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EFFECT OF NITROGEN FERTILIZATION AND LIMITED IRRIGATION ON SEED PRODUCTION OF MOLOPO BUFFEL GRASS

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SUMMARY

Elemental nitrogen in the form of commercial urea was applied, with and without limited irrigation, to a stand of Molopo buffel grass (*Cenchrus ciliaris* L.) during its third season.

In the absence of applied nitrogen, negligible amounts of seed were set. There was a continuing response to nitrogen up to the highest rate, i.e. 300 lb nitrogen per acre applied in early spring and repeated in midsummer. The 600 lb treatment yielded 449 lb of seed per acre for the season. Four separate harvest periods were recorded, but in the absence of further applications of nitrogen after the second havest little further seed was obtained.

A depression in total seed yield resulted from early-season irrigation.

Seed quality was not affected by nitrogen fertilization.

I. INTRODUCTION

Molopo buffel grass (*Cenchrus ciliaris* L.) shows greater frost tolerance than most cultivars of the species, a feature which makes it a very promising pasture grass in semi-arid, subtropical sections of Queensland. Inadequate supplies of seed, however, restrict its wider use. Stands on newly ploughed soil seed quite well but older swards frequently yield very little seed.

A 2-year-old stand at Biloela Research Station seeded well when irrigated and heavily fertilized with nitrogen (Cameron and Courtice 1965).

The present experiment, conducted on Biloela Research Station in sub-coastal Central Queensland, aimed at exploring the response of seed production of Molopo buffel grass to nitrogen with and without limited irrigation.

II. MATERIALS AND METHODS

The experimental area was planted with vegetative portions of Molopo buffel grass placed at 12-in. intervals in rows 3½ ft apart in October 1963. The soil was a deep grey-brown clay loam typical of the Callide alluvials described by Isbell (1954).

The area was irrigated occasionally over the first 2 years and inter-row cultivated several times early in the first season. By August 1965, the planted rows were still distinguishable but approaching sward condition. An excellent seed harvest was obtained in the first (1963-64) season, but in the absence of any applied nitrogen none was obtained the following year.

On August 26, 1965, the residues from the previous season were slashed to a height of 3 in. and all the trash removed. Following this, treatments of flood irrigation and nil irrigation were applied to appropriate plots.

On September 2, nitrogen fertilizer treatments were superimposed on the irrigation plots with a sub-plot size initially 10½ ft (3 rows) x 16 ft. The nitrogen rates per acre for this spring treatment, applied as commercial urea, were as follows:—

N0: Nil

N1: 75 lb

N2: 150 lb

N3: 300 lb

The urea was hand-broadcast and lightly watered with a hose. After the first two harvests had been taken, the area was closely mown and the trash removed.

The original nitrogen treatments were then reapplied on January 24 to one half of each original nitrogen sub-plot, giving, for the sub-plots receiving further nitrogen, the following spring and early summer applications

2N0: Nil

2N1: 75 lb + 75 lb

2N2: 150 lb + 150 lb

2N3: 300 lb + 300 lb

This fertilizer was spread in showery conditions with 0·70 in. of rain being recorded next morning and 0·53 in. the following morning.

Four replications were used in a 2 irrigations x 4 nitrogen levels x 4 replications randomized block.

The irrigation plots received further 3-in. waterings on October 14 and November 25. Good rainfall obviated the need for irrigation during December (5·33 in.) and January (2·83 in.). A further irrigation planned for the end of February (2·23 in.) was not possible. On March 18 and 19, 1·83 in. and 0·94 in. of rain were recorded, and a further 2·51 in. fell on March 24. Good moisture conditions followed until after the last seed harvest.

Four separate harvests were obtained. All mature seed was picked by hand at weekly intervals over a period of several weeks. The seed was bulked for each sub-plot, air-dried for 3 weeks after the final picking and weighed. The harvests were:

Harvest 1: Commenced Nov. 8, 1965—continued for 4 pickings

Harvest 2: Commenced Jan. 6, 1966—continued for 3 pickings

Harvest 3: Commenced Mar. 7, 1966—continued for 3 pickings

Harvest 4: Commenced May 3, 1966—completed next week (May 10).

