Efficacy of FoliActive and FoliPlus in Riesling Grape - Hawke's Bay 2005-06

Wood PN.

June 2006

Report to Donaghys Industries Limited

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Date: 29 June 2006	Date: 29 June 2006

CONTENTS

EXECUTIVE SUMMARY

Efficacy of FoliActive and FoliPlus on Riesling Grape - Hawke's Bay 2005-2006

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PROJECT OUTLINE

This report describes an evaluation of FoliActive and FoliPlus disease control efficacy and crop safety in Riesling grape in Hawke's Bay, New Zealand. The effectiveness of FoliActive and FoliPlus at two rates, two schedules (late season and full season) and FoliActive (high rate) co-applied with sulphur, was determined against downy mildew, powdery mildew, botrytis bunch rot and sour rot diseases in grape and compared with the efficacy of a standard Hawke's Bay fungicide programme, a sulphur-based powdery mildew control programme and untreated. The effects of the treatments on plant health, fruit quality and quantity were also assessed and compared with the standard fungicide programme.

KEY FINDINGS

- In Hawke's Bay, environmental conditions were highly favourable for downy mildew, botrytis bunch rot and sour rot development during the 2005-06 season.
- When FoliActive (6 L/ha) replaced botryticides from veraison on previously fungicide treated vines, rot control was similar ($P<0.05$) to that with the full season fungicide programme.
- FoliActive and FoliPlus, as stand alone treatments, performed poorly against rot and downy mildew on the susceptible variety Riesling under disease favourable conditions.
- FoliActive and FoliPlus did provide some powdery mildew control on leaves and fruit with indications that the lower rate (3 L/ha) was more effective.
- Fruit maturation and yields were not directly affected by FoliActive and FoliPlus treatment.
- FoliActive and FoliPlus did not cause direct phytotoxic effects to the vines.
- Overall FoliActive showed indications of more disease control merit than FoliPlus.

RECOMMENDATIONS

- Further investigations are required to confirm whether FoliActive will (and at what rate) act reliably as a fungicide replacement from veraison on previously fungicide treated vines.

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INTRODUCTION

A major challenge to cool climate viticulture worldwide continues to be good control of botrytis bunch rot (*Botrytis cinerea*), powdery mildew (*Uncinula necator*), downy mildew (*Plasmopara viticola*) and sour rot causing organisms. The development of fungicide resistance and the need to eliminate fungicide residues has limited the usefulness of several chemical groups, for example the dicarboximides, hence the need for new 'soft' fungicide treatments.

During the 2004-05 season we undertook vineyard-based studies of a microbial-based liquid concentrate (FoliActive) for Jenkins Biolabs Limited (now Donaghys Limited) for control of the above named diseases (Wood 2005). Donaghys chose to build on that initial research by bringing an additional Donaghys product (FoliPlus) into the current vineyard-based evaluation.

OBJECTIVES

This research was undertaken to evaluate the efficacy and crop safety of FoliActive and FoliPlus in Riesling grape in Hawke's Bay, New Zealand.

The specific aims were to determine the effectiveness of:

1. two rates of FoliActive and FoliPlus, (3 and 6 litres per hectare)
2. schedules (high rate of FoliActive and FoliPlus applied from veraison on vines previously treated with standard (STD) fungicides)
3. and FoliActive (high rate) co-applied with sulphur,

as control agents of downy mildew, powdery mildew, botrytis bunch rot and sour rot diseases in grape and compared with the efficacy of a standard Hawke's Bay fungicide programme, a sulphur-based powdery mildew control programme and untreated.

The effects of the treatments on plant health, fruit quality (soluble solids) and quantity were also assessed and compared with the standard fungicide programme.

MATERIAL AND METHODS

EXPERIMENTAL VINEYARD

The evaluation was conducted on Erindale Estate situated on Mt Erin Road in Hawke's Bay. The vineyard is planted with 15-year-old Riesling on the rootstock SO4. Vineyard rows were spaced 2.5 m apart with each vine 2.25 m apart within the rows, resulting in a vine density of 1778 per hectare. The vines were winter spur-pruned to approximately 50 buds per vine.

VINEYARD MANAGEMENT

Canopy management was by vertical shoot positioning followed by summer pruning with a machine trimmer three times between December 2005 and February 2006. To optimise bunch exposure to fungicide deposition and enhance berry quality, leaf removal was undertaken by manually plucking leaves from the fruiting zone just before the second bloom spray and again before the early-veraison spray.

TRIAL DESIGN

A total of 10 treatments were evaluated including an untreated control. Each treatment plot consisted of 4 vines in a single row with the two outside vines acting as buffers to prevent cross contamination of disease and over spray. The actual treated plot was 10 m long (equivalent to 22.5 m^2 of vineyard area). There were five replicate plots per treatment arranged in a randomised complete block design.

TREATMENTS

Treatments (Table 1 and Appendix 1) were applied using a motorised moderate-pressure high volume handgun at an application rate of 500 litres/ha during bloom (capfall); thereafter all applications were at 750 litres/ha.

Table 1: Treatment List of fungicides on grapes, Hawke's Bay, 2005/06.

