

AN EVALUATION OF METALOSATE[®] ZINC IN CITRUS IN SOUTH AFRICA

John E. Skinner and E. Tozer
Ocean Agriculture (Pty) Ltd
South Africa

Introduction

Metalosate[®] Zinc was tested in South African citrus orchards from 1991 to 1993. Most work was done at rates of two to three litres per hectare (27 to 41 fluid ounces per acre). This work was successful in showing mild increases in the zinc status of citrus leaves but growth responses were generally not seen. The absence of such responses was considered to be due to the fact that all commercial orchards are regularly sprayed with high levels of zinc nitrate and consequently the zinc status of the trees was generally relatively high. At the same time zinc nitrate, which was (and still is) firmly entrenched as an industry standard zinc source, produced good responses without evidence of phytotoxicity, and at a cost of about one third of the cost of Metalosate Zinc treatments. Since no benefits could be ascribed to the use of Metalosate Zinc that would justify the premium cost, research effort was switched to apples where the sensitivity to russet created a niche for products that were less harsh than zinc nitrate. Trial work with Metalosate Zinc in citrus was therefore discontinued. Thus sales of Metalosate Zinc in citrus remained low and its use was largely confined to sporadic and irregular instances of apparent acute zinc deficiency. During this time Tredgold¹ noted that mid-winter applications of Metalosate Zinc appeared to consistently produce beneficial responses. At the current time local formulation of Metalosate products reduced certain costs and so new opportunities are seen of establishing Metalosate Zinc in the citrus industry. This work therefore re-evaluates and explores the possibilities of establishing Metalosate Zinc in this market.

Summary

An orchard trial was planned to compare winter and spring applications of Metalosate Zinc in citrus. In view of the previous history of indifferent responses accruing in “average” orchards some effort was channelled into finding a test orchard with a suitably low zinc status to improve the probability of producing measurable responses. Arrangements for such a test site were successfully concluded, but shortly before spraying was due to commence, the farmer revealed that the orchard had in fact been recently sprayed with zinc nitrate. This development seriously jeopardised the trial and rather than risk the waste in time, effort and money on a “no-result” test, the site was abandoned and attempts were made to find an alternative site. This was not an easy exercise and several candidate orchards were turned down before a suitable orchard was found. This orchard of small-medium trees appeared to be fairly uniformly affected by *Phytophthora* root rot, which was thought to account for poor zinc uptake and the poor zinc status of the trees as reflected by leaf analyses. However by the time the site was found the calendar had

progressed to late August. The first sprays were consequently applied in early September. The concept of comparing winter with spring sprays could therefore not be implemented, but there was still sufficient motivation to compare dosage rates and timings during the spring / early summer period using locally formulated materials.

Sprays were applied either as a single spray, or as two or three sprays in which the targeted dosage was applied in one, two or three equal instalments. The total amounts of Metalosate Zinc to be applied were set at 1.44, 2.04, and 3.06 litres per hectare (19.7, 27.9, and 41.9 oz per acre) and these were the spray rates applied at the test site. This method of expressing dosage rates, although in general use, is actually not specific. It is normally understood that such rates would refer to the amount of product that should be applied to a hectare (2.47 acres) of mature trees, but mature trees also vary, with tree-size depending on a host of factors. Recent experiences have emphasised a need for more specific recommendations and attention is now being given to the development of a “benchmark-hectare” concept to which the dosage rates would apply directly. Application rates can be scaled upward or downwards according to tree size and density. These thoughts were applied to this project too, though in hindsight, as the concept emerged after the start of the field work for this trial. The trees currently considered as benchmark could be described as “large-medium” with a canopy area of 13,333 m² per hectare (58,078 ft² per acre). The application rates used in this project have been scaled upward from the small-medium trees (with a canopy area of 8571 m² (37,335 ft² per acre)) to reflect the amounts of product used per hectare (2.47 acres) in terms of the benchmark equivalent. Dosage rates are thus transformed and expressed as 2.24, 3.17 and 4.75 litres per benchmark (bm) hectare (30.7, 43.4, and 65.0 fluid ounces per bm acre) respectively. These benchmark rates will be used in the further discussion. In terms of the benchmark then, the amounts of Metalosate Zinc tested in the trial are somewhat higher than what might normally have been thought necessary.

The results provide much information of interest, but the four main findings are:

1. When working at the level of 3.17 litres per bm hectare (43.4 oz per bm acre), good results were obtained when the application was made as three sprays, each at 1.06 litre per bm hectare (14.5 oz per bm acre). The first of these was sprayed on early spring flush. The second was applied either onto the developing growth flush, or alternately, after petal drop. The third spray was applied at hardening of the spring leaves. Applying the full dose at the first timing produced a weaker response. Two sprays at 1.58 litres per bm hectare (21.6 oz per bm acre) applied at the second and fourth timing were also less effective.
2. Metalosate Zinc applied at the lower dosage rates of 2.24 and 3.17 litres per bm hectare (30.7 and 43.4 oz per bm acre), divided into three instalments as described above, produced good results and could probably be considered as adequate for maintenance purposes.

3. Zinc applied at the higher rates (i.e., relevant to Metalosate Zinc, zinc nitrate and ZincoSol® 701) produced an additional physiological response (as evidenced by a reduction in fruit drop) that was not seen at the lower dosage rates.
4. In addition to all the other responses observed, Metalosate Zinc applied at 4.75 litre per bm hectare (65 oz per bm acre), also produced a statistically significant improvement in the fruit grading leading to a 4.3% increase in the value of the fruit. This assessment is based on the size gradings per treatment, being applied to a fixed number of “pack-out” fruit (i.e. 200,000 oranges, the approximate equivalent to a pack-out of 40 tons per bm hectare (18 tons per bm acre)). The value attached to this increase is approximately R4000 per ha (\$1525 per acre). This increase is relative to zinc nitrate treatment, which failed to influence fruit size to any appreciable extent. The increase in fruit value associated with the Metalosate Zinc treatment is also additional to the 9.5% yield increase (relative to the Control treatment) due the application of zinc *per se*. It is regarded as noteworthy that the intermediate Metalosate Zinc dosages also tended to improve fruit size and value though the response was weaker. A response pattern is thus indicated suggesting that higher dosages might have produced even stronger responses. Results produced by zinc nitrate and ZincoSol 701 show absolutely no sign of affecting the fruit grading.

