

Report to Zespri Group Ltd

## Chemical compatibility of Psa sprays and phytotoxicity testing on kiwifruit foliage

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## EXECUTIVE SUMMARY

There is a large range of products that have demonstrated some efficacy against Psa and are now being widely used to protect kiwifruit vines. This study was undertaken to evaluate the potential for such products to be tank mixed with products listed in the Zespri CPP. The research reported here was carried out in two phases:

- (1) a laboratory test to determine the physical compatibility of prioritised mixes
- (2) a study on potted plants to evaluate potential phytotoxic effects resulting from tank mixing products that were judged compatible in (1).

**Chemical compatibility:** Twenty two different spray mixes were tested as advised by Zespri. Each spray mix was shaken vigorously for 30 seconds, then photographed and the pH measured. The solution was observed for foaming, heat production, precipitates or phase separation of solution. After 30 minutes standing the solution was re-photographed, the pH re-measured and solution characteristics noted. Where any precipitates existed, the solution was shaken for a further 30 secs to determine if the precipitate could be re-suspended.

- ❖ **All spray mixes, except that of Nordox+KeyStrepto+Actigard, were deemed sufficiently physically stable to be further tested for phytotoxicity on kiwifruit foliage.**
- ❖ **It should be noted that physical stability does not necessarily mean that the products mixed are chemically compatible or chemically stable. Chemical modification of any a.i. may change its toxicity to target pests.**

**Phytotoxicity screen:** Application of 21 spray solutions were made to Hort 16A leaves on 06/03/2013. Leaves were on healthy potted plants, at least 2 years old and approx. 2 m tall. Leaves were sprayed to runoff on both the top and bottom surfaces of each leaf. Assessments for phytotoxicity were carried out at 24 hours, 5 days, 8 days and 14 days after spraying. All leaves were photographed at 0 and 8 days after spraying, and also a selection of treatments at the 14 day assessment.

- ❖ **Most solutions tested caused no phytotoxicity to Hort 16A foliage after a single spray application.**
- ❖ **Non copper-containing spray mixes were never observed to cause any phytotoxicity.**
- ❖ **Some sprays containing copper were non-phytotoxic, but most tended to cause a slight black speckling within leaves.**
- ❖ **The addition of Engulf, a superspreading penetrant surfactant, to copper+Talstar sprays caused severe phytotoxicity with a single application, probably due to rapid infiltration of the spray into leaves via stomata. Such surfactants (e.g. horticultural and herbicide penetrants) should not be used in copper sprays applied to actively growing kiwifruit and used with caution on dormant canes, where there could be a risk of damaging buds.**

# **Chemical compatibility of Psa sprays and phytotoxicity testing on kiwifruit foliage**

## **Introduction**

Since Psa was discovered in New Zealand, spray applications to kiwifruit vines have increased dramatically as growers repeatedly apply products in the hope of providing some protection against infection or spread of the bacteria within the orchards. The increase in chemical use has put additional financial strain on growers, especially for those who rely on contractors to do their orchard spraying. Tank mixing products for Psa protection with other products that are being used in accordance with normal crop protection has the potential to reduce the number of sprayer passes required, and therefore reduce the cost of protecting the orchard.

There is a large range of products that have demonstrated some efficacy against Psa and are now being widely used to protect kiwifruit vines. This study was undertaken to evaluate the potential for such products to be tank mixed with products listed in the Zespri CPP. The research reported here was carried out in two phases:

- (1) a laboratory test to determine the physical compatibility of prioritised mixes
- (2) a study on potted plants to evaluate potential phytotoxic effects resulting from tank mixing products that were judged compatible in (1).

## **Methods and Materials**

### **1. Chemical compatibility**

Chemical treatments as advised by Zespri are listed, in their order of addition to the spray mix, along with their recommended use rates in Table 1. Spray dilution volumes used were 1000 L/ha for bud phase application, 1500 L/ha for flowering, 2000 L/ha for summer and 1000 L/ha for dormant cane sprays.