Treatments[1]	**Details**
Untreated	Used as the efficacy reference treatment
Sulphur then untreated from veraison	Used as a positive control for powdery mildew
Standard fungicides	Standard fungicide programme for Riesling in Hawke's Bay
STD then FoliActive 6 L/ha from veraison	Low residue programme – Standard fungicides then FoliActive (4 applications) for final 2 months pre-harvest
STD then FoliPlus 6 L/ha from veraison	Low residue programme – Standard fungicides then FoliPlus (4 applications) for final 2 months pre-harvest
FoliActive 3 L/ha	FoliActive 3 L/ha – nine applications from start of bloom
FoliActive 6 L/ha	FoliActive 6 L/ha – nine applications from start of bloom
FoliActive 6 L/ha (+Sulphur until veraison)	FoliPlus @ 6 L/ha – nine applications from start of bloom with Sulphur co-applied until veraison – augmentation test
FoliPlus 3 L/ha	FoliPlus @ 3 L/ha – nine applications from start of bloom
FoliPlus 6 L/ha	FoliPlus @ 6 L/ha – nine applications from start of bloom

[1]*See Appendix 1 for fungicides rates, application timing and climatic details*

DISEASE, VINE HEALTH AND FRUIT QUALITY MEASUREMENTS

Botrytis Bunch Rot

Botrytis bunch rot was assessed on 17 February, 3 and 16 March and at vintage on 4 April 2006. Fifty bunches per plot, selected at random, were assessed for botrytis bunch rot incidence (i.e. % of bunches infected) and rated for severity (i.e. % of bunch area infected). The percentage of the total crop infected by *Botrytis cinerea* was calculated from the botrytis bunch rot incidence and mean severity.

Sour Rot

Incidence, severity and proportion of total crop infected with sour rot were assessed on 4 April using the same procedure as that for botrytis bunch rot.

Powdery Mildew

Infections on fruit and leaves were assessed at veraison on 17 February 2006. Fifty bunches and fifty leaves per plot were inspected for mildew incidence (i.e. % of bunches and leaves infected) and rated for severity (i.e. % of bunch and leaf area infected). The percentage of the total crop and canopy infected was calculated from the mildew incidence and mean severity.

Downy Mildew

Downy mildew disease was assessed on Riesling fruit and leaves on 19 April using the same procedure as that described for powdery mildew.

Phytotoxicity

The effect of treatments on the foliage were determined by assessing canopy (leaf) health on 19 April by ranking the plots on a score where 0 = green/ healthy, 1 = green-slight yellowing, 2 = leaves yellowish green, 3 = mostly yellow and/or minor chlorosis and/or necrosis, 4 = significant chlorosis and/or necrosis present.

Treatment-induced damage to leaves and bunches was assessed at vintage as the percentage of the total canopy and percentage of the total crop damaged (burnt or russeted) on a plot basis.

Fruit maturity

Grape berry sugar levels (soluble solids) were measured with an Atago® digital refractometer on juice extracted from a randomly selected 50-berry sample from each plot at vintage.

Fruit yields

Crop yields and individual yield components (average bunch and berry numbers and weights) were calculated by harvesting all bunches from the middle 2 metres of each plot at vintage.

TREATMENT EFFICACY

The relative efficacy of a treatment was calculated from the difference between the untreated and the test treatment, and expressed as a percentage of the level of infection on the untreated plots.

The formula for relative fungicidal efficacy was E= ((U-T)/U) x 100,

where E= the relative efficacy of disease control for the treatment as a percentage
T= treatment disease level
U= 'untreated' disease level.

In this report, efficacy of control provided by each treatment was calculated from the percentage of total crop/canopy infected.

STATISTICAL ANALYSIS

Data were analysed by analysis of variance (ANOVA) using the MINITAB® statistical package. Treatment means were separated using LSD at the $P<0.05$ level (5% probability).

METEOROLOGICAL CONDITIONS AND DISEASE RISK IN 2005-2006 SEASON

Appendix 3 shows key meteorological details logged by the closest automated weather station to Erindale Estate (Te Aute ≈0.3 km distant). Treatment application dates in relation to powdery mildew disease risk and *B. cinerea* infection periods were identified using the MetWatch™ computer programme based on the Broome et al. (1995) infection period criteria model (Appendix 2).

RESULTS AND DISSUSSION

BOTRYTIS BUNCH ROT

In Hawke's Bay environmental conditions were favourable for bunch rot development during 2005-06 season with 24 monitored *Botrytis cinerea* infection periods (IPs) between capfall and vintage (Appendix 2).

Soon after the first flowering application on 25 November a severe IP occurred (Appendix 2) with 78 hours of surface wetness (duration) starting 26 November (70 mm rain). This was followed by a moderate risk IP on 6 December of 16 hours duration and 9 mm rain. The second application of treatments at late flowering (7 December) was followed by a moderate IP on 9 December (14 hours duration, 6 mm rain), a severe IP on the 10 December and another severe on 11 December (15 and 18 hours duration, 5 mm and 1 mm rain respectively).

Although February to mid March was relatively dry, the period 2 weeks before vintage, when the berries were highly susceptible to *B. cinerea* infection, was wet with four significant IPs occurring, totalling 153 hours of wetness.

