

Post flowering applications of copper to fruit – Hayward and Hort16A – France 2012

A- Executive Summary

Please note that this is a draft report and no statistical analysis has occurred on the data.

In trials on Hort16A and Hayward canes, comparing Kocide 2000 and Nordox75WG applications post flowering, no fruit marking associated with copper applications was seen. This indicates that it is possible to use low rate copper for Psa control if best practice is followed. Further work using commercial sprayers and a wider range of rates and timing is required to determine where phytotoxicity thresholds are. Industry experiences has shown it is possible to create fruit staining and or russet from inappropriate copper use.

In this work fruit colouring may have been advanced on Hort16A by copper applications but there was no impact on brix on Hayward fruit.

Results on fruit copper residues are presently being analysed and will be provided at a future date.

Trial context and aim

Copper is a powerful tool against Psa but to be efficient it requires good coverage all throughout the season, leading to re-application to cover new tissue. However, the potential for some undesirable effects must be considered. The major issue to look at in post flowering application is the risk for fruit marking.

This trial was designed to assess this risk, both on Hayward and Hort16A, starting applications at different timing after fruit set and applying 3 to 6 coppers on the same fruit with or without super-spreader. Fruit were picked and inspected individually at harvest time for signs of fruit marking phytotoxicity.

B- Protocols

Both orchards were located close to the Hastingues village, along the Adour River. Hort16A and Hayward blocks were owned by the same grower.

- 1- Trial design: Fifty female vines of each variety were chosen and marked. On each vine, three canes were marked with color ribbon.

Kocide2000 was trialed in France. It is registered on other crops than kiwifruit and as such can be used for trials. However, because there is no registration for kiwifruit for those products in France, all rates described above shouldn't be considered as recommendations for use in France.

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Five treatments (cuprous oxide and copper hydroxide at low rates, with or without a spreader):

- Nordox75WG at 25g/100L
- Nordox75WG at 25g/100L + Sticman 140ml/100L
- Kocide2000 at 70g/100L
- Kocide2000 at 70g/100L + Sticman 140ml/100L
- Control –nothing applied

(N.B. Sticman is the equivalent to Bond Xtra® in NZ)

Three timings of first applications (by cane)

- 2 + 6 weeks after fruit set – yellow ribbon
- 3 + 7 weeks after fruit set – white ribbon
- 4 + 8 weeks after fruit set – blue ribbon

All other applications from week 11 at the same time on the three canes per vine

Two total numbers of applications

- 3 times
- 6 times (only 5 on the Hayward due to harvest date)

See table below for summary and *Appendix for trial maps*

<u>Product sprayed</u>	<u>Batch 1 (Cane 1 - yellow)</u>		<u>Batch 2 (Cane 2 -white)</u>		<u>Batch 3 (Cane 3 -blue)</u>	
<u>Total number of sprays</u>	3 (Hort 16A)	6 (Hort16A) 5 (Hayward)	3 (Hort 16A)	6 (Hort16A) 5 (Hayward)	3 (Hort 16A)	6 (Hort16A) 5 (Hayward)
Kocide2000 at 70g/100L	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety
Kocide2000 at 70g/100L with spreader	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety
Nordox75WG at 25g/100L	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety
Nordox75WG at 25g/100L with spreader	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety
Control	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety	5 canes per variety

* Nordox was applied 6 times on Hayward but followed by immediate strong rain so not taken into account.

Kocide2000 was trialed in France. It is are registered on other crops than kiwifruit and as such can be used for trials. However, because there is no registration for kiwifruit for those products in France, all rates described above shouldn't be considered as recommendations for use in France.

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This tables shows that this trial has been designed as a factorial, and can be analyzed grouping for example similar treatment of Nordox with or without spreader, or all Nordox canes if not considering date of first application but only number of sprays.

2- Applications

The grower himself didn't apply any copper on his blocks throughout the season. Only the copper applied for the trial has reached the fruit. The vines used in this trial had had two pre-flowering copper applications applied to them.

