

Phytotoxicity Comparative Performance Trial

**Hortcare Copper Hydroxide 300
Grosafe Chemicals Ltd**

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1.0 Trial Background and Objective

In April of 2013 a preliminary trial was carried out to determine if a late season application of Hortcare Copper Hydroxide 300 would result in any staining or deposits on fruit. This application was compared with Kocide Opti. No staining was evident on assessment however it was recommended to do a full season programme to determine the performance of the product.

Trial Objective

The objective of the trial is to investigate if there are any phytotoxic issues with the use of a full season program of Hortcare Copper Hydroxide 300 and compare it with a current industry standard product Kocide Opti. Two rates of Hortcare Copper Hydroxide 300 were used, with and without an adjuvant and compared to one rate of Kocide Opti.

The trial was carried out on a commercial Sungold Kiwifruit (G3) orchard.

2.0 Trial Treatments and Layout

The trial included six treatments (refer Figure 1.0), with four replicates per treatment. The control was the untreated treatment. The design was randomised and each replicate (plot) was one bay in size. Refer to Appendix 1. for the trial randomised layout.

Photo 1. Replicate Tag



Treatments

Figure 1. Trial Treatments

Treatment	Product	Product Rate	Adjuvant	Adjuvant Rate	Water Rate per Hectare (litres)
1	Untreated-Control				1000
2	Hortcare Copper Hydroxide 300	50g/100L water	GSX002	25ml/100L spray mix	1000
3	Hortcare Copper Hydroxide 300	50g/100L water			1000
4	Kocide Opti	50g/100L water			1000
5	Hortcare Copper Hydroxide 300	70g/100L water	GSX002	25ml/100L spray mix	1000
6	Hortcare Copper Hydroxide 300	70g/100L water			1000

Spray Programme

The planned season spray programme was based on the application of seven sprays. It was recognised that there may need to be some flexibility with the number of sprays and the timing depending on weather conditions. It was however important to target the spraying to an expected “use pattern”.

Figure 2. Targeted Spray Timing

Spray Number	Spray Timing	Date
1	Pre-flowering	17 October
2	Pre-flowering	22 October
3	Post fruit set (5-7 days)	6 November
4	Post fruit set (20 days)	25 November
5	Copper coverage	20 December
6	Copper coverage	24 January
7	Copper coverage	7 March

Orchard Spray Programme

Prior to the Trial beginning the orchard had applied two Kocide Opti copper sprays and two Actigard sprays to protect the spring growth from PSA infection. Refer to Appendix 2. for the orchard spray programme.

3.0 Application

There are small volumes of water required for the four replicates per treatment so a portable 60 litre spray unit was used. This was mounted on a quad motor bike and powered by a 12 volt electric pump. A hand held wand with a spray nozzle-stainless steel tip (number 3) and a number 35 swirl plate was used to apply the sprays.

Calibration

To determine the correct amount of water per hectare on a bay (replicate) basis, water volume was measured into a 5 litre container and timed. The base water rate per hectare was 1000 litres.

Stephen Kenna, a kiwifruit spray contractor applied the spray treatments.

Growsafe Number: S15710 with an expiry of 22 February 2015.

Application Dates

Flowering of the G3 kiwifruit came on quickly so only one pre-flower copper spray was able to be applied. An additional post fruit set spray was applied in February.

Figure 3. Actual Spray Programme

Spray Number	Spray Timing	Date	Temperature	Relative Humidity
1	Pre-flowering	17 October 2013	22°C	75%
2	Post fruit set	9 November 2013	23°C	75%
3	Post fruit set	23 November 2013	23°C	75%
4	Copper coverage	18 December 2013	21°C	75%
5	Copper coverage	22 January 2014	20°C	75%
6	Copper coverage	18 February 2014	22°C	75%
7	Copper coverage	12 March 2014	20°C	75%

Photo 2. Portable Spray Unit



Spray Penetration

It is very difficult to penetrate the kiwifruit canopy with the hand held spray unit as the season progresses. As a result the underside of leaves receive significantly more coverage than the topside. It also means that fruit are well covered with spray giving results almost in a worst case scenario. Refer photos 3, 4 & 5.

Photo 3. Spray droplets on underside of leaves after February spray



Photo 5. Droplets of spray on fruit after February spray



Photo 4. Limited coverage of spray on topside of leaf after February spray (same leaf as above)

4.0 Results

Assessment

To monitor the impact of spray applications during the season, in each replicate, five shoots and ten fruit were tagged. They were visually assessed after each spray application. At the end of the trial these tagged samples were picked and scored to determine (if any) level of phytotoxicity.

Leaf Monitoring

At the time of the tagging the shoots (pre Hortcare Copper Hydroxide application) it was a challenge to identify shoots that did not have some degree of damage from what was suspected a nutrition issue and some wind damage. The shoots with the best leaves were chosen. In the assessments after the copper applications there was very little difference between the treatments. Only the control in the November assessment did there appear to be any difference. A visual assessment across all of the trial area showed there was yellowing of older more mature leaves on all treatments. This in fact was an industry wide issue on the G3 and throughout the Trial Orchard but less noticeable in the Control treatment (less copper). At the end of season assessments there was no difference between the treatments.