Table 1 Trial Details		
Locality	Strydom Block, Mapumalanga	
Co-operator	Mr J. Spear of Ivaura Estate	
Crop	Valencia oranges	
Orchard Information	Inter-row spacing	7.0 m
	Intra-row spacing	3.5 m
	Surface area per tree	24.5 m ²
	Tree population per ha	408
Canopy Area per Tree	Tree height	3.5 m
	Skirt height	0.5 m
	Tree width	3.5 m
	Canopy area	21.0 m ²
Canopy Area per ha	408 x 21.0 =	8571 m ²

(See the appendix for this table in American units)

Table 2
Timing of Spray Applications

A	New leaves emerging, flower buds about to open
B	New flush developing, flowers opening
C	Petal drop
D	Hardening of leaves of spring flush

Table 3
Treatments Applied

Product Applied		<i>Expressed as volume of product (ml) per 100 litre of spray solution</i>			
		A 9 Sep New Leaf ml/hl	B 17 Sep Flush Developing ml/hl	C 15 Oct Petal Drop ml/hl	D 19 Nov Leaf Hardening ml/hl
1	Metalosate® Zinc	170 ml	-	-	-
2	Metalosate® Zinc	-	85 ml	-	85 ml
3	Metalosate® Zinc	57 ml	57 ml	-	57 ml
4	Metalosate® Zinc	57 ml	-	57 ml	57 ml
5	Metalosate® Zinc	40 ml	40 ml	-	40 ml
6	Metalosate® Zinc	40 ml	-	40 ml	40 ml
7	Metalosate® Zinc	85 ml	85 ml	-	85 ml
8	Zincsol 701 60®	165 ml	-	165 ml	165 ml
9	Zinc nitrate 110	65 ml	-	65 ml	65 ml
10	Control	-	-	-	-

Zincsol 701 60® is a formulation of zinc gluconate

(See the appendix for this table in American units)

Table 4
Trial Design

Design	Randomised blocks of single tree plots separated by unsprayed guard trees
No of replications	Four
Method of spraying	Handguns fitted with 1 mm adjustable hollow cone nozzles operating at 20 bar pressure
Spray volume	1200 litre per hectare
140 ml of spray solution per square meter of leaf canopy area	

(See the appendix for this table in American units)

Table 5
Soil Analyses

	1999 mg/kg	2001 mg/kg
P	31	29
K	48	51
Ca	561	643
Mg	121	127
Na	29	23
pH (water)	6.17	6.92

Table 6
Leaf Analyses

		1998	1999	2000	2001
N	%	2.62	1.79	2.44	2.32
P	%	0.23	0.11	0.18	0.24
K	%	1.55	1.55	1.13	1.47
Ca	%	3.49	4.69	3.78	3.64
Mg	%	0.46	0.54	0.34	0.36
S	%	0.25	-	0.34	0.30
B	mg/kg	52	37	84	42
Cu	mg/kg	5	8	4	5
Fe	mg/kg	-	-	-	-
Mn	mg/kg	45	62	52	63
Mo	mg/kg	0.09	-	-	-
Zn	mg/kg	19	10	13	14

Table 7							
Treatments							
Product Applied		<i>Expressed as the volumes of product (L) and the amounts of zinc (g) applied per 8571 m² of canopy per hectare</i>					
		A	B	C	D	Total	Total
		9 Sep	17 Sep	15 Oct	19 Nov	Product per ha	Zinc per ha
		New Leaf	Developing Flush	Petal Drop	Leaf Hardening		
1	Metalosate [®] Zinc	2.04 L	-	-	-	2.04 L	173 g
2	Metalosate [®] Zinc	-	1.02 L	-	1.02 L	2.04 L	173 g
3	Metalosate [®] Zinc	0.68 L	0.68 L	-	0.68 L	2.05 L	174 g
4	Metalosate [®] Zinc	0.68 L	-	0.68 L	0.68 L	2.05 L	174 g
5	Metalosate [®] Zinc	0.48	0.48 L	-	0.48 L	1.44 L	122 g
6	Metalosate [®] Zinc	0.48 L	-	0.48 L	0.48 L	1.44 L	122 g
7	Metalosate [®] Zinc	1.02 L	1.02 L	-	1.02 L	3.06 L	260 g
8	Zincsol 701 60 [®]	1.98 L	-	1.98 L	1.98 L	5.94 L	356 g
9	Zinc Nitrate 110	0.78 L	-	0.78 L	0.78 L	2.34 L	234 g
10	Control (untreated)	-	-	-	-	0.00 L	0 g

Scaling of dosage rates according to the extent of canopy development

(See the appendix for this table in American units)

Comment

One would expect that recommendations for foliar sprays should be specific enough so that there could be some assurance that applications made by a group of people following a set recommendation (such as a label) would be reasonably similar. Yet this is not necessarily the case. Recommendations based on spray concentrations typically do not provide details concerning either the spray method or the spray volume. Relating spray volume to tree size is almost unheard of. This may be largely due to that fact that within areas, or perhaps within regions, these aspects are “understood” to conform to certain norms. However such insights may be lost when transferring recommendations from one area to another. Similar lack of precision occurs where recommendations are made in terms of the amounts of product per hectare without defining the canopy size and condition. Recent experiences have indicated that the lack of “precise” directions can be of critical importance. It is obvious too that more “precise” directions will be of help when converting research findings to commercial recommendations. For these reasons spray volumes used in this work are expressed above as the amount of spray solution sprayed per m² of canopy area (page 4). It is also

proposed that the amounts of chemicals applied should also be expressed in this way. These can then be extrapolated to provide application rates per hectare for specific canopy areas that could serve as points of reference or benchmarks. Here large-medium orange trees with a canopy area of 13,333 m² (58,078 ft² per acre) have been selected to serve as such a benchmark.

Tree height	4.5 m
Skirt height	0.5 m
Canopy height	4.0 m
Intra-row width	3.5 m
Constant (i.e. 2 sides of tree)	2.0
Canopy area per tree	28 m ²
Inter-row spacing	6.0 m
Soil area per tree	21 m ²
Trees	476 per hectare
Canopy area	13,333 m ² per hectare

(See the appendix for this table in American units)

Product Applied	Application Rates per Square Meter of Canopy Area		Application Rates per Square Meter of Canopy Area		Reference Large-Medium Trees Canopy 13,333 m ²	
	Product Applied ml/m ²	Zinc Applied mg/m ²	Product Applied L/ha	Zinc Applied g/ha	Product Applied L/ha	Zinc Applied g/ha
Metalosate® Zinc	0.168 ml	14.23 mg	1.44 L	122 g	2.24 L	190 g
Metalosate® Zinc	0.238 ml	20.18 mg	2.04 L	173 g	3.17 L	269 g
Metalosate® Zinc	0.357 ml	30.33 mg	3.06 L	260 g	4.75 L	404 g
Zincsol 701 60®	0.693 ml	41.54 mg	5.94 L	356 g	9.24 L	553 g
Zinc Nitrate 110	0.273 ml	29.98 mg	2.34 L	257 g	3.64 L	400 g

(See the appendix for this table in American units)

Results and Discussion

Visual Observations of Tree Responses. Trees were rated visually on 11 October, 2 November and on 3 March. In general the trees responded well to the zinc sprays. This was clearly evident as the unsprayed guard trees on either side of data trees failed to produce significant spring flush. These guard trees had the appearance of “dormancy” due to the dominance of old, hard, dull, dark green leaves. In contrast sprayed trees had a good mantel young light green, shiny leaves. This pattern was repeated at virtually every sprayed tree.