Applications were made using a hand sprayer. Fruit were targeted specifically and sprayed until runoff (drops falling from bottom of the fruit). Both sides of the cane were sprayed.

The addition of Sticman allowed the copper products to get below the fruitlet hairs on to the skin surface.

Weather was generally sunny with temperatures from 16°C to 30°C. Drying conditions were mostly good.

Note: all canes were thinned in order to avoid any work of the growers on those canes (likely to overthin removing marked fruit).

For details of volumes of water applied and weather, see Appendix

3- Harvest

Pre harvest, dead leaves were regularly removed from the canopy to avoid any fruit staining effect that would be due to tannins from leaves.

At harvest, each cane was picked separately.

- Fruits were counted and weighed to check the effect on fruit size
- Fruit were assessed one by one for severity of marking and ranked from 0 (nothing) to 4 (severe mark). Even though when example fruit from 0 to 4 were taken to packhouse to quality assessors, very few would have been discarded.
- Subsamples of fruit were tested for color for Hort16A and Brix for Hayward
- No formal assessment of leaf vein marking was undertaken but observationally, levels were either very low or non existent

See Appendix for pictures

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C- Results – please note that no statistical tests have yet been performed

1- Hort16A

a) Product effect

Fruit marking	Control	Kocide	Nordox
Average of % clean fruit	84.2	88.0	85.4
Average of % level 1	7.0	6.4	7.1
Average of % level 2	10.6	6.8	9.3
Average of % level 3	4.3	1.8	2.2
Average of % level 4	0.8	0.3	0.3
Average of fruit weight	99.9	102.5	105.5
Average of fruit number per cane	48.7	45.1	45.2

b) Effect of the spreader

Values	Control		Kocide		Nordox	
	N		N	Y	N	y
Average of % clean fruit	84.2		87.8	88.1	84.6	86.3
Average of % level 1	7.0		5.8	7.0	8.5	5.8
Average of % level 2	10.6		6.2	7.3	8.7	10.0
Average of % level 3	4.3		1.9	1.6	2.0	2.4
Average of % level 4	0.8		0.3	0.4	0.4	0.3
Average of fruit weight	99.9		106.1	99.0	105.6	105.4
Average of fruit number per cane	48.7		42.4	47.8	43.8	46.7

c) Effect of the number of applications

Values	3.0			6.0		
	Control	Kocide	Nordox	Control	Kocide	Nordox
Average of % clean fruit	86.1	86.8	84.1	82.4	89.2	86.8
Average of % level 1	5.3	5.6	6.6	8.6	7.2	7.7
Average of % level 2	9.7	8.6	10.6	11.4	4.8	8.0
Average of % level 3	3.6	2.3	2.7	5.0	1.2	1.7
Average of % level 4	1.0	0.6	0.6	0.6	0.1	0.0
Average of fruit weight	98.0	104.9	103.5	101.7	100.0	107.7
Average of fruit number per cane	46.9	45.8	45.5	50.4	44.3	45.0

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d) Effect of the date of first application

Marking	Control			Kocide			Nordox		
	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
Average of % clean fruit	84.0	86.2	82.4	88.2	89.1	86.7	86.6	83.9	85.8
Average of % level 1	8.9	4.6	7.4	4.4	7.3	7.4	7.0	8.4	6.0
Average of % level 2	9.4	10.9	11.4	6.4	6.6	7.3	7.4	10.0	10.6
Average of % level 3	3.7	3.4	5.7	2.0	1.3	2.0	1.3	3.0	2.3
Average of % level 4	0.0	0.9	1.4	0.3	0.3	0.4	0.3	0.6	0.1
Average of fruit weight per cane	99.4	99.3	101.0	102.2	102.8	102.6	106.5	107.8	102.3
	47.0	48.1	50.9	40.8	48.6	45.9	41.1	47.4	47.2

Note that nothing was applied on the control so the variation between the 3 batches gives an idea of natural variation.

e) Effect on fruit maturity (measured as color)

At the time of sampling for color testing only 12 vines were remaining unpicked

- 2 vines with canes treated 4 times with Nordox75WG
- 2 vines with canes treated 4 times with Nordox 75WG and spreader
- 1 vine with canes treated 6 times with Nordox 75WG
- 1 vine with canes treated 6 times with Nordox 75WG and spreader
- 1 vine with canes treated 4 times with Kocide 2000
- 1 vine with canes treated 4 times with Kocide2000 and spreader
- 1 vine with canes treated 6 times with Kocide2000
- 1 vine with canes treated 6 times with Kocide2000 and spreader
- 2 control vines

As a consequence, it is not possible to analyze data without grouping them otherwise what we might see would be the vine effect and not the treatment effect.

