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GISBORNE

**GOLD 3 PRELIMINARY COPPER PHYTOTOXICITY
STUDY 2011-2012**

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DISCLAIMER

This report has been prepared for Zespri International Ltd for the purpose of providing guidance as to the possible phytotoxicity risk in Gold 3. Lewis Wright Valuation and Consultancy Limited do not accept any liability in relation to the use of the report by any other person or entity, or any use of the report by the Zespri International Ltd beyond its intended purpose. Lewis Wright Valuation and Consultancy Limited do not accept any liability for any reliance on the report in situations where the risk of such reliance is evident in the report.

1. EXECUTIVE SUMMARY

A preliminary trial was conducted in Opotiki district during summer 2011-12 to determine whether Gold 3 has a window of high sensitivity to copper damage. Nordox 750WG, a formulation of cuprous hydroxide, and Latron B-1956, a surfactant, were applied to vines of Gold 3.

Treatments consisted of a single application of Nordox applied 36, 60, 82, 98, 132 or 161 days after fruit set.

A russet was observed on 34% of fruit sprayed 36 days after fruit set. Approximately 50% of russet fruit would not have met Zespri class 1 standard. Russet was not consistently observed at any other treatment timing.

Fruit dry matter may have been reduced from applications in January and February.

There was no leaf damage observed from any treatment timing

The results of this study should be confined by a further study including application in the period 7-14 days after fruit set. Other formulations of copper (eg cupric hydroxide) should also be considered.

The possible reduction in dry matter should be examined through application of 2-3 copper at 3 weekly intervals over summer.

2. STUDY OBJECTIVE

To determine whether Gold 3 has a window of high sensitivity to copper damage

3. MATERIALS AND METHOD

Trial Location, Design and Crop

A trial was conducted in commercial orchard located in Woodlands Road, Opotiki. Vines were Gold 3 top grafted in 2008. There was complete canopy fill.

Initial trial was a randomised complete block design with four replications. Two additional treatments (6 & 7) were added to the original design in mid March

Table 3.1: Trial location and details

Orchard and KPIN	P & M Anstis Family Trust Orchard, KPIN 79245
Location	498 Woodlands Road, Opotiki
Variety	Gold 3 top grafted 2008
Plot Length	3.0 metres
Row Width	2.5 metres
Vines per plot	0.25

Treatments and Timing

Copper was applied as Nordox 75WG, a formulation containing 750g/kg copper as cuprous oxide. Nordox 75WG was applied at 37.5ml/100 litres (562.5 ml/ha).

Latron B-1956, a general purpose surfactant containing modified phthalic glycerol alkyl resin and butyl alcohol, was added to the spray mix at 25ml/100 litres.

Applications were made with a Solo motorised knapsack with airshear mist blower attachment. Application volumes were applied within 3% of target volumes at each application. A water rate of 1,500 litres per hectare was used

Grower Spray Programme

The grower applied Nordox prior to flowering on 28 Sept 2011 and 21 Oct 2011. Subsequent applications for Psa management were either bio-control agents or elicitors. The Spray Diary Report is presented in Appendix 3.

Table 3.2: Treatment and timing details

Treatment	Rate	Planned Treatment Timing		Actual Application Timing	
		DAFS*	Date Range	Date	DAFS
1. Nordox	37.5ml/100L	26-33	9-16 Dec 2011	19-Dec-2011	36
2. Nordox	37.5ml/100L	53-60	5-12 Jan 2012	12-Jan-2012	60
3. Nordox	37.5ml/100L	75-82	27 Jan – 3 Feb 2012	3-Feb-2012	82
4. Nordox	37.5ml/100L	96-103	17-24 Feb 2012	19-Feb-2012	98
5. Untreated					
6. Nordox	37.5ml/100L		Late March	24-Mar-2012	132
7. Nordox	37.5ml/100L		Late April	22-Apr-2012	161

*DAFS: Days after fruit set.

The project outline included a further treatment timed 7-14 days after fruit set. This timing had past prior to receipt of the project outline and trial establishment and was not applied.

Weather at Application:

Temperatures at application were generally warm with moderate drying times typical of grower practise.