When botrytis bunch rot was first assessed on 17 February there were no statistical differences between the standard fungicide and FoliActive and FoliPlus treated vines (Table 2). Two weeks later on the 3 March botrytis bunch rot continued to be a minor occurrence, due to the fine dry weather conditions, with less than 2% crop rotted on the untreated and sulphur treated (Table 2 and Figure 1). Again the trial was assessed after a further interval of two weeks (16 March) and then the percentage of crop rotted had doubled on the untreated, sulphur and FoliPlus (high rate) treated – all being significantly more rotted than the standard fungicides treated (Table 2).

Table 2: Assessment of botrytis bunch rot infections pre-vintage, Hawke's Bay, 2006.

Treatments	**Total crop rotted** (% Volume)		
	17 February (veraison)	3 March (5.5 weeks pre-vintage	16 March (3 weeks pre-vintage
Untreated	1.6 ***m***	1.6	4.1 ***m***
Sulphur then untreated from veraison	0.9	1.5	3.3 ***m***
Standard fungicides	0.5	0.6	0.9
STD then FoliActive 6 L/ha from veraison	0	0.1	0.2
STD then FoliPlus 6 L/ha from veraison	0.1	0.3	1.2
FoliActive 3 L/ha	0.5	1.0	2.4
FoliActive 6 L/ha	0.7	1.7	2.2
FoliActive 6 L/ha (+Sulphur until veraison)	0.2	0.9	1.7
FoliPlus 3 L/ha	0.2	1.3	2.3
FoliPlus 6 L/ha	0.7	1.7	3.4 ***m***
LSD ($P < 0.05$)	0.7	1.2	2.0

m *= significantly more botrytis bunch rot than the 'standard fungicides' treatment (P< 0.05).*

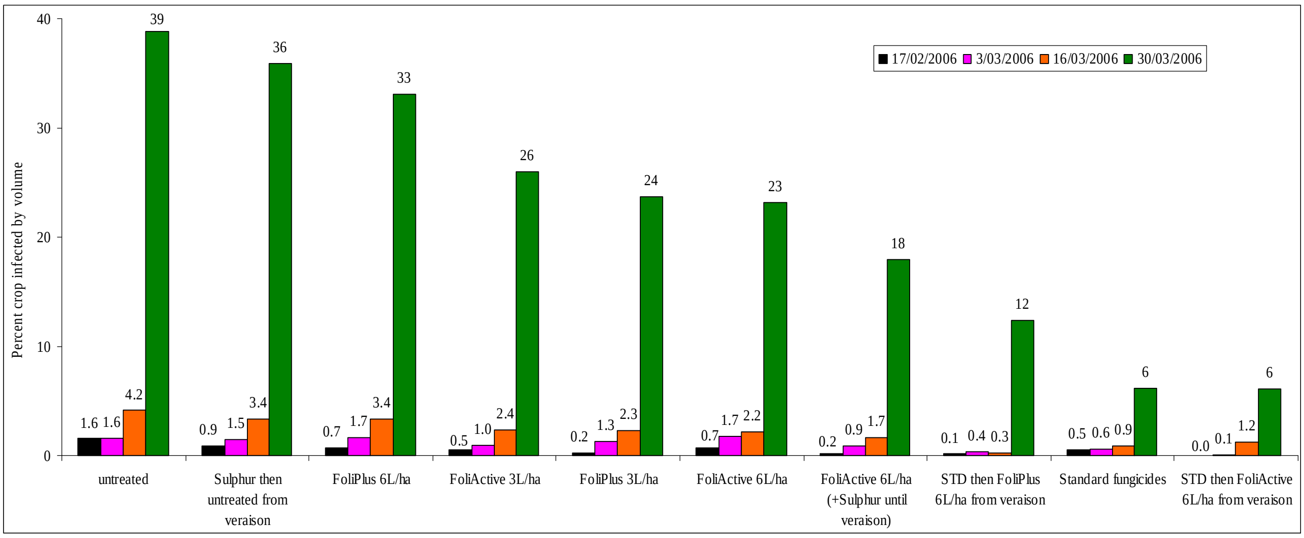

Figure 1: Botrytis bunch rot disease progression from veraison to vintage, Hawke's Bay, 2006.

At vintage (4 April), botrytis bunch rot was reassessed (Table 3 and Figure 1) and the percentage of crop rotted had increased up to ten fold since 16 March (Table 2).

Table 3: Assessment of botrytis bunch rot infections at vintage - , Hawke's Bay, 4 April 2006.

