

CORRECTION OF ZINC DEFICIENCY IN MAIZE ON THE DARLING DOWNS, QUEENSLAND

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SUMMARY

Zinc applied as a 0.5% zinc sulphate spray completely corrected symptoms of zinc deficiency. Copper, boron, magnesium, potassium and phosphorus applied as foliar sprays did not correct symptoms.

Concentration of solution (0.5, 1.0 and 1.5%) and number of applications (1 and 2) did not affect plant response significantly. There is evidence in one trial, and a trend in the other, to indicate that spraying at 7 weeks from emergence is too late for zinc sprays to increase yield, and that the optimum spraying time appears to be at about 5 weeks after emergence.

Yield increases from zinc foliar sprays ranged from 24 to 76% over control.

I. INTRODUCTION

Maize grown on most soil series of the black earths of the Darling Downs in south-eastern Queensland commonly develops striking chlorotic symptoms 2-3 weeks after emergence (Figure 1). Affected plants appear in patches of irregular shape and size in the field, with plants outside such patches appearing healthy. The chlorosis is interveinal, with the chlorotic stripes often continuous along the length of the leaf blade. Veins remain green. The chlorosis takes on a pale, and often yellow appearance, so the plant develops a "yellow-stripe" effect. In some cases, all leaves are affected, but most often only the older leaves develop these symptoms. In severe cases of the disorder, the terminal leaves do not develop chlorophyll, and death of older leaves on affected plants often occurs. Stunting is often associated with the disorder, and in extreme cases stunted plants produce no cobs.



Fig. 1.—Maize plants showing chlorotic symptoms characteristic of zinc deficiency.

On the evidence of Barnette and Warner (1935), Viets (1951), Pumpfrey and Koehler (1959) and Grunes *et al.* (1961) relating to zinc deficiency in maize, it was tentatively accepted that the disorder in Queensland, which showed similar symptoms, was also due to zinc deficiency. But as other deficiencies in maize had been described by Wallace (1961), it was decided to test the effects of application of a range of elements. As foliar application of zinc sulphate solution had been shown by Lingle and Holmberg (1956), Pumpfrey and Koehler (1959) and Grunes *et al.* (1961) to be effective in correcting zinc deficiency of maize, this was the method adopted in the tests reported here.

These tests led to a general field recommendation for the control of the disorder by the use of zinc sulphate as a spray. Later experiments, also reported here, were concerned with the rate, time and frequency of application.

II. MATERIALS AND METHODS

(a) *Trial 1*: 1961-62.—A 2⁶ half-factorial experiment was conducted to screen the elements zinc, phosphorus, copper, boron, potassium and magnesium. The treatments were:—

- (1) Zinc sulphate 0.5% spray.
- (2) Sodium dihydrogen phosphate 2.0% spray.
- (3) Copper sulphate 0.5% spray.
- (4) Boric acid 0.5% spray.
- (5) Potassium chloride 2.0% spray.
- (6) Magnesium sulphate 2.0% spray.

Commercial grade materials were used in all sprays.

All treatments were applied 3 and 5 weeks after emergence.

(b) *Trials 2 and 3*: 1964-65.—These trials were designed to determine the effects of various concentrations of zinc sprays at various times and frequencies of application. Both were 3³ factorial experiments with 2 replicates.

Concentrations used were 0.5, 1.0 and 1.5% zinc sulphate. Applications were made 3, 5 and 7 weeks after emergence. Frequencies of application were nil, once and twice (3 and 5 weeks, 5 and 7 weeks, 7 and 9 weeks).

All trials were carried out on the following series of Darling Downs black earths, as described by Beckmann and Thompson (1960): Waco series (trial 1), unclassified series (trial 2), and Anchorfield series (trial 3).

The variety in trials 1 and 2 was D.S. 606 and in trial 3 it was Q739.

Plots were 4 rows by 50 ft, 3 ft 6 in. apart, with the centre two rows being harvested as the datum area. Cobs were hand-picked and threshed by machine.

Spray applications were made at 10 gal/ac at 40 p.s.i. from a boom spray. "Agral LN" was used as a wetting agent in all sprays at 4 fl oz per 100 gal.

Grain yields were determined in all three trials, and in addition, in trial 1, stand counts were made and number of seeds per 10 g was calculated.

III. RESULTS

Trial 1.—Table 1 gives a summary of grain yields, stand counts and seed weight from the various treatments. Zinc is the only element that produced a significant response.