It was chosen not to take the spreader and date of first application into account.

Row Labels	4.0	6.0	Control
Kocide	104.2 (2)	105.3 (2)	
Nordox	105.1 (4)	105.4 (2)	
Control			107.0 (2)

Average hue of fruit – number of vines into brackets

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2- Hayward

a. Product effect

Values	Kocide	Nordox	Control
Average of % clean fruit	92.84	92.39	92.81
Average of % level 1	2.84	3.14	2.64
Average of % level 2	2.25	2.44	2.87
Average of % level 3	0.67	0.93	0.78
Average of % level 4	0.00	0.00	0.00
Average of fruit weight	109.16	111.58	112.71
Average of total number of fruit per cane	34.07	36.13	39.43
Average of brix	6.72	6.75	6.69

b. Effect of the spreader

Values	Kocide		Nordox		control
	N	Y	N	Y	N
Average of % clean fruit	94.16	91.47	93.12	91.65	92.81
Average of % level 1	2.33	3.37	2.95	3.33	2.64
Average of % level 2	1.63	2.89	2.02	2.87	2.87
Average of % level 3	0.62	0.72	0.62	1.24	0.78
Average of % level 4	0.00	0.00	0.00	0.00	0.00
Average of fruit weight	111.69	106.54	111.43	111.7	112.71
Average of total number of fruit per cane	33.20	34.97	36.53	35.73	39.43
Average brix	6.77	6.67	6.70	6.81	6.69

c. Effect of the number of applications

Values	Kocide	3			Kocide	5	
		Nordox	Control	Nordox		Control	
Average of % clean fruit	91.84	92.87	93.41	93.88	91.90	92.20	
Average of % level 1	3.18	2.71	2.95	2.49	3.57	2.33	
Average of % level 2	2.17	2.40	2.48	2.33	2.48	3.26	
Average of % level 3	0.85	0.70	0.62	0.48	1.16	0.93	
Average of % level 4	0.00	0.00	0.00	0.00	0.00	0.00	
Average of fruit weight	108.79	110.16	110.97	109.54	113.01	114.45	
Average of total number of fruit per cane	32.87	33.73	41.00	35.31	38.53	37.87	
Average brix	6.77	6.64	6.53	6.66	6.87	6.86	

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d. Effect of the date of first application

Values	Kocide			Nordox			Control		
	1	2	3	1	2	3	1	2	3
Average of % clean fruit	93.10	90.85	94.66	89.94	92.70	94.53	93.43	91.46	93.54
Average of % level 1	2.67	3.26	2.57	4.42	2.79	2.21	2.09	3.26	2.56
Average of % level 2	1.98	3.02	1.71	2.91	2.79	1.63	2.79	3.26	2.56
Average of % level 3	0.35	0.93	0.73	1.16	1.28	0.35	1.16	0.70	0.47
Average of % level 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average of fruit weight	109.80	106.93	110.83	113.28	111.82	109.64	109.75	117.62	110.76
Average of total number of fruit per cane	33.30	31.05	38.05	38.80	36.40	33.20	39.40	37.60	41.30
Average of brix	6.65	6.83	6.68	6.84	6.70	6.72	6.75	6.71	6.62

Note that nothing was applied on the control so the variation between the three batches gives an idea of natural variation.

D- Conclusion

Those results have not been analyzed statistically but the trends show there was no detrimental fruit marking effect when fruit were sprayed 3 to 6 times with low copper rate throughout the season, with fruit with no marks representing 85 to 95% depending on the variety. Please note that control fruit were showing as many (if not more) marks as treated fruit.