Table 10
Trees Rating Scale

Trees in exceptional condition	1
Trees in very good condition	2
Trees in acceptable, good condition	3
Trees showing early signs of poor growth	4
Poor vigour quite evident	5
Onset of tree decline	6

Table 11
The Mean Ratings of the 2nd November Assessment

Product Applied	Test Trees ¹	Reference Trees ²	Timing of Sprays ³			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	2.3	2.7	-
Metalosate® Zinc	2.04 L	3.17 L	2.4	2.5	2.5	2.7
Metalosate® Zinc	3.06 L	4.75 L	-	2.6	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	2.7	-
Zinc Nitrate	2.34 L	3.64 L	-	-	2.7	-

The mean rating for untreated control trees was 3.4

¹ Rate per hectare on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

³ This assessment was done before the application of sprays at timing “D”

(See the appendix for this table in American units)

Differences between treatments were not significant but trends suggest that responses to timing were stronger than were the responses to Metalosate application rates.

At the March assessment treated trees had an average rating of 1.4 while untreated control trees rated 2.1 Differences between treatments were not statistically significant though sprayed trees, and more particularly highest Metalosate Zinc treatment (4.75 litres per hectare or 65.1 fl oz per acre on bm trees), which rated very close to 1.0 (i.e. excellent), appeared better than control trees which were considered to be “very good” The generally improved growth ratings in March were due the presence of strong late summer growth flush being typical of the season and the region.

Leaf Analyses

Leaf samples were taken from late summer flush in March of 2002 and analysed for zinc by the “Soil Science Laboratory of the Institute for Tropical and Subtropical Crops”. The special significance of these samples is that these leaves had never been sprayed directly with zinc. Differences between analyses of samples are therefore a reflection of the efficiency of uptake and translocation of the spring foliar sprays. Samples were taken from all trees but leaves of replicate trees of each treatment were pooled. Results are summarised below.

Table 12 The Zinc Analyses (mg/kg) of Late Summer Flush.						
Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zn	1.44 L	2.24 L	-	31	29	-
Metalosate® Zn	2.04 L	3.17 L	31	29	30	33
Metalosate® Zn	3.06 L	4.75 L	-	37	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	39	-
Zinc Nitrate	2.34 L	3.64 L	-	-	38	-
The mean analysis value for untreated control trees was 19 mg/kg						
¹ Rate per hectare on small medium trees at test site						
² Proportionally adjusted rate for large medium reference trees						

(See the appendix for this table in American units)

In this case timing of sprays did not seem to influence the zinc status of the late summer growth. Application rate however seems to have played a major role. Using the large medium (mb) trees for calibration it seems that the lower application rates of Metalosate Zinc were quite sufficient to cause a marked increase in the zinc status of the leaves. It could therefore be expected that applications of two to three litres per hectare (27.4 to 41.1 fl oz per acre), (as a total amount, whether as one, two, or three sprays) would be quite adequate for the maintenance of a healthy zinc status. Such treatments would supply 190 to 270 g zinc per hectare (2.7 to 3.86 oz zinc per acre). Increasing the application rate of Metalosate Zinc to 4.75 L per hectare (65.1 fl oz per acre) raised the zinc status of the summer flush to a higher level and it may be unsure at this stage whether such an elevated concentration of leaf zinc are needed. It should be noted though that at this level the Metalosate Zinc treatment would supply the same amount of zinc to the trees as did the zinc nitrate treatment (400 g Zn ha⁻¹ or 5.71 oz Zn acre⁻¹). This latter treatment also produced similar higher leaf analyses.

December Fruit Drop

Table 13 Dropped Fruit Gathered from Under the Trees During Early December Results Expressed as Treatment Means per Tree						
Product Applied	Test		Reference		Timing of Sprays	
	Trees ¹	Trees ²	A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	24 abc	23 abcd	-
Metalosate® Zinc	2.04 L	3.17 L	22 bcd	24 abcd	22 abcd	26 a
Metalosate® Zinc	3.06 L	4.75 L	-	19 d	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	19 d	-
Zinc Nitrate	2.34 L	3.64 L	-	-	20	cd

The mean number of fruitlets collected under untreated control trees was 25 (ab)

Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)

¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Fruit drop was not a major problem in the 2001 season as the numbers of fruitlets collected from under the tree were low being less than 25 per tree for most treatments. This fruit drop was not influenced by treatments that applied 270 g zinc (or less) per hectare (3.86 oz per acre) of bm trees even though at these application rates, good levels of leaf zinc appeared to have been achieved. Fruit drop was however significantly reduced by treatments that applied 400 g zinc per hectare (5.71 oz per acre) of bm trees. These treatments included Metalosate Zinc at 4.75 litres per hectare (65.1 fl oz per acre), Zinc nitrate 110 at 3.64 litres per hectare (49.9 fl oz per acre), and Zincsol 701 at 9.19 litres per hectare (125.9 fl oz per acre) of bm trees.

As suggested above, the fact that certain treatments successfully reduced fruit drop seems comparatively unimportant from an economic point of view. However the mere fact that the application of higher quantities of zinc (which might otherwise seem to have been excessive) produced a physiological response would appear to be of considerable importance. This begs the question relating to whether the suppression of fruit drop is the only physiological response that followed the application of higher than normal amounts of zinc.

Yield

Table 14						
Mean Yields (kg) Produced per Treatment per Tree						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	116	112	-
Metalosate® Zinc	2.04 L	3.17 L	110	110	103	104
Metalosate® Zinc	3.06 L	4.75 L	-	116	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	114	-
Zinc Nitrate	2.34 L	3.64 L	-	-	116	-
The mean yield for untreated control trees was 104 kg per tree						
¹ Rate per hectare on small medium trees at test site						
² Proportionally adjusted rate on large medium reference trees						

(See the appendix for this table in American units)

Differences between treatment means are not significant. It is however clear that there appears to be two groups of means. The first consists of the control and also includes Metalosate Zinc at 3.17 L per bm hectare (43.4 fl oz per bm acre) applied at the ACD and BD timings. The second group includes all the remaining values and these seem to provide a homogenous sample of samples with a mean value of 113.4 kg of fruit per tree. Relating this value to the control it might appear that, concluding that zinc sprays in the main produced a 9.5% increase in yield, would be a more accurate conclusion than the conclusion that due to an absence of a statistical significant difference, zinc sprays did not affect yields.

