A Final Report for a Research and Extension Project Submitted to The New York Wine and Grape Foundation and The Lake Erie Regional Grape Research and Extension Program Processor Funding Group
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Project title: Evaluation of Cevya for grape black rot and powdery mildew control of juice and wine grapes

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New Research ☐ Continued Research ☒

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SECTION 2:

PROJECT SUMMARY IMPACT STATEMENT:

Cevya is a new fungicide chemistry for grapes in the FRAC 3 resistance group (sterol biosynthesis inhibitors). Previous testing at Cornell University has shown that Cevya is good to very good for controlling grape powdery mildew, but little to no research information was available regarding its efficacy on black rot of grapes, caused by the fungal pathogen, *Guignardia bidwellii*. Two years of tests at Penn State now show that Cevya has strong activity against black rot when applied preventatively and up to five days post infection, and it reaffirmed the results from Cornell with regard to powdery mildew on grapes. Phytotoxicity tests show no injury to leaves of Concord, Niagara, Chancellor, Chambourcin, Vignoles, and Vidal grapevines from multiple applications of Cevya, at double the label rate.

OBJECTIVES

Over two years, 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 biosynthesis inhibitor type fungicide (FRAC 3), 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.

MATERIALS AND METHODS

Trial 1: Evaluation of Cevya for control of black rot and powdery mildew of *Vitis* interspecific hybrid 'Chambourcin', 2020 and 2021. These trials were 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 with (2020) or without (2021) Induce surfactant, at 50 gal/A, pre and post

bloom (2020), and 50 gal/A pre bloom and 75 gal/A post bloom (2021), using a Friend covered-boom plot sprayer at a pressure of 125 psi. 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 August (2020) and 11-12 August (2021), from the most heavily infected clusters directly beneath each mummy cage (50 clusters per plot). Powdery mildew incidence and severity on fruit were determined on 5-6 August (2020), and 9 August (2021), from 50 randomly selected clusters per plot. Data were subjected to analysis of variance (ANOVA) using the general linear model function in Minitab 19.

RESULTS: Chambourcin

Total rainfall for May, Jun, Jul, Aug, and Sep was 4.54, 3.44, 4.25, 2.41, and 1.77 inches, respectively, in 2020, and 1.95, 2.86, 6.2, 3.47, and 3.89 inches in 2021, respectively. Capfall (bloom), which marks the beginning of the fruit susceptibility period for all diseases, began on 21 June in 2020, and 10 June in 2021.

Black Rot: In both years, 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 (Table 1 and 2).

Powdery mildew pressure was also low. Only Cevya treatments significantly reduced the incidence of powdery mildew on fruit when compared to the check. However, there were rate effects among Cevya treatments in both years: in 2020, the 5 fl oz rate was superior to the 3 fl oz rate, and in 2021, only the 4 and 5 fl oz rates were significantly better than the check. 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 in 2020. There was no phytotoxicity associated with any of the treatments (Table 1 and 2).

Trial 2: Evaluation of fungicides for control of black rot and powdery mildew of *Vitis labrusca* 'Concord' grapes, 2020 and 2021. These trials were 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. Fungicides were applied at 50 gal/A, pre and post bloom (2020), and 50 gal/A pre bloom and 75 gal/A post bloom (2021). All treatment applications were made with a Friend covered-boom plot sprayer at 125 psi. 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 in 2020 and 3 mummies per location on 1 June in 2021) 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 August (2020) and 10 August (2021), 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 on 14 August (2020) and 6 August (2021) and from 50 randomly selected leaves on 1 September (2020) and 26-27 August (2021) from the center vines of each plot. Data were subjected to analysis of variance (ANOVA) using the general linear model function in Minitab 19.

RESULTS: Concord

Total rainfall for May, Jun, Jul, Aug, and Sep was 4.54, 3.44, 4.25, 2.41, and 1.77 inches, respectively, in 2020, and 1.95, 2.86, 6.2, 3.47, and 3.89 inches, respectively, in 2021. Capfall (bloom), which marks the beginning of the fruit susceptibility period for all diseases, began on 16 June (2020) and 7 June (2021).

Black Rot: In both years, 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. In 2020, symptom development in the untreated control indicated most of the 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 3), 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 (Table 3).

In 2021, Weather conditions from mid-June through mid-July provided for several wetting periods favorable for black rot fruit infections. All treatments provided significant control of black rot *incidence* on Concord fruit (Table 4), however the Cevya and Manzate/Ziram/Tebustar programs were significantly more effective than Tebustar alone, when compared to the untreated control. All treatments provided equal and significant control of the *severity* of black rot on fruit (Table 4).

