Soft control strategies for grape powdery mildew (*Uncinula necator*) – 2001

Harold Larsen & Horst Caspari, Colorado State University, Western Colorado Research Center, 3168 B ½ Road, Grand Junction, CO 81503

Summary and Recommendations:

Three separate studies on the control of grape powdery mildew, *Uncinula necator*, were conducted in 2001 in a Chardonnay vineyard in western Colorado. Two studies compared various rotational spray programs applied on a calendar basis (about every 25 days). In the third study, no sprays were applied until the first symptoms of powdery mildew were observed.

Precipitation during the first half of the 2001 season was very low. The first symptoms of powdery mildew were observed on July 25, following an overnight rainfall event of close to 1 inch on July 14-15. Infections were slow to build until mid-August, at which time infection spread rapidly throughout the study block on foliage. As the fruit had reached veraison in late July there was no infection on berries.

No additional spray applications were made after veraison and severe foliar infection incidence and severity were observed in all treatments late in the season. Although the untreated control plots in all three studies showed the highest incidence and severity on leaves, there was no powdery mildew infection of fruit. Treatment costs (materials only) per acre ranged from a low of $0 for the untreated control to a high of $115. The severity of the late season infection after veraison raises the question if protective spray programs should be continued beyond veraison.

Introduction and Objectives:

Grape powdery mildew is the primary disease of wine grapes in western Colorado. Control currently depends heavily on use of elemental sulfur (both for organic plantings and for non-organic production plantings). Other options available include sterol inhibitors (currently used to some extent), strobilurins, oils, lime-sulfur + sulfur (used somewhat), and a biocontrol fungal parasite, *Ampelomyces quisquallis* (AQ10). Assessment of control efficacies for these options and a new biocontrol option (Serenade) is needed to help the wine grape industry knowledgeably select the best options for their vineyard situations. In addition, assessment is needed to validate use of the grape powdery mildew disease model used in California to guide control applications.

Two studies were conducted during the 2001 season to compare control efficacies of different rotational treatments. In addition, a third study tested the potential of not using protective fungicides but applying a "rescue" treatment after the first powdery mildew infection was observed in the vineyard.

Materials and Methods:

A randomized complete block design was used with six (study 1, 2) or 5 (study 3) replicates per treatment in a planting of Chardonnay with 5 ft. in-row x 10 ft. aisle spacing. Each replicate consisted of 1 panel of 8 vines. Treatment details are presented in Tables 2, 3, and 4.

Applications were done using a tunnel sprayer. In studies 1 and 2, sprays were applied at 3 - 4 wk intervals beginning at 2 weeks post-bud-break and continuing until veraison. In study 3, sprays were applied 1 day after observation of initial powdery

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mildew infections of the season following a 0.99 inch overnight rainfall event. Veraison occurred in the block shortly after (late July), so no additional sprays were applied.

Table 2. Spray programs, materials, and rates used on Chardonnay grapevines during 2001 - Study 1.

Trt No.	Treatment Program Type	Spray timing	Materials & rates used
1-1	Control	Non-treated	None
1-2	Standard sulfur[1]	5/9, 6/7, 6/29, & 7/24	Sulfur 80DF @ 5 lb / acre
1-3	Rotation no. 1: [1] Nova Sulfur Sovran Sulfur	 5/9, 6/7, 6/29, 7/24	 1. Nova 40W @ 5 oz / acre 2. Thiolux 80DF @ 5 lbs / acre 3. Sovran 50WDG @ 4 oz / acre 4. Thiolux 80DF @ 5 lbs / acre
1-4	Rotation no. 2: [1] Nova Serenade Sovran Serenade	 5/9, 6/7, 6/29, 7/24	 1.Nova 40W @ 5 oz / acre 2. Serenade @ 6 lbs / acre 3. Sovran 50WDG @ 4 oz / acre 4. Serenade @ 6 lbs / acre
1-5	Rotation no. 3: [1] AQ10+Rubigan AQ10 AQ10+Serenade AQ10+Serenade	 5/9, 6/7, 6/29, 7/24	 1. AQ10 @ 1 oz. / acre + Rubigan 1E @ 2 fl. oz./acre 2. AQ10 @ 0.5 oz / acre 3. AQ10 @ 1 oz / acre + Serenade @ 6 lb / acre 4.AQ10 @ 0.5 oz / acre + Serenade @ 6 lb / acre

[1] A spreader (B-1956 @ 0.0625 % V/V) was added to all sprays.