TABLE 1
TRIAL 1: MAIN EFFECTS OF ELEMENTS SCREENED

Treatment	Yield (bus/ac)	No. of Plants/plot	No. of Seeds/10g
- Zn	27.1	95.9	62.8**
+ Zn	47.8**	101.5	49.3
- P	38.3	97.4	55.1
+ P	36.7	100.0	57.0
- Cu	38.4	101.8	55.8
+ Cu	36.6	95.6	56.3
- B	37.3	98.6	57.0
+ B	37.7	98.8	55.2
- K	37.6	97.1	56.4
+ K	37.4	100.3	55.8
- Mg	36.6	99.0	57.1
+ Mg	38.4	98.4	55.0

** Denotes significance greater than opposing mean at 1% level.

Trial 2.—The table of mean yields for trial 2 (Table 2) shows the combined effects of spray concentration and time of application, the data for frequency of application being bulked. This was possible as no differences between treatments sprayed once or twice occurred (see Appendix 1 for full details).

TABLE 2
TRIAL 2: TABLE OF MEAN YIELDS
bus/ac

Concentration	3 Weeks	5 Weeks	7 Weeks	Mean
0.5%	73.96	83.59	74.42	77.32
1.0%	80.53	75.26	74.52	76.77
1.5%	76.09	81.18	68.31	75.19
Mean	76.86	80.01	72.42	

Necessary differences for significance (marginal) $\begin{cases} 5\% & 7.17 \\ 1\% & 9.75 \end{cases}$

There were no significant differences between concentrations. Application at 5 weeks was significantly better than application at 7 weeks (5% level), and one and two sprayings were both significantly better than no spraying (1% level).

Trial 3.—The table of mean yields for trial 3 (Table 3) shows the combined effects of spray concentrations and spray times, the data for frequencies of application being bulk, as again no significant differences between treatments sprayed once or twice occurred (see Appendix 2 for full details).

TABLE 3
TRIAL 3: TABLE OF MEAN YIELDS
bus/ac

Concentration	3 Weeks	5 Weeks	7 Weeks	Mean
0.5%	17.72	20.78	20.68	19.72
1.0%	19.38	21.24	14.10	18.24
1.5%	26.52	22.16	17.16	21.95
Mean	21.20	21.39	17.32	

Necessary difference for significance (marginal) $\left\{ \begin{array}{l} 5\% \quad 4.41 \\ 1\% \quad 6.00 \end{array} \right.$

There were no significant differences between concentrations or between times of application. Spraying twice was significantly better than no spraying at the 1% level of significance and spraying once was significantly better at the 5% level than no spraying.

IV. DISCUSSION

Zinc was the only one of the elements screened in trial 1 that gave a yield increase and produced healthy plants. Large vegetative responses were apparent within 10 days of zinc treatment and these persisted through to harvest.

Trial 1 also showed yield to be independent of plant population and at least part of the yield increase from zinc treatment to be due to increased seed weight (Table 1).

It was observed that plots receiving zinc had increased cob numbers and cob size.

Trial 2 showed that there were few differences among concentrations and frequencies of application tested. It appears that spraying at 7 weeks after emergence is too late to obtain maximum yield increases. There is a trend in mean yields in Table 2 to suggest that spraying at 5 weeks after emergence produces the best results.

Though in trial 3 no significant differences appeared as far as time of spraying is concerned, there is a similar trend in mean yield (Table 3) to that just discussed for trial 2—i.e. sprays applied at 7 weeks after emergence give lower yields and appear to be past the optimum spraying time. Again in trial 3, rate and frequency of application appear to have had no effect.

An interesting comparison can be drawn between trials 2 and 3. They were grown in the same season, but in different districts. Trial 2 was grown under ideal climatic conditions, while trial 3 was severely affected by drought. This is reflected in the level of yields from the two trials—62.2 bus/ac from trial 2 and 15.3 bus/ac from trial 3 for control treatments. Despite these widely differing growth conditions, the influence of zinc treatment has still been very significant. The average increase over unsprayed plots was 24% in trial 2 and 31% in trial 3.

Data from these trials indicate that foliar sprays of zinc sulphate will prevent deficiency symptoms in maize and increase yields, and that one spray of 1.0% zinc sulphate applied 5 weeks after emergence will provide a cheap and satisfactory commercial control of this nutritional disorder.

