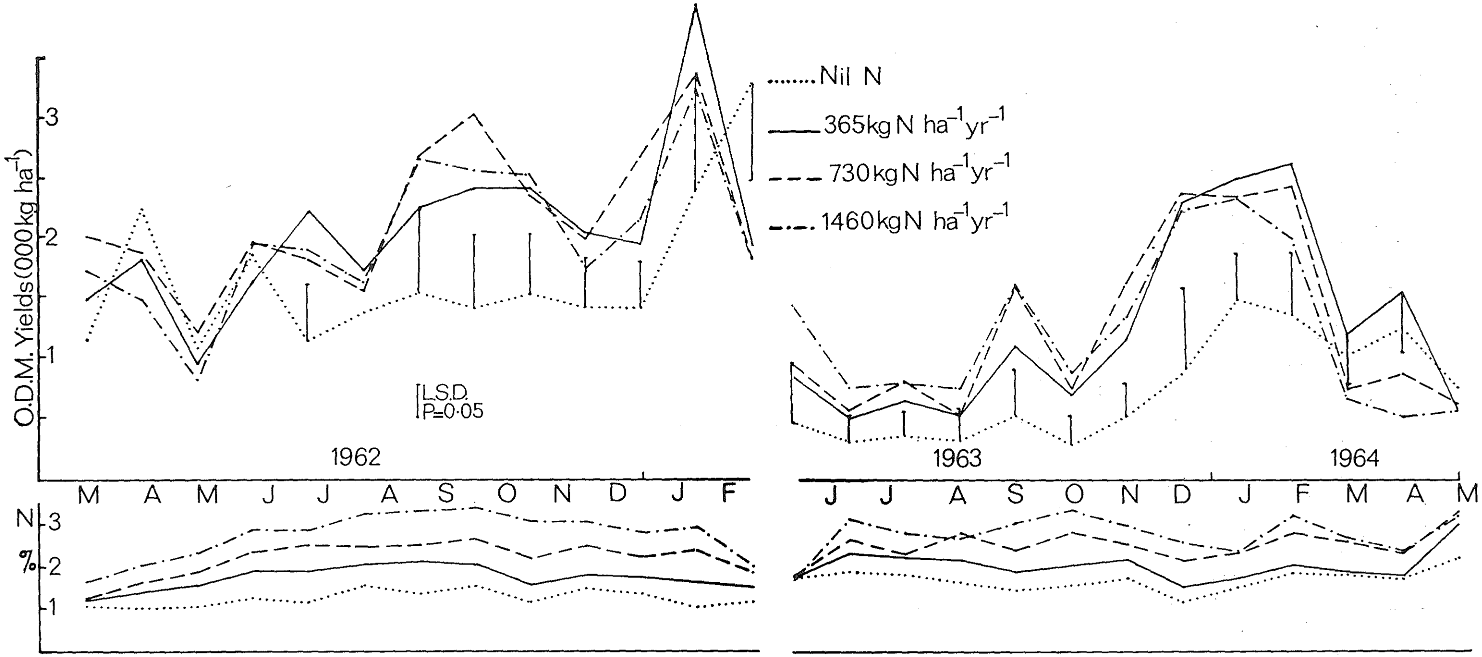

Figure 1.—Effect of 4-weekly applications of N on the 4-weekly regrowth of signal grass and N% of the dry matter (experiment 1).

Experiment 2

METHODS. In this grazing experiment, urea was applied at 28 kg N ha^{-1} at intervals of approximately 4 weeks in winter and 6 weeks in spring, with applications being made in showery weather. A basal dressing of 24 kg P ha^{-1} (as superphosphate) and 63 kg K ha^{-1} (as muriate of potash) was applied annually in September. Cattle were grazed rotationally with 1 week in and 2 weeks out over the three paddocks (see table 1).

RESULTS. Except for the periods December to January 1965–66 and February to April 1968, mean daily gain per head was lower in the absence of fertilizer nitrogen, particularly over the dry season (between June and January) (table 3).