Table 3.3: Application timing and weather data

Application	1	2	3	4	6	7
Date	19-Dec-2011	12-Jan-2012	3-Feb-2012	19-Feb-2012	24-Mar-2012	22-Apr-2012
Time	11.00	12.45	12.20	13.00	12.15	11.00
Wind speed (km/hr)	Nil	Nil	0-5km	0-5km	Nil	Nil
Wind direction	-	-	W	E	-	-
Temperature (°C)	19°C	22°C	22°C	20°C	23°C	18°C
Relative Humidity (%)	50%	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded
Drying Time (min)	45 mins	30 mins	1 hour	30 mins	45 mins	1 hour
Cloud cover (%)	70%	100%	60%	10%	70%	5%
Crop surface	Dry	Dry	Dry	Dry	Dry	Dry

4. RESULTS AND DISCUSSION

Harvest assessment was conducted on 2 May 2012, the date of commercial harvest for this block. Assessments were conducted as follows:

- 50 leaves per plot were assessed using the KVH scale of Kiwifruit leaf phytotoxicity effects. General leaf condition and leaf breakdown were also noted on a plot basis.
- 100 fruit per plot were harvested, weighed and individual fruit were assessed for possible symptoms of phytotoxicity.
- A 20 fruit sample was collected from the 100 fruit sampled per plot. These samples made up a composite 80 fruit sample for each treatment that was submitted to AgFirst BoP Ltd for dry matter determination.

Table 4.1: Summary of Harvest Assessments 2 May 2012

Treatment Timing	Mean Fruit Weight	% Dry Matter	% Russet	% Waterstain	% Bronzing	% Fruit Speckle
1. 19-Dec-2011	123.2	18.19 A	34.3	4.0	1.5	4.0
2. 12-Jan-2012	115.8	17.21 BC	1.0	2.5	1.0	28.8
3. 3-Feb-2012	98.8	17.11 BC	0.5	3.3	4.3	0.0
4. 19-Feb-2012	117.0	17.07 C	0.5	7.5	1.8	0.8
5. Untreated	109.8	17.83 AB	0.8	2.5	1.5	7.8
6. 24-Mar-2012	125.5	18.12 A	1.3	4.3	12.0	0.0
7. 22-Apr-2012	112.8	18.33 A	0.5	3.8	2.5	0.0
LSD (P=0.05)	27.6		26.2			
Treatment Prob(F)	0.388		0.057			

Fruit Weight: there was no significant difference between treatments.

Leaf Phytotoxicity: no leaves with symptoms of leaf russet were observed in any plot.

Dry Matter: Richard Keesing of AgFirst BoP Ltd reported the results of composite dry matter sample including comparisons for all pairs using Tukey-Kramer HSD. This analysis suggests there may be dry matter reductions from February and possibly January Nordox applications. Dry matter levels from December, March and April applications were not adversely affected. AgFirst report is presented in Appendix 2.

Russet: A light russet was noted on 34% of fruit from the 19-Dec-2011 application timing. Advice from a Zespri QA was that 50% of fruit would have been rejected for russet. Russet was not consistently observed in any other treatment timing.



Examples of fruit from treatment 1 (36 DAFS) with russet

As the first planned application timing 7-14 days post fruitset was not applied it is not possible to determine whether there is a safe period for Nordox application following fruitset.

Waterstain and Bronzing: there was no indication of treatment effects with waterstain. Waterstain may have been due to minor late season leaf breakdown. Bronzing showed up in 2 plots in treatment 6. These plots were noted to have leaf breakdown and a male had created an opening in the canopy. There was little or no bronzing in the other 2 plots for this treatment.

Fruit Speckle: this symptom was noted early in the assessments. The symptom was prominent raised and possibly russeted lenticels. As the assessment progressed this was noted to occur on larger fruit and was not recorded as a possible phytotoxicity.



Examples of fruit with fruit speckle – raised lenticels

5. CONCLUSIONS

Key conclusions from this study are:

Fruit Russet: Application of Nordox 750WG 36 days after fruit set resulted in 34% of fruit with russet. Approximately 50% of russet fruit would not have met Zespri class 1 standard.

