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# CORRECTION OF ZINC DEFICIENCY IN WHEAT ON THE DARLING DOWNS, QUEENSLAND

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SUMMARY

**Zinc sulphate applied as a 1% spray at 2-4 weeks after emergence, or at 1 cwt/ac drilled in, alleviated the symptoms. Grain yield increases were up to 35% higher than in untreated plots.**

**Applications 5 weeks after emergence did not produce significant yield increases.**

**There was an indication that cultural practices can also alleviate the symptoms.**

## I. INTRODUCTION

In the late 1950s and early 1960s, disorders which appeared to be of nutritional origin were observed in linseed, wheat and maize crops on the Darling Downs in south-eastern Queensland.

In the case of wheat, the symptoms resembled those attributed to zinc deficiency by Millikan (1942). In Queensland, affected wheat plants develop an unthrifty appearance and remain stunted. Grey necrotic spots appear on the leaves, and leaf tips often die. A general chlorosis develops in affected plants, and tillering is not as vigorous as in healthy plants. The onset of symptoms occurs early in the life of the plant, usually 4–5 weeks after emergence and before tillering. Subsequent growth is restricted. At all stages of later development of affected crops, an unevenness in height and maturity persists until maturity: this is the most noticeable field symptom.

Affected plants occur in patches varying in size from 3 ft to 12 ft across, while plants outside these patches appear to be healthy.

Millikan (1942) described one symptom which has not been consistently associated with the disorder on the Darling Downs, namely a characteristic sharp bend in the leaf at about the position where the necrotic lesions commence development.

In spite of the complete lack of agreement between the Victorian and Queensland symptoms, the disorder in Queensland has been accepted as zinc deficiency.

The exact economic importance of zinc deficiency in wheat in Queensland has not been established. Field observations suggest that wheat is affected most adversely in the second crop after a long fallow. Severe symptoms have been noted on the varieties Gala, Gabo and Gamenya, while Mendos and Festiguay are often apparently free.

Though numerous workers throughout the world had studied methods of correcting zinc deficiency in various crops, including soil and spray applications of zinc compounds, there was no information on concentration and time of application that could be used directly in formulating recommendations for field control of the disorder in wheat.

The experiments reported in this paper were carried out to provide such information.

## II. MATERIALS AND METHODS

*General.*—In all trials, the spray volume used was 10 gal/ac. Plots were sprayed from a boom attached to a Land Rover. "Agral LN" was used as a wetter at 4 fl oz per 100 gal of spray.

*Trial* 1.—In 1961, a 7 x 4 randomized block experiment (plot size 1/20 ac) was conducted with the following treatments:—

(1) Control—untreated.
(2) Zinc sulphate 1 cwt/ac.
(3) Superphosphate 5 cwt/ac.
(4) Zinc sulphate 1 cwt/ac + superphosphate 5 cwt/ac.
(5) Zinc sulphate 0·5% at 3 and 5 weeks after emergence.
(6) Sodium dihydrogen phosphate 2·0% at 3 and 5 weeks after emergence.
(7) Zinc sulphate 0·5% + sodium dihydrogen phosphate 2% at 3 and 5 weeks after emergence.

Commercial zinc sulphate ($ZnSO_4.7H_2O$), commercial dihydrogen phosphate and 22% superphosphate were used.

The variety used was Festival.

*Trial* 2.—In 1962–63, the area covered by trial 1 was planted over replicates 1 and 2 with panicum, and replicates 3 and 4 were fallowed.

In 1963, Mengavi wheat was planted over this whole area, so replicates 1 and 2 were double-cropped (from panicum) and replicates 3 and 4 were long-fallowed (15 months). This was done to gauge the residual effect of the 1961 fertilizer applications of 1 cwt of zinc sulphate and to determine the effects of double-cropping and long fallow on the expression of zinc deficiency in wheat.

Three quadrat cuts (each 1 sq yd) were taken in all four replicates at the soft-dough stage of development and the material was oven-dried.

*Trial* 3.—In 1965, another trial was conducted to determine the effectiveness of zinc sprays in alleviating the effects of zinc deficiency, in comparison with 1 cwt of zinc sulphate per acre drilled in with the seed. The treatments were:—

(1) Control—Untreated.

