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MAIZE FERTILIZER INVESTIGATIONS ON RED LOAM SOILS OF THE SOUTHERN DARLING DOWNS, QUEENSLAND

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SUMMARY

Steadily declining maize yields on red loam soils indicated a depletion in nutrient status through continuous grain cropping. In a series of three field trials, marked yield responses were obtained to phosphorus (as superphosphate) application in one season, and to nitrogen (as urea) in the other two seasons. Applications of potash and mixtures of trace elements were of little significance.

I. INTRODUCTION

Grain crops, particularly maize, have been grown almost continuously on the red loam soils of the Clifton area of the Darling Downs for approximately 50 years. Yields have been gradually declining and it was thought that the depletion of soil nutrients through continued cash cropping could be the major factor in the progressive yield decreases.

The series of field trials reported here were designed to determine the response of rain-grown maize to nitrogen, phosphorus, potassium and various trace elements both alone and in all combinations over a number of seasons.

II. MATERIALS AND METHODS

Treatments.—The investigation comprised three field trials each of which was set down as a 3 x 3 x 2 x 2 design of 6 blocks each of 12 plots. Three blocks constituted one replication. Treatments were factorial combinations of 3 rates of nitrogen (nil, ½ cwt and 1 cwt urea (46% N) per acre), 3 rates of phosphate (nil, 1 cwt and 2 cwt superphosphate (9·6% P) per acre), 2 rates of potash (nil

and 1 cwt muriate of potash per acre) and 2 rates of a mixture of trace elements (nil and 100 lb of Ferro Fritted trace elements per acre). Plot size was 4 rows of 40 ft, each 42 in. apart.

Soils.—Each of the trial areas had been cultivated for approximately 50 years, and had been sown to maize or forage sorghum for the three prior summer seasons, with winter fallow periods.

Soil samples for chemical analysis were obtained from each area prior to trial establishment. Each sample was a composite of four sub-samples collected at random from within the trial area. Chemical analyses of these samples were performed by officers of the Department's Agricultural Chemical Laboratory. The methods of the Bureau of Sugar Experiment Stations (1961) were used in the determination of pH, available phosphorus and replaceable potassium. Morgan tests were those of the Morgan Soil Testing System (Anon. 1950). Percentage total nitrogen was determined by the method of Piper (1942), using Winkler's modification and copper sulphate. The results of the chemical analyses are shown in Table 1.

TABLE 1

ANALYSES OF SOILS FROM EXPERIMENTAL SITES

Site and Depth	Colour	Texture	pH	Avail. P (p.p.m.)	Repl. K^+ (m-equiv. %)	Total N (%)	Morgan Tests	
							NO_3 Nitrogen	NH_3 Nitrogen
Expt. 1								
0–10 in.	Dark-brown	Clay loam	5·8	18	0·45	0·12	Medium	Low
10–20 in.	Dark-brown	Clay loam	6·0	10	0·16	0·11	Medium	Low
Expt. 2								
0–4 in.	Dark-brown	Silty loam	4·9	18	0·92	..	Medium	Very low
4–8 in.	Dark-brown	Silty loam	6·1	10	..	..	..	..
Expt. 3								
0–9 in.	Dark-brown	Clay ..	6·2	56	0·58	0·09	Low	Low
9–15 in.	Grey-brown	Clay ..	6·4	>160	0·31	0·08	Very low	Very low

Establishment.—In experiment 1 (1961-62), the hybrid maize variety DS28 was sown by hand in furrows on January 2, 1962, an established stand of 8,300 plants per acre being obtained. Fertilizer placement was directly below the seed and was made immediately prior to seeding.

In experiment 2 (1962-63), the hybrid maize DS606 was sown through a maize planter on October 30, 1962, giving an established stand of 6,600 plants per acre. Fertilizer placement was in a band 2 in. above the seed and the fertilizer was covered by a further inch of soil.

In experiment 3 (1963-64), DS606 was sown through a maize planter on December 6, 1963, and established stand count was 5,800 plants per acre. Fertilizer placement was as a band 4 in. to one side of the seed and at equal depth.