Reduction in Dry Matter: there may be dry matter reductions from February and possibly January Nordox applications.

Leaf phytotoxicity: was not observed from a single application of Nordox 75WG in any treatment

6. FUTURE WORK

Russet: This study identified a russet sensitive period 36 days after fruit set for Gold 3. This should be confined by a further study including the period 7-14 days after fruit set. Other formulations of copper (eg cupric hydroxide) should also be considered.

Dry Matter: there may be a reduction in dry matter accumulation from summer copper application. This is an important aspect for Gold 3 where high dry matter is important for taste acceptability.

This effect could be examined through application of multiple coppers. Treatments could include 2-3 applications of copper at 3 weekly intervals over summer.

7. ACKNOWLEDGEMENTS

The owners and management of P & M Anstis Family Trust Orchard for provision and maintenance of the trial site. William Max applied the spray treatments and assisted with harvest assessment.

The study was funded by Zespri International Ltd.

8. APPENDIX 1 Trial Photos



General View of Trial 19 December 2011



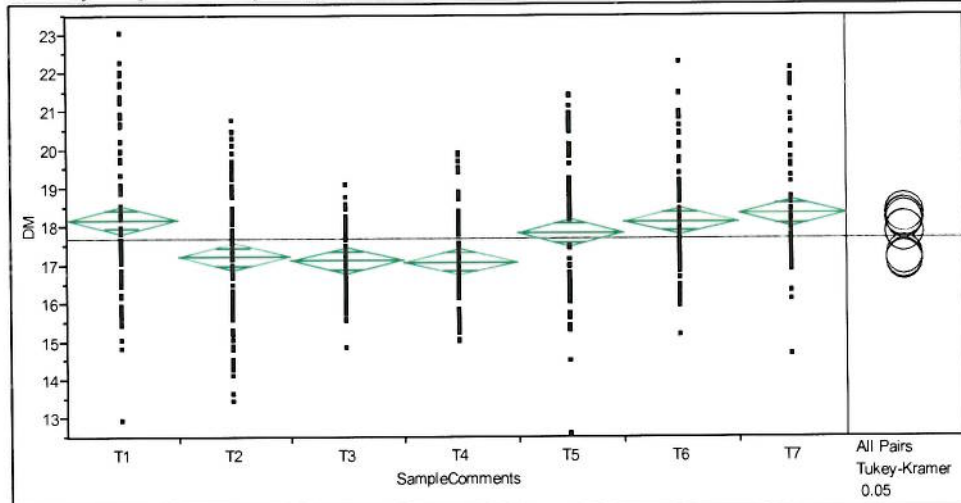
Fruit assessment 2 May 2012



Fruit size and crop load 19 December 2011

9. APPENDIX 2: AgFirst Dry Matter Report

Oneway Analysis of DM By SampleComments



Missing Rows 1

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

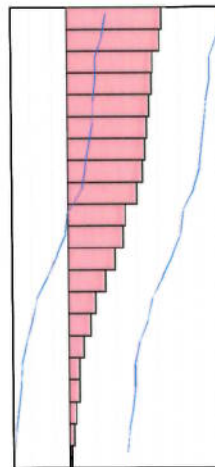
	q*	Alpha						
	2.95936	0.05						
Abs(Dif)-LSD								
	T7	T1	T6	T5	T2	T3	T4	
T7	-0.75447	-0.61385	-0.54195	-0.26550	0.36983	0.47046	0.50862	
T1	-0.61385	-0.74486	-0.67291	-0.39657	0.23884	0.33946	0.37764	
T6	-0.54195	-0.67291	-0.73111	-0.45492	0.18060	0.28123	0.31942	
T5	-0.26550	-0.39657	-0.45492	-0.76447	-0.12922	-0.02859	0.00955	
T2	0.36983	0.23884	0.18060	-0.12922	-0.74019	-0.63957	-0.60138	
T3	0.47046	0.33946	0.28123	-0.02859	-0.63957	-0.74019	-0.70201	
T4	0.50862	0.37764	0.31942	0.00955	-0.60138	-0.70201	-0.73561	

Positive values show pairs of means that are significantly different.