(2) Zinc sulphate 1 cwt/ac at planting.

(3) Zinc sulphate 1·0% at 2 and 3 weeks after emergence.

(4) Zinc sulphate 1·0% at 3 and 4 weeks after emergence.

(5) Zinc sulphate 1·0% at 4 and 5 weeks after emergence.

(6) Zinc sulphate 1·0% at 5 and 6 weeks after emergence.

(7) Zinc sulphate 1·0% at 6 and 7 weeks after emergence.

The plot size was again 1/20 ac. The variety used was Mendos.

## III. RESULTS

The results of trial 1 are presented in Table 1. There was no significant difference in yield between the control and other treatments, but there was a trend towards increased yields from zinc application both to the soil and to the plants, the means being:—

| | |
|---|---|
| No zinc applied to the soil .. .. .. .. | 617·8 lb |
| Zinc applied to the soil .. .. .. .. | 649·7 lb |
| No zinc applied to the plants .. .. .. | 609·4 lb |
| Zinc applied to the plants .. .. .. .. | 660·0 lb |

**TABLE 1**

TRIAL 1: MEAN GRAIN YIELDS (LB/AC)

| Treatment | Yield (lb/ac) |
|---|---|
| 1. Control—no treatment .. .. .. .. .. | 620·6 |
| 2. Zinc sulphate 1 cwt/ac .. .. .. .. .. | 635·6 |
| 3. Superphosphate 5 cwt/ac .. .. .. .. .. | 615·0 |
| 4. Zinc sulphate 1 cwt/ac + superphosphate 5 cwt/ac .. | 663·7 |
| 5. Zinc sulphate 0·5% at 3 and 5 weeks .. .. .. | 663·7 |
| 6. Sodium dihydrogen phosphate 2·0% at 3 and 5 weeks .. | 598·1 |
| 7. Zinc sulphate 0·5% + sodium dihydrogen phosphate 2·0% at 3 and 5 weeks .. .. .. .. .. | 656·2 |
| Necessary differences for significance .. .. .. 5% | 59·8 |
| Necessary differences for significance .. .. .. 1% | 82·0 |

The results of trial 2 are given in Table 2. The drilled zinc sulphate produced highly significant increases (1% level) in dry matter, irrespective of the cropping history—i.e. on both double-cropped and long-fallowed plots.

**TABLE 2**

TRIAL 2: MEAN DRY-MATTER YIELDS (LB/AC)

| Treatment | Double-Cropped | Long-Fallowed | Means |
|---|---|---|---|
| 1. Control—no treatment . . | 1,438·6 | 1,004·7 | 1,221·7 |
| 2. Zinc sulphate 1 cwt/ac . . | 2,702·3 | 2,633·0 | 2,667·7 |
| 3. Superphosphate 5 cwt/ac | 1,675·8 | 1,018·0 | 1,346·9 |
| 4. Zinc sulphate 1 cwt + superphosphate 5 cwt/ac | 2,722·6 | 2,423·6 | 2,573·1 |
| 5. Zinc sulphate 0·5% at 3 and 5 weeks | 1,508·0 | 1,195·0 | 1,352·0 |
| 6. Sodium dihydrogen phosphate 2·0% at 3 and 5 weeks | 1,535·0 | 947·7 | 1,241·4 |
| 7. Zinc sulphate 0·5% + sodium dihydrogen phosphate 2·0% at 3 and 5 weeks | 1,613·4 | 1,015·9 | 1,314·7 |
| Means | 1,885·2 | 1,462·6 | 1,673·9 |
| Necessary differences for significance 5% | | | 249·3 |
| Necessary differences for significance 1% | | | 349·4 |

The dry-matter data also indicate that the disorder effects are much more severe on the long-fallowed plots than on the double-cropped plots.

The interaction fertilizer x cropping history was highly significant at the 1% level (Table 3). On the double-cropped plots there were no significant differences between treatments. On the long-fallowed plots, the zinc sulphate drilled in at planting at 1 cwt/ac gave yields significantly higher (1% level) than all other treatments. This response was not affected by the addition of superphosphate.