For harvests 1 and 2, the central 7 ft x 12 ft of each nitrogen sub-plot was picked, the outer area having first been removed with a lawn mower. For harvests 3 and 4, two 7 ft x 5 ft areas similarly defined were harvested within each original 7 ft x 12 ft sub-plot.

Following each harvest, a subsample of seed from each sub-plot was tested for germination in water and in potassium nitrate.

More detailed examination of samples from harvest 1 failed to reveal differences between nitrogen and irrigation treatments and was not carried out on samples from subsequent harvests.

III. RESULTS

Yield figures are given in Table 1. For harvest 1, the effects of irrigation and of increasing rate of nitrogen were both highly significant; for harvest 3, with and without further nitrogen, irrigation had no effect, and the only significant response to nitrogen was to the single application of 300 lb. For harvest 4, with two applications of nitrogen, no irrigation significantly outyielded irrigation and the effects of nitrogen were highly significant at all rates above zero.

Since other harvests and the seasonal totals exhibited clear trends, further analyses were considered superfluous.

Data on seed quality are given in Tables 2 and 3.

For harvest 1, the main treatments did not significantly affect caryopsis count or germination of seed dried at 40°C for 10 days or of undried seed when tested in water and in potassium nitrate. Samples from subsequent harvests were therefore tested only in the undried condition.

TABLE 1

SEED YIELDS (LB/AC) FROM THREE LEVELS OF NITROGEN APPLIED IN SPRING AND EARLY SUMMER

Harvest	Irrigation Treatment	Nitrogen Applied (lb/ac)									
		Spring Application					Spring and Early Summer Application				
		0	75	150	300	Mean	0	75+75	150+150	300+300	Mean
1	Irrigated	1·0	15·1	53·0	102·5	42·9	..	..	..	..	..
	Not irrigated ..	0·3	2·8	7·2	14·2	6·1	..	..	..	..	..
2	Irrigated	0·7	2·2	7·1	51·0	15·3	..	..	..	..	..
	Not irrigated ..	1·1	30·1	111·3	172·1	78·6	..	..	..	..	..
3	Irrigated	1·6	3·7	2·8	8·4	4·1	3·0	72·3	115·1	50·1	60·1
	Not irrigated ..	4·1	7·5	14·9	28·8	13·8	5·5	102·7	91·8	91·6	72·9
4	Irrigated	0·1	1·4	0·7	7·2	2·3	0·9	16·6	37·0	136·1	47·6
	Not irrigated ..	0·0	1·1	7·9	17·4	6·6	0·3	14·5	75·5	171·1	65·4
Total	Irrigated	3·4	22·4	63·6	169·1	64·6	5·6	106·2	212·2	339·7	165·9
	Not irrigated ..	5·5	41·5	141·3	232·5	105·1	7·2	150·1	285·8	449·0	223·0

TABLE 2

SEED GERMINATION IN WATER (%)

Harvest	Irrigation Treatment	Nitrogen Applied (lb/ac)							
		Spring Application				Spring and Early Summer Applications			
		0	75	150	300	0	75+75	150+150	300+300
1	Irrigated ..	11·0	2·7	4·0	4·3	..	..	..	..
	Not irrigated ..	9·5	7·7	8·3	8·3	..	..	..	..
2	Irrigated ..	5·0	6·0	1·7	4·7	..	..	..	..
	Not irrigated ..	2·0	9·3	5·3	10·0	..	..	..	..
3	Irrigated ..	7·0	9·0	7·5	7·7	17·0	11·7	16·2	16·2
	Not irrigated ..	15·0	7·3	5·7	6·0	9·0	11·0	15·2	17·5
4	Irrigated ..	*	24·0	*	22·5	7·0	24·5	18·7	19·2
	Not irrigated ..	*	27·0	25·6	20·5	*	26·2	18·7	12·7

* Insufficient seed set for testing.

