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

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SUMMARY

Significant yield increases were obtained from the application of zinc sulphate sprays at critical times. The effect of spray concentration (0·5, 1·0 and 1·5%) and frequency of spraying (single or dual applications) was not significant. To be fully effective, sprays had to be applied at 2 weeks after emergence.

Soil applications of 1 cwt of zinc sulphate per acre were fully effective. The lower rates of 28 and 70 lb/ac were not fully effective in all trials.

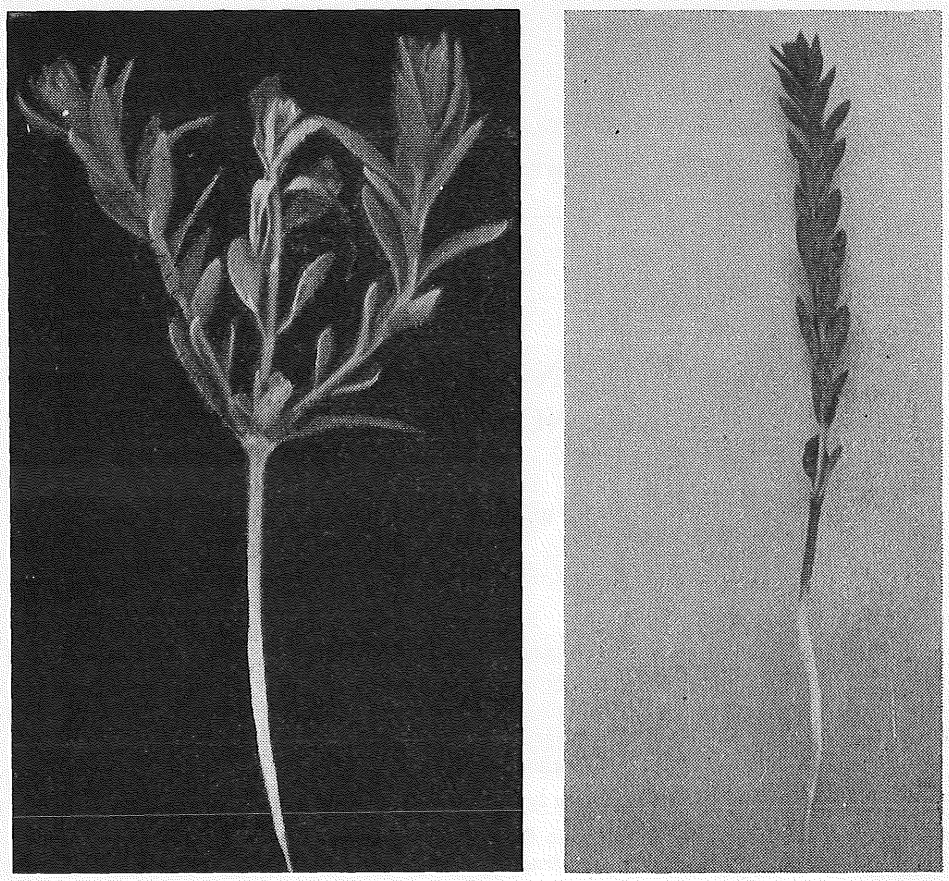
The practical implications of these findings is that zinc sulphate sprays applied at 1·0% at 10 gal/ac at 2 weeks after emergence will control zinc deficiency in linseed at a low cost.

I. INTRODUCTION

Zinc deficiency is widespread in linseed crops in Queensland, having been observed on most soil types of the Darling Downs in south-eastern Queensland and in the Central Highlands.

Three separate expressions of symptoms are now recognized in linseed affected by the deficiency (Australian reports include Millikan 1946, Cass Smith and Harvey 1948, Hewitt 1962, and Adam and Piper 1964). These expressions are:

(1) *Tip dieback* (Figure 1, A).—Faint leaf spotting of terminal leaves precedes necrosis of these leaves. Necrotic lesions are usually grey-white. Cessation of terminal growth occurs and in severe cases the plant may die. Usually there is a distinct recovery of plants affected by tip dieback, this being effected by development of side shoots low on the plant.



A B

Fig. 1.—Linseed plants affected by: A, tip dieback; B, bronze spotting.