There is some suggestion that copper applications are advancing colour change in Hor16A. Maturity of Hayward did not appear to be affected

Also remember that fruit, once taken to the Packhouse Quality Assessors and rubbed, were mostly looking fine. Only part of fruit marked 3 and 4 would have been out of Grade for staining.

Climatic conditions between France and New Zealand differs so this study should be viewed cautiously in a NZ context. It does not provide absolute proof that spraying low rates of copper post fruit set is safe, but it gives reassuring indications that low rates of copper, applied 3 to 6 times under good drying conditions can be used to provide Psa control without causing problems to Hort16A or Hayward fruit.

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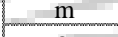
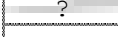

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Appendix

Appendix 1 - Maps of the trials

Hayward

18	38			
17	39	37	14*	13*
16	40	36	15*	12*
15	m	35*	m	11*
14	41*	34*	16	10
13	42*	33*	17	9
12	43*	m	18	m
11	44*	32*	19	8
10	45*	31*	20	7
9	m	30	m	6
8	46	29	21*	5*
7	47	28	22*	4*
6	48	m	23*	m
5	49	27	24*	3*
4	50	-	25*	2*
3	-	26	-	1*
2	-	-	-	-
1	m	m	m	m

	Nordox		
	Nordox + super spreader		
	Kocide		
	Kocide + super spreader		
	Control		
	Male		
	Missing plant		
	Unusual female		

PATH





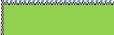



* Vines with canes treated 5 times

Kocide2000 was trialed in France. It is are registered on other crops than kiwifruit and as such can be used for trials. However, because there is no registration for kiwifruit for those products in France, all rates described above shouldn't be considered as recommendations for use in France.

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Hort16A

19	-	-	14	-
18	39	m	15*	m
17	-	.	16*	13*
16	40	38	17	12*
15	m	37*	m	11*
14	.	36	18	10
13	41*	35	19	9
12	-	m	20*	m
11	42*	34*	21*	8
10	43*	-	22	7
9	m	33*	m	6
8	44*	32	23*	5*
7	45*	31	24*	4*
6	46	m	25	m
5	47	30*	26	3*
4	48	29*	27*	2*
3	49	28	-	1*
2	50	-	-	-
1	m	m	m	m

	Nordox		
	Nordox + super spreader		
	Kocide		
	Kocide + super spreader		
	Control		
	Male		
	Missing plant		
	Unusual female		

PATH

* Vines with canes treated 6 times

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Appendix 2 - Table of products and volumes applied

On Hort16A

Volume of product applied on Hort16A	Nordox75WG at 25g/L	Nordox75WG at 25g/L and spreader	Kocide 2000 at 70g/100L	Kocide 2000 at 70g/100L and spreader
30/05/2012, batch 1 (10 canes)	Unknown	Unknown	Unknown	unknown
08/06/2012 batch 2 (10 canes)	Unknown	Unknown	Unknown	unknown
14/06/2012 batch 3 (10 canes)	Unknown	Unknown	Unknown	unknown
28/06/2012 batch 1 (10 canes)	500ml	500ml	400ml	500ml
09/07/2012 batch 2 (10 canes)	500ml	550ml	560ml	650ml
13/07/2012 batch 3 (10 canes)	500ml	450ml	400ml	750ml
2/08/2012 batches 1, 2 and 3 (30 canes)	2950ml	2600ml	2600ml	3000ml
23/08/2012 half of batches 1, 2 and 3 (15 canes)	1050ml	1500ml	1350ml	1450ml
14/09/2012 half of batches 1, 2 and 3 (15 canes)	1200ml	1425ml	1350ml	1450ml
01/10/2012 half of batches 1, 2 and 3 (15 canes)	1300ml	1300ml	1150ml	1400ml