Plants were evaluated just prior to each spray and after harvest for mildew incidence and severity. For incidence readings, a 1-10 subjective rating system was used in which incidence values were based on estimated percentages of leaf or cane numbers with infection symptoms; a value of 1 represented less than 10% of leaves or canes exhibiting infection, a value of 5 represented an estimated 50% of leaves or canes exhibiting infection symptoms, and a value of 10 represented approximately 100% of leaves or canes exhibiting infection symptoms. A similar 1-10 rating system was used for severity estimates based on estimated percentage of surface area with symptoms for leaves and canes; a value of 1 represented less than 10% of total surface, a value of 5 represented an estimated 50% of surface affected, and a value of 10 represented an estimated 100% of surface affected. For the post-harvest evaluation on Oct. 4, 2001, two age categories of leaves and canes were used: early, in which growth from leaf nodes one to 10 was included, and late season, in which growth for the last 10 nodes was included.

Table 3. Spray programs, materials, and rates used on Chardonnay grapevines during 2001 - Study 2.

Trt No.	Treatment Program Type	Spray timing	Materials & rates used
2-1	Control	Non-treated	None
2-2	Flint / sulfur Rotation[1]	5/9, 6/7, 6/29, 7/24	1. Flint 50WDG @ 2 oz / acre 2. Thiolux 80DF @ 5 lbs / acre 3. Flint 50WDG @ 2 oz / acre 4. Thiolux 80DF @ 5 lbs / acre
2-3	Procure / sulfur Rotation[1]	5/9, 6/7, 6/29, 7/24	1. Procure 50W @ 6 oz / acre 2. Thiolux 80DF @ 5 lbs / acre 3. Procure 50W @ 6 oz / acre 4. Thiolux 80DF @ 5 lbs / acre
2-4	Serenade / sulfur Rotation[1]	5/9, 6/7, 6/29, 7/24	1. Serenade @ 6 lbs / acre 2. Thiolux 80DF @ 5 lbs / acre 3. Serenade @ 6 lbs / acre 4. Thiolux 80DF @ 5 lbs / acre
2-5	Stylet-Oil	5/9, 6/7, 6/29, 7/24	Stylet-Oil @ 1.5%

[1] A spreader (B-1956 @ 0.0625 % V/V) was added to all sprays.

Table 4. Spray programs, materials, and rates used on Chardonnay grapevines during 2001 - Study 3.

Trt No.	Treatment	Spray timing [1]	Materials & rates used
3-1	Control	Non-treated	None
3-2	Erase	7/27/'01	Erase @ 1%, applied at 50 gal. / acre
3-3	Stylet-Oil	7/27/'01	Stylet-Oil @ 2%, applied at 50 gal. / acre
3-4	AQ10 + Rubigan	7/27/'01	AQ10 @ 1 oz / acre + Rubigan @ 1.5 fl. oz/acre, applied at 50 gal. / acre

[1] Spray applied at first observation of grape powdery mildew in the research plots. Veraison began late July.

Results and Discussion:

The 2001 growing season was a hot, dry one with limited rainfall until mid-July. No powdery mildew infections were observed in any of the grape plantings prior to July 25. Representative for all treatments and studies, Table 5 shows zero ratings for incidence and severity in study 1. The first symptoms of powdery mildew were observed on July 25, about 10 days after a significant rainfall event with 0.99" of rain overnight which occurred on July 15. Infections were slow to build until mid-August, at which time infection spread rapidly throughout the study block on foliage. The fruit reached veraison in late July and no additional spray applications were made after that time because of the understanding from the literature that protective sprays are not needed after that time.