Level	Mean
T7 A	18.325325
T1 A	18.189494
T6 A	18.124390
T5 A B	17.831333
T2 B C	17.208125
T3 B C	17.107500
T4 C	17.071605

Levels not connected by same letter are significantly different.

Level	- Level	Difference	Lower CL	Upper CL
T7	T4	1.253720	0.508619	1.998821
T7	T3	1.217825	0.470458	1.965192
T1	T4	1.117889	0.377639	1.858139
T7	T2	1.117200	0.369833	1.864567
T1	T3	1.081994	0.339463	1.824524
T6	T4	1.052785	0.319423	1.786148
T6	T3	1.016890	0.281225	1.752555
T1	T2	0.981369	0.238838	1.723899
T6	T2	0.916265	0.180600	1.651930
T5	T4	0.759728	0.009552	1.509905
T5	T3	0.723833	-0.028594	1.476261
T5	T2	0.623208	-0.129219	1.375636
T7	T5	0.493991	-0.265495	1.253478
T1	T5	0.358160	-0.396568	1.112889
T6	T5	0.293057	-0.454917	1.041031
T7	T6	0.200934	-0.541949	0.943818
T2	T4	0.136520	-0.601384	0.874424
T7	T1	0.135831	-0.613852	0.885514
T2	T3	0.100625	-0.639567	0.840817
T1	T6	0.065103	-0.672914	0.803121
T3	T4	0.035895	-0.702009	0.773799



10. APPENDIX 3: Grower Spray Diary Report



New Zealand Kiwifruit

ZESPRI INTERNATIONAL LIMITED

Spray Diary Report for Season 2012 for KPIN 7924

KPIN: 7924

P & M Anstis Trust

498 Woodlands Road

Opotiki

Lessee:

Pest Monitoring Center: OPAC (Factory Road)

Packhouse: OPAC (Factory Road)

Spray Contractor:

Spray Details

Date	Applicator	Equipment	Litres	Water Source	Blocks	Product, ingredient, rate and reason for application
17/5/2011	Donna Beckett	Typhoon 2000	740	Spring1	Top 10	Nordox 75 WG 100gm (Copper Compounds) for PSA Management, RainGard 30ml (Adjuvant) for PSA Management
19/5/2011	Donna Beckett	Typhoon 2000	1520	Spring1	Top 9; Top 11	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
17/6/2011	Donna Beckett	Typhoon 2000	770	Spring1	Top 7	Nordox 75 WG 100g (Copper Compounds) for PSA Management, RainGard 30ml (Adjuvant) for Adjuvant/Additive/Surfactant
21/6/2011	Donna Beckett	Typhoon 2000	2880	Spring1	Block 5 Top; Top 8; Top 6	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
20/7/2011	Donna Beckett	Typhoon 2000	501	Spring1	Top 6	Cyan 5500ml (Hydrogen cyanamide) for Improved Budbreak, Driftstop 50ml (Adjuvant) for Adjuvant/Additive/Surfactant
22/7/2011	Donna Beckett	Typhoon 2000	865	Spring1	Block 5 Top	Cyan 5500ml (Hydrogen cyanamide) for Improved Budbreak, Driftstop 50ml (Adjuvant) for Adjuvant/Additive/Surfactant
31/7/2011	Donna Beckett	Typhoon 2000	1200	Spring1	Top 3; Top 8; Top 7	Graphic Biocide 750ml (Benzalkonium chloride + copper sulphate) for PSA Management
04/8/2011	Donna Beckett	Typhoon 2000	480	Spring1	Block 5 Top	Graphic Biocide 750ml (Benzalkonium chloride + copper sulphate) for Winter Clean up
05/8/2011	Donna Beckett	Typhoon 2000	364	Spring1	Top 4	Cyan 5500ml (Hydrogen cyanamide) for Improved Budbreak, Driftstop 50ml (Adjuvant) for Adjuvant/Additive/Surfactant
10/8/2011	Donna Beckett	Typhoon 2000	2173	Spring1	Block 5 Top; Top 8; Top 7; Top 6	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
20/8/2011	Donna Beckett	Typhoon 2000	487	Spring1	Top 11	Cyan 6000ml (Hydrogen cyanamide) for Improved Budbreak
21/8/2011	Donna Beckett	Typhoon 2000	1176	Spring1	Bottom 79242	Cyan 6000ml (Hydrogen cyanamide) for Improved Budbreak
24/8/2011	Peter Grantham Anstis	Sprayer	539	Spring1	Top 6	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
29/8/2011	Donna Beckett	Typhoon 2000	260	Spring1	Top 1 79243	Cyan 5500ml (Hydrogen cyanamide) for Improved Budbreak
29/8/2011	Peter Grantham Anstis	Sprayer	931	Spring1	Block 5 Top	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
01/9/2011	Peter Grantham Anstis	Sprayer	1610	Spring1	Top 3; Top 8; Top 7	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
03/9/2011	Donna Beckett	Typhoon 2000	500	Spring1	Top 10	Cyan 5500ml (Hydrogen cyanamide) for Improved Budbreak, Driftstop 50ml (Adjuvant) for Adjuvant/Additive/Surfactant
10/9/2011	Donna Beckett	Typhoon 2000	1118	Spring1	Top 10; Top 11	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
10/9/2011	Donna Beckett	Typhoon 2000	578	Spring1	Top 9	Nordox 75 WG 100gm (Copper Compounds) for PSA Management
14/9/2011	Donna Beckett	Typhoon 2000	770	Spring1	Top 6	Mesurool SC 150ml (Methiocarb) for Bird Control, RainGard 30ml (Adjuvant) for Adjuvant/Additive/Surfactant
23/9/2011	Peter Grantham Anstis	Sprayer	675	Spring1	Block 5 Top	Mesurool SC 150ml (Methiocarb) for Bird Control