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On Hayward

Volume of product applied on Hayward	Nordox75WG at 25g/L	Nordox75WG at 25g/L and spreader	Kocide 2000 at 70g/100L	Kocide 2000 at 70g/100L and spreader
20/06/2012, batch 1 (10 canes)	400ml	500ml	300ml	440ml
28/06/2012 batch 2 (10 canes)	450ml	300ml	450ml	400ml
09/07/2012 batch 3 (10 canes)	325ml	450ml	600ml	700ml
19/07/2012 batch 1 (10 canes)	750ml	750ml	750ml	800ml
26/07/2012 batch 2 (10 canes)	650ml	800ml	700ml	850ml
02/08/2012 batch 3 (10 canes)	800ml	1000ml	800ml	850ml
23/08/2012 batches 1, 2 and 3 (30 canes)	2650ml	3000ml	3150ml	2900ml
14/09/2012 half of batches 1, 2 and 3 (15 canes)	1350ml	1475ml	1250ml	1500ml
01/10/2012 half of batches 1, 2 and 3 (15 canes)	1350ml	1450ml	1250ml	1500ml

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Appendix 3 -Table of Weather

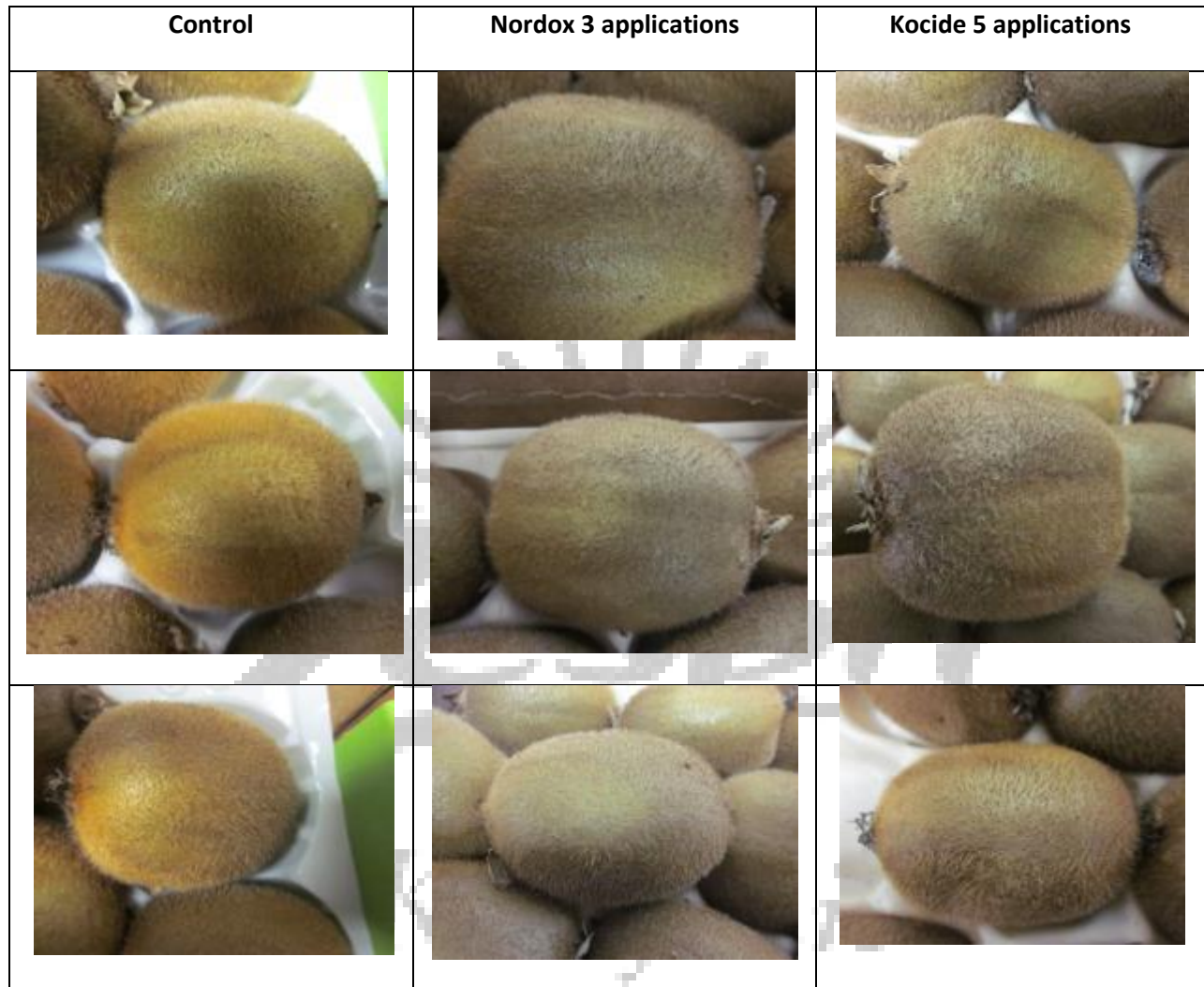
Date	Comment	Weather
30/05/2012	Spray	Cloudy, Sunny, 20 to 25°C
08/06/2012	Spray	Showers, 16°C
14/06/2012	Spray	Sunny 30°C
20/06/2012	Spray	Sunny 30°C
28/08/2012	Spray	Cloudy 24 to 26°C
09/07/2012	Spray	Cloudy 22°C
13/07/2012	Spray	Sunny 23 to 25°C
19/07/2012	Spray	Cloudy 26°C
26/07/2012	Spray	Sunny, cloudy 23 to 26°C
02/08/2012	Spray	Cloudy 24 to 25°C
23/08/2012	Spray	Sunny 22 to 27°C
14/09/2012	Spray	Sunny
01/10/2012	Spray	Sunny
25/10/2012	Harvest Hort16A	Showers, then strong rain
29/10/2012	Harvest Hort16A	Sunny
07/11/2012	Harvest Hayward	Sunny