The different fertilizer placement from year to year reflects an attempt to simplify and expedite the seeding and fertilizing operations.

Seasonal conditions.—All three experiments were grown under well above average rainfall conditions. The rainfall data (in inches) during the growing period, with the Clifton averages for the equivalent periods bracketed, are as follows:—

Experiment 1:—20·67 (11·29)
Experiment 2:—22·99 (16·04)
Experiment 3:—24·17 (14·75)

However, on occasions distribution was not ideal. Eight inches received in the fortnight following planting of experiment 1 caused fairly severe waterlogging during the period. Also, a very hot dry period occurred during the tasselling and early grain-setting stages of experiment 3.

Harvesting.—The trials were harvested by hand. Harvesting dates were June 21, 1962 (experiment 1), April 8, 1963 (experiment 2) and May 12, 1964 (experiment 3). Yield data were obtained from the inner two rows, with a buffer area being discarded at each end of these rows.

III. RESULTS

(a) General Observations

Treatment growth responses were limited to an early height response to phosphate in experiment 1 and a darker green foliage colour response to nitrogen, which became evident shortly prior to tasselling, in experiments 2 and 3. Lodging was negligible in experiments 1 and 3, and while severe in experiment 2 was not related to treatment. A slight infestation of Helminthosporium leaf blight occurred in experiment 1. Experiment 2 was disease-free. In experiment 3 the incidence of Diplodia cob rot was severe, but occurrence did not appear to be related to the presence or absence of any particular nutrient.

(b) Grain Yields

Grain yield data are presented in Tables 2-4 and may be summarized as follows:—

Main effects.—In experiment 1, phosphate at 1 and 2 cwt/ac levels of superphosphate significantly increased yield at the 1% level of significance; 2 cwt superphosphate significantly outyielded 1 cwt at the 5% level.

In experiment 2, the major response was to nitrogen. The means of both ½ and 1 cwt urea applications significantly outyielded the means of nil nitrogen at the 1% level. Significant response to urea application did not extend beyond the ½ cwt level.

In experiment 3, the major response was again to nitrogen. Both ½ and 1 cwt urea again outyielded nil urea at the 1% level, with no significant increase over the ½ cwt level.

Interactions.—In experiment 1 the response to phosphate changed with the level of potash. With nil potash, the response to phosphate occurred mainly at the 2 cwt level of superphosphate, but with the addition of potash the response to phosphate occurred at the 1 cwt level of superphosphate with no extra response to the 2 cwt level.

In experiments 2 and 3, no significant interactions occurred.

TABLE 2

EXPERIMENT 1 (1961–62): SUMMARY OF MEAN YIELDS (BUS/AC.)

——	P0	P1	P2	T0	T1	K0	K1	Means
N0	30·7	37·5	42·6	36·9	37·0	37·1	36·7	36·9
N1	36·2	37·1	40·6	39·4	36·6	37·5	38·5	38·0
N2	33·4	37·7	38·6	36·1	37·0	37·1	36·0	36·6
K0	33·8	35·4	42·4	37·3	37·1	..	..	37·2
K1	33·1	39·5	38·7	37·6	36·6	..	..	37·1
T0	33·3	37·4	41·7	..	..	..	..	37·5
T1	33·6	37·5	39·4	..	..	..	..	36·8
Means	33·5	37·4	40·6	37·5	36·8	37·2	37·1	37·1

s.e./plot = 4·97 bus/ac.

Necessary differences for significance—

Means of	5%	1%
Interactions: N x P	5·1	6·8
Interactions: P x T, P x K, N x T, N x K	4·1	5·5
Main effects: N0 *v.* N1 *v.* N2, P0 *v.* P1 *v.* P2 ..	2·9	3·9
Main effects: T0 *v.* T1, K0 *v.* K1	2·4	3·2

TABLE 3

EXPERIMENT 2 (1962–63): SUMMARY OF MEAN YIELDS (BUS/AC.)

