A Progress Report for a Continuing Research and Extension Project Submitted to:
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Evaluation of Cevya for grape black rot and powdery mildew control of juice and wine grapes

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INTRODUCTION AND OBJECTIVES

Field trials were set up at the Lake Erie Regional Grape Research and Extension Center to examine the efficacy of Cevya for control of black rot and powdery mildew on Concord and Chambourcin grapes under Lake Erie region climatic conditions. These varieties were chosen due to their high susceptibility to these diseases and their importance to the Lake Erie region grape production area. The objectives of this project are:

1. To determine the efficacy of preventive applications of Cevya, a new sterol inhibitor type fungicide, for grape black rot control.
2. To determine the post infection efficacy of Cevya for grape black rot control.
3. To expand the pool of data regarding the efficacy of Cevya for powdery mildew control and the potential for injury to *labrusca* and hybrid wine grapes.

EXPERIMENTAL PROCEDURES TO ACCOMPLISH OBJECTIVES AND RESULTS

Trial 1: Evaluation of Cevya for control of black rot and powdery mildew of *Vitis* interspecific hybrid 'Chambourcin'. This trial was conducted in a mature vineyard at the Lake Erie Regional Grape Research and Extension Center in North East, PA. Vines were trained to a single-curtain, high-wire cordon system. Treatments were applied to six-vine plots in a randomized complete block design with four replications. Fungicides were applied at 50 gal/A using a Friend covered-boom plot sprayer at a pressure of 125 psi. Applications were initiated 3 weeks before bloom on 1 June, and spray intervals ranged from 11-15 days. The objectives of the trial were to compare the new sterol biosynthesis inhibitor (SI) in Cevya (mefentrifluconazole) to a program of existing SIs commonly used on grapes in Pennsylvania (difenoconazole (Revus Top), and tebuconazole (Tebustar)), a standard chemical program, and an unsprayed check, for black rot and powdery mildew control on fruit. In each plot, black rot fruit mummies were hung from the trellis wire at four locations within the east end of plots (4-5 mummies per location on 8 June) to provide additional inoculum during the fruit susceptibility period. Black rot incidence (percent clusters diseased) and severity (percent area of clusters diseased) on fruit were determined on 12-13 Aug from the most heavily infected clusters directly beneath each mummy cage (50 clusters per plot). Powdery mildew incidence (percent infected) and severity (percent area infected) on fruit were determined on 5-6 Aug from 50 randomly selected clusters per plot. Data were subjected to analysis of variance (ANOVA) using the general linear model function in Minitab 19.

Total rainfall for May, Jun, Jul, Aug, and Sep was 4.54, 3.44, 4.25, 2.41, and 1.77 in., respectively. Capfall (bloom), which marks the beginning of the fruit susceptibility period for all diseases, began on 21 June. **Black Rot:** Low natural inoculum levels and predominately dry weather conditions during the period of fruit susceptibility completely prevented disease development except where mummies had been hung in the trellis, where small amounts of black rot developed in the check. All treatments provided essentially complete control of black rot on Chambourcin fruit.

Powdery mildew pressure was also low. Only Cevya treatments significantly reduced the incidence of powdery mildew when compared to the check, but there was a rate effect with the high 5 fl oz rate being superior to the low 3 fl oz rate. All treatments significantly reduced the severity of powdery mildew on fruit, with the high rate of Cevya being significantly more effective than the standard rotation of Tebustar/Quintec/Endura/Vivando/Torino. There was no phytotoxicity associated with any of the treatments.

Incidence and severity of black rot and powdery mildew on Chambourcin fruit

Treatment and rate/A	Days after first application[z]	Black Rot Incidence	Black Rot Severity[y]	Black Rot % Control[x]	Powdery Mildew Incidence	Powdery Mildew Severity[y]	Powdery Mildew % Control[x]
Cevya 3.3SC at 3 fl oz + Induce 0.25%	0, 15, 26, 40, 54	0.0 b[w]	0.00 b[w]	100	65.0 b[w]	1.52 bc[w]	77
Cevya 3.3SC at 4 fl oz + Induce 0.25%	0, 15, 26, 40, 54	0.0 b	0.00 b	100	57.5 bc	1.36 bc	79
Cevya 3.3SC at 5 fl oz + Induce 0.25%	0, 15, 26, 40, 54	0.0 b	0.00 b	100	46.0 c	1.08 c	83
Tebustar 5 oz + Induce 0.25% Revus Top 4SC 7 fl oz + Induce 0.25%	0, 15, 26, 40, 54	0.5 b	0.01 b	98	91.5 a	2.64 bc	59
Manzate ProStick 3 lbs	0, 15, 26, 40						
Tebustar at 5 oz + Induce 0.25%	0						
Quintec 4 fl oz + Induce 0.25%	15						
Endura 4.5 oz + Induce 0.25%	26						
Vivando 15.4 fl oz + Induce 0.25%	40						
Torino 3.4 fl oz + Induce 0.25%	54						
Ziram 4 lbs	54	0.0 b	0.00 b	100	99.0 a	2.80 b	57
Unsprayed check		15.0 a	0.43 a		87.5 a	6.50 a	

