# Evaluation of fungicide programs for management of bunch rot of grapes: 2022 field trials

Karina Elfar, Karen Alarcon, Carlos Carachure, Victor Bravo, Marcelo Bustamante, Molly Arreguin, Janet Kuzmenko and Akif Eskalen
Department of Plant Pathology, University of California, Davis, CA, 95616

University of California Cooperative Extension,
Department of Plant Pathology,
University of California, Davis, September 2022

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# Report Summary

Bunch rot and sour rot of grapes caused by *Botrytis cinerea* and a number of other filamentous fungi including *Aspergillus niger, A. carbonarius, Alternaria tenuis, Cladosporium herbarum, Rhizopus arrhizus, Penicillium* sp. Both diseases leads to a reduction in the yield and quality of table, raisin, and wine grapes, with high economic losses in some locations or years (Flaherty et al. 1992). Botrytis overwinters as sclerotia in mummified berries on the vine or ground or on dormant canes. The disease may first appear as shoot blight following frequent spring rains; flowers can become infected during bloom (Bulit and Dubos 1988). In infected fruits, disease symptoms are latent until late in the season. As sugar concentration increases in the berry, the fungus resumes growth and infects the entire fruit, often resulting in berry splitting and sporulation on the fruit surface (Flaherty et al. 1992). Free water is a requirement for the pathogen, and favorable conditions include humidity's exceeding 90% and temperatures between 15-27° (Bulit and Dubos 1988, Gubler et al. 2008, Steel et al., 2011). Along with leaf removal and other cultural controls, good spray coverage with a synthetic fungicide is currently the most effective form of disease management.

In this trial, we examined the efficacy of 47 experimental and registered fungicide treatment programs (Table 1) for control of Botrytis bunch rot and sour rot in Riesling vineyard in Clarksburg in 2022

# Materials and Methods

## A. Experimental design

**Table 1.** Experimental design

| | | | |
|---|---|---|---|
| Experimental design | Completely randomized design with 5 replicates | | |
| Experimental unit | 3 adjacent vines = 1 plot | | |
| Row and tree spacing | 11 ft (row) and 5 ft (vine) | Plot unit area | 165 $ft^2$ |
| Area/treatment | 825 $ft^2$ or 0.01956 acre/treatment (5 replicates = 1 treatment) | | |
| Fungicide Applications, Volume water/Acre | A bloom, May 9$^{th}$, 100 gallons = 1.5152 gal/5 reps<br>B pre-close, June 6$^{th}$, 150 gallons = 2.2727 gal/5 reps<br>C veraison, July 14$^{st}$, 150 gallons = 2.2727 gal/5 reps<br>D pre-harvest, August 5$^{th}$, 150 gallons = 2.2727 gal/5 reps | | |
| Equipment | Stihl SR 430 Backpack Sprayers | | |