Tip dieback usually appears at 3–4 weeks after emergence and the onset is rapid. The pattern is patchy in the field; patches vary in size from 3 ft to 12 ft in diameter, with plants outside the patches appearing quite healthy. The affected plants remain stunted for several weeks, so at one stage there may be a difference in height of 6 in. between plants in affected and unaffected areas.

(2) *Lower leaf necrosis* (Figure 2).—This is a less severe expression of the disorder which appears on plants intermingled with those showing tip dieback. It occurs about 5 weeks after emergence, with pale necrotic lesions usually developing on the lower leaves. Appearance of lesions can be followed by death of whole leaves. Leaves showing these lesions often absciss. Side shoots, if present, are usually free of necrosis.

Plants showing lower leaf necrosis are usually not set back markedly, and side-shoot stimulation is not as marked as with tip dieback.

Fig. 2.—Linseed plants affected by lower leaf necrosis.

(3) *Bronze spotting* (Figure 1, B).—The least severe form of the disorder encountered on the Darling Downs is the appearance of small bronze necrotic spots on the central leaves of the plant. These usually appear later than the other two symptoms, and no apparent setback in plant growth results.

Andrew, Kipps, and Barford (1952) obtained relief of symptoms of zinc deficiency in *Paspalum* on Darling Downs soils in pots with zinc sulphate sprays and soil dressings at 7 lb/ac. Hewitt (1962) obtained responses in field trials with linseed on the Darling Downs with 1 cwt zinc sulphate per acre drilled in with the seed but was unable to obtain responses to zinc sprays.

Field experiments were designed to ascertain suitable rates and frequencies of soil and foliar applications of zinc to commercial crops. These experiments are reported in this paper.

II. MATERIALS AND METHODS

All three trials conducted included the following treatments:

Soil applications

Zinc sulphate at 28, 70 and 112 lb/ac drilled in with the seed.

Superphosphate at 5 cwt/ac drilled in with the seed.

Zinc sulphate at 112 lb and superphosphate at 5 cwt/ac drilled in with the seed.

Foliar applications

Zinc sulphate at 0·5, 1·0 and 1·5% single applications 2, 4 and 6 weeks after emergence.

Zinc sulphate at 0·5, 1·0 and 1·5%, two applications, 2 and 4 weeks after emergence.

Details are given in Table 2. Commercial zinc sulphate ($ZnSO_4$. $7H_2O$) and 22% superphosphate were used. Spray applications were at 40 p.s.i. and 10 gal/ac from a boom spray. "Agral LN" was used as a wetter in all sprays at 4 fl oz. per 100 gal of spray.

Three replicates were used in all trials. Plot size was 1/20 ac, with 1/30 ac harvested as datum area.

Trial 1 was located on Condamine soil series, trial 2 on Anchorfield series and trial 3 on Waco series (see Beckmann and Thompson 1960 for descriptions).

All the trials were conducted on the variety Walsh planted after a long (16 months) fallow following summer crops.

In order to establish the degree of severity of the disorder on the trial sites, plants showing four categories of symptoms were counted on 4 x 10 ft lengths of row in the control plots in all replicates. The symptom categories were tip dieback, lower leaf necrosis, bronze spotting, and healthy.

III. RESULTS

Table 1 indicates that the application of the highest rate (1 cwt/ac) of zinc sulphate significantly increased yields in all trials, but the lowest rate (28 lb) had no significant effect in any of the trials. The 70-lb application significantly improved yield only in trial 3.

TABLE 1

LEVEL OF SEVERITY OF SYMPTOMS IN CONTROL PLOTS

Symptoms	Percentage of Plants Affected		
	Trial 1	Trail 2	Trial 3
Tip dieback	65·5	32·1	11·4
Lower leaf necrosis	5·8	12·4	27·5
Bronze leaf spotting	4·1	8·4	38·3
Healthy	24·6	47·1	22·8

Superphosphate alone at 5 cwt/ac increased grain yield in trial 3 but not in trials 1 and 2. In none of the three trials did the combined superphosphate and zinc sulphate dressings yield significantly less than zinc sulphate alone. In trial 3, this combined treatment was significantly better ($P < 0{\cdot}01$) than either zinc sulphate or superphosphate alone.

No significant differences between spray concentrations (0·5, 1·0 and 1·5%) occurred in any of the trials.