[z]The first fungicide application was on 1 June. 0 = 3 weeks pre-bloom; 15 = 1 week pre-bloom; 26 = 1st post bloom/end of bloom; 40 = 2nd post-bloom; 54 = 3rd post-bloom.

[y]Severity was rated using the Barratt-Horsfall scale and was converted to % area infected (0-100 %) using Elanco conversion tables.

[x]Percent control = control of disease severity over that of the unsprayed check.

[w]Means followed by the same letter within columns are not significantly different according to Fisher's LSD ($P \leq 0.05$).

Trial 2: Evaluation of fungicides for control of black rot and powdery mildew of *Vitis labrusca* 'Concord' grapes, 2020. This trial was conducted in a vineyard with mature Concord vines trained to a single-curtain, high-wire cordon system at the Lake Erie Regional Grape Research and Extension Center in North East, PA. Concord treatments were applied to 6-9-vine plots in a randomized complete block design with four replications. All treatment applications were made with a Friend covered-boom plot sprayer at 125 psi and 50 gal/A. In each plot, black rot fruit mummies were hung from the trellis wire at four locations within the east end of plots (4-5 mummies per location on 8 Jun) to provide additional inoculum during the fruit susceptibility period. Black rot incidence (percent clusters diseased) and severity (percent area of clusters diseased) were determined on 11 Aug from the most heavily infected clusters directly beneath each mummy cage (50 clusters per plot). Powdery mildew incidence and severity were determined from 50 randomly selected clusters (14 Aug) and leaves (1 Sep) from the center of each plot. Data were subjected to analysis of variance (ANOVA) using the general linear model function in Minitab 19.

Total rainfall for May, Jun, Jul, Aug, and Sep was 4.54, 3.44, 4.25, 2.41, and 1.77 in., respectively. Capfall (bloom), which marks the beginning of the fruit susceptibility period for all diseases, began on 16 June. **Black Rot:** Natural inoculum levels were very low due to drought like conditions in previous years, and little fruit infection took place except where mummies had been hung in the trellis. Symptom development in the untreated control indicated that the vast majority of fruit infection occurred during later stages of susceptibility, covered by spray days 40 (10 July), and especially 54 (24 July; 4-5 weeks after bloom). All treatments reduced black rot incidence on fruit when compared to the control, but at days 40 and 54, Ziram/Ziram was significantly less effective than Ziram/Ziram + Tebuzol and all rates of Cevya (Table 1), a demonstration of the effectiveness of the sterol demethylation inhibitors for black rot control. All treatments provided outstanding control of the severity of black rot.

Powdery mildew: On fruit, powdery mildew control would have come from spray days 15, 26, and 40. All three rates of Cevya provided good and statistically equivalent control, that was generally superior to rotations of older, standard fungicides of Vivando/Mettle/Torino and Quintec/Endura/Vivando, that provided only fair levels of control (Table 2). On leaves, the last three spray days would likely have had the most significant effects on powdery mildew disease development (days 54, 66, and 80; Table 3). All rates of Cevya maintained essentially complete control of powdery mildew by 1 Sep when compared to the untreated control, despite the termination of sprays after day 54 (24 July). Likewise, a rotational program of Quintec, Vivando, and Badge X2 at days 54, 66, and 80, respectively, that extended all the way to 19 August, provided nearly complete control of the severity of leaf infections, but was inferior to the Cevya programs for control of leaf disease incidence. Lastly, a late season rotation of Tebuzol followed by two applications of Badge X2 that extended to 19 August, provided good control of leaf infection that was significantly better than the untreated control, but inferior to the other programs. There was no phytotoxicity associated with any of the treatments.

