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NUTRITIONAL INVESTIGATIONS IN IRRIGATED MAIZE ON SOME BLACK EARTH SOILS, DARLING DOWNS, QUEENSLAND

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SUMMARY

A number of nutrients suspected of being deficient were applied singly and in selected combinations in field trials.

Significant grain yield responses were obtained only to nitrogen, and in one locality to phosphorus. Zinc gave a non-significant yield increase in one trial. However, a temporary zinc unavailability may occur sporadically on irrigated country.

Applications of potassium, manganese, boron, molybdenum and iron did not have any effect on plant foliage or grain yields.

Full benefit from nitrogen applications and high maize yields may not be realized if waterlogging occurs after irrigation. In phosphate-deficient areas, nitrogen and phosphorus are required in combination to secure highest yields.

I. INTRODUCTION

Disorders spasmodically appear in maize crops grown on a number of black earth soils on the Darling Downs, Queensland. Purpling of leaves, interveinal chlorosis, necrotic areas on leaves and yellowing of plants have occurred. Tall spindly plants, dwarf plants with stunted internodes, apparently normal plants with markedly reduced grain set on cobs, multiple cobbing and cob-like tassels are other disorders.

The problems appear to be nutritional and have been most serious on potentially high-yielding irrigation country. Deficiencies of various nutrients such as zinc, phosphorus, nitrogen, manganese and boron have been directly or indirectly cited as the cause of the disorders.

Zinc deficiency in maize on the Darling Downs can be corrected with zinc sulphate sprays (Duncan 1967). Other nutrient deficiencies may be linked with a zinc deficiency, since purpling of stems and leaves, white chlorotic areas and paleness, which could be ascribed to other deficiencies, sometimes disappear with the application of the zinc sprays.

The purpling effect has been described as a phosphorus deficiency by Nelson (1956), though this disorder may occur on soils of high phosphate status on the Darling Downs. Phosphorus deficiency does occur in winter cereals on soils of the Mywybilla series (Hibberd, Whitehouse and Duncan 1969) and on sandy-surfaced soils referred to as Cecilvale series by Beckmann and Thompson

(1960). Duncan (1967), however, found no response to applications of phosphorus, copper, boron, potassium and magnesium on soil of the Waco series (Beckmann and Thompson 1960).

Mineral nitrogen varies seasonally on the Downs (Martin and Cox 1956) and symptoms of a combined nitrogen and zinc deficiency have appeared. Unconfirmed reports of increased vegetative growth in maize from potash application have come from the Wyreema district.

This paper summarizes the results of five fertilizer trials conducted at four localities to determine nutrient deficiencies and assess the need for fertilizers. A number of nutrients suspected of being deficient were applied alone and in selected combinations as an introductory step to further investigations.

II. MATERIALS AND METHODS

The basic trial design consisted of 14 treatments x 3 replicates in randomized blocks conducted at four sites. Treatments are set out in Table 3.

With the exception of nitrogen and iron, the fertilizers were applied in the bottom of the drill prior to planting. One-third of the amount of nitrogen was applied in this way and the remainder was applied as a side-dressing just before the last cultivation. Iron was applied as iron chelate spray.

Fertilizers and rates applied were: N as urea at 2 cwt/ac, P as superphosphate at 2 cwt/ac, K as muriate of potash at 1 cwt/ac, Zn as zinc sulphate at 40 lb/ac, Mn as manganese sulphate at 40 lb/ac, Mo as sodium molybdate at 2 lb/ac, B as borax at 6 lb/ac, and Fe as 0·1% iron chelate spray at 3 weeks after emergence.

Soils at all sites were black earths. Soil chemical analyses are presented in Table 1. The trial at Clintonvale in 1966-67 was spray-irrigated, and the other trials received flood irrigation. The maize variety used was DS606A, except at Brookstead in 1967-68 and Branchview in 1967-68 where Q1152 was grown.

TABLE 1

ROUTINE CHEMICAL ANALYSES OF THE TOP 3 IN. OF SOIL FROM THE TRIAL SITES

—	Branchview 1966–67	Clintonvale* 1966–67	Brookstead 1966–67	Brookstead 1967–68
pH	7·1	7·6	8·1	8·0
Available P (p.p.m.)	22	170 +	170 +	170 +
Replaceable K (m-equiv. %)	0·75	1·61	1·28	1·96
Colour	Dark grey brown	Grey	Dark grey brown	Dark grey brown
Texture	Clay	Fine silty clay	Clay	Clay
Total N (%)	n.d.	0·10	0·086	n.d.

