Evaluation of environmentally friendlx products for control of fungal diseases of grapes.

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Abstract

Various environmentally friendly products were tested for efficacy in controlling powdery mildew, downy mildew, black rot, Phomopsis, and Botrytis bunch rot in grapes over several years. The products tested were: JMS stylet oil (paraffinic oil), Serenade (*Bacillus subtilis*), Croplife (citrus and coconut extract) + Plant food (foliar fertilizer), Armicarb (potassium bicarbonate), Elexa (chitosan), Milsana (giant knotweed extract), and AQ10 (*Ampelomyces quisqualis*). JMS Stylet Oil, Armicarb, Serenade, AQ10, Elexa, and Milsana all provided moderate control of downy and powdery mildew. JMS Stylet Oil and Armicarb also reduced Phomopsis rachis infections. Armicarb looks especially promising for black rot control. Serenade and Croplife + Plantfood provided moderate to good control of Botrytis bunch rot, and moderate control of downy mildew and Phomopsis leaf spot. Milsana provided moderate control of Botrytis bunch rot. The tested products were often out-performed by standard or new products, especially under the humid conditions common in Michigan. However, some products appeared promising for certain diseases and merit further study, especially those that may be of interest to organic growers. Optimizing timing of these products may enhance their performance, since most of them are protectants and have little or no eradicant activity.

Keywords

Powdery mildew, downy mildew, black rot, Phomopsis, Botrytis bunch rot, JMS Stylet oil, Serenade, Croplife, Plant Food, Armicarb, Elexa, Milsana, AQ10.

Introduction

Grapes in the humid Midwestern and northeastern growing regions of the United States are afflicted by a number of diseases, such as powdery mildew (*Uncinula necator*), downy mildew (*Plasmopara viticola*), black rot (*Guignardia bidwelii*), Phomopsis cane and leaf spot (*Phomopsis viticola*), and Botrytis bunch rot (*Botrytis cinerea*) (Pearson and Goheen, 1988; Ramsdell, 1994). Due to high disease pressure and strict market demands for fruit quality, grape growers rely heavily on fungicides to manage their crops, especially during wet years. Generally, wine grapes receive more fungicide applications than juice grapes, because they are more susceptible to major diseases and have a higher value. Also, growers often apply more fungicides than may be necessary as an insurance policy against potential losses.

Even though grape growers are keen to incorporate environmentally sound disease management methods, highly effective alternatives for disease control are currently not available or not cost-effective. Some products are currently labelled for grapes without having been thoroughly tested for efficacy against multiple grape diseases. Other materials are still under development and may have been tested on other crops but little is known about their efficacy on grapes. We there-

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fore decided to investigate environmentally friendly alternatives to conventional fungicides for control of grape diseases, particularly powdery mildew, downy mildew, black rot, Phomopsis cane and leaf spot, and Botrytis bunch rot.

Materials and Methods

Over a period of several years, the following products were evaluated for control of grape diseases: Armicarb 100 (potassium bicarbonate), Serenade (*Bacillus subtilis*), Croplife (citrus and coconut extract) + Plant food (a foliar fertilizer containing N, P, K, and micronutrients), Milsana (giant knotweed extract), Elexa (chitosan), AQ10 (*Ampelomyces quisqualis* – a mycoparasite), and JMS Stylet Oil (paraffinic oil). The products Croplife, Milsana, and Elexa are not yet labelled for use on grapes in the US. Unsprayed plots and plots treated with standard fungicides were used as controls. Efficacy trials were conducted in mature vineyards on experiment stations and commercial farms in southwest and northwest Michigan. At the Trevor Nichols Research Complex (TNRC) in Fennville, MI, the experiments were conducted in a Concord juice grape vineyard. Treatments were applied to seven-vine plots and were replicated four times in a randomized complete block design. Buffer rows separated treatment rows. Sprays were applied with a tractor-pulled air-blast sprayer at a volume of 470 L/ha. On commercial farms in Lawton and Leland, MI, and at the Clarksville Horticultural Experiment Station in Clarksville, MI, treatments were applied to four-vine plots of various inter-specific hybrid cultivars (Vidal, Vignoles, Seyval) and were replicated four times in a randomized complete block design. Sprays were applied with an R&D Research CO_2 backpack or cart-styled sprayer. Sprays were applied at 276 kPa and 280 L/ha. Spray volume was increased to 470 L/ha after bloom. Disease incidence (% leaves/fruit clusters infected) and severity on diseased plant parts (% of the leaf/cluster area infected) were visually estimated between veraison and harvest. Severity over the entire plot was calculated as incidence x severity/100. Data were subjected to analysis of variance followed by LSD mean separation using StatGraphics.

Results and Discussion

In 1999, JMS Stylet Oil and Armicarb provided moderate control of foliar powdery mildew and good control of powdery mildew on the rachis (Table 1). Better control might have been achieved if applications had been continued, since considerable powdery mildew development occurred late in the season. Even though Phomopsis pressure was low, a significant reduction in rachis lesions was noticed in all fungicide treatments.