The critical factor in the spray treatments is shown to be time of application. Results of trial 3 show a clear pattern of response in that only the sprays applied at 2 weeks (0·5, 1·0 and 1·5%) and all dual sprays applied at 2 and 4 weeks (0·5, 1·0 and 1·5%) are significantly better than unsprayed plots. In trial 1, the response pattern is much the same except that it is the 0·5% spray at 4 weeks and not the 0·5% spray at 2 weeks which has significantly increased the yield. In trial 3 there appears to be a discrepancy from these findings in that it is the 1·0% spray at 6 weeks, and not the early spray (1·0%), which has increased yield. This result is inexplicable. There is general agreement between the trials, however, in that the early sprays appear to have an advantage over the later sprays.

IV. DISCUSSION

The results indicate that zinc applied in a soil or spray application can alleviate symptoms of zinc deficiency and increase yield.

The severity ratings for the three trials show how severe zinc deficiency in linseed can be in the field—75·4, 52·9, and 77·2% of plants were affected by the disorder in the three trials. A breakdown of the symptoms shows that, in trial 1, 65·5% of the plants were affected by the severest form of the disorder, in trial 2, 32·1%, and in trial 3, 11·4%.

Trial 3 has a greater percentage of plants affected by lower leaf necrosis and bronze leaf spotting (see Table 1). These symptoms appear later than tip dieback and this may be the reason why responses to sprays applied 6 weeks after emergence were obtained in this trial alone.

Spray concentration (0·5, 1·0 and 1·5%) appears relatively unimportant. Trials 1 and 2 showed no significant differences between rates. Trial 3, however, did show a significant yield increase with the 1·5% sprays over the 0·5 and 1·0% sprays. There were occasional signs of spray burn with the higher concentration in all three trials.

Frequency of application appears to have no significant effect on yields—i.e. dual applications are no better than a single application at the critical stage.

Time of spraying is the important factor, and it is obvious that for such sprays to be fully effective they have to be applied before the appearance of the deficiency symptoms. In all three trials the spraying time that was consistently best was 2 weeks after emergence.

Superphosphate did not aggravate the disorder in any of the three trials. Only in trial 3 was there a positive interaction between zinc and phosphate and in neither of the other trials was there a negative zinc-phosphate interaction.

From the data presented in Table 2, it would appear that between 70 and 112 lb. of zinc sulphate per acre represents a practical rate of application for prevention of zinc deficiency.

TABLE 2

LINSEED YIELDS (LB/AC)

Treatment	Grain Yields (lb/ac)		
	Trial 1	Trial 2	Trial 3
1. Zinc sulphate 28 lb/ac	408	610	463
2. Zinc sulphate 70 lb/ac	437	640	753
3. Zinc sulphate 112 lb/ac	461	825	593
4. Superphosphate 5 cwt/ac	397	605	593
5. Zinc sulphate 1 cwt/ac + superphosphate 5 cwt/ac	529	898	810
6. Zinc sulphate 0·5% at 2 weeks	428	728	657
7. Zinc sulphate 0·5% at 4 weeks	450	615	443
8. Zinc sulphate 0·5% at 6 weeks	375	560	557
9. Zinc sulphate 1·0% at 2 weeks	470	718	437
10. Zinc sulphate 1·0% at 4 weeks	417	568	537
11. Zinc sulphate 1·0% at 6 weeks	381	582	603
12. Zinc sulphate 1·5% at 2 weeks	448	720	647
13. Zinc sulphate 1·5% at 4 weeks	444	648	567
14. Zinc sulphate 1·5% at 6 weeks	392	662	553
15. Zinc sulphate 0·5% at 2 and 4 weeks	456	755	560
16. Zinc sulphate 1·0% at 2 and 4 weeks	484	745	623
17. Zinc sulphate 1·5% at 2 and 4 weeks	510	818	630
18. Control	372	618	447
Necessary differences for significance 5%	75	93	137
Necessary differences for significance 1%	101	125	184

In only one case (trial 2) was the soil application of zinc more effective than the spray applications made at the critical time, i.e. the early sprays. This is of some practical importance, as 1 cwt of zinc sulphate per acre at current prices costs approximately $9 while a 1·0% zinc sulphate spray applied at 10 gal/ac costs less than $1 per acre. These costs are for materials only (1966).

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