Fruit Grading by Size

The diameters of 100 fruit per tree were measured with a calliper, sampling equal proportions of fruit at various heights and on various sides of the tree so as to achieve representative values for the tree as a whole. The fruit sizes were then sorted into categories that matched the pack sizes of 48, 56, 64, 72, 88, and 105 fruit per carton of 15 kilograms (33 pounds).

These fruit cartons were valued at current (September 2003) “Delivered In Port” (DIP) prices of R34 (\$5.25), R35 (\$5.41), R35 (\$5.41), R34 (\$5.25), R33 (\$5.10) and R30 (\$4.63) respectively. The impact of fruit size on crop value becomes more evident however when these values are expressed on a “per orange” basis rather than on a “per carton” basis as shown below.

Fruit Count per Carton	DIP Value per Carton	Relative Value per Carton	DIP Value per Orange	Relative Value per Orange
48	R34	97	70.83 c	100
56	R35	100	62.50 c	88
64	R35	100	54.69 c	77
72	R34	97	47.22 c	67
88	R33	94	37.50 c	53
105	R30	86	28.57 c	40

(See the appendix for approximate American dollar conversions from the South African Rand)

Thus it should be safe to conclude that adding value to the crop starts with adding size to the fruit and this seems to be well illustrated by the results of this trial.

The influence of treatments on the proportion (%) of the crop falling into the various size categories are shown in the tables below.

Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	3.00	4.25	-
Metalosate® Zinc	2.04 L	3.17 L	2.47	4.00	3.00	3.00
Metalosate® Zinc	3.06 L	4.75 L	-	3.50	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	3.75	-
Zinc Nitrate	2.34 L	3.64 L	-	-	3.75	-

The mean yield for untreated control trees was 3.00
Differences between means are not significant
¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

Table 17
Grade 56

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	7.0 bcd	8.0 bc	-
Metalosate® Zinc	2.04 L	3.17 L	9.3 ab	9.5 ab	9.3 ab	6.5 cd
Metalosate® Zinc	3.06 L	4.75 L	-	11.0 a	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	6.0d	-
Zinc Nitrate	2.34 L	3.64 L	-	-	7.0bcd	-

The mean yield for untreated control trees was 8.0 bc
Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)

¹ Rate per hectare on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

Table 18
Grade 64

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	17.8ab	20.5a	-
Metalosate® Zinc	2.04 L	3.17 L	15.5bc	15.3bc	15.5 bc	20.3 a
Metalosate® Zinc	3.06 L	4.75 L	-	19.3a	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	15.5bc	-
Zinc Nitrate	2.34 L	3.64 L	-	-	15.8bc	-

The mean yield for untreated control trees was 14.5 c
Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)

¹ Rate per hectare on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

Table 19
Grade 72

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	29.0a	27.0 ab	-
Metalosate® Zinc	2.04 L	3.17 L	24.8 b	28.0 ab	27.3 ab	21.0c
Metalosate® Zinc	3.06 L	4.75 L	-	25.5 ab	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	26.8 ab	-
Zinc Nitrate	2.34 L	3.64 L	-	-	27.0 ab	-

The mean yield for untreated control trees was 28.5 a
Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)

¹ Rate per hectare on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

Table 20						
Grade 88						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	30.5	28.3	-
Metalosate® Zinc	2.04 L	3.17 L	32.3	31.8	30.8	33.3
Metalosate® Zinc	3.06 L	4.75 L	-	30.5	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	32.0	-
Zinc Nitrate	2.34 L	3.64 L	-	-	30.8	-

The mean yield for untreated control trees was 30.5
Differences between means are not significant
¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

Table 21						
Grade 105						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	12.8	12.0	-
Metalosate® Zinc	2.04 L	3.17 L	15.7	11.5	14.3	16.0
Metalosate® Zinc	3.06 L	4.75 L	-	10.3	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	16.0	-
Zinc Nitrate	2.34 L	3.64 L	-	-	15.8	-

The mean yield for untreated control trees was 15.5
Differences between means are not significant
¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(See the appendix for this table in American units)

The above grading results are expressed more concisely below. Here results of the ABD and ACD timings have been combined for the treatments 2.24 litres and 3.17 litres per hectare (30.7 and 43.4 fl oz per acre) of bm trees since the data for these treatments are very similar. This data is shown in the tabulation below as “Metalosate Zn-190 to 270 g Zn per ha” (2.71 to 3.86 oz per acre). The data shows clearly that zinc nitrate had very little effect on fruit size as the grading remained very similar to that of the Control treatment. However Metalosate Zinc, at the same dosage rate, caused strong increases in the proportions of fruit falling into the more valuable counts of “56” and “64”. Expressed on a proportional basis, the numbers of fruit falling into these categories were increases by 37.5% and by 33.1% respectively. These increases above the Control treatment and above the Zinc nitrate treatment are shown to be statistically significant which is very important. Since the fruit gradings are expressed as percentages, it follows that increases in one area of the distribution range must be accompanied by decreases in another. This

is clearly shown here too where the proportions of the fruit falling into the less valuable counts of “72” and “105” were reduced by 10.5% and 34.2% respectively. The pooled data for the lower Metalosate Zinc dosage rates produce very similar trends. Although at this level statistical differences are not demonstrated, the result is very important because it demonstrates that both results form part of a consistent and robust response pattern. This in turn suggests with, a high probability, that Metalosate Zinc could well provide similar beneficial responses in commercial orange orchards.

Treatment	Zinc Sprayed	8	56	64	72	88	105
	g/ha ¹	71 c	63 c	55 c	47 c	38 c	29 c
Control		3.0%	8.0%	14.5%	28.5%	30.5%	15.5%
Zinc Nitrate	400 g	3.8%	7.0%	15.8%	27.0%	30.8%	15.8%
Metalosate® Zinc	190 to 270g	3.6%	8.4%	17.3%	27.8%	30.3%	12.6%
Metalosate® Zinc	400 g	3.5%	11.0%	19.3%	25.5%	30.5%	10.3%

¹ Relate to total amounts sprayed on one hectare (2.47 acre) of benchmark (LM) trees.