Treatments	**Incidence** (% Bunches infected)	**Severity** (% Bunch area)	**Total crop rotted** (% Volume)	**Treatment Efficacy** (%)
Untreated	95 ***m***	40 ***m***	39 ***m***	0 ***m***
Sulphur then untreated from veraison	95 ***m***	38 ***m***	36 ***m***	7 ***m***
Standard fungicides	38	16	6	84
STD then FoliActive 6 L/ha from veraison	42	14	6	84
STD then FoliPlus 6 L/ha from veraison	52	24	12	68
FoliActive 3 L/ha	86 ***m***	30	26 ***m***	33 ***m***
FoliActive 6 L/ha	79 ***m***	27 ***m***	23 ***m***	40 ***m***
FoliActive 6 L/ha (+Sulphur until veraison)	76 ***m***	22	18 ***m***	54 ***m***
FoliPlus 3 L/ha	82 ***m***	28 ***m***	24 ***m***	39 ***m***
FoliPlus 6 L/ha	92 ***m***	36 ***m***	33 ***m***	15 ***m***
LSD ($P < 0.05$)	15	10	10	24

m *= significantly more botrytis bunch rot than the 'standard fungicides' treatment (P< 0.05).*

All FoliActive and FoliPlus stand-alone treatments performed poorly under the high diseases pressure evidenced this trial. Where standard fungicides (STD fungicides) were applied up to veraison followed by FoliActive or FoliPlus, botrytis bunch rot was better controlled (68-84% efficacy) (Table 3).

There were indications that FoliPlus gave weaker control than FoliActive, for example where FoliActive had been applied from veraison after STD fungicides, efficacy was 84% (same as STD fungicides). However where FoliPlus had been applied for the same period, efficacy was only 68%. Likewise the stand-alone FoliPlus applied at six litres per hectare had the lowest efficacy of all stand-alone treatments.

Sour Rots

Good sour rot control in the vineyard is essential, as this rot can be very detrimental to wine quality. In the Riesling bunches *Rhizopus* spp. and *Botryspheria* spp. were observed as the predominant sour rot causing pathogens.

Sour rot was widespread across the trial with 11-21% incidence and 8-23 % severity (Table 4). FoliActive and FoliPlus did not appear to control sour rots and surprisingly the percent crop with sour rot was significantly (P<0.05) higher where standard fungicides had been applied then followed by FoliPlus from veraison.

Table 4: Assessment of sour rot infections at vintage - Hawke's Bay, 4 April 2006.

Treatments	**Incidence** (% Bunches infected)	**Severity** (% Bunch area)	**Total crop rotted** (% Volume)
Untreated	14	9	1.4
Sulphur then untreated from veraison	17	14	2.5
Standard fungicides	14	21 ***m***	3.1
STD then FoliActive 6 L/ha from veraison	15	13	1.8
STD then FoliPlus 6 L/ha from veraison	20	23 ***m***	4.5 ***m***
FoliActive 3 L/ha	14	10	1.4
FoliActive 6 L/ha	11	12	1.3
FoliActive 6 L/ha (+Sulphur until veraison)	21	11	2.5
FoliPlus 3 L/ha	16	10	1.6
FoliPlus 6 L/ha	18	8	1.4
LSD ($P< 0.05$)	7	8	1.9

m *= significantly more sour rot than the 'untreated' treatment (P< 0.05).*

Total Rots

Total crop volume rotted at vintage (total rot = sour rot + botrytis bunch rot), is a key parameter used by wineries to assess the value of the crop. A threshold of 4% of the total crop rotted is a common limit in New Zealand wineries. Because of the extreme susceptibility of Riesling combined with the wet weather (4 IPs) before vintage, all treatments in this trial produced crop with rots over this limit (Appendix 3).

The 'Standard fungicides' and the 'Standard then FoliActive 6 L/ha from veraison' treatments produced the highest efficacy (77-80%) for the control of all rots. The 'Standard then FoliPlus 6 L/ha from veraison' treatment was the next best performer with a significantly (P>0.05) poorer result at 58% efficacy. The next grouping was the 'stand alone' FoliActive and FoliPlus (except high rate) treatments and 'FoliActive & sulphur' with efficacies of 49-32%. The 'stand alone' high rate FoliPlus treatment (14%) was not significantly better than the untreated and sulphur control treatments.

Table 5: Total bunch rot levels (botrytis & sour rots combined) at vintage - Hawke's Bay, 4 April 2006.

Treatments	**Total crop rotted** (% Volume)	**Treatment Efficacy** (%)
Untreated	40 ***m***	0 ***m***
Sulphur then untreated from veraison	39 ***m***	4 ***m***
Standard fungicides	9	77
STD then FoliActive 6 L/ha from veraison	8	80
STD then FoliPlus 6 L/ha from veraison	17	58
FoliActive 3 L/ha	28 ***m***	32 ***m***
FoliActive 6 L/ha	25 ***m***	39 ***m***
FoliActive 6 L/ha (+Sulphur until veraison)	20 ***m***	49 ***m***
FoliPlus 3 L/ha	25 ***m***	37 ***m***
FoliPlus 6 L/ha	35 ***m***	14 ***m***
LSD ($P< 0.05$)	10	21