28/9/2011	Peter Grantham Anstis	Sprayer	360	Spring1	Top 4	Nordox 75 WG 50gm (Copper Compounds) for Bacterial Disease Control, Omniwett (formerly Elicit) 150ml (Adjuvant) for Adjuvant/Additive/Surfactant
29/9/2011	Peter Grantham Anstis	Sprayer	1170	Spring1	Bottom 79242	Nordox 75 WG 100gm (Copper Compounds) for Bacterial Disease Control
08/10/2011	Donna Beckett	Typhoon 2000	2100	Spring1	Block 5 Top; Top 6	Alexin 150ml (Other Foliar) for Foliar Fert, Kiwifruit Complex 500gm (Other Foliar) for Foliar Fert, Movento 40ml (Spirotetramat) for Scale Control, Prodigy 30ml (Methoxyfenozide) for Leafroller Control
14/10/2011	Peter Grantham Anstis	Sprayer	2100	Spring1	Block 5 Top; Top 6	Nordox 75 WG 37.5gm (Copper Compounds) for Bacterial Disease Control, Omniwett (formerly Elicit) 50ml (Adjuvant) for Adjuvant/Additive/Surfactant, Spotless 100ml (Propiconazole+benzalkonium chloride+salicylic acid) for Bacterial Disease Control
21/10/2011	Donna Beckett	Typhoon 2000	1800	Spring1	Bottom 79242	Hywet 75ml (Adjuvant) for Adjuvant/Additive/Surfactant, Nordox 75 WG 37.5gm (Copper Compounds) for Bacterial Disease Control
21/10/2011	Donna Beckett	Typhoon 2000	2900	Spring1	Top 3; Top 4; Top 8; Top 7	Hywet 75ml (Adjuvant) for Adjuvant/Additive/Surfactant, Nordox 75 WG 37.5gm (Copper Compounds) for Bacterial Disease Control
24/10/2011	Donna Beckett	Typhoon 2000	1500	Spring1	Top 9; Top 10; Top 11	Hywet 75ml (Adjuvant) for Adjuvant/Additive/Surfactant, Nordox 75 WG 37.5gm (Copper Compounds) for Bacterial Disease Control
24/10/2011	Peter Grantham Anstis	Sprayer	2200	Spring1	Block 5 Top; Top 6	Blossom Bless 30gm (Pantoea agglomerans P10c) for Bacterial Disease Control
24/10/2011	Peter Grantham Anstis	Sprayer	2800	Spring1	Top 3; Top 4; Top 8; Top 7	Comic 8.6gm (Tebufenozide) for Leafroller Control, Kiwifruit Complex 1000gm (Other Foliar) for Foliar Fert, Movento 30ml (Spirotetramat) for Scale Control, Partner 200ml (Adjuvant) for Adjuvant/Additive/Surfactant
03/11/2011	Peter Grantham Anstis	Sprayer	1000	Spring1	Top 3; Top 8	Blossom Bless 30gm (Pantoea agglomerans P10c) for Bacterial Disease Control
03/11/2011	Peter Grantham Anstis	Sprayer	800	Spring1	Top 6	TripleX 200ml (Bacillus amyloliquefaciens - Conventional only) for Bacterial Disease Control