(See the appendix for American units and approximate American dollar conversions from the South African Rand)

1	Zinc Nitrate—Control	+0.8%	-1.0%	+1.3%	-1.5%	+0.3%	+0.3%
2	Metalosate® Zinc (< 270)—Control	+0.6%	+0.4%	+2.5%	-0.7%	-0.2%	-2.9%
3	Metalosate® Zinc (400) -	+0.5%	+3.0%	+4.8%	-3.0%	0.0%	-5.3%

An estimate has been made of the manner in which the above trends could impact on a commercial yield. Data generated by this trial indicate that with fruit grading as those of the Control treatment, a pack-out of 200,000 oranges per hectare would translate to a pack-out of approximately 40 tons of fruit per ha (18 tons per acre). The gradings from the various treatments have been applied to this number of fruit and multiplied by the value per fruit.

Table 24						
Gross Values for 200,000 Oranges.						
Product Applied	Test Trees¹	Benchmark Trees²	Values in R'000			
			A	Timing of Sprays		
				ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	R90.0	R92.0	-
Metalosate® Zinc	2.04 L	3.17 L*	R88.6	-	-	R88.4
Metalosate® Zinc	2.04 L	3.17 L	-	R91.0	R89.7	-
Metalosate® Zinc	3.06 L	4.75 L	-	R92.6	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	R88.2	-
Zinc Nitrate	2.34 L	3.64 L	-	-	R88.9	-

The mean value for untreated control trees was R88.7
 *These treatments gave poor results due to less favourable timings. They have therefore been shown separately from similar treatments applied more effectively.
¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(See the appendix for American units and approximate American dollar conversions from the South African Rand)

Table 25						
Increases, Relative to the Control treatment, in the Values of 200,000 Oranges as Influenced by the Source, Amount, and Timing of Zinc Sprays.						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	1.44 L	2.24 L	-	R1,205	R3,229	-
Metalosate® Zinc	2.04 L	3.17 L*	-R108	-	-	R321
Metalosate® Zinc	2.04 L	3.17 L	-	R2,291	R958	-
Metalosate® Zinc	3.06 L	4.75 L	-	R3,820	-	-
Zincsol 701®	5.94 L	9.19 L	-	-	-R576	-
Zinc Nitrate	2.34 L	3.64 L	-	-	R93	-

*These treatments gave poor results due to less favourable timings. They have therefore been shown separately from similar treatments applied more effectively.
¹ Rate per hectare on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(See the appendix for American units and approximate American dollar conversions from the South African Rand)

Responses to Timing of Applications

Treatments based on the intermediate application rate of Metalosate Zinc (i.e. 3.17 litre per benchmark hectare (43.4 fl oz per bm acre) were applied at four timings as described on page 4. Of these responses to applications at timings of “A” and “BD” seem to have been particularly weak in certain cases but also producing positive responses in others. For example, sprays applied at the BD timing produced the highest zinc analysis value within the group. Additionally the tree vigour and general growth condition was rated in November at somewhat better than “good”, In the March rating the trees were considered to be half way between “very good” and “excellent”. There seems to be no obvious reason therefore why these trees should yield below average, other than perhaps that this effect was not statistically significant and thus the effect should be ascribed to natural variability within the orchard. But then we would still need to explain the poor fruit-drop responses and the low proportion of the fruit in Grade 56, which were significant.

Results obtained at the single application at “A” also produced good leaf analyses values being 12 mg per kg higher than the control and demonstrating clearly that the zinc was taken up in adequate amounts and that it was translocated in sufficient amounts for enrichment of tissues that were not directly sprayed with zinc containing sprays. Fruit drop was significantly less than in the case of the BD timing, while general tree condition was as favourable. Yields were close to the average yield determined for sprayed trees. Yet the fruit grading was too close to that of the control fruit for an improvement in fruit value to be observed.

Thus responses were evident where Metalosate Zinc was applied either as a single spray at “A”, or as two sprays at “BD”. Similar responses were obtained where the Metalosate Zinc application was divided over three applications but, in addition, these data also indicate a shift in the fruit grading as discussed above.

With regard to the timing of the three sprays, this work would suggest that ABD and ACD sprays produced similar results and so these findings become mutually supportive. The confirmation of the trend also strengthens the trend. The same trend is also evident at the lower application rate of 2.24 litres Metalosate Zinc per benchmark hectare (30.7 fl oz per bm acre). The trend is thus confirmed yet again. This latter result is actually more clearly defined and eclipses to some degree the results obtained at the higher application rate. The trend is of course continued at the highest application rate of 4.75 litres per benchmark hectare (65.1 fl oz per bm acre).

Total Metalosate® Zinc Applied per Benchmark Hectare	Timing of Application	Value of 200 000 Oranges	Percentage Increase in Value of Fruit
Control	Untreated	R88,761	-
3.17 L	A and BD	R88,547	-0.24%
3.17 L	ABD and ACD	R90,386	1.83%
2.24 L	ABD and ACD	R90,878	2.39%
4.75 L	ABD	R92,581	4.30%

(See the appendix for American units and approximate American dollar conversions from the South African Rand)

Conclusion

In a Valencia orchard with low zinc status, sprays of Metalosate Zinc during spring and early summer at moderate rates of 2.24 and 3.17 litre per hectare (30.7 and 43.4 fl oz per acre) (of benchmark trees, increased the zinc content of the unsprayed leaves of the late summer flush from 19 to 32 mg per kg. At a higher application rate of 4.75 litre per benchmark hectare (65.1 fl oz per acre) Metalosate Zinc increased the zinc content of the summer flush leaves to 38 mg per kg. Similar analyses values were found where Zinc nitrate and Zincsol 701 were applied. Zinc nitrate and the highest Metalosate Zinc treatment (ie 4.75 litre per bm hectare or 65.1 fl oz per acre) both delivered 400 g of zinc per hectare (5.71 oz per acre) so in this sense the treatments were equal. Both of these treatments reduced the December fruit drop and so once again, the treatments produced similar results. Metalosate Zinc at the higher level however increased the proportion of large fruits in the harvest and also increased the value of the yield (based on a packout of 200,000 oranges per bm hectare (2.47 acres)) by 4.3%. Intermediate applications of Metalosate Zinc applications also tended to improve the grading of the yield although these latter effects were not shown to be statistically significant. Zinc nitrate sprays however did not affect the fruit grading. Zincsol 701 was applied at a higher zinc concentration than Zinc nitrate. Results obtained with this material were similar to those obtained with zinc nitrate in all respects.

Final Comment

A trial was run on Valencia oranges in 1991 which tested Metalosate Zinc at 2.0, 4.0, and at 8.0 litres per hectare (27.4, 54.8, and 109.6 fl oz per acre). Zinc EDTA and Zinc nitrate were used as standards for comparison.