TABLE 3

SEED GERMINATION (%) IN KNO_3

Harvest	Irrigation Treatment	Nitrogen Applied (lb/ac)							
		Spring Application				Spring and Early Summer Applications			
		0	75	150	300	0	75+75	150+150	300+300
1	Irrigated ..	12·5	7·7	5·5	5·5	..	..	..	..
	Not irrigated ..	5·5	7·7	7·7	14·6	..	..	..	..
2	Irrigated ..	9·0	5·6	6·5	13·5	..	..	..	..
	Not irrigated ..	4·0	12·2	14·0	11·5	..	..	..	..
3	Irrigated ..	5·0	3·0	5·0	6·3	14·0	7·7	15·7	10·5
	Not irrigated ..	21·0	7·3	7·5	4·3	5·2	11·5	16·2	10·0
4	Irrigated ..	*	30·0	*	18·5	10·0	24·0	24·7	23·7
	Not irrigated ..	*	25·0	28·6	20·0	*	25·7	22·0	13·0

* Insufficient seed set for testing.

IV. DISCUSSION

At the first harvest there was a marked response to irrigation. Rainfall was meagre over this period and most of the seed from unirrigated plots came from areas where obvious seepage of water from adjacent plots had occurred. The insignificant yields of the unirrigated plots were, however, more than compensated for at the second and subsequent harvests. The differences between irrigation and no irrigation at harvest 3, however, were not significant.

The seasonal totals consistently favour not irrigating. Somes losses of nitrogen may have occurred through leaching by the two irrigations applied after the first fertilizer application. At harvest 3, however, the need for further moisture to produce a full seed crop at the higher levels of applied nitrogen was clearly indicated. Further water should have been applied at the end of February but circumstances prevented this. The highest nitrogen rate with lush growth was moisture-deficient before a full seed crop was set. However, it withstood the stresses so imposed and produced a heavy crop at harvest 4 following the rain occurring after the third harvest period. Under the conditions of moisture stress the best yields were at 75 lb and 150 lb for the two applications of nitrogen.

In spite of up to 600 lb of nitrogen per acre being used in this experiment, the maximum response level of this stand of Molopo buffel grass was not reached. Even with two applications of nitrogen, the total seed yields for the season with and without irrigation show straight-line responses to a total of 300 lb of nitrogen for the season, and only a slight departure from this response line at the highest level of 600 lb for the season. This clearly demonstrates the sensitivity of Molopo buffel grass to nitrogen for seed production. In the absence of applied nitrogen, less than 10 lb of seed per acre was obtained, while at the highest rate of nitrogen in the absence of irrigation 449 lb. per acre was harvested. This effect was apparent not only on seed yield but also on vegetative growth. Without applied nitrogen, plots remained 12-18 in. high and pale in colour, with only occasional seed-heads present. With increasing increments of applied nitrogen, an increase in height, bulk and brightness of colour occurred; at the highest levels, plants reached a height of 5 ft and were extremely bulky.

Much higher rates of nitrogen were used in this experiment than those recommended by Wheeler and Hill (1957) for grass seed production in the United States of America. They suggested 20 lb nitrogen per acre under dry conditions, up to 50 lb for over 20-in. rainfall, and up to 90 lb under irrigation.

Seed quality generally improved as the season progressed but there was no effect of nitrogen on seed germination within harvests. It is noted that Miltimore, Mason, and Rogers (1962) recorded no improvement in quality or increase in germination of seed of *Agropyron inerme* under annual rainfalls of 11 to 13 in. in western Canada, despite a substantial increase in seed yield from the application of nitrogen. Patel (1964), on the other hand, recorded three- to four-fold increases in seed crops of *Bromus inermis* in Kansas, but germination was reduced by up to 15% where crops were not irrigated. This reduction in germination is not apparent in the present data even at harvest 3, where moisture stress was evident.

In contrast, Wheeler and Hill (1957) stated that preliminary tests in the U.S.A. indicated that nitrogen fertilization not only increased seed yield but also resulted in improved quality of the seed produced.

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