In 2000, disease pressure in a commercial Vidal vineyard used for the study was relatively high. AQ10, Armicarb, Milsana, Elexa, and Serenade all reduced downy mildew and powdery mildew significantly compared to the untreated control (Table 2), but not as well as a standard fungicide program. Of the group, Serenade provided numerically the best downy mildew control, whereas Milsana provided the best powdery mildew control. Both Milsana and Elexa are thought to induce disease resistance in grapes.

Table 1. Efficacy of JMS Stylet Oil and Armicarb against powdery mildew and Phomopsis in Concord grapes in Fennville, MI, in 1999.

Treatment and rate/ha	Spray timing[1]	Powdery mildew: % Leaf area infected	Powdery mildew: % Rachis area infected	Phomopsis: % Rachis area infected
Untreated check	....	34.4 a[2]	24.9 a	1.8 a
JMS Stylet oil, 1.5% v/v	1, 3, 5, 7, 8	16.9 b	1.9 b	0.2 b
Armicarb 100, 5.6 kg	1, 3, 5, 7, 8	14.7 b	1.6 b	0.8 b
Dithane 75DF, 3.4 kg	1, 2,			
Dithane 75DF, 4.5 kg	3			
Sovran 50WG, 0.2 kg	4, 6,			
Nova 40WP, 0.35 kg	7, 8	1.8 c	0.2 c	0.8 b

[1]Spray dates: 1 = 11 May (1-3" shoot), 2 = 20 May (12" shoot), 3 = 28 May (pre-bloom), 4 = 4 Jun (bloom), = 8 Jun (bloom), 6 = 18 Jun (pea-size berry), 7 = 2 Jul (bunch closing), 8 = 18 Jul.
[2]Column means followed by the same letter are not significantly different according to the Waller-Duncan K ratio test (*P*#0.05).

Table 2. Efficacy of various products against downy and powdery mildew in 'Vidal' grapes in Lawton, MI, in 2000.

Treatment and rate/ha	Spray timing[1]	% Leaf area infected: Downy mildew[2]	% Leaf area infected: Powdery mildew[3]
Untreated check	....	18.6 a[5]	43.1 a
AQ10 58WG, 70 g + NuFilm, 1.12 L	1, 2, 3, 4, 5, 6, 7, 8	14.7 ab	10.6 c
Armicarb 100, 5.6 kg	1, 2, 3, 4, 5, 6, 7, 8	10.7 b	15.0 bc
Milsana, 1% v/v	1, 2, 3, 4, 5, 6, 7, 8	10.0 bc	9.8 cd
Elexa-4, 2.5% v/v	1, 2, 3, 4, 5, 6, 7, 8	9.4 bc	11.9 c
Serenade WP (QRD 132), 9 kg	1, 2, 3, 4, 5, 6, 7, 8	5.9 cd	18.2 b
Penncozeb 75DF, 3.4 kg	1,		
Elite 45DF, 0.28 kg	2,		
BAS 500 20WG, 0.56 kg	3, 4,		
Penncozeb 75DF, 3.4 kg + Elite 45DF, 0.28 kg	5,		
BAS 500 20WG, 0.56 kg	6, 7,		
Ziram 76DF, 4.5 kg	8	3.0 d	1.2 e

[1]Spray dates: 1 = 20 May (3-5" shoot), 2 = 31 May (8" shoot), 3 = 8 Jun (10" shoot), 4 = 19 Jun (bloom), 5 = 28 Jun (1/4" berry), 6 = 12 Jul (bunch closing), 7 = 19 Jul, 8 = 31 Jul (pre-veraison).
[2]Values shown are actual means; statistical analysis was performed on log(x)-transformed data.
[3]Values shown are actual means; statistical analysis was performed on arcsine-transformed data.
[4]Column means followed by the same letter are not significantly different according to the Fisher's Protected LSD test (*P*#0.05).

ease resistance in grapes.

In 2000, various products were also tested against Botrytis bunch rot in Vignoles grapes in Leland, MI. Disease pressure was moderate. In the untreated control over 50% of the clusters had at least one infected berry, and 15% of the berries, on average, were infected in the diseased clusters. While a Vangard/Flint program was numerically superior, Croplife+ Plant Food, Serenade, and Milsana were statistically similar in their performance. Croplife + Plant Food appeared particularly promising. Rovral was not significantly different from the control, perhaps because resistant strains were present in the vineyard.

Table 3. Efficacy of various products against Botrytis bunch rot in Vignoles grapes in Leland, MI, in 2000.