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Table 5. Incidence and severity ratings of powdery mildew on Chardonnay leaves prior to spray applications on 6/7, 6/29, and 7/24/2001 (Study 1).

Trt. No.	Treatment	Infection Incidence			Infection Severity		
		6/6	6/28	7/23	6/6	6/28	7/23
1-1	Control	0	0	0	0	0	0
1-2	Standard sulfur program	0	0	0	0	0	0
1-3	Nova/Sulfur/Sovran Rotation	0	0	0	0	0	0
1-4	Nova/Serenade/Sovran Rotation	0	0	0	0	0	0
1-5	AQ10 rotation	0	0	0	0	0	0

Post-harvest observations found the non-treated control plants to have extremely high infection incidence and severity for early season leaves and late season leaves (Table 6, 8, 10).

Table 6. Incidence and severity ratings of powdery mildew on Chardonnay leaves on 10/4/2001, near the end of the 2001 growing season (Study 1).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
1-1	Control	8.7 A	10.0 A	9.0 A	8.8 A
1-2	Standard sulfur program	8.0 A	9.5 A	8.0 A B	8.2 A
1-3	Nova/Sulfur/Sovran Rotation	3.0 B	7.7 B	2.2 C	5.0 B
1-4	Nova/Serenade/Sovran Rotation	6.8 A	9.0 A	6.8 B	7.5 A
1-5	AQ10 rotation	7.0 A	9.0 A	7.5 A B	7.7 A

[1]Numbers with differing letters differ at the $p>0.05$ level.

Cane infections in the non-treated control plants were lower for early season cane tissue and quite severe for the late season cane tissue (Table 7, 9, 11). In study 1, the myclobutanil / sulfur / kresoxim-methyl / sulfur (Nova / Thiolux / Sovran / Thiolux) rotation provided the best control (Tables 6 & 7). Early season foliage protected with this rotational spray program had half the incidence and less than 25% of the severity ratings for the control plants on October 4. Thus it would appear that this rotational program had substantial carryover protection following the final spray application. This is also reflected in the cane infection data in Table 7. The relatively poor performance of the standard sulfur program likely reflects the warm temperatures experienced during late

July and August. These would have accelerated the conversion of the elemental sulfur to the SO_2 and SO_3 forms that air currents then carry out of the vineyard. Once all the sulfur has been converted, no further protection against infection is provided.

Table 7. Incidence and severity ratings of powdery mildew on Chardonnay canes on 10/4/2001, near the end of the 2001 growing season (Study 1).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
1-1	Control	4.8 A	9.7	3.3 A	8.0
1-2	Standard sulfur program	3.3 A B	9.5	2.2 A B	7.0
1-3	Nova/Sulfur/Sovran Rotation	1.2 C	5.7	1.0 B	3.8
1-4	Nova/Serenade/Sovran Rotation	1.7 B C	7.3	1.3 B	4.7
1-5	AQ10 rotation	1.7 B C	8.7	1.0 B	5.7

[1]Numbers with differing letters differ at the p>0.05 level.

Table 8. Incidence and severity ratings of powdery mildew on Chardonnay leaves on 10/4/2001, near the end of the 2001 growing season (Study 2).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
2-1	Control	8.7 A	8.2	7.3 A	7.8
2-2	Flint / sulfur Rotation	2.7 C	8.3	2.0 C	6.7
2-3	Procure / sulfur Rotation	3.8 B C	8.8	2.7 B C	7.0
2-4	Serenade / sulfur Rotation	5.0 B	8.8	3.8 B	7.2
2-5	Stylet-Oil	5.2 B	8.5	4.0 B	7.3

[1]Numbers with differing letters differ at the p>0.05 level.