——	P0	P1	P2	T0	T1	K0	K1	Means
N0	28·71	33·11	32·83	31·50	31·59	32·98	30·11	31·55
N1	36·21	37·76	41·37	38·14	38·75	38·94	37·95	38·45
N2	39·39	40·33	36·96	38·45	39·33	39·38	38·40	38·89
K0	34·89	37·96	38·46	36·85	37·35	..	..	37·10
K1	34·65	36·17	35·63	35·21	35·77	..	..	35·49
T0	35·49	36·07	36·53	..	..	..	..	36·03
T1	34·05	38·05	37·57	..	..	..	..	36·56
Means	34·77	37·06	37·05	36·03	36·56	37·10	35·49	36·29

s.e./plot = 3·99 bus/ac.

Necessary differences for significance—

Means of	5%	1%
Interactions: N x P	4·07	5·47
Interactions: P x T, P x K, N x T, N x K	3·32	4·47
Main effects: N0 *v.* N1 *v.* N2, P0 *v.* P1 *v.* P2 ..	2·35	3·16
Main effects: T0 *v.* T1, K0 *v.* K1	1·92	2·58

TABLE 4

EXPERIMENT 3 (1963–64): SUMMARY OF MEAN YIELDS (BUS/AC.)

——	P0	P1	P2	T0	T1	K0	K1	Means
N0	26·49	24·47	25·55	24·91	26·10	26·03	24·98	25·50
N1	33·77	29·71	32·62	33·06	31·00	32·90	31·18	32·03
N2	31·29	33·61	31·90	31·83	32·70	34·35	30·18	32·27
K0	30·51	31·63	31·14	31·10	31·09	..	..	31·09
K1	30·53	26·90	28·92	28·76	28·78	..	..	28·78
T0	29·29	30·18	30·32	..	..	..	..	29·93
T1	31·74	28·34	29·72	..	..	..	..	29·93
Means	30·52	29·26	30·02	29·93	29·93	31·09	28·78	29·93

s.e./plot = 5·90 bus/ac.

Necessary differences for significance—

Means of	5%	1%
Interactions: N x P	6·02	8·10
Interactions: P x T, P x K, N x T, N x K ..	4·91	6·61
Main effects: N0 *v.* N1 *v.* N2, P0 *v.* P1 *v.* P2 ..	3·47	4·68
Main effects: T0 *v.* T1, K0 *v.* K1	2·84	3·82

IV. DISCUSSION

A marked response to nitrogen application was obtained in experiments 2 and 3. In experiment 1, 8 in. of rain were received in the fortnight following planting and resulted in fairly severe waterlogging of the trial area. The lack of response to applied nitrogen in this experiment could be attributed to early unavailability, due to either the anaerobic conditions or leaching below the root zone in the early growth stages, or a combination of these effects. Waring and Teakle (1960) demonstrated accumulations of nitrate nitrogen, below the normal depth of usage of annual crops, due to downward displacement by leaching on the heavy black earths of the Darling Downs. Also, Gasser (1961) and Wetselaar (1962) have shown that rainfalls of the order of 7-10 in. can result in leaching of nitrate nitrogen from the surface 6 in. of clay loam soils.

The overall response to phosphorus in experiment 1 would appear to indicate the desirability of added phosphorus, especially when analysis of the surface soils reveals an initial figure of below 28 p.p.m. available phosphorus. The lack of response to phosphorus in experiment 3 could be expected in view of the fact that the initial figure for available phosphorus in the surface soil was 56 p.p.m. These responses to phosphorus are in agreement with results obtained by van Haeringen (1965) in maize fertilizer investigations on the red loam soils of the Atherton Tableland, where responses were obtained to added phosphorus only where the initial figure of available phosphorus was below 28 p.p.m.

No overall response to potash or trace elements was obtained, but in one treatment, P1 in experiment 1, a response to potash did occur in the presence of phosphorus. This is presumed to have been a fortuitous occurrence.

As indicated earlier, a considerably higher than average rainfall was received for each of the trial periods. More normal rainfall conditions would probably have modified the responses obtained.

Results of these trials suggest that time and rate of application studies of nitrogen and phosphorus could profitably be undertaken in relation to plant population.

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