Product mixing order was determined from the literature (Niederholzer & Smith) whereby the most difficult to disperse materials are added first. The products were combined using the following mixing order (first to last): water soluble pouches, wettable powders, dry flowables/ water-dispersible granules, suspension concentrates / flowables, capsule suspensions, emulsifiable concentrates, soluble liquids, soluble powders, surfactants, oils and remaining adjuvants.

All formulants were dispensed individually (Table 2) and then added to the total spray mix of 200 ml volume in the order listed. The pH of the deionised water used in the experiment was 6.65, and the study was carried out at a temperature of 21-22.4 °C.

The spray mix was shaken vigorously for 30 seconds, then photographed and the pH measured immediately (Jenco VisionPlus pH6175). The solution was observed for foaming, heat production, precipitates or phase separation of solution. After 30 minutes standing the solution was re-photographed, the pH re-measured and solution characteristics noted. Where any precipitates existed, the solution was shaken for a further 30 secs to determine if the precipitate could be re-suspended.

**Table 1** List of spray mixes, in order of addition, with recommended use rates (taken from Zespri CPP or product label recommendation)

Test #	Spray vol (L/ha)	Product 1		Product 2		Product 3		Product 4	
1	2000	Nordox	37.5 g*	Pyganic	100 ml	-	-	-	-
2	2000	Kocide Opti	90 g	Greenseal Pyrethrum	500 ml	-	-	-	-
3	2000	Champ	140 g	Key Pyrethrum	500 ml	-	-	-	-
4	2000	Pyganic	100 ml	BioAlexin	200 ml	-	-	-	-
5	2000	Key Pyrethrum	500 ml	BioAlexin	200 ml	-	-	-	-
6	2000	Kocide Opti	90 g	Rovral Flo	150 ml	-	-	-	-
7	1500	Flint	15 g	Kocide Opti	1.3 kg/ha	-	-	-	-
8	1500	Serenade Max	400 g	Flint	15 g	-	-	-	-
9	2000	Kocide Opti	90 g	Movento	48 ml	Prodigy	25 ml	-	-
10	1000	Nordox	37.5 g	Movento	960 ml/ha	Prodigy	500 ml/ha	-	-
11	1000	Nordox	37.5 g	Luna Privilege	300 ml/ha	Movento	960 ml/ha	Prodigy	500 ml/ha
12	1000	Proclaim	4 g	BioAlexin	400 ml	Du-Wett	500 ml/ha	-	-
13	1000	Kocide Opti	180 g	Proclaim	4 g	Du-Wett	500 ml/ha	-	-
14	1000	Serenade Max	800 g	Proclaim	4 g	Du-Wett	500 ml/ha	-	-
15	2000	Champ DF	140 g	Excel Oil	1%	-	-	-	-
16	2000	Kocide Opti	90 g	Excel Oil	1%	-	-	-	-
17	2000	BioAlexin	200 ml	Excel Oil	1%	-	-	-	-
18	1500	Dipel	50 g	Champ	140 g	-	-	-	-
19	1000	Kocide Opti	1.3 kg/ha	Mesuro	150 ml	-	-	-	-
20	1000	KeyStrepto	720 g	Nordox	37.5 g	Actigard	200 g/ha	-	-
21	1000	Nordox	1.1 kg/ha	Talstar	1 L/ha	Engulf	1 L/ha	-	-
22	1000	Kocide Opti	1.3 kg/ha	Talstar	1 L/ha	Engulf	1 L/ha	-	-

\*All rates presented per 100 L, except where stated as (minimum) per ha or as % concentration

Shaded treatments were formulated as 2x concentrate sprays, normally applied at 2000 L/ha