Table 1: Black rot fruit rot development (under mummies in the trellis) on Concord grape (11 Aug)

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	% Control[x]
Cevya 3 fl oz	0, 15, 26, 40, 54	0.0 c[w]	0.00 b[w]	100
Cevya 4 fl oz	0, 15, 26, 40, 54	0.0 c	0.00 b	100
Cevya 5 fl oz	0, 15, 26, 40, 54	0.0 c	0.00 b	100
Manzate Pro-Stick 75DF 3 lb	0, 15			
METTLE 125ME 5 fl oz	0, 26			
Vivando 10.3 fl oz	15, 66			
Ziram 76DF 4 lb	26, 40, 54			
Torino 3.4 fl oz	40			
Quintec 4 fl oz	54			
Badge X2 1.75 lb + 1.75 lb lime	80	13.5 b	0.63 b	98
Manzate Pro-Stick 75DF 3 lb	0, 15			
Quintec 4 fl oz	15			
Endura 4.5 oz	26			
Ziram 76DF 4 lb	26, 40, 54			
Vivando 10.3 fl oz	40			
Tebuzol 5 oz	54			
Badge X2 1.75 lb + lime 1.75 lb	66, 80	3.5 c	0.12 b	100
Untreated Control		94.0 a	28.47 a	

[z]Timing: The first fungicide application was made on 1 Jun. 0 = 10-12" shoots; 15 = immediate pre-bloom; 26 = 1st post-bloom; 40 = 2nd post bloom; 54 = 3rd post bloom; 66 = 4th post bloom; 80 = 5th post bloom

[y]Severity was rated using the Barratt-Horsfall scale (0-11) and was converted to % area infected (0-100 %) using Elanco conversion tables.

[x]Percent control = control of disease severity on clusters relative to the untreated control.

[w]Means followed by the same letter within columns are not significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 2: Powdery mildew development on Concord fruit (14 Aug)

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	% Control[x]
Cevya 3 fl oz	0, 15, 26, 40, 54	21.0 c[w]	0.52 d[w]	80
Cevya 4 fl oz	0, 15, 26, 40, 54	23.0 c	0.60 cd	77
Cevya 5 fl oz	0, 15, 26, 40, 54	24.5 c	0.56 cd	79
Manzate Pro-Stick 75DF 3 lb	0, 15			
METTLE 125ME 5 fl oz	0, 26			
Vivando 10.3 fl oz	15, 66			
Ziram 76DF 4 lb	26, 40, 54			
Torino 3.4 fl oz	40			
Quintec 4 fl oz	54			
Badge X2 1.75 lb + 1.75 lb lime	80	46.5 b	1.20 bc	55
Manzate Pro-Stick 75DF 3 lb	0, 15			
Quintec 4 fl oz	15			
Endura 4.5 oz	26			
Vivando 10.3 fl oz	40			
Tebuzol 5 oz	54			
Ziram 76DF 4 lb	26, 40, 54			
Badge X2 1.75 lb + lime 1.75 lb	66, 80	52.5 ab	1.58 b	40
Untreated Control		61.0 a	2.65 a	

[z]Timing: The first fungicide application was made on 1 Jun. 0 = 10-12" shoots; 15 = immediate pre-bloom; 26 = 1st post-bloom; 40 = 2nd post bloom; 54 = 3rd post bloom; 66 = 4th post bloom; 80 = 5th post bloom

[y]Severity was rated using the Barratt-Horsfall scale (0-11) and was converted to % area infected (0-100 %) using Elanco conversion tables.

[x]Percent control = control of disease severity on clusters relative to the untreated control.

[w]Means followed by the same letter within columns are not significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 3: Powdery mildew development on Concord leaves (1 Sep)

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	% Control[x]
Cevya 3 fl oz	0, 15, 26, 40, 54	0.5 d[y]	0.01 c[w]	100
Cevya 4 fl oz	0, 15, 26, 40, 54	2.0 d	0.05 c	100
Cevya 5 fl oz	0, 15, 26, 40, 54	0.0 d	0.00 c	100
Manzate Pro-Stick 75DF 3 lb	0, 15			
METTLE 125ME 5 fl oz	0, 26			
Vivando 10.3 fl oz	15, 66			
Ziram 76DF 4 lb	26, 40, 54			
Torino 3.4 fl oz	40			
Quintec 4 fl oz	54			
Badge X2 1.75 lb + 1.75 lb lime	80	16.0 c	0.69 bc	97
Manzate Pro-Stick 75DF 3 lb	0, 15			
Quintec 4 fl oz	15			
Endura 4.5 oz	26			
Vivando 10.3 fl oz	40			
Tebuzol 5 oz	54			
Ziram 76DF 4 lb	26, 40, 54			
Badge X2 1.75 lb + lime 1.75 lb	66, 80	38.0 b	2.89 b	89
Untreated Control		90.5 a	27.50 a	

[z]Timing: The first fungicide application was made on 1 Jun. 0 = 10-12" shoots; 15 = immediate pre-bloom; 26 = 1st post-bloom; 40 = 2nd post bloom; 54 = 3rd post bloom; 66 = 4th post bloom; 80 = 5th post bloom

[y]Severity was rated using the Barratt-Horsfall scale (0-11) and was converted to % area infected (0-100 %) using Elanco conversion tables.