In Study 3, the treatment programs provided at least some control of powdery mildew leaf infections for a short time after the 7/27 spray, but none provided control long enough to last substantially past veraison. Post-harvest observations found the non-treated control plants to have extremely high infection incidence and moderately high severity for both early and late season leaves (Table 10). Cane infections in the treated plants were very low for early season cane tissue (moderately low for the non-treated control plants) and moderately severe for all treatments on the late season cane tissue (Table 11).

Table 9. Incidence and severity ratings of powdery mildew on Chardonnay canes on 10/4/2001, near the end of the 2001 growing season (Study 2).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
2-1	Control	5.7 A	9.5	3.7 A	5.7 A
2-2	Flint / sulfur Rotation	1.2 B	7.3	1.0 B	3.2 C
2-3	Procure / sulfur Rotation	1.8 B	8.0	1.5 B	4.2 B C
2-4	Serenade / sulfur Rotation	1.7 B	7.8	1.0 B	3.8 B C
2-5	Stylet-Oil	2.2 B	7.8	1.5 B	5.0 A B

[1]Numbers with differing letters differ at the p>0.05 level.

Table 10. Incidence and severity ratings of powdery mildew on Chardonnay leaves on 10/4/2001, near the end of the 2001 growing season (Study 3).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
3-1	Control	7.6	8.6	6.8	7.8
3-2	Erase	6.6	9.0	5.4	8.2
3-3	Stylet-Oil	6.2	8.8	5.6	7.4
3-4	AQ10 + Rubigan	5.6	7.2	4.4	6.0

[1] Values do not differ at the p>0.05 level.

Table 11. Incidence and severity ratings of powdery mildew on Chardonnay canes on 10/4/2001, near the end of the 2001 growing season (Study 3).

Trt. No.	Treatment	Infection Incidence		Infection Severity	
		Early [1]	Late [1]	Early [1]	Late [1]
3-1	Control	2.6	8.8 A	1.8	6.2 A
3-2	Erase	1.8	9.2 A	1.2	5.2 A
3-3	Stylet-Oil	1.4	8.6 A	1.2	5.8 A
3-4	AQ10 + Rubigan	1.4	6.2 B	1.0	3.6 B

[1]Values with differing letters differ at the p>0.05 level.

Treatment costs (materials only) per acre ranged from a low of $0 for the untreated control to a high of $134.63 (Table 12). Although substantial treatment differences were found with respect to foliage and cane infections there was no infection on the fruit itself. Significant costs reductions for powdery mildew control appear

feasible in the Colorado climate. However, the carry-over effects of severe late-season infections have yet to be determined.

Table 12. Material costs for spray programs used on Chardonnay grapevines during 2001 (see Tables 1 to 3 for treatment details).

Treatment number	Treatment type	Number of applications	Material costs per acre ($)
1-1, 2-1, 3-1	Control	0	0
1-2	Sulfur	4	15.40
1-3	Rotation	4	52.20
1-4	Rotation	4	114.76
1-5	Rotation	4	134.63
2-2	Rotation	4	64.20
2-3	Rotation	4	48.70
2-4	Rotation	4	74.20
2-5	Oil	4	36.00
3-2	Rescue	1	45.00
3-3	Rescue	1	12.00
3-4	Rescue	1	21.72

Current recommendations call for cessation of mildew spray applications once the grapes reach veraison. Observations on the rapid expansion of infection in the vineyard after veraison in 2000 (data not shown) and 2001 lead to a question of whether an additional spray application (or possibly two sprays) may be needed even after veraison. Substantial infections were observed on second-set fruit clusters, and damage to foliage could influence their photosynthetic capability and, hence, fruit quality and bud strength. Future studies should include a comparison of treatment continuation after veraison with early cessation of spray protection at start of veraison to see what effect this might have on fruit quality and bud strength as well as on overwinter survival of the pathogen.

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