* At Clintonvale the top 10 in. was analysed.

In the experiments at Branchview in 1966-67 and 1967-68, iron chelate foliar spray was omitted. In both trials the whole site received a basal dressing of nitrogen fertilizer before the listed treatments were applied. In 1966-67 this dressing was 70 lb N as urea and in 1967-68 it was 75 lb N as urea.

In all trials, each plot consisted of four maize rows of which the centre two only were harvested. Plot length varied from 35 ft to 60 ft at different sites to obtain convenient yields for handling purposes. Plots were harvested by hand-picking the cobs and threshing them by machine.

In the three trials conducted in the 1966-67 season, assessment of grain setting was on the basis of percentage of cobs setting grain. In the two trials in 1967-68, grain setting was assessed by the mean number of grains set per cob determined from 1,000 grain weights.

Cropping history of all trial sites is shown in Table 2.

TABLE 2

CULTURAL HISTORY OF THE TRIAL AREAS

Year	Branchview 1966–67	Clintonvale 1966–67	Brookstead 1966–67	Brookstead 1967–68	Branchview 1967–68
1963		Wheat		Linseed	
1964	Barley	Maize	Maize	Fallow	Barley
1965	Barley	Maize	Maize	Maize	Barley
1966	Trial maize	Trial maize	Trial maize	Maize	Maize + 1 cwt urea and 1 cwt superphosphate
1967				Trial maize	Trial maize

III. RESULTS

Yields are presented in Table 3.

TABLE 3

MEAN GRAIN YIELD (LB/AC) FROM THE TRIALS

Treatment	Clintonvale 1966–67	Brookstead 1966–67	Brookstead 1967–68	Branchview 1966–67	Branchview 1967–68
Control	8,210	3,884	879	3,316	2,098
N	8,080	5,191	1,960	3,426	2,018
P	7,470	4,635	1,011	3,870	2,214
K	7,910	4,029	918	3,272	1,779
Zn	6,340	4,374	840	*	2,049
Mn	7,140	3,945	988	*	*
N + P	8,190	3,703	2,054	4,235	2,888
N + K	7,190	4,037	2,054	3,695	2,187
P + K	7,510	4,222	762	3,866	2,457
N + P + K	7,300	4,719	2,684	3,317	2,457
N + P + K + Zn	7,740	4,803	2,614	4,328	2,760
N + P + K + Mn	7,710	4,646	1,968	*	*
N + P + K + Zn + Mn	7,830	4,490	2,925	*	*
N + P + K + Zn + Mn + B + Mo + Fe	8,920	4,948	2,170	4,217	2,528
S.E. of treatment means	500	260	301	224	279
Necessary differences for significance 5%	n.s.	757	875	570	838
Necessary differences for significance 1%		1,023	1,183	783	1,122

* Treatments not included at Branchview.

High grain yields were recorded at Clintonvale in 1966-67 (control mean yield of 8,210 lb/ac), indicating inherent high fertility (Table 1). No significant differences were obtained and there were apparently no nutritional problems associated with the crop.

The two trials at Brookstead (1966-67 and 1967-68) showed large grain yield increases with nitrogen applications. Both Branchview trials (1966-67 and 1967-68) produced negligible responses to nitrogen following basal treatments with this element.