[x]Percent control = control of disease severity on clusters relative to the untreated control.

[w]Means followed by the same letter within columns are not significantly different according to Fisher's LSD ($P \leq 0.05$).

Field inoculations: In addition to small plot, field trial evaluations (spray and wait for disease to develop naturally), inoculations of field grown clusters was performed to assess the post infection 'reach back' activity of Cevya, a property common to other FRAC 3 chemistries. In a separate row of Concord and Chambourcin grapes, 8 treatments were set up as shown in the table below. Each treatment was represented by 6-9 clusters and the experiment was replicated 8 times on Concord, and 6 times on Chambourcin. Treatments were inoculated with the black rot pathogen and subsequently evaluated for disease development about 3 weeks after inoculation. Most (6) of the inoculations were with a 5 x 10^4 spores per ml inoculum, but 2 of the later inoculations utilized 1 x 10^5 spores/ml inoculum. Spores were harvested from black rot fruit mummies that were soaked in distilled water for 3-4 hours, and applied with a small, hand-held preval sprayer. After inoculation, clusters were enclosed within Ziploc bags and a small volume of water to maintain saturation for 16 hours (overnight) at field temperatures. Bagged clusters were covered with white sheets to prevent exposure to direct sun which would otherwise 'cook' clusters inside. After the infection period, bags were removed, and clusters observed for symptom development. Inoculations were conducted on 25, 29, and 30 of June and 2, 6, 8, 13, and 14 of July.

Black rot fruit rot development on inoculated clusters of Concord and Chambourcin grapes

	Concord		Chambourcin	
Treatment/timing before/after inoculation	Incidence (%)	Severity[z] (%)	Incidence (%)	Severity[z] (%)
Unsprayed check 1	96.9 a[y]	55.99 a[y]	100.0 a[y]	44.80 ab[y]
Unsprayed check 2	96.0 a	43.10 a	95.1 a	58.77 a
Ziram 4 lbs/A, 1 day before inoculation	**3.1 b**	**0.36 b**	**3.3 c**	**0.04 c**
Ziram 4 lbs/A, 1 day after inoculation	94.3 a	49.10 a	76.0 ab	32.09 b
Cevya 5 fl oz/A, 1 day before inoculation	**1.8 b**	**0.06 b**	**0.0 c**	**0.00 c**
Cevya 5 fl oz/A, 1 day after inoculation	**0.0 b**	**0.00 b**	**0.0 c**	**0.00 c**
Cevya 5 fl oz/A, 3 days after inoculation	**1.8 b**	**0.37 b**	**0.0 c**	**0.00 c**
Cevya 5 fl oz/A, 5 days after inoculation	**7.8 b**	**0.25 b**	**56.7 b**	**3.18 c**
P-value	p<0.001	p<0.001	p<0.001	p<0.001

[z]Severity was rated using the Barratt-Horsfall scale (0-11) and was converted to % area infected (0-100 %) using Elanco conversion tables.

[y]Means followed by the same letter within columns are not significantly different according to Fisher's LSD ($P \leq 0.05$).

Results: For each repetition of the experiment, treatments were set up across several vines. Check 1 was located on a vine that also held the Ziram treatments. Check 2 was added to vines that held more than one Cevya treatment, in order to rule out systemic activity between Cevya treated clusters on the same vine. It is clear from the level of disease in Check 2 that there was **no systemic protection afforded to the check 2 clusters, from Cevya treated clusters on the same vine.**

Ziram was very effective on black rot, providing nearly complete control when present before inoculation/infection. However, when applied just one day after inoculation, Ziram had no effect on black rot development: Ziram is strictly a surface protectant with no 'reach back' activity. On the other hand, Cevya, applied before, or up to 5 days after inoculation/infection, provided nearly complete control of black rot. These experiments provide strong evidence of the post infection efficacy of Cevya and, along with the field trials, help define the practical activity of materials under test for use under Lake Erie region weather conditions. These experiments should be repeated in 2021 to confirm results.