**TABLE 3**

TRIAL 2: MEAN GRAIN YIELDS (LB/AC)

| Treatment | Double-Cropped | Long-Fallowed | Means |
|---|---|---|---|
| 1. Control—no treatment . . | 2,675 | 2,010 | 2,342 |
| 2. Zinc sulphate 1 cwt/ac . . | 2,825 | 2,805 | 2,815 |
| 3. Superphosphate 5 cwt/ac | 2,695 | 2,135 | 2,415 |
| 4. Zinc sulphate 1 cwt + superphosphate 5 cwt/ac | 2,770 | 2,775 | 2,772 |
| 5. Zinc sulphate 0·5% at 3 and 5 weeks | 2,770 | 2,045 | 2,408 |
| 6. Sodium dihydrogen phosphate 2·0% at 3 and 5 weeks | 2,805 | 2,105 | 2,455 |
| 7. Zinc sulphate 0·5% + sodium dihydrogen phosphate 2·0% at 3 and 5 weeks | 2,880 | 2,160 | 2,520 |
| Means | 2,774 | 2,291 | 2,532 |
| Fertilizer means: Necessary differences for significance 5% | | | 198·8 |
| Fertilizer means: Necessary differences for significance 1% | | | 278·7 |
| Individual means: Necessary differences for significance 5% | | | 281·2 |
| Individual means: Necessary differences for significance 1% | | | 394·2 |

The increase in dry matter resulting from the residual effect of zinc sulphate at 1 cwt/ac, as shown in Table 2, was reflected in grain yield increases on the long-fallowed but not on the double-cropped plots.

The results of trial 3 are given in Table 4. The application of zinc sulphate either to the soil at 1 cwt/ac or as a 1·0% spray at 10 gal/ac produced significant grain yield increases over control areas. The level of increase declined as the age of plants at time of spraying increased. The greatest increase ($P<0\cdot01$) occurred when plants were 2–4 weeks old, and the increase ceased to be significant ($P<0\cdot05$) after the plants were 5 weeks old.

**TABLE 4**

TRIAL 3: MEAN GRAIN YIELDS (LB/AC)

| Treatment | | Yield |
|---|---|---|
| 1. Control—no treatment | | 1225 |
| 2. Zinc sulphate 1 cwt/ac | | 1503 |
| 3. Zinc sulphate 1·0% at 2 and 3 weeks | | 1521 |
| 4. Zinc sulphate 1·0% at 3 and 4 weeks | | 1576 |
| 5. Zinc sulphate 1·0% at 4 and 5 weeks | | 1424 |
| 6. Zinc sulphate 1·0% at 5 and 6 weeks | | 1348 |
| 7. Zinc sulphate 1·0% at 6 and 7 weeks | | 1244 |
| Necessary differences for significance | 5% | 146 |
| | 1% | 209 |

## IV. DISCUSSION

In the first trial in this programme, it was apparent that zinc sulphate as a spray or as a drill application alleviated the effects of zinc deficiency in wheat.

J. K. Leslie (personal communication) has found that the disorder can also be alleviated by cultural means—e.g. the use of double-cropping with panicum. The second experiment confirms this fact and also shows that it is comparable to the residual effect of 1 cwt of zinc sulphate in its effectiveness in relieving the disorder. It is also apparent that long-fallowing, for some reason not yet clear, aggravates the expression of the disorder.

In the third experiment, no foliar symptoms were apparent at any stage. The only obvious symptom was that the crop was uneven in height and maturity. This experiment, however, showed conclusively that zinc sprays applied at the critical stage (i.e. at 2–4 weeks old) will alleviate the disorder to the same extent as 1 cwt of zinc sulphate per acre drilled in at planting. The drill application costs approximately $8 per ac for materials as against a cost of $0.15 for materials for spray application.

While the second experiment in this programme showed that large residual responses are possible, it is still considered more economical to use sprays each year.

The yield increases in these trials resulting from zinc treatment ranged up to 35% above unsprayed areas, equivalent to an increase of 4 bags of wheat grain per acre.

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## REFERENCE

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