Treatment and rate/ha	Spray timing[1]	% Clusters with Botrytis
Untreated check	....	52.5 a[2]
Rovral 50WP, 1.7 kg	1, 2, 3, 4............	37.5 ab
Milsana, 1% v/v	1, 2 , 3, 4............	25.0 bcd
Serenade WP (QRD 132), 9 kg............	1, 2 , 3, 4............	25.0 bcd
Croplife, 0.29 L + Plant Food, 18.7 L............	1, 2 , 3, 4............	11.3 cd
Vangard 75WG, 0.7 kg............ Flint 50WG, 0.14 kg	1, 3, 2, 4	5.0 d

[1]Spray dates: 1 = 24 Jul (pre-bunch closing), 2 = 16 Aug (pre-veraison), 3 = 13 Sep (post-veraison), 4 = 3 Oct (pre-harvest).
[2]Column means followed by the same letter are not significantly different according to Fisher's Protected LSD test (*P*#0.05).

In 2001, Armicarb provided good control of black rot and powdery mildew, statistically similar to conventional fungicide programs (Table 4). The mode of action of Armicarb is not well understood, but it may desiccate fungal spores as well as kill powdery mildew colonies on the plant surface.

Table 4. Efficacy of Armicarb vs. conventional fungicides for black rot and powdery mildew control in Concord grapes in Fennville, MI, in 2001.

Treatment, rate/ha	Application timing[1]	% Berries with black rot[2]	% Leaf area with powdery mildew[3]
Untreated		18.5 a[4]	9.0 a
Armicarb 100, 5.6 kg.........	1, 2, 3, 4, 5, 6, 7	2.3 bc	0.6 cd
Nova 40WP, 0.35 kg.........	3, 4, 5, 6	0.4 c	1.3 bc
Dithane 75DF, 3.4 kg........ Elite 45DF, 0.28 kg	1, 2, 3 4, 5, 6, 7	0.2 c	0.8 cd
Ferbam Granuflo, 4.5 kg... Bayleton 50DF, 0.28 kg .. Ziram Granuflo, 4.5 kg..	1, 2, 3 4, 5 6, 7	0.2 c	0.1 d

Spray dates: 1 = 8 May (3-5" shoot), 2 =18 May (8-10" shoot),, 3 = (immediate pre-bloom), 4 = 25 Jun (1st post-bloom), 5 = 9 Jul (2nd post-bloom), 6 = 24 Jul (3rd post-bloom), 7 = 8 Aug (4th post-bloom).
Values shown are actual means; statistical analysis was performed on arcsine-transformed data.
Values shown are actual means; statistical analysis was performed on log (x+1)-transformed data.
Column means followed by the same letter are not significantly different according to the Fisher's Protected LSD test (*P*#0.05).

In a trial in a Seyval vineyard with moderately high disease pressure in 2001, Serenade and Croplife + Plant Food reduced overall downy mildew severity by about 60% and Phomopsis leaf spot severity by about 50% (Table 5). Fruit and rachis infection by Phomopsis was reduced also, but the data were not statistically significant and therefore not shown. Standard fungicides performed significantly better than either Serenade or Croplife + Plant Food. However, since Serenade is labelled for use in organic production, it may still be of interest. Perhaps late-season applications would improve performance of the products, as most downy mildew development in Michigan tends to take place late in the growing season.

Table 5. Efficacy of various products against downy mildew and Phomopsis on the foliage of Seyval grapes, Clarksville, MI, 2001.

		% Leaf area infected	
Treatment, rate/ha	Application timing[1]	Downy mildew[2]	Phomopsis leaf spot[2]
Untreated............		32.0 a	15.9 a
Serenade (QRD 137), 9 kg............	1, 2, 3, 4, 5, 6, 7	12.3 b	7.8 b
Croplife, 0.29 L + Plant Food, 18.7 L	1, 2, 3, 4, 5, 6, 7	11.2 b	7.0 bc
Penncozeb 75DF, 3.4 kg............ Flint 50WG, 0.14 kg............	1, 2, 3 4, 5, 6, 7	6.3 c	2.0 d
Captan 50WP, 4.5 kg............	1, 2, 3, 4, 5, 6, 7	3.1 d	2.5 cd
Penncozeb 75DF, 3.4 kg............	1, 2, 3, 4, 5, 6, 7	2.9 d	4.4 cd

[1]Spray dates: 1 = 23 May (3-5" shoot), 2 = 4 Jun (6-10" shoot), 3 = 22 Jun (immediate pre-bloom), 4 = 2 Jul (1st post-bloom), 5 = 16 Jul (2nd post-bloom), 6 = 30 Jul (3rd post-bloom), 7 = 13 Aug (4th post-bloom).
[2]Column numbers are actual means; statistical analysis was performed on log (x)-transformed data.
[3]Column means followed by the same letter are not significantly different according to Fisher's Protected test (*P*#0.05).

Conclusion

In most cases, the evaluated biological and reduced-risk chemical products significantly reduced disease incidence and severity in grapes compared to the untreated controls. However, they were often out-performed by conventional fungicides, especially under high disease pressure. Some products appeared promising for certain diseases and merit further study, particularly those that may be of interest to organic growers. Optimizing timing of these products may enhance performance, since most of them are protectants and have little or no eradicant activity.

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