TABLE 3

MEAN DAILY LIVEWEIGHT GAINS PER HEAD (kg) FOR EACH 3-MONTHLY PERIOD

(EXPERIMENT 2)

Treatment	Nil N and 0·29 ha per head	196 kg N ha^{-1} yr^{-1} and 0·29 ha per head	196 kg N ha^{-1} yr^{-1} and 0·22 ha per head
Period 1965–66—			
Sep—Nov ..	0·33	0·61	0·69
Dec—Feb ..	0·65	0·57	0·57
Mar—May ..	0·37	0·33	0·45
June—Aug ..	0·41	0·57	0·57
Period 1966–67—			
Nov—Jan* ..	0·29	0·37	0·49
Period 1967–68—			
May—Jul ..	0·29	0·29	0·33
Aug—Oct ..	0·49	0·57	0·57
Nov—Jan ..	0·61	0·65	0·61
Feb—Apr ..	0·49	0·49	0·37

* An unusually dry period

Gain per hectare was consistently greater at the higher stocking rate and lower in the absence of applied nitrogen (figure 2). At 0·22 ha per head and 196 kg N ha^{-1} yr^{-1}, liveweight gains of 1 030 and 869 kg ha^{-1} were recorded in 1965–66 and 1967–68 respectively; these compared with 740 and 693 kg ha^{-1} at 0·29 ha per head and the same nitrogen rate, and 592 and 553 kg ha^{-1} at 0·29 ha per head with no additional nitrogen.

Experiment 3

METHODS. The area of experiment 2 was enlarged and refenced, and experiment 3 commenced on 10 July 1969. By this time residual effects of previous nitrogen treatments should have been minimised. From 10 July 1969 cattle were grazed on alternate weeks in each of the two paddocks for each fertilizer/stocking rate combination (see table 1). Ammonium nitrate replaced urea as the source of fertilizer nitrogen, allowing greater flexibility in time of application. A basal dressing of 24 kg P ha^{-1} (as superphosphate) and 63 kg K ha^{-1} (as muriate of potash) was applied annually in September. This experiment was terminated in April 1971 when the plant population was drastically reduced following severe soil pugging after exceptionally heavy rains.

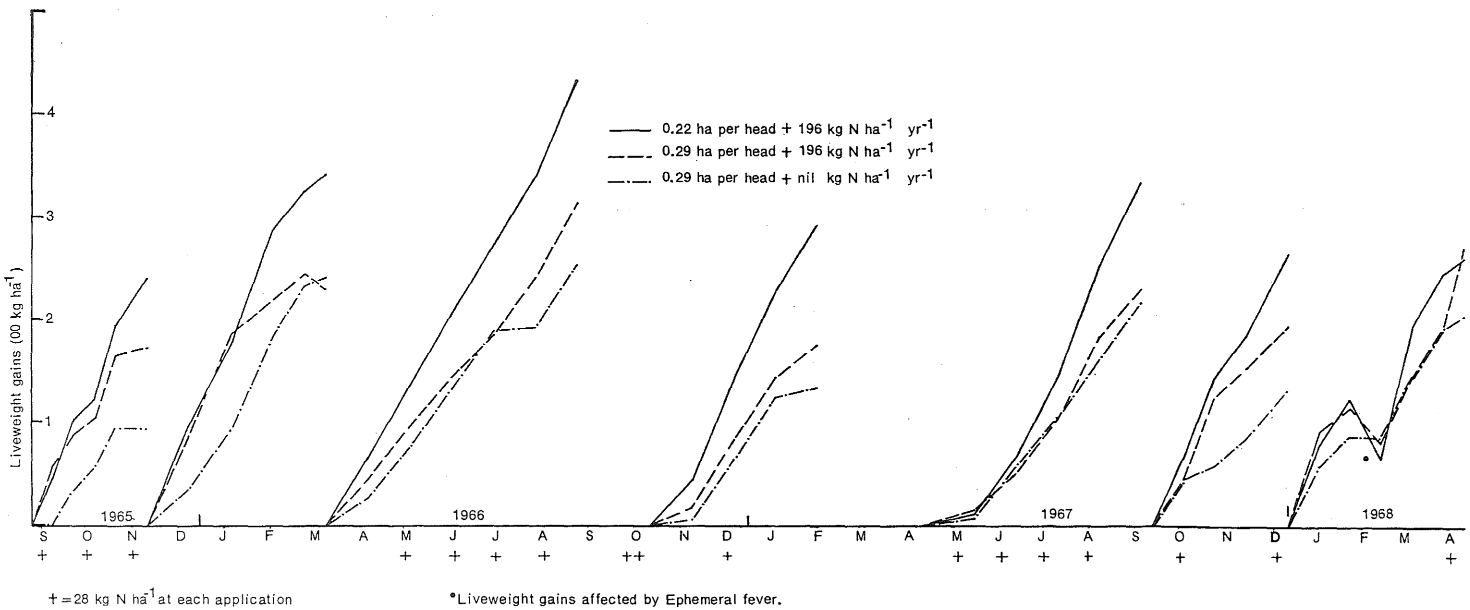

Figure 2.—Cumulative liveweight gains per ha for each draft of steers grazing signal grass at two stocking rates and two N rates (experiment 2).