**Table 2** Weights and volumes of formulants for the 200 ml spray mixes

Test #	Product		Mixes			
	1	+	2	+	3	4
1	75 mg Nordox	+	200 µl Pyganic			
2	180 mg Kocide Opti	+	1 mL Greenseal Pyrethrum			
3	280 mg Champ	+	1 mL Key Pyrethrum			
4	200 µl Pyganic	+	400 µl BioAlexin			
5	1 mL Key Pyrethrum	+	400 µl BioAlexin			
6	180 mg Kocide Opti	+	300 mg Rovral Flo			
7	30 mg Flint	+	173 mg Kocide Opti			
8	800 mg Serenade Max	+	30 mg Flint			
9	180 mg Kocide Opti	+	96 µl Movento	+	50 µl Prodigy	
10	75 mg Nordox	+	192 µl Movento	+	100 µl Prodigy	
11	75 mg Nordox	+	60 mg Luna Privilege	+	192 µl Movento	+
12	8 mg Proclaim	+	800 µl BioAlexin	+	100 µl Du-Wett	100 µl Prodigy
13	360 mg Kocide Opti	+	8 mg Proclaim	+	100 µl Du-Wett	
14	1600 mg Serenade Max	+	8 mg Proclaim	+	100 µl Du-Wett	
15	280 mg Champ DF	+	2 ml Excel Oil			
16	180 mg Kocide Opti	+	2 ml Excel Oil			
17	400 µl BioAlexin	+	2 ml Excel Oil			
18	100 mg Dipel	+	280 mg Champ			
19	260 mg Kocide Opti	+	300 µl Mesurol			
20	144 mg KeyStrepto	+	75 mg Nordox	+	40 mg Actigard	
21	220 mg Nordox	+	200 µl Talstar	+	200 µl Engulf	
22	260 mg Kocide OPTi	+	200 µl Talstar	+	200 µl Engulf	

## **2. Phytotoxicity screen**

Application of spray solutions (Table 2), excluding Treatment #20, were made to Hort 16A leaves on 06/03/2013.

Healthy, potted Hort 16A plants, which had been grown at PPC<sub>NZ</sub> (Rotorua) for the past 2 years and were ~2 m in height, were used. Leaves were tagged with the various treatments, as four replicates of each on four different plants. Leaves selected were green and generally free from blemish (sun damage) and all were photographed prior to spraying. Treatment solutions were made up (Table 2) and applied within 10 mins using a hand sprayer. Leaves were sprayed to runoff on both the top and bottom surfaces of each replicate leaf. A paper cone was placed around the leaf when spraying so as to not contaminate other adjacent leaves on the plant.

Assessments for phytotoxicity and visible spray residues were carried out at 24 hours, 5 days, 8 days and 14 days after spraying. All leaves were re-photographed at 8 days after spraying and a selection of treatments at the 14 day assessment.

The plants were well watered each day with no water applied to the foliage during this time. No rain fell for 7 days after spraying; 0.2 mm fell on day 8, then approx. 30 mm fell over days 12-14.

## RESULTS AND DISCUSSION

### 1. Chemical compatibility

Photos of all treatment mixes (Table 3), taken immediately after initial mixing and then after standing for 30 mins, are included in Appendix 1.

*pH effects:* Four treatments, all containing BioAlexin, had very low pHs of <4 (#4,5,12,17). This product should not be combined with any other product which is unstable in highly acidic conditions, e.g Du-Wett adjuvant. Many treatments had quite alkaline pHs of >9 (#3,7,9,13,15,16,18,19) and these all contained either Champ DF or Kocide Opti. Some products, e.g. Dipel, should not be mixed with highly alkaline materials because they can affect pesticidal activity. The pH of three solutions containing Nordox increased measurably (by up to 0.6 units) in the 30 mins after mixing (# 1,10,20). Changes in pH over time were also observed with Kocide Opti formulations (# 6,9,16,19).

*Foaming:* Foaming was not an issue in any treatment, except one containing Du-Wett (#14). Excessive foaming is a property of superspreader adjuvants, and the foaming in this treatment indicated that the co-formulants, Serenade and Proclaim, had no effect on this physical property of the superspreader. Other Du-Wett solutions (# 12,13) did not foam similarly, suggesting that Kocide Opti and BioAlexin suppress foaming of Du-Wett.