***m** = significantly more botrytis bunch rot than the 'standard fungicides' treatment (P< 0.05).*

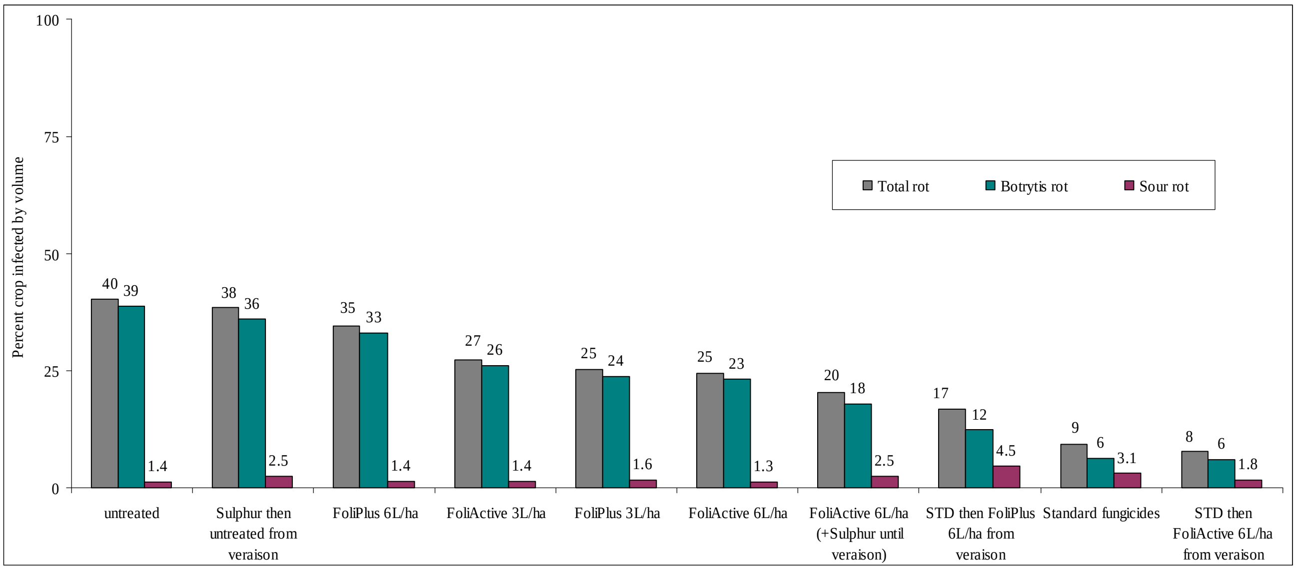

Figure 2: Total rot, botrytis bunch rot and sour rot levels at vintage, Hawke's Bay, 2006.

POWDERY MILDEW

Powdery mildew disease was not well established at this trial site probably because of good grower practices in previous years. At veraison only 4% of leaves on unsprayed vines were infected, being less than 1% of the total canopy area (Table 6). The only other treatments to show significant (P>0.05) incidence of powdery mildew infections were the FoliActive and the FoliPlus treatments (high rate). Severity of infection was significantly higher than with the standard fungicides in all 'stand alone' FoliActive and FoliPlus treatments (Table 6).

Table 6: Powdery mildew infections on leaves at veraison – Hawke's Bay, 17 February 2006.

Treatments	**Incidence** (% leaves infected)	**Severity** (% leaf area)	**Canopy infected** (% area)	**Treatment Efficacy** (%)
Untreated	4.4 ***m***	13.0 ***m***	0.620 ***m***	0 ***m***
Sulphur then untreated from veraison	0.2	0.6	0.004	99.5
Standard fungicides	0.1	0.2	0.002	99.8
STD then FoliActive 6 L/ha from veraison	0.2	0.3	0.002	99.8
STD then FoliPlus 6 L/ha from veraison	0.2	1.2	0.004	99.4
FoliActive 3 L/ha	0.8	3.4 ***m***	0.034	94.5
FoliActive 6 L/ha	1.4 ***m***	5.0 ***m***	0.070	88.7 ***m***
FoliActive 6 L/ha (+Sulphur until veraison)	0.1	0.2	0.002	99.8
FoliPlus 3 L/ha	1.1	5.4 ***m***	0.062	90.0 ***m***
FoliPlus 6 L/ha	1.9 ***m***	4.6 ***m***	0.102	83.7 ***m***
LSD (P< 0.05)	1.0	3.1	0.159	8.3

m *= significantly more powdery mildew than the 'standard fungicides' treatment (P< 0.05).*

At veraison, the point at which the crop is no longer susceptible to infection, powdery mildew disease on untreated fruit was found on nearly 15% of the bunches. In comparison the sulphur and standard fungicide treated vines were essentially disease-free (Table 6). Corresponding to that found on leaves, the efficacy of control by the 'stand alone' FoliActive (except low rate) and FoliPlus treatments was significantly (P>0.05) weaker than that provided by sulphur or standard fungicide-based treatments.

Table 7: Powdery mildew infections on bunches at veraison – Hawke's Bay, 17 February 2006.