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Appendix 4 - Pictures of phytotoxicity observed

Hayward



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Hort16A



Fruit with 1, 2 and 3 mark



Fruit with 1 mark



Fruit with various marks, none would cause rejecting at packing

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Appendx 5.

List of treatmnrns applied to Hort16A fruit.

NB Hayward was the saem exopt there was no application at week 20.

Treatment		Sprays timing post fruit set (weeks)	Adjuvant	Number of application post fruit set
1	Nordox 75WG 25g/100l	2 6 11 14 17 20	Yes	6
2	Nordox 75WG 25g/100l	2 6 11 14 17 20	No	6
3	Nordox 75WG 25g/100l	2 6 11	Yes	3
4	Nordox 75WG 25g/100l	2 6 11	No	3
5	Nordox 75WG 25g/100l	3 7 11 14 17 20	Yes	6
6	Nordox 75WG 25g/100l	3 7 11 14 17 20	No	6
7	Nordox 75WG 25g/100l	3 7 11	Yes	3
8	Nordox 75WG 25g/100l	3 7 11	No	3
9	Nordox 75WG 25g/100l	4 8 11 14 17 20	Yes	6
10	Nordox 75WG 25g/100l	4 8 11 14 17 20	No	6
11	Nordox 75WG	4 8 11	Yes	3

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	25g/100l			
12	Nordox 75WG 25g/100l	4 8 11	No	3
13	Control	No sprays	no	0
14	Kocide 70g/100l	2 6 11 14 17 20	Yes	6
15	Kocide 70g/100l	2 6 11 14 17 20	No	6
16	Kocide 70g/100l	2 6 11	Yes	3
17	Kocide 70g/100l	2 6 11	No	3
18	Kocide 70g/100l	3 7 11 14 17 20	Yes	6
19	Kocide 70g/100l	3 7 11 14 17 20	No	6
20	Kocide 70g/100l	3 7 11	Yes	3
21	Kocide 70g/100l	3 7 11	No	3
22	Kocide 70g/100l	4 8 11 14 17 20	Yes	6
23	Kocide 70g/100l	4 8 11 14 17 20	No	6
24	Kocide 70g/100l	4 8 11	Yes	3
25	Kocide 70g/100l	4 8 11	No	3

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