THE CONTROL OF IRON CHLOROSIS IN CITRUS TREES BY THE USE OF IRON CHELATES IN THE LIMPOPO PROVINCE, SOUTH AFRICA

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Introduction

Foliar sprays of Metalosate products were tested on citrus in the Sundays River Valley during the 2002/03 season. The object of this work was to study the effects of spray adjuvants on the efficacy of the foliar sprays. Out of a range of adjuvants tested, only the organic silicone wetting agent, Silwet®, provided acceptable results. Micrel Fe 600 (Fe EDDHA) was used as the standard reference product in this trial but no responses were observed to this treatment and this caused some concern. The current trial continues the theme. It examines the efficacy of an alternate wetter (OAA 01) that is chemically similar to Silwet but commercially more attractive, and it further examines the efficacy of Micrel Fe 600 by comparing it with Bolikel, a similar product but of renowned high quality. The results are reported below.

Key words: iron chelates, iron deficiency, citrus

Summary

A randomised block trial was conducted in the Messina area of Limpopo Province using six-year old du Roi Valencia orange trees on Swingle citrummelo root stock. The soil is strongly alkaline. Under these conditions the tree canopies were very chlorotic due to severe iron deficiency.

Under these conditions three foliar sprays of Metalosate Iron (with wetter) in the April to May period, produced an effective rapid control of the chlorosis, but the effect weakened somewhat as the new spring leaf flush emerged in September and October, (as assessed in early November). These results support those of the previous season when the addition of Silwet was found to strongly improve the efficacy of foliar sprays of Metalosate Iron. Similar good results were also obtained in this trial where OAA 01 was used a wetter in place of Silwet. The rates of Metalosate Iron, viz. 2, 4, and 6 litre per hectare (27, 55, and 82 fluid ounces/acre) per spray were all equally effective.

Responses to soil applied chelates were slower to manifest. Bolikel did produce a somewhat quicker response that Micrel Fe 600, but over the longer term Micrel Fe 600 produced a better result than Bolikel. The perceived weakness of Micrel Fe 600 in the earlier trial is therefore not supported by the findings of this trial. Results were not sensitive to dosage rate. It should be added though that in the case of the soil applied chelates, the responses observed would be better described as “alleviation” rather than “control” of the iron chlorosis.

Materials and Methods

Trial site. The trial was conducted in the autumn of 2003 in a Valencia (du Roi) citrus orchard at Marois farm situated in the Messina area, in the Limpopo Province, South Africa. The citrus trees are planted on Swingle citrummelo rootstock having a spacing of 3.3m x 7.5m (10.83 ft x 24.60 ft) i.e. 404 trees per hectare (163.6 trees per acre).

Treatments.

1 Metalosate Iron at 2 litre/hectare (27 fluid ounces/acre) with 0.05% OAA 01

2 Metalosate Iron at 4 litre/hectare (55 fluid ounces/acre) with 0.05% OAA 01

3 Metalosate Iron at 6 litre/hectare (82 fluid ounces/acre) with 0.05% OAA 01

4 Metalosate Iron at 2 litre/hectare (27 fluid ounces/acre) with 0.05% Silwet

5 Metalosate Iron at 4 litre/hectare (55 fluid ounces/acre) with 0.05% Silwet

6 Metalosate Iron at 6 litre/hectare (82 fluid ounces/acre) with 0.05% Silwet

7 Untreated control

8 Micrel Fe 600 (Fe EDDHA) at 30g per m^2 (2.6 oz per ft^2) drip area, applied in three instalments

9 Micrel Fe 600 (Fe EDDHA) at 30g per m^2 (2.6 oz per ft^2) drip area, as a single application

10 Micrel Fe 600 (Fe EDDHA) at 50g per m^2 (4.3 oz per ft^2) drip area, as a single application

11 Bolikel (Fe EDDMHA) at 30g per m^2 (2.6 oz per ft^2) drip area, applied in three instalments

12 Bolikel (Fe EDDMHA) at 30g per m^2 (2.6 oz per ft^2) drip area, as a single application

13 Bolikel (Fe EDDMHA) at 50g per m^2 (4.3 oz per ft^2) drip area, as a single application

Method

Foliar applied iron. Foliar spray applications were made by means of a backpack mistblower. The foliar sprays were based on a total volume of 808 litre/hectare (86 gallons/acre) (404 trees x 2 L (68 fluid ounces) per tree). Two litres (68 fluid ounces) of spray solution was made up for each treatment and applied directly to each tree. The treatments were applied on the 15th of April, 2nd of May and 20th of May 2003.

Soil applied iron. The soil drenches were applied to a 2 m^2 (21.5 ft^2) drip area per tree. The synthetic iron chelate was mixed with water and the solution was applied to a groove made directly under the dripper line, across the tree diameter. The treated areas were covered with soil to prevent exposure to ultra violet light. The soil application was done on the 15th of April with follow-up treatments on the second and third date (mentioned above) for treatments 8 and 11.