Treatments	**Incidence** (% Bunches infected)	**Severity** (% Bunch area)	**Total crop infected** (% Volume)	**Treatment Efficacy** (%)
Untreated	14.4 ***m***	6.7 ***m***	0.86 ***m***	0 ***m***
Sulphur then untreated from veraison	0	0	0	100.0
Standard fungicides	0	0	0	100.0
STD then FoliActive 6 L/ha from veraison	0	0	0	100.0
STD then FoliPlus 6 L/ha from veraison	0	0	0	100.0
FoliActive 3 L/ha	0.8	15.0 ***m***	0.12	86.0
FoliActive 6 L/ha	4.4 ***m***	8.0 ***m***	0.28	68.0 ***m***
FoliActive 6 L/ha (+Sulphur until veraison)	0.4	1.0	0.01	99.6
FoliPlus 3 L/ha	6.0 ***m***	3.3	0.22	73.8 ***m***
FoliPlus 6 L/ha	2.8	15.2 ***m***	0.44 ***m***	48.6 ***m***
LSD (P< 0.05)	3.2	7.3	0.29	32.9

m *= significantly more powdery mildew than the 'standard fungicides' treatment (P< 0.05).*

In summary, the rankings of treatment performance were similar for leaves and fruit (Tables 6 and 7, Figure 3). Surprisingly the data suggest that higher rates of the two products were less effective than the lower, although we caution that these differences are not statistically significant (P>0.05).

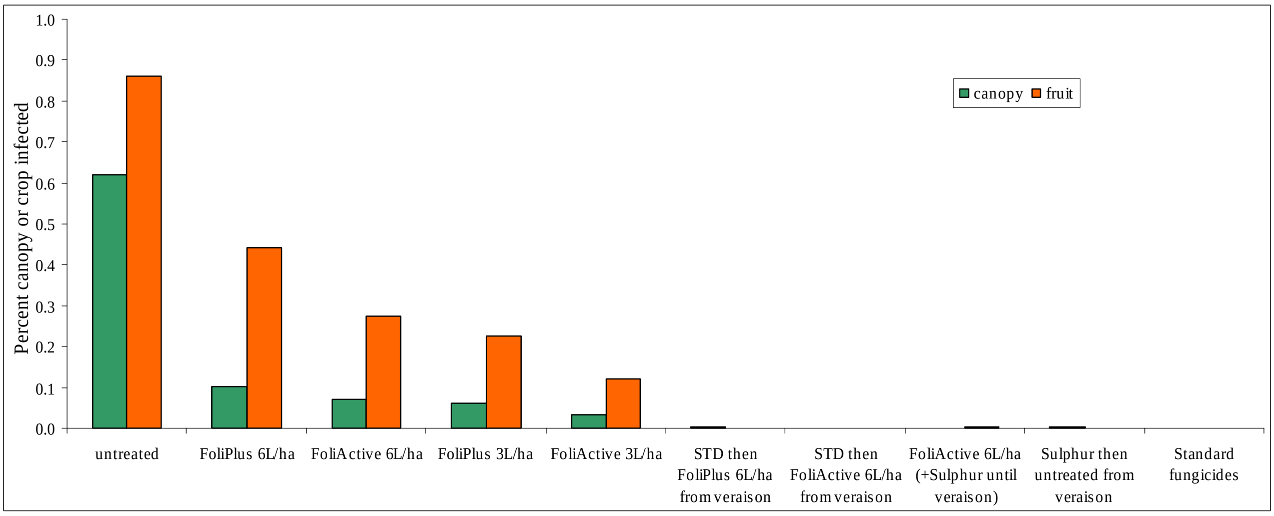

Figure 3: Canopy and fruit powdery mildew infections at veraison - Hawke's Bay, 17 February 2006.

Downy Mildew

Downy mildew disease, first observed in early March, developed rapidly during the period from late March to early April in the Riesling canopy, but not on fruit (now post-susceptible stage). When symptoms were clearly visible in mid April, 42% of the untreated leaves were infected compared with only 4% on vines receiving standard fungicides (Table 8). FoliActive and FoliPlus treatments with standard fungicides applied up to veraison, were provided protection from downy mildew by the previous applications of Captan FLO pre-veraison, and had just 0.8-1% of the whole canopy area infected. Sulphur also provided some protection. All stand-alone FoliActive and FoliPlus treated vines had significantly (P>0.05) more canopy infected than those treated with standard fungicides. There appears to have been a degree of downy mildew control provided by the products tested, as the stand-alone FoliActive (except high rate) and FoliPlus treated vines, with efficacies of 34-53%, had significantly less canopy infected than the untreated (Table 8).

Table 8: Downy mildew infections on leaves post-vintage - Hawke's Bay, 19 April 2006.

Treatments	**Incidence** (% leaves infected)	**Severity** (% leaf area)	**Canopy infected** (% area)	**Treatment Efficacy** (%)
Untreated	42 ***m***	32 ***m***	13.7 ***m***	0 ***m***
Sulphur then untreated from veraison	18 ***m***	14 ***m***	2.4 ***L***	82
Standard fungicides	4	5	0.2 ***L***	99
STD then FoliActive 6 L/ha from veraison	9	8	0.8 ***L***	94
STD then FoliPlus 6 L/ha from veraison	10	9	1.0 ***L***	93
FoliActive 3 L/ha	36 ***m***	18 ***m***	6.4 ***m L***	53
FoliActive 6 L/ha	43 ***m***	28 ***m***	12.3 ***m***	10 ***m***
FoliActive 6 L/ha (+Sulphur until veraison)	21 ***m***	17 ***m***	3.6 ***L***	74
FoliPlus 3 L/ha	33 ***m***	27 ***m***	9.1 ***m L***	34
FoliPlus 6 L/ha	33 ***m***	18 ***m***	6.4 ***m L***	53
LSD (P< 0.05)	9	7	3.6	74

m *= significantly more downy mildew than the 'standard fungicides' treatment (P< 0.05).*
L*= significantly less canopy infected with downy mildew than the 'untreated' treatment (P< 0.05).*

PHYTOTOXICITY

All sprayed vines were free of treatment-induced damage on the leaves and fruit. However, canopy health when scored after vintage was poorer on vines in all treatments that had not received standard fungicides (Table 9). The apparent decline in canopy health in most treatments was actually due to the effects of downy mildew disease (Table 8) on the foliage.