*Heat:* There was no heat generated in any of the mixes tested.

*Precipitation:* Instant formation of a precipitate was observed in Serenade Max solutions (# 8,14), as is expected of a wettable powder once agitation ceases. All copper formulations (Nordox, Kocide Opti and Champ DF) formed an increasing precipitate over time with the exception of Kocide Opti combined with Movento+Prodigy (#9). The latter may indicate that some type of chemical reaction occurred to solubilise the copper in this solution, e.g. formation of a salt. The combination of Nordox+KeyStrepto+Actigard (# 20) resulted in undissolved material floating on the surface after mixing. This had disappeared by 30 mins, when a typical copper precipitate was observed, and did not re-occur after shaking. No precipitates were observed in any solutions containing BioAlexin (# 4,5,12,17)

*Liquid phase separation:* The only separation observed occurred with Excel oil solutions (# 15,16,17) at 30 mins after mixing, and this disappeared with agitation.

*Re-suspension at 30 mins after mixing:* Three solutions, all containing BioAlexin, stayed in stable suspension for at least 30 mins after mixing (# 4,5,12). The Serenade Max solutions (# 8,14) were never totally suspended at any time, settling out immediately agitation ceased. All other solutions were readily re-suspended with agitation.

- ❖ **All solutions, except that of Nordox+KeyStrepto+Actigard (# 20), were deemed sufficiently physically stable to be further tested for phytotoxicity on kiwifruit foliage.**
- ❖ **It should be noted that physical stability does not necessarily mean that the products mixed are chemically compatible or chemically stable. Chemical modification of any a.i. may change its toxicity to target pests.**



**Table 3** Compatibility testing of spray formulations

Tmt	Time (mins)	pH	Foaming	Heat	Precipitate	Phase separation	30 min re-suspension	Other comments
1	0	6.96	✓	x	x	x		
	30	7.19	x	x	✓	x	✓	
2	0	9.05	✓	x	x	x		
	30	8.96	✓	x	✓	x	✓	
3	0	10.02	✓	x	x	x		
	30	9.95	✓	x	✓	x	✓	
4	0	3.35	✓	x	x	x		in suspension at 30 mins
	30	3.28	✓	x	x	x	N/A	
5	0	3.42	✓	x	x	x		in suspension at 30 mins
	30	3.44	✓	x	x	x	N/A	
6	0	8.71	x	x	x	x		
	30	8.95	x	x	✓	x	✓	
7	0	9.17	✓(slight)	x	x	x		
	30	9.27	x	x	✓	x	✓	
8	0	5.86	✓	x	✓	x		never totally in suspension
	30	5.81	✓	x	✓	x	x	
9	0	9.07	✓	x	x	x		
	30	9.26	✓	x	x	x	✓	
10	0	6.78	✓	x	x	x		
	30	7.19	✓	x	✓	x	✓	
11	0	6.76	✓	x	x	x		
	30	6.76	✓	x	✓	x	✓	
12	0	3.31	✓	x	x	x		in suspension at 30 mins
	30	3.25	✓	x	x	x	N/A	
13	0	9.66	✓	x	x	x		
	30	9.65	✓	x	✓	x	✓	
14	0	5.86	✓+++	x	✓	x		never totally in suspension
	30	5.86	✓+++	x	✓	x	x	
15	0	9.77	✓	x	x	x		
	30	9.83	✓	x	✓	✓ (a little)	✓	
16	0	9.71	✓	x	x	x		
	30	9.42	✓	x	✓	✓	✓	
17	0	3.45	✓	x	x	x		
	30	3.56	✓	x	x	✓	✓	
18	0	9.59	✓(slight)	x	x	x		
	30	9.70	x	x	✓	x	✓	
19	0	9.58	x	x	x	x		
	30	9.27	x	x	✓	x	✓	
20	0	7.56	✓	x	✓ (on top)	x		
	30	8.16	x	x	✓ (bottom)	x	✓	
21	0	6.52	✓	x	x	x		
	30	6.56	✓	x	✓	x	✓	
22	0	9.17	✓	x	x	x		
	30	9.10	✓	x	✓	x	✓	

## 2. Phytotoxicity screen

A photographic record of all leaves treated, at 0 time and 8 days after treatment, is presented in Appendix 2. A selection of treatments were also photographed at day 14.