Photo 6. Leaf yellowing in November

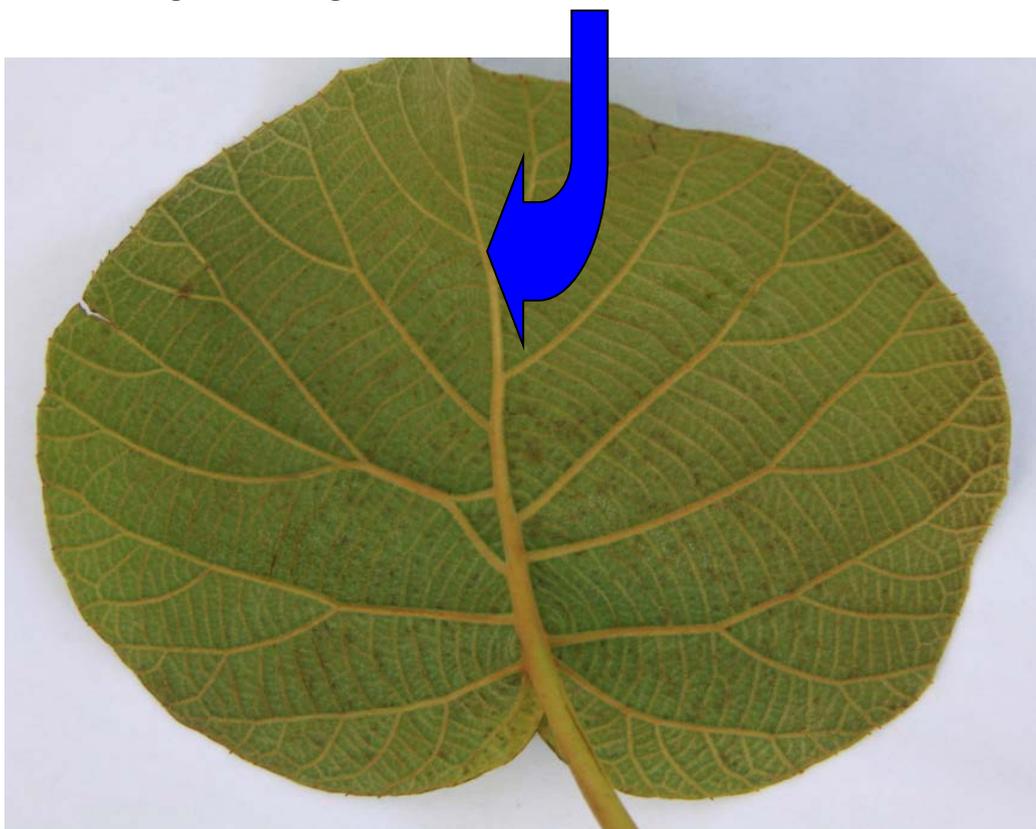


There were some typical copper phytotoxicity symptoms on leaf veins with some browning however overall the phytotoxicity was minimal.

Photo 7. Underside of leaf in the lower canopy spray zone that had no browning of veins



Photo 8. Underside of leaf in the spray zone that had slight browning of leaf veins



Fruit Monitoring

Fruitlets were tagged after pollination to monitor for any marking or damage after copper application. Figure 4 below is a summary of the monitoring. Fruit was assessed 7 days after the copper application. There was no marking on fruit after any copper application.

Photo 9. Tagged fruit for monitoring



Figure 4. Fruit Monitoring Results

Treatment	Copper Application Date						
	17-10-13	09-11-13	23-11-13	18-12-13	22-01-14	18-02-14	12-03-14
1	Pre-flower	No marking					
2	Pre-flower	No marking					
3	Pre-flower	No marking					
4	Pre-flower	No marking					
5	Pre-flower	No marking					
6	Pre-flower	No marking					

Photo 10. Water stain on fruit coming from leaves above

Pre Harvest Fruit Assessment

Although the seasonal fruit monitoring showed there was no presence of obvious fruit marking or staining a further fruit assessment was completed.

It is typical within the kiwifruit industry to use a stain remover prior to harvest to maximise export kiwifruit. This targets the removal of tannins on fruit that come from pruning residual left in canopy and any leaf breakdown washed down with rain. This is called fruit water stain. If there was any copper marking, a fruit assessment prior to the spray application would capture this. A post spray assessment would provide a comparison and help confirm the most likely cause of any fruit marking.

To ensure that the trial was fully assessed prior to this spray application, 50 fruit were randomly picked per replicate giving a total number of fruit per treatment of 200 pieces. Each replicate fruit sample was individually assessed for any marking.

Each fruit piece was assessed for any mark with a note of what the mark may be, water stain, sooty mould or copper. It was also noted if the mark would meet the Class 1 export standards or not.