Table 9: Assessment of canopy health at vintage - Hawke's Bay, 4 April 2006.

Treatments	**Canopy Health Score[1]**
Untreated	2.6 ***w***
Sulphur then untreated from veraison	1.7 ***w***
Standard fungicides	1.2
STD then FoliActive 6 L/ha from veraison	1.3
STD then FoliPlus 6 L/ha from veraison	1.5
FoliActive 3 L/ha	2.0 ***w***
FoliActive 6 L/ha	2.3 ***w***
FoliActive 6 L/ha (+Sulphur until veraison)	1.8 ***w***
FoliPlus 3 L/ha	2.4 ***w***
FoliPlus 6 L/ha	2.3 ***w***
LSD (*P*<0.05)	0.4

[1] Canopy health score (0 = green/ healthy, 1 = green with slight yellowing, 2 = leaves yellowish green, 3 = mostly yellow and/or minor chlorosis and/or necrosis, 4 = significant chlorosis and/or necrosis)

w *= significantly worse canopy health score compared to the 'Standard Fungicides' treatment (P< 0.05).*

FRUIT MATURITY

Grape berry sugar levels (soluble solids) are used by wineries for fruit quality bonuses, so it is important that they are not adversely affected by fungicide treatments. The soluble solids of all fruit sampled at vintage (Table 10) were lower than the 20-22 °Brix desirable, as the crop required harvesting because of the high levels of rots. Soluble solids appeared to be lower in fruit from several treatments, compared with those treated with the standard fungicides. This was likely to be because the ripest berries had rotted, forcing the sampling of less ripe berries.

Table 10: Fruit maturity at vintage based on soluble solids, Hawke's Bay, 2006.

Treatments	**Soluble Solids** (°Brix)
Untreated	18.0 ***L***
Sulphur then untreated from veraison	17.9 ***L***
Standard fungicides	18.8
STD then FoliActive 6 L/ha from veraison	18.9
STD then FoliPlus 6 L/ha from veraison	18.4
FoliActive 3 L/ha	18.3
FoliActive 6 L/ha	18.1 ***L***
FoliActive 6 L/ha (+Sulphur until veraison)	18.3
FoliPlus 3 L/ha	17.8 ***L***
FoliPlus 6 L/ha	18.5
LSD (*P*< 0.05)	0.5

L *= significantly lower maturation than the 'Standard Fungicides' treatment (P< 0.05).*

FRUIT YIELDS

There were no statistically significant (P>0.05) treatment effects on berry weight (Table 11), suggesting that treatments did not affect pollination. Berry weights are principally affected by seed number, hence pollination.

The number of berries per bunch and bunch weights were significantly lower on untreated vines because of the effects of bunch rots (Table 5), as infected berries commonly fall off the bunch. Vines treated with FoliPlus and those treated with the highest rate of FoliActive had significantly (P>0.05) lighter bunches due to rotted (fewer) berries than those treated with standard fungicides or standard fungicides then FoliActive 6 L/ha from veraison.

The average number of bunches per vine is a function of the number and fruitfulness of buds retained during winter pruning. Therefore usually we do not see an effect of treatments applied during the season on the average number of bunches per vine. Nevertheless we do measure bunch numbers in order to understand any unusual crop yields. For example the standard fungicide then FoliActive 6 L/ha from veraison treated vines had higher crop yields than the standard fungicides treated vines because on average they carried more bunches.

Table 11: Fruit Yields and yield components at vintage - Hawke's Bay, 4 April 2006.

Treatments	**Crop Yield** (kg/vine)	**Bunches per vine**	**Bunch weight** (g)	**Berries per bunch**	**Berry weight** (g)
Untreated	7.5	59	125 ***L***	55 ***L***	2.3
Sulphur then untreated from veraison	6.6 ***L***	58	112 ***L***	51 ***L***	2.2
Standard fungicides	9.7	64	150	67	2.2
STD then FoliActive 6 L/ha from veraison	11.3	70	161	71	2.3
STD then FoliPlus 6 L/ha from veraison	7.0	57	120 ***L***	53 ***L***	2.3
FoliActive 3 L/ha	10.6	79	137	61	2.2
FoliActive 6 L/ha	8.4	70	118 ***L***	54 ***L***	2.2
FoliActive 6 L/ha (+Sulphur until veraison)	8.3	80	100 ***L***	44 ***L***	2.2
FoliPlus 3 L/ha	8.2	67	122 ***L***	54 ***L***	2.3
FoliPlus 6 L/ha	8.1	77	106 ***L***	46 ***L***	2.3
LSD (P< 0.05)	3.0	19	22	11	0.2 NS