There was no evidence of phytotoxicity from any treatment at 24 h after spray application, with the exception of those containing Engulf (#21,22). These treatments showed some slight browning and cell necrosis. It is highly probable that rapid infiltration of these sprays into leaves occurred, via stomata, due to the inclusion of Engulf penetrant adjuvant (0.1%).

By 8 days after treatment some evidence of black speckling in some copper treatments existed. This was generally very slight and not uniform across all four replicates, except in treatments #21 & 22 where progression of phytotoxicity was very evident as black spotting around the leaf margins (Fig. 1) and, in some replicates, quite definitive necrosis of cells (Appendix 2). Changes observed on leaves in most treatments were mostly due to sun damage or senescence, and unrelated to the sprays applied (Appendix 2).

**Fig. 1** Lower leaf showing phytotoxic damage from Nordox+Talstar+Engulf spray (Tmt #21)



By 14 days after treatment, definite phytotoxic symptoms were observed in nine of the 21 treatments tested (Table 4). These sprays all contained copper (Nordox, Kocide Opti or Champ) and symptoms were observed as a black speckle within the leaf. The speckling was generally minor (Fig. 2 cf tmt #1 vs #18), but multiple sprays may compound such effects. Not all sprays containing copper showed leaf speckling (Table 2, Fig. 2).

Only in two treatments (#21, 22) was some blackening of veins evident and plant tissue was observed to die (Fig. 2). These treatments should not be applied to green foliage; it is recommended that no copper sprays with the addition of Engulf, or similar penetrant adjuvants, be applied to growing vines because of the risk of phytotoxicity. Such sprays may be relatively safe applied to dormant canes but there may be a risk of damaging dormant buds, especially close to bud break.

**Table 4** Phytotoxicity recorded at 14 days after treatment application on Hort 16A leaves

Tmt #	Treatment	Number of replicates displaying symptoms (n=4)		
		No phyto	Possible phyto	Definite phyto
1	Nordox+Pyganic	2	2	0
2	Kocide Opti+Greenseal Pyrethrum	2	2	0
3	Champ+Key Pyrethrum	4	0	0
4	Pyganic+BioAlexin	4	0	0
5	Key Pyrethrum+BioAlexin	4	0	0
6	Kocide Opti+Rovral Flo	4	0	0
7	Flint+Kocide Opti	1	0	3 (slight)
8	Serenade Max+Flint	4	0	0
9	Kocide Opti+Movento+Prodigy	0	2	2 (slight)
10	Nordox+Movento+Prodigy	2	2	0
11	Nordox+Luna Privilege+Movento+Prodigy	2	0	2
12	Proclaim+BioAlexin+Du-Wett	3	1	0
13	Kocide Opti+Proclaim+Du-Wett	2	1	1
14	Serenade Max+Proclaim+Du-Wett	4	0	0
15	Champ+Excel oil	2	0	2
16	Kocide Opti+Excel oil	4	0	0
17	BioAlexin+Excel oil	4	0	0
18	Dipel+Champ	0	3	1
19	Kocide Opti+Mesurol	0	2	2
21	Nordox+Talstar+Engulf	0	0	4
22	Kocide Opti+Talstar+Engulf	0	2	2

Green shaded treatments showed no evidence of phytotoxicity

White shaded treatments may cause some phytotoxicity

Pink shaded treatments caused minor damage (speckling)

Red shaded treatments caused major damage

- ❖ Most solutions tested caused no phytotoxicity to Hort 16A foliage after a single spray application.
- ❖ Non copper-containing spray mixes were never observed to cause any phytotoxicity.
- ❖ Some sprays containing copper were non-phytotoxic, but most tended to cause a slight black speckling within leaves.
- ❖ The addition of Engulf, a superspreading penetrant surfactant, to copper+Talstar sprays caused severe phytotoxicity with a single application, probably due to rapid infiltration of the spray into leaves via stomata. Such surfactants (e.g. horticultural and herbicide penetrants) should not be used in copper sprays applied to actively growing kiwifruit and used with caution on dormant canes, where there could be a risk of damaging buds.