TABLE 4

COMPONENTS OF YIELD AT BROOKSTEAD IN 1966–67 AND 1967–68

Treatment	No. of Cobs per Acre		No. of Stems per Acre at Maturity		Percentage of Cobs with 76–95% Grain Set, 1966–67	Yield of Grain per Cob 1967–68 (oz)	Mean No. of Grains Set per Cob, 1967–68
	1966–67	1967–68	1966–67	1967–68			
Control	16,700	18,170	16,440	15,430	25·1	0·80	70
N	17,300	18,790	19,310	16,300	33·6	1·73	158
P	15,830	17,360	16,260	15,500	34·4	0·94	84
K	17,440	17,110	19,490	16,180	35·1	0·85	75
Zn	15,700	17,420	16,440	17,860	40·9	0·80	75
Mn	17,130	19,040	16,570	17,670	28·7	0·84	75
N + P	18,440	21,590	18,620	17,300	28·5	1·53	138
N + K	16,260	20,470	16,000	18,480	29·5	1·62	147
P + K	16,870	17,050	17,570	17,740	37·3	0·74	67
N + P + K	19,620	19,910	20,190	17,980	45·9	2·19	198
N + P + K + Zn	17,000	19,480	17,000	17,360	39·6	2·19	200
N + P + K + Mn	16,700	22,400	18,180	20,100	42·8	1·51	142
N + P + K + Zn + Mn	16,000	22,900	17,750	18,170	51·1	2·10	190
N + P + K + Zn + Mn + B + Mo + Fe	16,130	17,360	18,440	16,180	26·2	1·95	168
S.E. of treatment means	1,400	1,250	1,570	950	4·9	0·26	23
Necessary differences for significance 5%	4,050	3,640	4,530	2,760	14·1	0·76	65
Necessary differences for significance 1%	5,490	4,920	6,150	3,730	19·1	1·03	88

Superphosphate highly significantly increased yields at Branchview in 1966-67. Applications of nitrogen and phosphorus in combination raised grain yields significantly in the 1966-67 season at this locality. No interaction between the two nutrients was evident. While no significant responses occurred in the 1967-68 season, all plots receiving two elements yielded considerably higher than the unfertilized plots.

No significant grain yield responses were recorded to other nutrients applied in any of the trials. However, zinc increased yield at Brookstead in 1966-67 and zinc and other trace elements decreased slightly the number of days to flowering at Branchview in 1966-67.

Stems per acre, cobs per acre and measures of grain set for Brookstead in 1966-67 and 1967-68 are presented in Table 4.

IV. DISCUSSION

Any grain yield responses which occurred were confined to nitrogen, except for a response to phosphorus in one locality.

No response to nitrogen was recorded at Clintonvale in 1966-67, probably because the soil total nitrogen content of 0·10% was comparatively high and the mineralization rate was probably fast enough to provide the mineral nitrogen requirement for crop growth.

The nitrogen responses at Brookstead in 1966-67 were variable and are difficult to interpret. The differences appear to be due to variations in plant spacing caused by planting machinery, although stand counts on their own were not significantly different (Table 4). Differences could not be attributed to the number of cobs formed, or any tillering increases, but nitrogen did show an increase in grain set per cob (Table 4) in the 76–95% category.

The very marked yield increase at Brookstead in 1967-68 with nitrogen was brought about by nitrogen increasing grain-setting on cobs, a slight increase in tillering and an increased number of cobs set per stem (Table 4). Yields were very much decreased in this trial (control yield of 879 lb/ac) owing to water-logging caused by excessive rain after one flood irrigation.

Nitrogen and phosphorus applications applied separately or in combination at Branchview in 1967-68 did not increase yield significantly. An increase with phosphorus, which did occur in 1966-67, could well be expected with soils so naturally low in available phosphorus (mean 22 p.p.m. by 0.01N H_2SO_4 extraction). It is most likely that the poor responses were due to the basal nitrogen dressing over the whole area, and some carry-over effect from the previous season, when 1 cwt of superphosphate had been applied to the area. In this situation it is reasonable to assume that both elements are required in this area.

The seemingly spasmodic unavailability of zinc and associated conditions cannot be definitely predicted on the black earth soils. However, in the zinc spray applications made by Duncan (1967) and in experiments by Hibberd (unpublished data) with ground applications, zinc has produced maize plants with healthy foliage and higher grain yields.

Other nutrients did not play any significant role in these trials. The long fallow disorder described by Hart (1962) rarely occurs on irrigation country, which is subjected to a short fallow only. In this situation the problem appears to be primarily a temporary zinc unavailability, despite various other symptoms of nutrient deficiencies that plants might show.

Therefore there is a requirement for nitrogen, together with phosphorus on soils of a low P status, and possibly for zinc, as fertilizers for maize under irrigation. Both nitrogen and phosphorus are required at Branchview to maximize yields.

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