Technical Contributions/Tegniese Bydrae

THE FERTILIZATION OF MAIZE FOR SILAGE PRODUCTION

(Met opsomming in Afrikaans)

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Abstract

An N, P, K and lime factorial experiment was conducted at the Research Station of African Explosives and Chemical Industries at Bapsfontein.

The fertilizer combination which produced the highest silage yield was 200 lb N, 88 lb P and 100 lb K per morgen on a limed soil.

The most economic production, however, came from the combination of 100 lb N, 44 lb P and 100 lb K per morgen on a limed soil.

Introduction

Farmers in areas which experience a severe winter must make provision for winter feed for their animals. Silage is one of the most efficient and economic means of fodder conservation. With the possible exception of artificially dried hay, the nutritional losses occurring during the silage conservation process are the lowest of all types of preserved feed (Henning, Sim and Pazzi). This is especially the case with regard to carotene (Morrison). Van Wyk compares the value of silage with other popular fodder crops. (Table 1).

TABLE 1. *Value of fodder crops*

Type of fodder	Value per ton	Yield per morgen	Value per morgen
Silage	R 3.50	20 tons 40 tons	R 70 R140
Teff	R12.00	3 tons 5 tons	R 36 R 60
Cowpeas	R13.00	2 tons 5 tons	R 26 R 65
Green fodder Oats	R 2.50 per grazing month (GM)	 4 GM 8 GM	 R 10 R 20

The figure of R3.50 per ton for silage was arrived at by comparing its digestible nutrients with those contained in other feeds of known market value.

In order to obtain more information about silage production on the Highveld a silage experiment was commenced on the Research Station of AE & CI at Bapsfontein in 1966. Prior to the 1966/67 season the experiment was conducted for grain yield. The treatments had been applied since 1957. The results for the 1966/67 and 1967/68 seasons are presented in this paper.

Experimental procedure

The Research Station falls within the Msinga soil series and has an average rainfall of 686 mm (27 inches) per season.

The experiment was planted mechanically in 3 foot rows with a plant population of 30 000 per morgen.

In the first season the hybrid SA4 was planted and in the second SA60.

Design The experiment had a split plot design with a 3P x 2 lime factorial in whole plots. The whole plots were then split to contain nine sub-plots of 3N x 3K factorial.
There were two replications.

Treatments — lb per morgen (commenced in 1957)

N_0	0	P_0	0	K_0	0	L_0	0 lime
N_1	100	P_1	44	K_1	50	L_1	4 000 lime
N_2	200	P_2	88	K_2	100		

Nitrogen was applied as urea, the phosphorus as single superphosphate and the potassium as potassium chloride.

The superphosphate was banded at planting. The urea and potassium chloride were applied by hand as a side-dressing when the plants were approximately 12 inches high.

Lime was not applied annually but only when the soil pH dropped below 5.5 (in H_2O).

Discussion of results

At the 'soft dough' stage of development (70 to 75% moisture) the plants were cut and weighed, and samples were taken to determine the dry matter and crude protein content.

Green material yields

These are given in Tables 2, 3, and 4.

TABLE 2. *Mean green material yields in tons per morgen for the seasons* 1966/67 *and* 1967/68

P	K	L	N_0	N_1	N_2
0	0	0	18.85	19.60	20.00
0	0	1	20.26	24.40	24.45
0	1	0	19.95	24.27	18.40
0	1	1	24.71	30.88	30.56
0	2	0	22.95	24.48	23.70
0	2	1	28.32	31.84	34.56
1	0	0	22.07	27.41	22.75
1	0	1	20.32	27.89	31.30
1	1	0	24.21	34.10	35.31
1	1	1	27.19	36.64	35.99
1	2	0	25.76	36.08	36.80
1	2	1	28.16	39.02	39.87
2	0	0	25.12	29.14	27.52
2	0	1	26.75	31.20	30.91
2	1	0	24.96	35.71	35.68
2	1	1	26.96	37.74	38.23
2	2	0	27.44	38.55	39.20
2	2	1	29.76	39.89	43.62

TABLE 3. Main effects. Green material yields

	Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha
N_0	24.65	26.11	P_0	24.57	26.02	K_0	25.00	26.48	L_0	27.41	29.03
N_1	31.60	33.47	P_1	30.60	32.41	K_1	30.08	31.86	L_1	31.16	33.00
N_2	31.60	33.47	P_2	32.69	34.63	K_2	32.78	34.72			

TABLE 4. Green material yields. Ten fertilizer combinations giving highest yields

Treatment				Yield	
				Tons per morgen	Tonnes per ha
N	P	K	L		
2	2	2	1	43.62	46.20
1	2	2	1	39.89	42.25
2	1	2	1	39.87	42.23
2	2	2	0	39.20	41.52
1	1	2	1	39.02	41.33
1	2	2	0	38.55	40.83
2	2	1	1	38.23	40.49
1	2	1	1	37.74	39.97
2	1	2	0	36.80	38.98
1	1	1	1	36.64	38.81

The results clearly show the importance of balanced fertilization.

Lime was less important when the other elements were well supplied.

Nitrogen gave the largest increase viz. 6.95 tons per morgen at the second level (N_1) in Table 3. Of the highest yielding fertilizer combinations (Table 4) 70 per cent contained potassium at the upper level.