Powdery mildew: In 2020, powdery mildew control on <u>fruit</u> 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 5). On <u>leaves</u>, the last three spray days would likely have had the most significant effects on powdery mildew disease development (days 54, 66, and 80; Table 6). All rates of Cevya maintained essentially complete control of powdery mildew by 1 September 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 (Table 6).

In 2021, control of powdery mildew on fruit would have been attributed mainly to fungicide applications at 13 and 24 days after first application. All three rates of Cevya provided very good and statistically equivalent control (85-89%) when compared to the untreated control. Cevya was generally superior to older, standard fungicides of Quintec, Endura, Vivando, and Tebustar, that provided only fair levels of significant control (49-60%, Table 7). For leaf disease, most control would have come from applications at 35, 48, 61, and 74 days after first application. All rates of Cevya and the rotation of Quintec/Endura/Vivando/Tebustar/and Cuprofix, maintained significant control of powdery mildew incidence by late August, when compared to the untreated control (Table 8). All treatments provided significant control of leaf disease severity compared to the control, however the Tebustar treatment was significantly less effective (only 15% control) than the other treatments. It's worth noting that the Cevya treatments provided equivalent control to the standard rotation despite terminating almost four weeks earlier (Table 8).

<u>Bottom Line for field trials:</u> All rates of Cevya provided complete control of black rot on both varieties and in both years, as good or better than current standards. All rates of Cevya provided good to excellent control of powdery mildew on Chambourcin and Concord fruit and on Concord leaves and was generally superior to current standard fungicides. There was no phytotoxicity associated with any of the treatments in either year.

Field inoculations: In addition to small plot, field trial evaluations (spray and wait for disease to develop naturally), inoculations of field grown clusters were 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 tables 9-11 below. Each treatment was represented by 6-9 clusters (on 3 shoots) and the experiment was replicated 8 times on Concord (2020 and 2021), and 6 (2020) and 7 (2021) times on Chambourcin. Treatments were inoculated with the black rot pathogen and subsequently evaluated for disease development about 3 weeks after inoculation. Most of the inoculations (the first 6 in 2020, first 7 in 2021) were conducted with a 5 x 10^4 spores per ml inoculum, but the last 2 (2020) and 1 (2021) of the 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 about 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. In 2020, inoculations were conducted on 25, 29, and 30 of June and 2, 6, 8, 13, and 14 of July. In 2021, inoculations were conducted on 17, 21, 22, 24, 28, and 30 of June and 5 and 6 of July (Concord bloom occurred 9 days earlier in 2021 than in 2020).

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, to rule out systemic activity between Cevya treatments 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. This was also the case with Tebustar (tebuconazole) on Chambourcin in 2021. These experiments provide strong evidence of the post infection efficacy of Cevya (and tebuconazole) and, along with the field trials, help define the practical activity of materials under test for use under Lake Erie region weather conditions.

Recommendations for using Cevya in spray programs for the Lake Erie region:

Cevya is very effective at controlling powdery mildew and black rot on grapes. In our trials, Cevya performed as good or better on powdery mildew, than current standards like Quintec, Vivando, Tebuconazol products, and Torino, and could be used to control powdery mildew (and certainly black rot) at the critical time for fruit protection around bloom, *on native varieties like Concord and Niagara* and perhaps some hybrids with low to moderate susceptibility to powdery mildew. However, for very susceptible wine grapes (*Vitis vinifera*) there may be more effective options around bloom for powdery mildew control on fruit, particularly the newer succinate dehydrogenase inhibitor products with chemistries like fluopyram (Luna Experience/Sensation) and benzovindiflupyr (Aprovia/Aprovia Top). On very susceptible varieties, like *V. vinifera*, Cevya might be a good fit applied in a tank mix with sulfur (for powdery mildew), either shortly before bloom or in the second post bloom spray.

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

For the second year (the injury trials began in 2019), 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 injured (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 6 grapevine varieties.** Please see the photos taken (with/without Cevya in 2020) in the injury trial in the 'Attachments' section below.

TECHNOLOGY TRANSFER PLAN: The results of these trials have 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 conveyed to New York and Pennsylvania growers at the recent LERGP Winter Grower Conference, February 16 zoom session ("2022 Pest Management Spray Schedule – What's Your Plan?"), and was also used to update the **2021 and 2022 NY and PA Pest Management Guidelines for Grapes**.

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

B. Hed and S. Paulson Evaluation of fungicides for control of black rot and powdery mildew of *Vitis labrusca* 'Concord' grapes, 2020. Plant Disease Management Reports (online) Vol 15:PF017. The American Phytopathological Society, St. Paul, MN.