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APPENDIX 1

TRIAL 2: DETAILS OF PLOT YIELDS

Plot No.	Treatment	Yield (bus/ac)	Plot No.	Treatment	Yield (bus/ac)
1	1.0% at 3 and 5 weeks ..	85.9	28	0.5% at 7 and 9 weeks ..	72.5
2	1.5% at 5 weeks	81.5	29	Control	67.0
3	0.5% at 3 weeks	64.7	30	1.5% at 5 weeks	89.3
4	Control	49.1	31	Control	59.1
5	1.0% at 7 weeks	81.5	32	Control	65.8
6	0.5% at 5 and 7 weeks ..	81.5	33	1.0% at 7 weeks	72.5
7	1.5% at 7 and 9 weeks ..	64.7	34	1.0% at 5 and 7 weeks ..	74.8
8	Control	68.1	35	0.5% at 3 weeks	69.2
9	Control	51.3	36	1.5% at 3 and 5 weeks ..	68.1
10	1.5% at 5 and 7 weeks ..	81.5	37	0.5% at 3 and 5 weeks ..	84.8
11	Control	61.4	38	1.0% at 3 weeks	87.0
12	1.0% at 5 weeks	53.6	39	1.0% at 7 and 9 weeks ..	69.2
13	1.0% at 7 and 9 weeks ..	71.4	40	1.5% at 5 and 7 weeks ..	69.2
14	Control	59.1	41	0.5% at 5 weeks	84.8
15	1.5% at 3 weeks	65.8	42	Control	56.9
16	Control	56.9	43	Control	61.4
17	0.5% at 7 weeks	81.5	44	1.5% at 7 weeks	85.9
18	0.5% at 3 and 5 weeks ..	73.7	45	Control	54.7
19	1.5% at 7 weeks	74.8	46	Control	75.9
20	1.5% at 3 and 5 weeks ..	83.7	47	1.0% at 3 and 5 weeks ..	92.6
21	Control	67.0	48	1.0% at 5 weeks	84.8
22	0.5% at 5 weeks	78.1	49	Control	67.0
23	Control	74.8	50	0.5% at 5 and 7 weeks ..	98.2
24	Control	69.2	51	0.5% at 7 weeks	74.8
25	1.0% at 3 weeks	64.7	52	Control	60.3
26	1.0% at 5 and 7 weeks ..	87.0	53	1.5% at 3 weeks	85.9
27	0.5% at 7 and 9 weeks ..	68.1	54	1.5% at 7 and 9 weeks ..	55.8

Mean:

Unsprayed	62.4	Sprayed 1.5%	77.9	Sprayed 7 weeks	75.8
Sprayed 0.5%	77.7	Sprayed 3 weeks	77.3	Sprayed once	76.8
Sprayed 1.0%	77.9	Sprayed 5 weeks	80.4	Sprayed twice	76.3

APPENDIX 2

TRIAL 3: DETAILS OF PLOT YIELDS

Plot No.	Treatment	Yield (bus/ac)	Plot No.	Treatment	Yield (bus/ac)
1	1.0% at 3 and 5 weeks	31.3	28	0.5% at 7 and 9 weeks	23.4
2	1.5% at 5 weeks	26.8	29	Control	14.5
3	0.5% at 3 weeks	22.3	30	1.5% at 5 weeks	23.4
4	Control	13.4	31	Control	19.0
5	1.0% at 7 weeks	21.2	32	Control	15.6
6	0.5% at 5 and 7 weeks	13.4	33	1.0% at 7 weeks	12.3
7	1.5% at 7 and 9 weeks	16.7	34	1.0% at 5 and 7 weeks	20.1
8	Control	15.6	35	0.5% at 3 weeks	15.6
9	Control	12.3	36	1.5% at 3 and 5 weeks	33.5
10	1.5% at 5 and 7 weeks	24.5	37	0.5% at 3 and 5 weeks	17.9
11	Control	17.9	38	1.0% at 3 weeks	17.9
12	1.0% at 5 weeks	26.8	39	1.0% at 7 and 9 weeks	21.2
13	1.0% at 7 and 9 weeks	3.3	40	1.5% at 5 and 7 weeks	15.7
14	Control	19.0	41	0.5% at 5 weeks	19.0
15	1.5% at 5 weeks	17.9	42	Control	11.2
16	Control	14.5	43	Control	13.4
17	0.5% at 7 weeks	20.1	44	1.5% at 7 weeks	16.7
18	0.5% at 3 and 5 weeks	16.7	45	Control	14.5
19	1.5% at 7 weeks	23.4	46	Control	15.6
20	1.5% at 3 and 5 weeks	33.5	47	1.0% at 3 and 5 weeks	14.5
21	Control	14.5	48	1.0% at 5 weeks	15.6
22	0.5% at 5 weeks	25.7	49	Control	12.3
23	Control	20.1	50	0.5% at 5 and 7 weeks	26.8
24	Control	15.6	51	0.5% at 7 weeks	17.9
25	1.0% at 3 weeks	15.6	52	Control	15.6
26	1.0% at 5 and 7 weeks	20.1	53	1.5% at 3 weeks	19.0
27	0.5% at 7 and 9 weeks	19.0	54	1.5% at 7 and 9 weeks	13.4

Averages:

Unsprayed	15.4	Sprayed 1.5%	21.9	Sprayed 7 weeks	18.3
Sprayed 0.5%	19.9	Sprayed 3 weeks	21.2	Sprayed once	19.9
Sprayed 1.0%	18.3	Sprayed 5 weeks	22.5	Sprayed twice	20.3