Experimental Design

A randomised block design with single-tree plots using four replications. Treatments comprised two sets with factorial grouping. The first consists of three dosage rates on foliar Metalosate Iron times two wetters. The second has three dosage rates of synthetic iron chelates as soil treatment times two chelate products. In the absence of interaction between the main factors within the groupings we therefore have 12 replications of wetter treatments and of the soil applied chelate products, with eight replications for dosage rate for both the foliar and soil treatments.

Results

Trees were assessed for the percentage chlorotic foliage prior to the first application on 15th April, and again at one and six months after the last applications, i.e. on 19th June and 11th November respectively. Results are tabulated Table 1 and Figure 1.

Discussion

During the June assessment of canopy condition it was noticed that many of the chlorotic leaves on the sprayed trees had a rather mottled appearance (See Figure 2) which seemed to be caused by a “partial” re-greening in parts of the leaf with the chlorosis being unaffected in other parts. Areas where re-greening occurred seemed to be those where twists or folds in the leaf resulted in cupping and it seems that the spray deposit may have collected in these areas to produce stronger responses. By contrast, spray deposits seemed to have drained from “expanded” areas of the leaf to leave the chlorosis unaffected. This pattern suggests that the concentration of the wetter may have been marginally high. More attention will need to be given to this aspect in the future.

Results of the assessments of the amounts of chlorosis present in the trees before and after treatment, show that interactions between the main elements of the treatments did not occur. This simplifies the interpretation of the results since one need only concentrate on the treatment main effects.

Table 1
The Mean Percentage of the Canopy Affected by Iron Chlorosis in the Soil and Foliar Treatments

Treatment	15 Apr (pre-treatment)	19 Jun (post-treatment)	11 Nov (post-treatment)
Control	88%	81%	65%
Metalosate® foliar products	48%	6%	29%
Soil applied chelates	49%	20%	21%

The overall main treatment effects are very interesting since they show that three sprays of Metalosate Iron with wetter were effective in reducing iron chlorosis. Initially this control was more effective than the control provided by the soil applied synthetic chelates. The control afforded by the Metalosate foliar products did however weaken in the November assessment and this was mainly due to the reappearance of chlorosis in the new spring flush. The soil applied chelates were less effective initially providing suppression rather than control of the chlorosis. This suppression extended into the spring with very little (or no) chlorosis developing in the new growth.

Table 2
The Mean Percentage of the Canopy Affected by Iron Chlorosis After Treatment with Soil Applied Synthetic Iron Chelates

Treatments	15 Apr (pre-treatment)	19 Jan (post-treatment)	11 Nov (post-treatment)
Product Main Effect			
Micrel Fe 600 (EDDHA)	44%	26%	17%
Bolikel® (EDDHMA)	53%	15%	25%
Dosage Main Effect			
30 g/m2 (0.32 oz/ft^2) in three applications	57%	24%	21%
30 g/m2 (0.32 oz/ft^2) as single application	41%	17%	21%
50 g.m2 (0.54 oz/ft^2) as single application	49%	20%	22%

The tree responses to soil applications of synthetic iron chelates do not show strong differences between treatments. Thus it is indicated that applying a 30 g/m2 (0.32 oz/ft^2) dose in three instalments spread over a thirty five day period, did improve upon responses provided by the same dose applied as

single treatment. Similarly no benefit was achieved by increasing the dosage to 50 g/m2 (0.54 oz/ft^2) of drip area.

Perhaps the most important indication from this section of the trial is the continued reduction in the level of chlorosis caused by treatment with Micrel Fe 600. Bolikel by contrast produced a quicker but shorter response.

Table 3
The Mean Percentage of the Canopy Affected by Iron Chlorosis After Treatment with Foliar Sprays of Metalosate Iron with Wetter

Treatments	15 Apr (pre-spray)	19 Jun (post-spray)	11 Nov (post-spray)
Wetter Main Effect			
OAA 01	45%	8%	27%
Silwet®	51%	4%	32%
Main Effect of Metalosate® Spray Rate			
2 litre per hectare (27 fluid ounces/acre) per spray	39%	7%	30%
4 litre per hectare (55 fluid ounces/acre) per spray	48%	7%	30%
6 litre per hectare (82 fluid ounces/acre) per spray	57%	3%	28%

As in the case of the soil applied chelates, the responses to sprays of Metalosate Iron are little influenced by the variations between treatments. However the data does suggest that Silwet plus Metalosate Iron produced a slightly stronger response than did the OAA 01 combination. It is also indicated good effects were obtained at comparatively low dosage rates. Attention needs to be drawn to the fact that these tests were done on small trees. Further calibration work is now needed to determine the effective spray rates for larger trees.

Conclusion

Results obtained indicate that foliar applied Metalosate Iron has a quicker effect on iron chlorosis than soil applied synthetic iron chelates. The residual effect of Metalosate Iron was insufficient to protect the new spring flush four to five months later. Bolikel was slightly more effective than Micrel Fe 600 as soil applied synthetic chelates. Both however were slower working than Metalosate Iron, but had longer residual action. These observations lead to interesting speculations on the merits of combining the foliar sprays and soil treatments into a treatment program.