B. Hed and S. Paulson Evaluation of fungicides for control of black rot and powdery mildew of *Vitis labrusca* 'Concord' grapes, 2021. Plant Disease Management Reports (online) Vol 16:PF018. The American Phytopathological Society, St. Paul, MN.

ATTACHMENTS: Tables 1 through 10, and photos (Appendix: with/without Cevya in 2020) in the injury trial. Additional information may be obtained by contacting Bryan Hed at bxh38@psu.edu

Table 1. Incidence and severity of black rot and powdery mildew on Chambourcin fruit in 2020

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%	0, 40, 54						
Revus Top 4SC 7 fl oz + Induce 0.25%	15, 26	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 ($P \leq 0.05$).

Table 2. Incidence and severity of black rot and powdery mildew on Chambourcin fruit in 2021

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	0, 8, 20, 33, 47	0.0 b[w]	0.00 b[w]	100	83.5 ab[w]	3.02 b[w]	92
Cevya 3.3SC at 4 fl oz	0, 8, 20, 33, 47	0.0 b	0.00 b	100	61.0 b	2.32 b	94
Cevya 3.3SC at 5 fl oz	0, 8, 20, 33, 47	0.0 b	0.00 b	100	61.0 b	1.70 b	96
Revus Top 4SC 7 fl oz		0.0 b	0.00 b	100	84.0 ab	2.63 b	93
Manzate ProStick 3 lbs	0, 8, 20, 33						
Tebustar at 5 oz	0						
Quintec 4 fl oz	8						
Endura 4.5 oz	20						
Vivando 15.4 fl oz	33						
Torino 3.4 fl oz	47						
Ziram 4 lbs	47	0.5 b	0.01 b	99	100.0 a	13.23 b	66
Unsprayed check		21.0 a	0.93 a		91.0 a	38.37 a	

[z]The first fungicide application was on 2 June. 0 = 3 weeks pre-bloom; 8 = trace bloom; 20 = 1st post bloom/end of bloom; 33 = 2nd post-bloom; 47 = 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 ($P \leq 0.05$).

Table 3: Black rot fruit rot development (under mummies in the trellis) on Concord grape (11 Aug) in 2020

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 4: Black rot fruit rot development (under mummies in the trellis) on Concord grape (10 Aug) in 2021

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	Control[x] (%)
Cevya 3 fl oz	0, 13, 24, 35, 48	0.0 c[w]	0.00 b[w]	100
Cevya 4 fl oz	0, 13, 24, 35, 48	0.0 c	0.00 b	100
Cevya 5 fl oz	0, 13, 24, 35, 48	0.0 c	0.00 b	100
Manzate Pro-Stick 75DF 3 lb	0			
Quintec 4 fl oz	13			
Endura 4.5 oz	24			
Vivando 10.3 fl oz	35			
Tebustar 5 oz	48			
Cuprofix Ultra 40 Disperss 1.25 lb + 2.5 lb lime	61, 74			
Ziram 76DF 4 lb	13, 24, 35, 48	1.0 c	0.03 b	100
Tebustar 5 oz	0, 13, 24, 35, 48	14.5 b	1.06 b	93
Untreated Control		94.0 a	15.80 a	

[z]Timing: The first fungicide application was made on 27 May. 0 = 10-12" shoots; 13 = mid-bloom; 24 = 1st post-bloom; 35 = 2nd post bloom; 48 = 3rd post bloom; 61 = 4th post bloom; 74 = 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 5: Powdery mildew development on Concord fruit (14 Aug) in 2020

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 6: Powdery mildew development on Concord leaves (1 Sep) in 2020

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 ($P \leq 0.05$).

Table 7: Powdery mildew development on Concord fruit (6 Aug) in 2021

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	Control[x] (%)
Cevya 3 fl oz	0, 13, 24, 35, 48	27.5 c[w]	0.76 c[w]	85
Cevya 4 fl oz	0, 13, 24, 35, 48	23.0 c	0.60 c	88
Cevya 5 fl oz	0, 13, 24, 35, 48	22.0 c	0.54 c	89
Manzate Pro-Stick 75DF 3 lb	0			
Quintec 4 fl oz	13			
Endura 4.5 oz	24			
Vivando 10.3 fl oz	35			
Tebustar 5 oz	48			
Cuprofix Ultra 40 Disperss 1.25 lb + 2.5 lb lime	61, 74			
Ziram 76DF 4 lb	13, 24, 35, 48	67.5 b	2.01 b	60
Tebustar 5 oz	0, 13, 24, 35, 48	66.5 b	2.57 b	49
Untreated Control		89.0 a	5.05 a	