A simple economic analysis was done based on the following information:-

1) A 10 per cent loss in green material weight due to the silage process.
2) A silage valuation of R3.50 per ton.
3) Costs of fertilizing materials were
   N_1 — 100 lb N per morgen = R 6.93
   N_2 — 200 lb N per morgen = R13.86
   P_1 — 44 lb P per morgen = R 6.78
   P_2 — 88 lb P per morgen = R13.56
   K_1 — 50 lb K per morgen = R 1.74
   K_2 — 100 lb K per morgen = R 3.47
   L_1 — 4000lb lime per morgen = R 7.00

(Lime, however, was only required on average every three years which reduced its cost to approximately R2.30 per season).

The gross profit was then calculated and the most favourable fertilizer combination was 100 lb N, 44 lb P and 100 lb K per morgen on a limed soil (1121).

The calculation derived from the 1121 treatment is compared with those from the highest yielding treatment (2221) and the control (0000) in Table 5.

TABLE 5. Economic comparison

Treatment	Ton		Value	Fertilizer cost	Difference
	Green material	Silage			
2 2 2 1	43.62 less 10%	= 39.26	R 137	R 33	+ R 104
1 1 2 1	39.02 „ „	= 35.12	R 123	R 19	+ R 104
0 0 0 0	18.85 „ „	= 16.96	R 59	nil	+ R 59

Dry matter yields

The results were similar to those of the green material and are set out in Tables 6, 7 and 8.

TABLE 6. Mean dry matter yields in tons per morgen for the seasons 1966/67 and 1967/68

P	K	L	N_0	N_1	N_2
0	0	0	4.81	5.01	5.09
0	0	1	5.79	8.01	7.31
0	1	0	4.92	6.43	4.55
0	1	1	7.06	9.03	8.95
0	2	0	6.40	5.46	5.16
0	2	1	8.55	9.31	10.60
1	0	0	6.86	8.61	6.12
1	0	1	5.90	7.94	8.76
1	1	0	6.45	9.48	9.98
1	1	1	8.20	10.85	10.01
1	2	0	8.25	9.10	12.90
1	2	1	7.84	12.03	12.66
2	0	0	7.12	9.39	7.48
2	0	1	9.27	9.09	8.25
2	1	0	7.19	8.90	9.96
2	1	1	9.56	12.62	10.15
2	2	0	6.92	9.06	10.54
2	2	1	8.52	10.74	12.28

TABLE 8. Dry matter yields. Ten fertilizer combinations giving highest yields

Treatment				Yield	
				Tons per morgen	Tonnes per ha
2	1	2	0	12.90	13.66
2	1	2	1	12.66	13.41
1	2	1	1	12.62	13.37
2	2	2	1	12.28	13.01
1	1	2	1	12.03	12.74
1	1	1	1	10.85	11.49
1	2	2	1	10.74	11.38
2	0	2	1	10.60	11.23
2	2	2	0	10.54	11.16
2	2	1	1	10.15	10.75

TABLE 7. Main effects. Dry matter yields

	Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha		Ton/morg	Tonnes per ha
N_0	7.20	7.63	P_0	6.80	7.20	K_0	7.27	7.70	L_0	7.49	7.93
N_1	8.95	9.48	P_1	9.00	9.53	K_1	8.57	9.08	L_1	9.23	9.78
N_2	8.93	9.46	P_2	9.28	9.83	K_2	9.24	9.79			

In both seasons the statistical analyses showed the main effect of all four elements to be significant at the second and third level (over the first). In the second season 1967/68, the interactions of N x P, N x K and P x K were also significant.

Crude protein yield

As may be expected the nitrogen treatments had the greatest effect on the crude protein yields.

TABLE 9. Crude protein yields. Ten fertilizer combinations giving highest crude protein yields

Treatment				Crude protein	
N	P	K	L	lb per morgen	Tonnes per ha
2	2	1	0	1 899	1 006
2	2	2	1	1 862	986
2	1	2	1	1 701	901
2	2	2	0	1 678	889
2	2	1	1	1 634	865
2	1	2	0	1 608	852
2	1	1	0	1 602	848
2	1	1	1	1 564	828
1	2	2	1	1 532	811
1	2	1	1	1 426	755

Of the top-yielding combinations 80 per cent contained nitrogen at the upper level and the 1967/68 statistical analysis showed $N_2 < N_1 < N_0$ at the 1% level of significance.

Conclusions

The investigation clearly showed that balanced fertilization was required for high yield of maize silage.

The amounts of 100 lb N, 44 lb P and 100 lb K per morgen produced the most economic silage yields on a limed soil.

Similar results have been obtained at Bapsfontein with regard to maize grain yields.

Opsomming

DIE BEMESTING VAN MIELIES VIR KUILVOERPRODUKSIE

'n NPK kalk faktoriaal eksperiment is uitgevoer op die Navorsingstasie van Afrikaanse Springstowwe en Chemiese Nywerhede te Bapsfontein.

Die kunsmisbehandeling wat die hoogste kuilvoeropbrengs gelewer het, was 200 lb N, 88 lb P en 100 lb K per morg op grond wat kalk ontvang het.

Die mees ekonomiese produksie is egter verkry van die behandeling 100 lb N, 44 lb P en 100 lb K per morg op grond wat kalk ontvang het.

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