04/11/2011	Peter Grantham Anstis	Sprayer	300	Spring1	Top 4	Actigard 30gm (acibenzolar-S-methyl) for Bacterial Disease Control, Spotless 150ml (Propiconazole+benzalkonium chloride+salicylic acid) for Bacterial Disease Control
04/11/2011	Peter Grantham Anstis	Sprayer	1600	Spring1	Top 3; Top 8; Top 7	Actigard 30gm (acibenzolar-S-methyl) for Bacterial Disease Control
07/11/2011	Peter Grantham Anstis	Sprayer	508	Spring1	Block 5 Top; Top 6	Actigard 20gm (acibenzolar-S-methyl) for Bacterial Disease Control
08/11/2011	Peter Grantham Anstis	Sprayer	550	Spring1	Top 4	Blossom Bless 30gm (Pantoea agglomerans P10c) for Bacterial Disease Control
11/11/2011	Donna Beckett	Typhoon 2000	5000	Spring1	Bottom 79242; Top 1 79243; Top 2; Top 9; Top 10; Top 11	Comic 8.5gm (Tebufenozide) for Leafroller Control, Kiwifruit Complex 500gm (Other Foliar) for Foliar Fert, Movento 20ml (Spirotetramat) for Scale Control, Partner 200ml (Adjuvant) for Adjuvant/Additive/Surfactant, Spotless 100ml (Propiconazole+benzalkonium chloride+salicylic acid) for Bacterial Disease Control
13/11/2011	Donna Beckett	Typhoon 2000	2900	Spring1	Top 3; Top 4; Top 8; Top 7	TripleX 200ml (Bacillus amyloliquefaciens - Conventional only) for Bacterial Disease Control
15/11/2011	Donna Beckett	Typhoon 2000	2900	Spring1	Top 3; Top 4; Top 8; Top 7	TripleX 200ml (Bacillus amyloliquefaciens - Conventional only) for Bacterial Disease Control
15/11/2011	Donna Beckett	Typhoon 2000	770	Spring1	Top 6	Benefit Kiwi 200ml (Other Foliar) for Foliar Fert
15/11/2011	Donna Beckett	Typhoon 2000	2000	Spring1	Block 5 Top	Benefit Kiwi 200ml (Other Foliar) for Foliar Fert
18/11/2011	Peter Grantham Anstis	Sprayer	3500	Spring1	Bottom 79242; Top 11	Actigard 15gm (acibenzolar-S-methyl) for Bacterial Disease Control, Spotless 50ml (Propiconazole+benzalkonium chloride+salicylic acid) for Bacterial Disease Control
19/11/2011	Donna Beckett	Typhoon 2000	4000	Spring1	Top 1 79243; Top 2; Top 9; Top 10	Actigard 15gm (acibenzolar-S-methyl) for Bacterial Disease Control
23/11/2011	Donna Beckett	Typhoon 2000	2850	Spring1	Block 5 Top; Top 6	Alexin 50ml (Other Foliar) for Bacterial Disease Control, Benefit Kiwi 200ml (Other Foliar) for Foliar Fert
24/11/2011	Peter Grantham Anstis	Sprayer	2300	Spring1	Top 3; Top 8; Top 7	Alexin 50ml (Other Foliar) for Bacterial Disease Control, Benefit Kiwi 200ml (Other Foliar) for Foliar Fert, Proclaim 2gm (Emamectin) for Leafroller Control