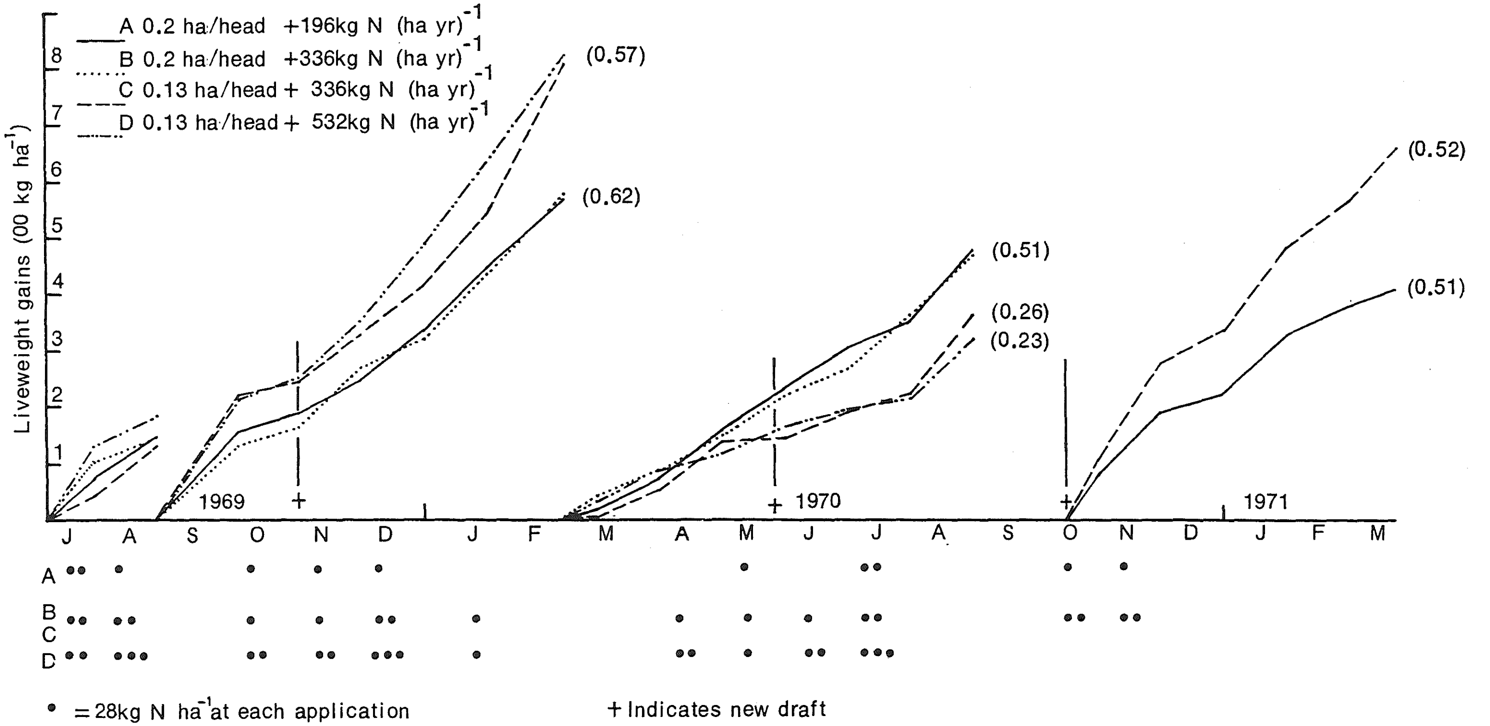

Figure 3.—Cumulative seasonal liveweight gains per hectare of steers grazing signal grass at two stocking rates and three N rates (experiment 3), with daily liveweight gain (kg) for each period in parenthesis.

RESULTS. Annual liveweight gains were not greatly increased by rates of fertilizer nitrogen above 196 kg N ha^{-1} yr^{-1} but large seasonal differences were recorded (figure 3). For the spring/summer period of 1969–70 and 1970–71, highest gains per hectare occurred at 0·13 ha per head and the two higher nitrogen rates; for the autumn/winter period of 1970, the lighter stocking rate and the lowest rate of nitrogen produced the highest gain.