**Treatment 1 (Nordox+Pyganic)**

Leaf upper side

Leaf under side



**Treatment 18 (Dipel+Champ)**

Leaf upper side

Leaf under side



**Treatment 21 (Nordox+Talstar+Engulf)**

Leaf upper side

Leaf under side



**Fig. 2** Effects of selected treatments on upper and lower surfaces of Hort 16A leaves at 14 days after application

## ACKNOWLEDGEMENTS

Thanks to Justin Nairn and Kevin Steele for valuable technical assistance.

## REFERENCES

- Gaskin RE, Steele KD, Horgan DB, van Leeuwen R, 2011. Studies to determine the rainfastness of residues of commercial and organic copper sprays on dormant kiwifruit canes. *Report to Zespri Group Ltd, July 2011*. 15 pp.
- Niederholzer F, Smith R. How to check product compatibility with a 'jar test'.  
[http://uscan.agrinos.com/how\\_to\\_perform\\_a\\_jar\\_test](http://uscan.agrinos.com/how_to_perform_a_jar_test) Accessed January 2013



**APPENDIX 1: Photographic record of chemical compatibility of treatments at 0 and 30 mins after mixing**

Treatment 1



0 mins

30 mins

Treatment 2



0 mins

30 mins

Treatment 3



0 mins

30 mins

Treatment 4



0 mins

30 mins

Treatment 5



0 mins

30 mins

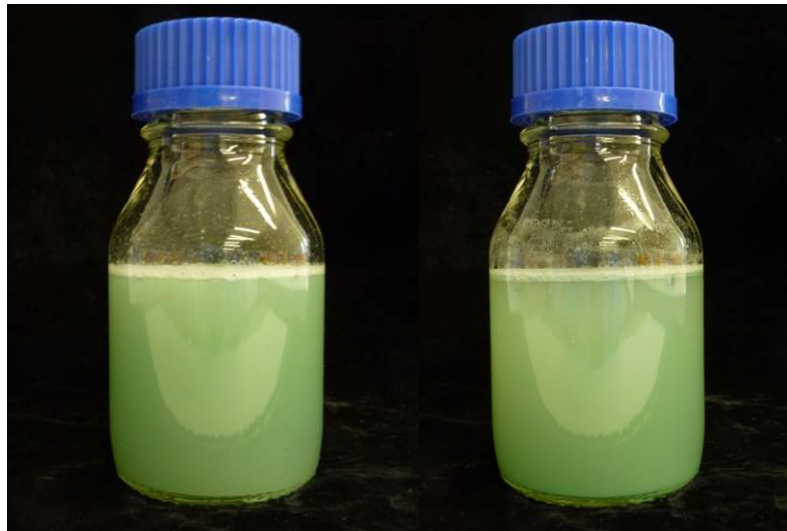
Treatment 6



0 mins

30 mins

Treatment 7



0 mins

30 mins

Treatment 8



0 mins

30 mins

Treatment 9



0 mins

30 mins

Treatment 10



0 mins

30 mins

Treatment 11



0 mins

30 mins

Treatment 12



0 mins

30 mins



Treatment 13



0 mins

30 mins

Treatment 14



0 mins

30 mins

Treatment 15



0 mins

30 mins

Treatment 16



0 mins

30 mins

Treatment 17



0 mins

30 mins

Treatment 18



0 mins

30 mins

Treatment 19



0 mins

30 mins

Treatment 20



0 mins

30 mins

Treatment 21



0 mins

30 mins

Treatment 22



0 mins

30 mins



**APPENDIX 2: Photographic record of Hort 16A leaves (adaxial surface) at 0 time and 8 days after treatment with different spray mixes**