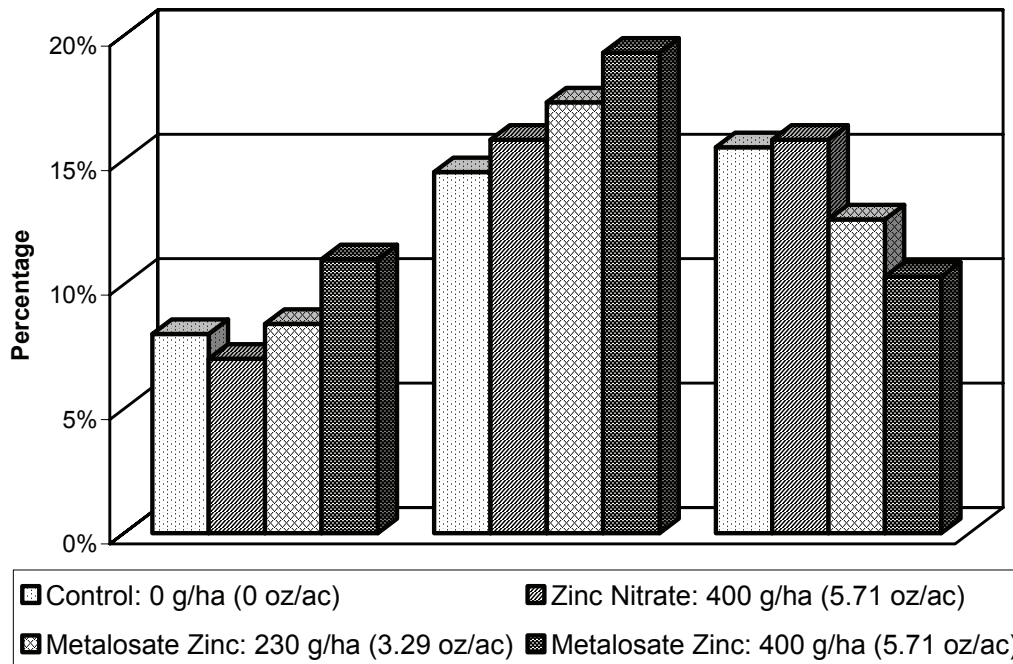
This work produced results that were qualitatively similar to those described above in respect of fruit grading. These results, treated in the same way as the results of the current trial, are illustrated below.

Product Applied	Dosage per at Test Orchard	Dosage per Benchmark	Value of 200,000 Fruit as Graded R '000	Percent Increase Above Control	Percent Increase Above Zinc Nitrate
Control	-	-	R77	0.0%	-6.1%
Zinc EDTA			R78	1.4%	-4.9%
Zinc Nitrate			R82	7.0%	0.0%
Metalosate® Zinc	2.0 L/ha	4.0L/ha	R80	4.8%	-2.4%
Metalosate® Zinc	4.0L/ha	8.0 L/ha	R83	8.3%	1.2%
Metalosate® Zinc	8.0L/ha	16.0L/ha	R90	17.0%	9.8%

(See the appendix for American units and approximate American dollar conversions from the South African Rand)

The trees at the 1919 trial site were small and widely spaced. The dosage rate equivalents for a benchmark orchard are estimates and may well have been slightly higher. In subsequent trials lower (more economic) application rates were used and effects on fruit grading were not noticed. It is however noteworthy that the sort of responses found in the current trial have in fact been seen before.

Amounts of Zinc Sprayed per Hectare of Large Medium Orange Trees
 (Estimate of canopy area per hectare = 13,000 m² (58,102.55 ft²/acre))



*On Farm Values at 2003 price approximate conversions from the South African Rand to American dollar.

Figure 1. The Influence of the Zinc Source Applied on the Grading of Valencia Oranges

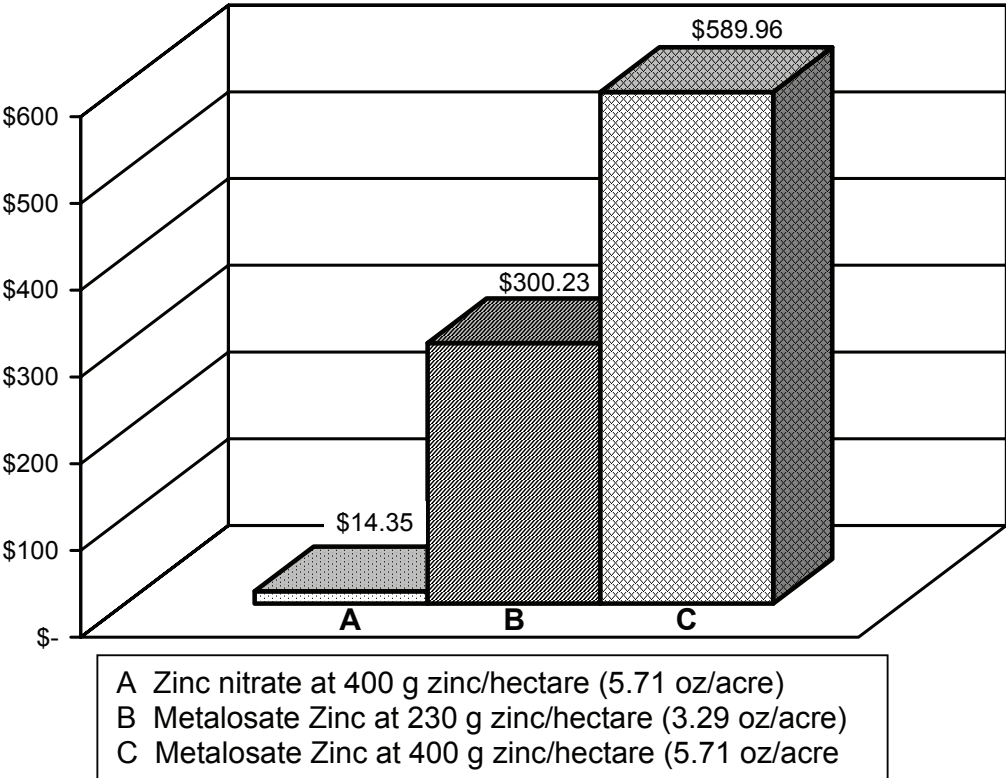


Figure 2. The Increase in the Value of a Valencia Orange Harvest (Based on a Pack-out of 200,000 oranges per hectare (81,000 oranges/acre)) as Influenced by the Source of Zinc Applied

(Note: Dollar figures are approximate conversions from the South African Rand to American dollar)