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REFERENCES

Carlson, R. 2003. The control of iron chlorosis in citrus tress by the use of Iron Metalosate in combination with different wetting agents. Ocean Agriculture (Pty) Ltd - Report 11 of 2002.

APPENDIX

Table 4
The Percentage Chlorotic Foliage

Tr. No.	Date Assessed	A	B	C	D	Average % Chlorosis	Average % Reduction in Chlorosis
1	15-Apr	50	30	50	20	37.5	0
	19-Jun	20	7	7	2.5	9.125	28.375
	11-Nov	10	20	30	40	25	12.5
2	15-Apr	75	50	30	30	46.25	0
	19-Jun	7	20	0	10	9.25	37
	11-Nov	40	30	10	40	30	16.25
3	15-Apr	100	20	50	30	50	0
	19-Jun	7	2.5	2.5	7	4.75	45.25
	11-Nov	10	30	30	30	25	25
4	15-Apr	30	50	30	50	40	0
	19-Jun	7	10	2.5	0	4.875	35.125
	11-Nov	30	30	40	40	35	5
5	15-Apr	75	50	20	50	48.75	0
	19-Jun	10	2.5	0	7	4.875	43.875
	11-Nov	30	30	30	30	30	18.75
6	15-Apr	75	100	50	30	63.75	0
	19-Jun	0	0	2.5	0	0.625	63.125
	11-Nov	40	40	30	10	30	33.75
7	15-Apr	75	100	75	100	87.5	0
	19-Jun	75	100	50	100	81.25	6.25
	11-Nov	50	80	50	80	65	22.5
8	15-Apr	50	30	50	75	51.25	0
	19-Jun	20	20	20	75	33.75	17.5
	11-Nov	5	10	30	30	18.75	32.5
9	15-Apr	30	30	30	30	30	0
	19-Jun	20	7	10	20	14.25	15.75
	11-Nov	30	10	10	10	15	15
10	15-Apr	50	75	30	50	51.25	0
	19-Jun	20	50	2.5	50	30.625	20.625
	11-Nov	40	10	10	10	17.5	28.75
11	15-Apr	50	75	50	75	62.5	0
	19-Jun	7	10	7	30	13.5	49
	11-Nov	30	30	20	10	22.5	40
12	15-Apr	50	75	50	30	51.25	0
	19-Jun	30	30	10	10	20	31.25
	11-Nov	10	40	30	30	27.5	23.75
13	15-Apr	75	50	30	30	46.25	0
	19-Jun	20	10	7	2.5	9.875	36.375
	11-Nov	30	5	30	40	26.25	25

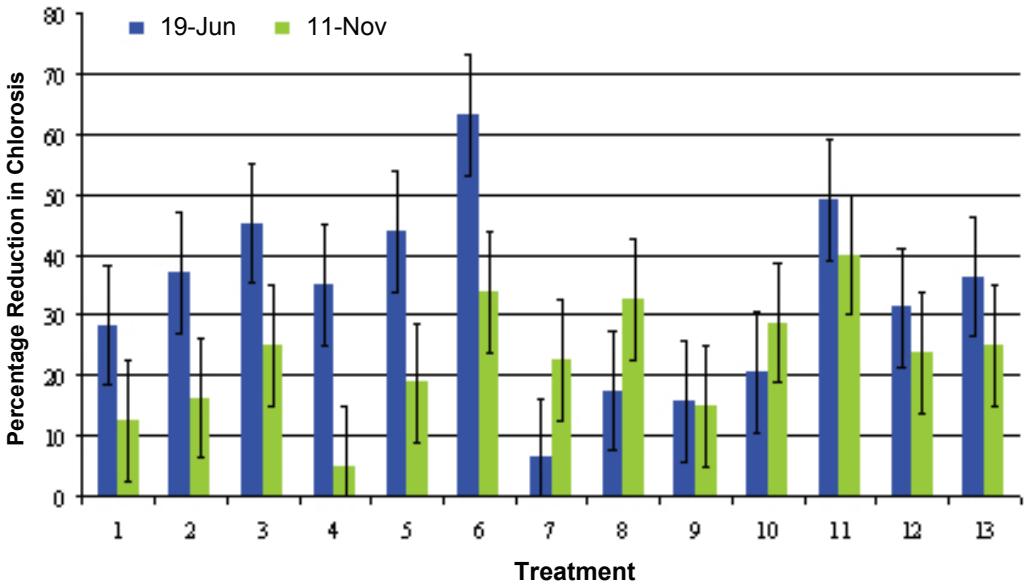

Figure 1. Percentage Reduction in Iron Chlorosis

Figure 2. Partial Regreening of Chlorotic Leaves Treated with Metalosate Iron

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Micrel Fe 600 is an Fe EDDHA chelated product marketed by Ocean Agriculture
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