**Treatment 1: Nordox + Pyganic**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3

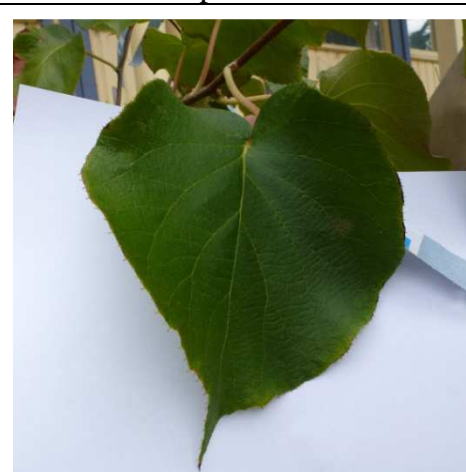


Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



## Treatment 2: Kocide Opti + Greenseals Pyrethrum

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





### Treatment 3: Champ DP + Key Pyrethrum

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



#### Treatment 4: Pyganic + BioAlexin

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





### Treatment 5: Key Pyrethrum + BioAlexin

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





## Treatment 6: Kocide Opti + Rovral Flo

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



## Treatment 7: Flint + Kocide Opti

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4

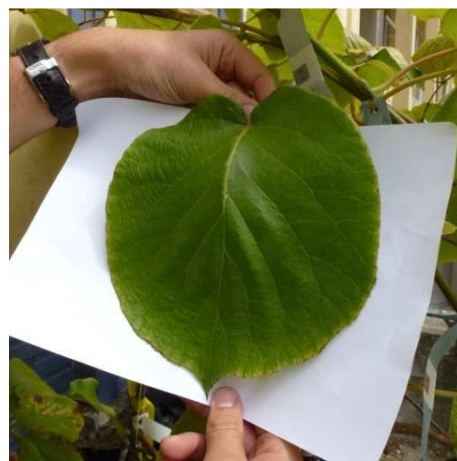


8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





## Treatment 8: Serenade Max + Flint

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



**Treatment 9: Kocide Opti + Movento + Prodigy**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





**Treatment 10: Nordox + Movento + Prodigy**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



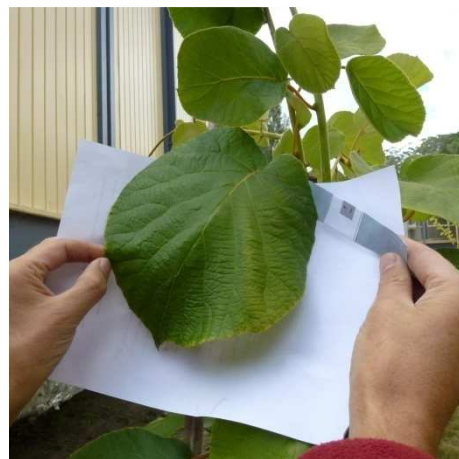
**Treatment 11: Nordox + Luna Privilege + Movento + Prodigy**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





**Treatment 12: Proclaim + BioAlexin + Du-Wett**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



### Treatment 13: Kocide Opti + Proclaim + Du-Wett

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





**Treatment 14: Serenade Max + Proclaim + Du-Wett**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



## Treatment 15: Champ DP + Excel Oil

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





## Treatment 16: Kocide Opti + Excel Oil

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



## Treatment 17: BioAlexin + Excel Oil

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





## Treatment 18: Dipel + Champ DP

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



## Treatment 19: Kocide Opti + Mesurol

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4





**Treatment 21: Nordox + Talstar + Engulf**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4



**Treatment 22: Kocide Opti + Talstar + Engulf**

Time 0 Before Spraying

Rep 1



Rep 2



Rep 3



Rep 4



8 Days after spraying

Rep 1



Rep 2



Rep 3



Rep 4







**Plant Protection ChemistryNZ Ltd** is an independent provider of research, advisory and extension services relating to the use and efficacy of agrichemicals.

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