Differences in liveweight gains per head were small in spring and summer of both years, but in the autumn and winter of 1970, large differences were recorded in favour of the lighter stocking rate (figure 3). During the September to February period there was no advantage in applying more than 112 kg N ha^{-1} at the lower stocking rate or more than 196 kg N ha^{-1} at the higher stocking rate. (These quantities of nitrogen are the sum of applications made between late August and January as part of the 196 kg N ha^{-1} and 336 kg N ha^{-1} annual rates respectively—see figure 3.) From March to August, there was no advantage in applying more than 84 kg ha^{-1} when stocked at 0·2 ha per head.

III. DISCUSSION

In the cutting experiment (experiment 1), the optimum annual rate of fertilizer nitrogen was 365 kg N ha^{-1} in terms of dry matter yield and efficiency of use. Generally, recovery of applied nitrogen in the dry matter of signal grass was comparable to that of other tropical grasses under similar experimental conditions (approximately monthly cutting, annual nitrogen rate around 365 kg ha^{-1}) in a similar climate. However, kilograms of dry matter produced per kilogram of nitrogen applied was generally lower (e.g. Vicente-Chandler, Silva and Figarella 1959).

The most important result was the response of signal grass to applied nitrogen in both dry matter and nitrogen content in the cool and dry season from June to January. In this period, dry matter yields were limited more by lack of available nitrogen than by moisture deficiency, as has been found in lower rainfall areas of south-east Queensland (Henzell and Stirk 1963). Without nitrogen addition, dry matter yields did not increase rapidly until the hotter, wetter months. An unusually cold and dry winter in 1963 was probably the main reason for lower yields in that year, whereas in 1962 the winter was slightly warmer and wetter than average. Lack of response and decline in yields with applied nitrogen in autumn coincides with decreasing daylength and low sunshine hours caused by thick cloud cover during prolonged periods of heavy rain.

In the first grazing experiment (experiment 2) nitrogen was applied to the pastures only when increased forage production could be expected (June to January). Forage produced in the fertilized treatment was well utilized at the higher stocking rate (0·22 ha per head) but underutilized at the lower stocking rate (0·29 ha per head), where liveweight gains per hectare were lower although individual gains were similar. Mean daily liveweight gains per head on nitrogen fertilized signal grass were similar to those reported on other tropical grasses fertilized with nitrogen in high rainfall areas (Caro-Costas, Vicente-Chandler and Figarella 1965).

The second grazing experiment (experiment 3) showed that over the period September to February, optimum use of nitrogen applied over the dry season was recorded with 112 kg ha^{-1} at a stocking rate of 0·2 ha per head or with 196 kg ha^{-1} at 0·13 ha per head. The additional forage produced by higher nitrogen applications could only be utilized by increasing the stocking rate. This limit on individual gains could well be explained by the work of Minson (1973) who found that where basic diets contained over 0·96% N, nitrogen fertilizer had no effect on dry matter digestibility or voluntary intake of tropical grasses. From March to August 1970, liveweight gains were poor at the highest stocking rate (0·13 ha per head) even at the highest nitrogen rate, reflecting slow pasture growth in autumn. Over these months however, signal grass stocked at 0·2 ha per head produced sufficient forage to maintain daily liveweight gains of 0·5 kg per head.

The combined results of the two grazing experiments suggested that the optimum stocking x nitrogen rate combination for the March to August period was 0·2 ha per head with 84 kg N ha^{-1} (applied May to July) or 0·3 ha per head with no applied nitrogen.

Commercial grass/legume pastures on the wet tropical coast are mostly based on guinea grass (*Panicum maximum*) cultivars. These pastures have a marked seasonal growth pattern (Grof and Harding 1970) and, to reduce the off-season feed gap, they are usually understocked (Teitzel, McTaggart and Hibberd 1971). The experiments outlined in this paper showed that strategic applications of nitrogen fertilizer to signal grass swards during the winter/spring months can produce high quality forage when grass/legume pastures are slow growing. This suggests that a management strategy based on having portion of a property devoted to intensively managed pasture of nitrogen-fertilized signal grass would increase forage production in winter/spring. This would allow grass/legume pastures to be more fully utilized in summer by stocking to optimum capacity. Grazing experiments designed to examine the feasibility and elucidate the practical details of this strategy are in progress (J. K. Teitzel, personal communication).

Walsh (1959) referred to signal grass as an unpalatable species. However, no palatability problems were encountered in these experiments where it was maintained in a short leafy condition.

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