NS = All treatments are not significantly different within the column (P<0.05).
L *= significantly lower yields and bunch weights and fewer berries per bunch than the 'Standard Fungicides' treatment (P< 0.05).*

CONCLUSIONS

Challenging climatic conditions made for a rigorous evaluation. Under such conditions we conclude that FoliActive has proven activity against powdery mildew (albeit not as strong as sulphur) and weak activity against botrytis when used as a stand-alone treatment from the start of bloom. When FoliActive, applied at six litres per hectare, replaced botryticides from veraison on previously fungicide treated vines, rot control was similar to that with the full season fungicide programme. Such an outcome demonstrates FoliActive's potential for replacing fungicides and thus reduction of fungicide residues. However, late season FoliActive performance needs confirming by using a late season untreated control for comparison in future studies, as the standard fungicides applied up to veraison may have provided season-long *Botrytis* control, thus confounding our conclusion of FoliActive merit.

Generally FoliPlus appeared to provide equal or inferior disease control to FoliActive. Both products, as stand-alone treatments, performed relatively poorly against botrytis bunch rot and downy mildew on the very susceptible variety Riesling under this season's disease-favourable conditions.

When we take into consideration that high rot levels led to the sampling of sound but less ripe fruit, and rots reduced yields, we conclude that maturation and yields were not directly affected by FoliActive or FoliPlus treatment. With respect to plant safety, FoliActive and FoliPlus did not cause any direct phytotoxic effects to the foliage or fruit.

RECOMMENDATIONS

- Further investigations, with the extra experimental rigour of a late season unsprayed treatment on previously fungicide treated vines, are required to confirm whether FoliActive will reliably act as a fungicide-replacement from veraison.
- An understanding ought to be sought as to why FoliActive appeared to provide better disease control than FoliPlus.
- Also we recommend an investigation into why the lower rates often appeared to perform better than the higher. Such rate effects are in common with the results of *in vitro* studies carried out by Dr Reglinski where (only) the low rate of FoliActive increased the resistance of Chardonnay leaves to subsequent infection by *B. cinerea.*
- Such an understanding may then lead to enhanced next generation products.

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APPENDICES

Appendix 1. Treatments, application details and vine phenology, Hawke's Bay, 2005/06.

Untreated from flowering	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated
Sulphur only	Thovit	Thovit	Thovit	Thovit	Thovit	untreated	untreated	untreated	untreated
Standard FUNGICIDES	Euparen Multi Thovit	Switch Thovit	Captan Thovit	Switch Thovit	Captan Thovit	Captan	Captan	Captan	Captan
STD Fungicides then FoliActive 6L/ha from veraison	Euparen Multi Thovit	Switch Thovit	Captan Thovit	Switch Thovit	Captan Thovit	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha
STD Fungicides then FoliPlus 6L/ha from veraison	Euparen Multi Thovit	Switch Thovit	Captan Thovit	Switch Thovit	Captan Thovit	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha
FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha	FoliActive 3 L/ha
FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha
FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha	FoliPlus 3 L/ha
FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha	FoliPlus 6 L/ha
Sulphur + FoliActive 6L/ha	FoliActive 6 L/ha Thovit	FoliActive 6 L/ha Thovit	FoliActive 6 L/ha Thovit	FoliActive 6 L/ha Thovit	FoliActive 6 L/ha Thovit	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha	FoliActive 6 L/ha
	application 1	application 2	application 3	application 4	application 5	application 6	application 7	application 8	application 9
Phenology	10-15% capfall	85-95% capfall	Berries Pea Size	Pre-Bunch Closure	Post Bunch Closure	Veraison	post Veraison	5 wk Pre-vintage	2.5 wk Pre-vintage
Date Treatments Applied	25-Nov-05	7-Dec-05	26-Dec-05	7-Jan-06	23-Jan-06	7-Feb-06	15-Feb-06	1-Mar-06	17-Mar-06
Time applied	2000	1500	2000	1500	2100	1600	1300	1400	1900
Temperate [C]	12.7	20.4	19.7	22.6	18.3	23.4	25.5	23.8	18.8
Humidity [%RH]	67	71	71	40	80	57	47	57	73
Cloud Cover [%]	100	5	30	15	90	15	15	10	95
Wind [m/sec]	3.0	2.1	3.5	2.2	3.5	3.9	2.3	3.3	3.2
wind direction 0=north	185	128	24	250	86	73	232	71	169
Drying time hrs	1.5	1.0	1.5	0.5	0.5	0.25	0.25	0.25	1.0
Application Volumes [L/ha]	500	500	750	750	750	750	750	750	750

- Captan (Captan FLO) was applied at 200 ml/100 litres and contained 480 g/kg captan in the form of a suspension concentrate.
- Euparen® Multi was applied at 2 kg/ha and contained 500 g/kg dichlorfluanid in the form of a water dispersible granule.
- Switch® was applied at 800 g/ha and contained 375 g/kg cyprodinil and 250 g/kg fludioxionil in the form of a water dispersible granule.
- Thiovit (Thiovit Jet) was applied at 3 kg/ha and contained 800 g/kg sulphur as a wettable powder.