A post stain remover spray application fruit assessment was also done on the same basis.



Photo 11. Water stain on fruit



Photo 12. No marking on fruit



Pre Stain Remover Assessment

It was evident from the fruit assessments that the main marking on the fruit was water stain and the majority of the stain met the class 1 export fruit standard. Although treatment 3 and 5 had more water stain compared to the others, this is primarily because of more dead leaf material left in after canopy summer pruning. This is supported by treatment 1, the untreated control which had more marking than treatments, 2, 4, and 6. Refer Figure 5.

Figure 5. Fruit Assessment Pre Stain Remover

Treatment Number	Treatment	Fruit Pieces with No Mark	Fruit Pieces with a Mark	Mark meets Class 1 Export Standards	Mark does not meet Class 1 Export Standards
1	Untreated-Control	189	10	10	0
2	Hortcare Copper Hydroxide 300,50g/100l +adjuvant	193	7	7	0
3	Hortcare Copper Hydroxide 300, 50g/100l	179	21	17	4
4	Kocide Opti 50g/100l	195	5	5	0
5	Hortcare Copper Hydroxide 300.70g/100l +adjuvant	180	20	17	3
6	Hortcare Copper Hydroxide 300, 70g/100l	193	7	7	0

Post Stain Remover Assessment

After the water stain remover was applied, fruit was picked and assessed. The water staining on the fruit (albeit minor and most being export quality fruit) had been removed. Kiwilustre and Du-Wett Stainless were the stain removing products used. There was no staining on any fruit. Refer Figure 6.

Figure 6. Fruit Marking Post Water Stain Comparison

Treatment Number	Treatment	Fruit with Stain Prior to Water Stain Remover Application (%)	Fruit with Stain Post Stain Remover Application (%)
1	Untreated-Control	5.29%	0%
2	Hortcare Copper Hydroxide 300,50g/100l +adjuvant	3.62%	0%
3	Hortcare Copper Hydroxide 300, 50g/100l	11.73%	0%
4	Kocide Opti 50g/100l	2.56%	0%
5	Hortcare Copper Hydroxide 300.70g/100l +adjuvant	11.11%	0%
6	Hortcare Copper Hydroxide 300, 70g/100l	3.62%	0%

Photo 13. Fruit Samples for Assessment



5.0 Discussion

The objective of the trial was to investigate if there are any phytotoxic issues with the use of a full season program of Hortcare Copper Hydroxide 300 and compare it with a current industry standard product, Kocide Opti. Two rates of Hortcare Copper Hydroxide 300 were used, with and without an adjuvant and compared to one rate of Kocide Opti. The rates used are typical of kiwifruit industry copper spray practice.

The replicated trial and application timing of the different copper treatments reflected a typical 'use pattern' together with testing to see if any fruit marking or damage occurred in the fruit sensitive period (30 days post fruitset). The nature of the seasonal weather conditions (sunny and fine) also meant more coppers were put on in the trial than was necessary.

Fruit monitoring throughout the growing season indicated that the application of Hortcare Copper Hydroxide 300 and Kocide Opti did not cause fruit staining or damage. Leaf phytotoxicity was minimal. There was no difference between the rate of product used and the use of an adjuvant or not.

The hand held spray method overall applies more spray to the fruiting part of the canopy as it does not have the fan and pressure of a commercial sprayer. Fruit and lower leaves therefore receive a greater proportion of coverage at a water rate of 1000 litres per hectare meaning that the results are likely to be a worst case scenario.

To confirm that there was no staining or damage to fruit prior to harvest a large fruit sample was taken off the six treatments and assessed. There was some staining on the fruit but this was categorised as 'water stain' caused from summer pruning leaf debris. Following the application of a water stain remover the second sample of fruit taken and assessed showed no staining on the fruit at all and was all Class One export quality fruit. The fruit was remarkably clean and indicates the slight staining on a small amount of fruit was caused by 'water stain'.

6.0 Conclusion

The Hortcare Copper Hydroxide 300 in a full season kiwifruit spray program was assessed to be the same as Kocide Opti in terms of fruit and canopy phytotoxicity. There was no damage to fruit and acceptable levels of phytotoxicity to leaves.

6.0 Appendix

Appendix 1. Trial Layout - Randomised Plots

	101-4	201-2	301-5	401-1		
	102-1	202-3	302-6	402-4		
	103-6	203-6	303-3	403-2		
	104-2	204-1	304-2	404-6		
	105-3	205-5	305-4	405-3		
	106-5	206-4	306-1	406-5		

Kiwifruit Bays

Shelter Rows



Appendix 2. Orchard Spray Programme Prior to Trial Starting

Figure 7. Orchard Spray Programme Prior to Trial Starting

Date	Product
9 September	Kocide & Du-Wett
27 September	Kocide & Du-Wett
5 October	Actigard & Du-Wett
18 October	Actigard & Movento

7.0 Acknowledgement

Grosafe Chemicals Ltd and KWKIWI Ltd would like to thank the property owners for the use of their orchard for the trial.