APPENDIX
Tables in American Units

Table 1 Trial Details		
Locality	Strydom Block, Mapumalanga	
Co-operator	Mr J. Spear of Ivaura Estate	
Crop	Valencia oranges	
Orchard Information	Inter-row spacing	23 ft
	Intra-row spacing	11 ft
	Surface area per tree	264 ft ²
	Tree population per acre	165
Canopy Area per Tree	Tree height	11 ft
	Skirt height	20 in
	Tree width	11 ft
	Canopy area	226 ft ²
Canopy Area per acre	165 x 226 =	37,290 ft ²

Table 3 Treatments Applied					
Product Applied		Expressed as Volume of Product In 100 Gallons of Spray Solution			
		A	B	C	D
		9 Sep	17 Sep	15 Oct	19 Nov
		New Leaf	Flush Developing	Petal Drop	Leaf Hardening
1	Metalosate® Zinc	22 fl oz	-	-	-
2	Metalosate® Zinc	-	11 fl oz	-	11 fl oz
3	Metalosate® Zinc	7 fl oz	7 fl oz	-	7 fl oz
4	Metalosate® Zinc	7 fl oz	-	7 fl oz	7 fl oz
5	Metalosate® Zinc	5 fl oz	5 fl oz	-	5 fl oz
6	Metalosate® Zinc	5 fl oz	-	5 fl oz	5 fl oz
7	Metalosate® Zinc	11 fl oz	11 fl oz	-	11 fl oz
8	Zincsol 701 60®	21 fl oz	-	21 fl oz	21 fl oz
9	Zinc Nitrate 110	8 fl oz	-	8 fl oz	8 fl oz
10	Control	-	-	-	-
Zincsol 701 60 is a formulation of zinc gluconate					

Table 4
Trial Design

Design	Randomised blocks of single tree plots separated by unsprayed guard trees
No of replications	Four
Method of spraying	Handguns fitted with 1 mm adjustable hollow cone nozzles operating at 20 bar pressure
Spray volume	120 gallons per acre
0.4 fluid ounces of spray solution per square foot of leaf canopy area	

Table 7
Treatments

Product Applied		<i>Expressed as the volumes of product (fl oz) and the amounts of zinc (oz) applied per 37,290 ft² of canopy per acre.</i>					
		A	B	C	D	Total Product per Acre	Total Zinc per Acre
		9 Sep	17 Sep	15 Oct	19 Nov		
		New Leaf	Developing Flush	Petal Drop	Leaf Hardening		
1	Metalosate® Zinc	27.9 fl oz	-	-	-	27.9 fl oz	19.8 oz
2	Metalosate® Zinc	-	14.0 fl oz	-	14.0 fl oz	28.0 fl oz	19.8 oz
3	Metalosate® Zinc	9.3 fl oz	9.3 fl oz	-	9.3 fl oz	28.0 fl oz	19.9 oz
4	Metalosate® Zinc	9.3 fl oz	-	9.3 fl oz	9.3 fl oz	28.0 fl oz	19.9 oz
5	Metalosate® Zinc	6.6 fl oz	6.6 fl oz	-	6.6 fl oz	19.8 fl oz	13.9 oz
6	Metalosate® Zinc	6.6 fl oz	-	6.6 fl oz	6.6 fl oz	19.8 fl oz	13.9 oz
7	Metalosate® Zinc	14.0 fl oz	14.0 fl oz	-	14.0 fl oz	42.0 fl oz	29.7 oz
8	Zincsol 701 60®	27.1 fl oz	-	27.1 fl oz	27.1 fl oz	81.3 fl oz	40.7 oz
9	Zinc Nitrate 110	10.7 fl oz	-	10.7 fl oz	10.7 fl oz	32.1 fl oz	26.7 oz
10	Control (untreated)	-	-	-	-	0 fl oz	0 oz
Scaling of dosage rates according to the extent of canopy development							

Table 8
Details of Benchmark Tree and Canopy Sizes

Tree height	15 ft
Skirt height	20 in
Canopy height	13 ft
Intra-row width	11 ft
Constant (i.e. 2 sides of tree)	2.0
Canopy area per tree	300 ft ²
Inter-row spacing	20 ft
Soil area per tree	226 ft ²
Trees	193 per acre
Canopy area	58,080 ft ²

Table 9
Treatments Standardised for Large-Medium Reference Trees Based on Relative Canopy Areas

Product Applied	Application Rates per Square Foot of Canopy Area		Application Rates per Square Foot of Canopy Area		Reference Large-Medium Trees Canopy 58,080 ft ²	
	Product Applied ml/ft ²	Zinc Applied mg/ft ²	Product Applied fl oz/ac	Zinc Applied oz/ac	Product Applied fl oz/ac	Zinc Applied oz/ac
Metalosate [®] Zinc	0.0156	1.322	19.7	1.74	30.7	2.71
Metalosate [®] Zinc	0.0221	1.874	27.9	2.47	43.4	3.84
Metalosate [®] Zinc	0.0331	2.818	41.9	3.71	65.1	5.77
Zincsol 701 60 [®]	0.0644	3.859	81.4	2.09	126.5	7.90
Zinc Nitrate 110	0.0254	2.785	32.1	3.67	49.9	5.71

Table 11
The Mean Ratings of the 2nd November Assessment

Product Applied	Test Trees ¹	Reference Trees ²	Timing of Sprays ³			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	2.3	2.7	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	2.4	2.5	2.5	2.7
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	2.6	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	2.7	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	2.7	-

The mean rating for untreated control trees was 3.4

¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees
³ This assessment was done before the application of sprays at timing “D”

Table 12
The Zinc Analyses (mg/kg) of Late Summer Flush.

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	31	29	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	31	29	30	33
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	37	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	39	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	38	-

The mean analysis value for untreated control trees was 19 mg/kg.

¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate for large medium reference trees

Table 14
Mean Yields (lb) Produced per Treatment per Tree

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	256	247	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	243	243	227	229
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	256	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	251	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	256	-

The mean yield for untreated control trees was 229 lbs per tree.

¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Table 15
Impact of Fruit Size on Crop Value

Fruit Count per Carton	DIP Value per Carton	Relative Value per Carton	DIP Value per Orange	Relative Value per Orange
48	\$5.25	97	\$0.1094	100
56	\$5.41	100	\$0.0965	88
64	\$5.41	100	\$0.0845	77
72	\$5.25	97	\$0.0729	67
88	\$5.10	94	\$0.0579	53
105	\$4.63	86	\$0.0441	40

(The dollar calculations above are approximate conversions from the South African Rand to American dollar)

Table 16
Grade 48

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	3.00	4.25	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	2.47	4.00	3.00	3.00
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	3.50	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	3.75	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	3.75	-

The mean yield for untreated control trees was 3.00

Differences between means are not significant

¹ Rate per acre on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

Table 17
Grade 56

Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	7.0 bcd	8.0 bc	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	9.3 ab	9.5 ab	9.3 ab	6.5 cd
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	11.0 a	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	6.0 d	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	7.0 bcd	-

The mean yield for untreated control trees was 8.0 bc

Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)

¹ Rate per acre on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

Table 18 Grade 64						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	17.8 ab	20.5 a	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	15.5 bc	15.3 bc	15.5 bc	20.3 a
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	19.3 a	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	15.5 bc	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	15.8 bc	-

The mean yield for untreated control trees was 14.5 c
Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)
¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Table 19 Grade 72						
Product Applied	Test Trees¹	Benchmark Trees²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	29.0 a	27.0 ab	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	24.8 b	28.0 ab	27.3 ab	21.0 c
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	25.5 ab	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	26.8 ab	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	27.0 ab	-

The mean yield for untreated control trees was 28.5 a
Absence of a common letter following means (both within and across columns) indicate a significant difference between those treatments (P=0.05)
¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Table 20 Grade 88						
Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	30.5	28.3	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	32.3	31.8	30.8	33.3
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	30.5	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	32.0	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	30.8	-

The mean yield for untreated control trees was 30.5
Differences between means are not significant
¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Table 21 Grade 105						
Product Applied	Test Trees ¹	Benchmark Trees ²	Timing of Sprays			
			A	ABD	ACD	BD
Metalosate® Zinc	19.7 fl oz	30.7 fl oz	-	12.8	12.0	-
Metalosate® Zinc	27.9 fl oz	43.4 fl oz	15.7	11.5	14.3	16.0
Metalosate® Zinc	41.9 fl oz	65.1 fl oz	-	10.3	-	-
Zincsol 701®	81.4 fl oz	125.9 fl oz	-	-	16.0	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	15.8	-

The mean yield for untreated control trees was 15.5
Differences between means are not significant
¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

Table 22 Fruit Grading by Fruit Counts per Carton (and Value per Orange)							
Treatment	Zinc Sprayed	8	56	64	72	88	105
	g/ha ¹	71 c	63 c	55 c	47 c	38 c	29 c
	fl oz/acre						
Control		3.0%	8.0%	14.5%	28.5%	30.5%	15.5%
Zinc Nitrate	5.71 oz	3.8%	7.0%	15.8%	27.0%	30.8%	15.8%
Metalosate® Zinc	2.71 to 3.86 oz	3.6%	8.4%	17.3%	27.8%	30.3%	12.6%
Metalosate® Zinc	5.71 oz	3.5%	11.0%	19.3%	25.5%	30.5%	10.3%

¹ Relate to total amounts sprayed on one hectare (2.47 acre) of benchmark (LM) trees.
(The dollar calculations above are approximate conversions from the South African Rand to American dollar)

Table 24 Gross Values for 200,000 Oranges.						
Product Applied	Test Trees ¹	Benchmark Trees ²	Values in \$1,000			
			A	ABD	ACD	BD
Metalosate [®] Zinc	19.7 fl oz	30.7 fl oz	-	13.9	14.2	-
Metalosate [®] Zinc	27.9 fl oz	43.4 fl oz*	13.7	-	-	13.7
Metalosate [®] Zinc	27.9 fl oz	43.4 fl oz	-	14.0	13.9	-
Metalosate [®] Zinc	41.9 fl oz	65.1 fl oz	-	14.3	-	-
Zincsol 701 [®]	81.4 fl oz	125.9 fl oz	-	-	13.62	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	13.7	-

The mean value for untreated control trees was 13.7 thousand dollars.
 *These treatments gave poor results due to less favourable timings. They have therefore been shown separately from similar treatments applied more effectively.
¹ Rate per acre on small medium trees at test site
² Proportionally adjusted rate on large medium reference trees

(The dollar calculations above are approximate conversions from the South African Rand to American dollar)

Table 25
Increases, Relative to the Control treatment, in the Values of 200,000
Oranges as Influenced by the Source, Amount,
and Timing of Zinc Sprays.

Product Applied	Test Trees ¹	Benchmark Trees ²	A	Timing of Sprays		
				ABD	ACD	BD
Metalosate [®] Zinc	19.7 fl oz	30.7 fl oz	-	\$186.10	\$498.70	-
Metalosate [®] Zinc	27.9 fl oz	43.4 fl oz*	\$16.70	-	-	\$49.60
Metalosate [®] Zinc	27.9 fl oz	43.4 fl oz	-	\$353.80	\$148.00	-
Metalosate [®] Zinc	41.9 fl oz	65.1 fl oz	-	\$590.00	-	-
Zincsol 701 [®]	81.4 fl oz	125.9 fl oz	-	-	\$89.00	-
Zinc Nitrate	32.1 fl oz	49.9 fl oz	-	-	\$14.00	-

* These treatments gave poor results due to less favourable timings. They have therefore been shown separately from similar treatments applied more effectively.

¹ Rate per acre on small medium trees at test site

² Proportionally adjusted rate on large medium reference trees

Table 26			
Influences of the Timing of Application and Metalosate® Zinc Dosage Rates, on Fruit Grading as Reflected in Fruit Value			
Total Metalosate® Zinc Applied per Benchmark Acre	Timing of Application	Value of 200 000 Oranges	Percentage Increase in Value of Fruit
Control	Untreated	\$13,708	-
43.4 fl oz	A and BD	\$13,675	-0.24%
43.4 fl oz	ABD and ACD	\$13,959	1.83%
30.7 fl oz	ABD and ACD	\$14,035	2.39%
65.1 fl oz	ABD	\$14,298	4.30%

Table 27					
Results of a Trial on Valencia Oranges in 1991 which tested Metalosate Zinc Compared With Zinc EDTA and Zinc Nitrate					
Product Applied	Dosage per at Test Orchard	Dosage per Benchmark	Value of 200,000 Fruit as Graded \$1,000	Percent Increase Above Control	Percent Increase Above Zinc Nitrate
Control	-	-	11.89	0.0%	-6.1%
Zinc EDTA			12.05	1.4%	-4.9%
Zinc Nitrate			12.66	7.0%	0.0%
Metalosate® Zinc	27.4 fl oz/acre	54.8 fl oz/acre	12.36	4.8%	-2.4%
Metalosate® Zinc	54.8 fl oz/acre	109.6 fl oz/acre	12.82	8.3%	1.2%
Metalosate® Zinc	109.6 fl oz/acre	219.1 fl oz/acre	13.90	17.0%	9.8%