Evaluation of Cevya for injury to *Vitis labrusca* and *Vitis* interspecific hybrid grape varieties

For the second year, this trial was conducted with mature vines of *Vitis labrusca* 'Concord' and 'Niagara', and *Vitis* interspecific hybrids 'Chambourcin', 'Chancellor', 'Vidal', and 'Vignoles', at the Lake Erie Regional Grape Research and Extension Center in North East, PA. Cevya was applied to six-vine plots with Induce NIS (0.25%) at 0 or 10 fl oz/A (double the maximum label rate) in 50 gal/A using a Friend covered-boom plot sprayer at a pressure of 125 psi. Applications were initiated on 1 June (about 2-3 weeks before bloom), and reapplied on 15 and 26 June, and 10 and 24 July (about every 11-15 days until about 4-5 weeks after bloom, depending on variety). Injury incidence (percent leaves showing injury) and severity (percent area leaves showing injury) were determined on 25 June (just after bloom) and 10 August (about 2 weeks after the last application), from 25 randomly selected leaves per plot. Severity of injury was rated using the Barratt-Horsfall scale and was converted to % area infected (0-100 %) using Elanco conversion tables. Data were subjected to analysis of variance (ANOVA) using the general linear model function in Minitab 19. Leaf injury was very low and there was no injury associated with Cevya to leaves of these grapevine varieties.

June 25 injury rating (leaves)

Grape Variety	Rate of Cevya/A	Incidence	severity
Chambourcin	0 fl oz	96	2.34
	10 fl oz	80	1.87
Chancellor	0 fl oz	84	2.25
	10 fl oz	76	1.97
Concord	0 fl oz	84	2.25
	10 fl oz	64	1.87
Niagara	0 fl oz	44	1.03
	10 fl oz	60	1.40
Vidal	0 fl oz	52	1.22
	10 fl oz	52	1.22
Vignoles	0 fl oz		
	10 fl oz		
All varieties	0 fl oz	72 .0	1.82
	10 fl oz	66.4	1.67

August 10 injury rating (leaves)

Grape Variety	Rate of Cevya/A	Incidence	severity
Chambourcin	0 fl oz	20	0.47
	10 fl oz	16	0.37
Chancellor	0 fl oz	24	0.56
	10 fl oz	20	0.47
Concord	0 fl oz	16	0.37
	10 fl oz	20	0.47
Niagara	0 fl oz	4	0.09
	10 fl oz	4	0.09
Vidal	0 fl oz	12	0.28
	10 fl oz	12	0.28
Vignoles	0 fl oz	24	0.56
	10 fl oz	24	0.56
All varieties	0 fl oz	16.7	0.39
	10 fl oz	16.0	0.37

Outreach: The results of these trials has been discussed with processors at field rep meetings, and growers at 'coffee pot' meetings and other extension based, meetings in the Lake Erie area and Pennsylvania. Information from this project was also used to update the **2021 NY and PA Pest Management Guidelines for Grapes**.

Impact Statement: Cevya is effective for controlling grape powdery mildew. Our first year tests also show that Cevya has strong activity against black rot when applied preventatively and post infection. A second year of phytotoxicity tests show no injury to leaves of Concord, Niagara, Chancellor, Chambourcin, Vignoles, and Vidal grapevines from Cevya.

Publications: Results of the Concord trial were submitted for publication in Plant Disease Management Reports, an online publication through the American Phytopathological Society (APS).

Appendix: Photos (with/without Cevya) in the injury trial may be obtained by contacting Bryan Hed at bxh38@psu.edu

A Progress Report Appendix for a Continuing Research and Extension Project Submitted to:
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Appendix: Below are photos of six varieties used in the Cevya injury trial. Photos compare vines after 5 applications of 0 and 10 fl oz/A of Cevya + Induce 0.25%

Chambourcin 0 fl oz/A Cevya

Chambourcin 10 fl oz/A Cevya

Chancellor 0 fl oz/A Cevya

Chancellor 10 fl oz/A Cevya

Concord 0 fl oz/A Cevya

Concord 10 fl oz/A Cevya

Niagara 0 fl oz/A Cevya

Niagara 10 fl oz/A Cevya

Vidal 0 fl oz/A Cevya

Vidal 10 fl oz/A Cevya

Vignoles 0 fl oz/A Cevya

Vignoles 10 fl oz/A Cevya