[z]Timing: The first fungicide application was made on 27 May. 0 = 10-12" shoots; 13 = mid-bloom; 24 = 1st post-bloom; 35 = 2nd post bloom; 48 = 3rd post bloom; 61 = 4th post bloom; 74 = 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 8: Powdery mildew development on Concord leaves (26-27 Aug) in 2021

Treatment and rate/A	Days after first application[z]	Incidence (%)	Severity[y] (%)	Control[x] (%)
Cevya 3 fl oz	0, 13, 24, 35, 48	70.5 c[w]	20.22 c[w]	73
Cevya 4 fl oz	0, 13, 24, 35, 48	68.0 c	13.14 c	82
Cevya 5 fl oz	0, 13, 24, 35, 48	77.5 bc	13.11 c	82
Manzate Pro-Stick 75DF 3 lb	0			
Quintec 4 fl oz	13			
Endura 4.5 oz	24			
Vivando 10.3 fl oz	35			
Tebustar 5 oz	48			
Cuprofix Ultra 40 Disperss 1.25 lb + 2.5 lb lime	61, 74			
Ziram 76DF 4 lb	13, 24, 35, 48	70.0 c	19.01 c	74
Tebustar 5 oz	0, 13, 24, 35, 48	98.0 ab	62.77 b	15
Untreated Control		100.0 a	73.70 a	

[z]Timing: The first fungicide application was made on 27 May. 0 = 10-12" shoots; 13 = mid-bloom; 24 = 1st post-bloom; 35 = 2nd post bloom; 48 = 3rd post bloom; 61 = 4th post bloom; 74 = 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 9. Black rot fruit rot development on inoculated clusters of Concord and Chambourcin grapes in 2020

	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 ($P \leq 0.05$).

Table 10. Black rot fruit rot development on inoculated clusters of Concord grapes in 2021

	Concord	
Treatment/timing before/after inoculation	Incidence (%)	Severity[z] (%)
Unsprayed check 1	96.9 a[y]	65.99 a[y]
Unsprayed check 2	89.3 a	65.95 a
Ziram 4 lbs/A, 1 day before inoculation	**8.0 b**	**1.01 b**
Ziram 4 lbs/A, 1 day after inoculation	89.6 a	67.26 a
Cevya 5 fl oz/A, 1 day before inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 1 day after inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 3 days after inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 5 days after inoculation	**5.7 b**	**0.45 b**
P-value	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 ($P \leq 0.05$).

Table 11. Black rot fruit rot development on inoculated clusters of Chambourcin grapes in 2021

	Chambourcin	
Treatment/timing before/after inoculation	Incidence (%)	Severity[z] (%)
Unsprayed check 1	92.9 a[y]	45.53 a[y]
Tebustar 5 oz/A, 1 day before inoculation	**0.0 b**	**0.00 b**
Tebustar 5 oz/A, 3 days after inoculation	**0.0 b**	**0.00 b**
Tebustar 5 oz/A, 5 days after inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 1 day before inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 1 day after inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 3 days after inoculation	**0.0 b**	**0.00 b**
Cevya 5 fl oz/A, 5 days after inoculation	**0.0 b**	**0.00 b**
P-value	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 ($P \leq 0.05$).

Table 10: Incidence and severity of chemical injury from Cevya in 2020, on six varieties of grapes.

June 25, 2020 injury rating (leaves)				August 10, 2020 injury rating (leaves)			
Grape Variety	Rate of Cevya/A	Incidence	severity	Grape Variety	Rate of Cevya/A	Incidence	severity
Chambourcin	0 fl oz	96	2.34	Chambourcin	0 fl oz	20	0.47
	10 fl oz	80	1.87		10 fl oz	16	0.37
Chancellor	0 fl oz	84	2.25	Chancellor	0 fl oz	24	0.56
	10 fl oz	76	1.97		10 fl oz	20	0.47
Concord	0 fl oz	84	2.25	Concord	0 fl oz	16	0.37
	10 fl oz	64	1.87		10 fl oz	20	0.47
Niagara	0 fl oz	44	1.03	Niagara	0 fl oz	4	0.09
	10 fl oz	60	1.40		10 fl oz	4	0.09
Vidal	0 fl oz	52	1.22	Vidal	0 fl oz	12	0.28
	10 fl oz	52	1.22		10 fl oz	12	0.28
Vignoles	0 fl oz			Vignoles	0 fl oz	24	0.56
	10 fl oz				10 fl oz	24	0.56
All varieties	0 fl oz	72 .0	1.82	All varieties	0 fl oz	16.7	0.39
	10 fl oz	66.4	1.67		10 fl oz	16.0	0.37

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 Covay

Vidal 10 fl oz/A Cevya

Vignoles 0 fl oz/A Cevya

Vignoles 10 fl oz/A Cevya