## B. Map

| Row 1 | Row 2 | Row 3 | Row 4 | Row 5 | Row 6 | Row 7 | Row 8 |
|---|---|---|---|---|---|---|---|
| x | x | x | 9-OKD | x | x | x | 28-G |
| x | x | 42-PWD | | x | 6-O | 18-YKC | |
| x | x | | 15-YC | 44-PWC | | | 6-O |
| x | x | 11-ONS | | | 30-GS | 49-B+Y | |
| x | x | | 29-GD | 10-OKS | | | 46-PKS |
| 28-G | x | | | | 39-BKS | 39-BKS | |
| | 31-GKD | 40-BKC | 30-GS | 14-YS | | | 22-RD |
| 27-RKC | 32-GKS | 29-GD | | | 28-G | 49-B+Y | |
| | | | 39-BKS | 16-YKD | | | 43-PWS |
| 35-BD | 7-OS+O | 42-PWD | | x | 34-B | 3-KD | |
| | | | 18-YKC | x | | | 41-Pu |
| 50-B+G | 27-RKC | 20-YRS | | x | 7-OS+O | 41-Pu | |
| | | | 8-OC+O | 3-KD | | | x |
| 9-OKD | 44-PWC | 17-YKS | | | 45-PKD | 22-RD | 23-RS+R |
| | | | 4-KS | 48-B+K | | | |
| 46-PKS | 25-RKD | 3-KD | | | 49-B+Y | 23-RS+R | 24-RC+R |
| | | | 5-KC | 8-OC+O | | | |
| 1-W | 45-PKD | 33-GKC | | | 7-OS+O | 1-W | 26-RKS |
| | | | 4-KS | 13-YD | | | |
| 37-BC | 12-Y | 19-YRD | | | 43-PWS | 37-BC | 11-ONS |
| | | | 45-PKD | 25-RKD | | | |
| 25-RKD | 34-B | 23-RS+R | | | 8-OC+O | 23-RS+R | 40-BKC |
| | | | 24-RC+R | 10-OKS | | | |
| 30-GS | 31-GKD | 33-GKC | | | 15-YC | 33-GKC | 2-K |
| | | | 46-PKS | 16-YKD | | | |
| 21-R | 41-Pu | 44-PWC | | | 41-Pu | 16-YKD | 21-R |
| x | | | 15-YC | 19-YRD | | | |
| 36-BS | 44-PWC | 18-YKC | | | 12-Y | 45-PKD | 43-PWS |
| | | | 5-KC | 14-YS | | | |
| 11-ONS | 32-GKS | 41-Pu | | x | 16-YKD | 5-KC | 20-YRS |
| | | | 12-Y | x | | | |
| 12-Y | 31-GKD | 13-YD | | 17-YKS | 39-BKS | 25-RKD | 18-YKC |
| | | | 47-PKC | | | | |
| 46-PKS | 16-YKD | 14-YS | | 23-RS+R | 38-BKD | 38-BKD | 29-GD |
| | | | 30-GS | | | | |
| 40-BKC | 42-PWD | 26-RKS | | 34-B | 30-GS | 15-YC | 28-G |
| | | | 17-YKS | | | | |
| 7-OS+O | 38-BKD | 19-YRD | | 19-YRD | 9-OKD | 49-B+Y | 48-B+K |
| | | | 50-B+G | | | | |
| 45-PKD | 9-OKD | 10-OKS | | 15-YC | 29-GD | 18-YKC | 2-K |
| | | | 37-BC | | | | |
| 48-B+K | 36-BS | 8-OC+O | | 9-OKD | 39-BKS | 26-RKS | 35-BD |
| | | | 31-GKD | | | | |
| 12-Y | 32-GKS | 50-B+G | | 27-RKC | 14-YS | 4-KS | 46-PKS |
| | | | 20-YRS | | | | |
| 33-GKC | 28-G | 2-K | | 42-PWD | 25-RKD | 3-KD | 40-BKC |
| | | | 4-KS | | | | |
| 35-BD | 48-B+K | 24-RC+R | | 2-K | 11-ONS | 6-O | 13-YD |
| | | | 24-RC+R | | | | |
| 47-PKC | 19-YRD | 48-B+K | | 36-BS | 37-BC | 21-R | 4-KS |
| | | | 3-KD | | | | |
| 44-PWC | 5-KC | 26-RKS | | 10-OKS | 40-BKC | 32-GKS | 5-KC |
| | | | x | | | | |
| 37-BC | 47-PKC | 36-BS | 17-YKS | 38-BKD | 6-O | 50-B+G | 1-W |
| 11-ONS | 22-RD | 22-RD | 17-YKS | 1-W | 2-K | 29-GD | 7-OS+O |
| 43-PWS | 36-BS | 34-B | 27-RKC | 35-BD | 43-PWS | 35-BD | 14-YS |
| 33-GKC | 34-B | 21-R | 49-B+Y | 13-YD | 50-B+G | 26-RKS | 21-R |
| 20-YRS | 27-RKC | 13-YD | 31-GKD | 20-YRS | 6-O | 24-RC+R | 32-GKS |
| 38-BKD | 47-PKC | 1-W | 10-OKS | 22-RD | 42-PWD | 8-OC+O | 47-PKC |
| Row 1 | Row 2 | Row 3 | Row 4 | Row 5 | Row 6 | Row 7 | Row 8 |

N

| Color | |
|---|---|
| B | Blue |
| G | Green |
| K | Black |
| O | Orange |
| P | Pink |
| Pu | Purple |
| R | Red |
| Y | Yellow |
| W | White |
| N | Gray |

| Pattern | |
|---|---|
| C | Checker |
| D | Dot |
| S | Stripe |

## C. Experimental treatments

The treatments described in this report were conducted for experimental purposes only and crops treated in a similar manner may not be suitable for commercial or other use.

## D. Vine Management

During the application period, vines were irrigated by drip irrigation. Sucker shoot removal and leafing were done during the duration of trial.

## E. Data Collection and Statistics

Daily temperature and precipitation were obtained from a CIMIS weather station in Sacramento Valley (Station 243). The temperature data is shown in Figure 1.

Disease was assessed on August 29th (berries with 15.7 total soluble solids). Bunch rot (Botrytis Bunch Rot and Sour Rot) incidence and severity were assessed in each treatment by evaluating twenty-five random clusters. Incidence was defined as the proportion of clusters in a plot having bunch rot. Severity was determined by estimating the percentage of area of a cluster that was infected; the severity value of all clusters was then averaged to give a plot-wide estimate of disease severity. Mean incidence and severity values for each treatment were computed. Trial models were analyzed using the ANOVA Tests for data. Means comparisons were made using Fisher's LSD with $\alpha$=0.05.

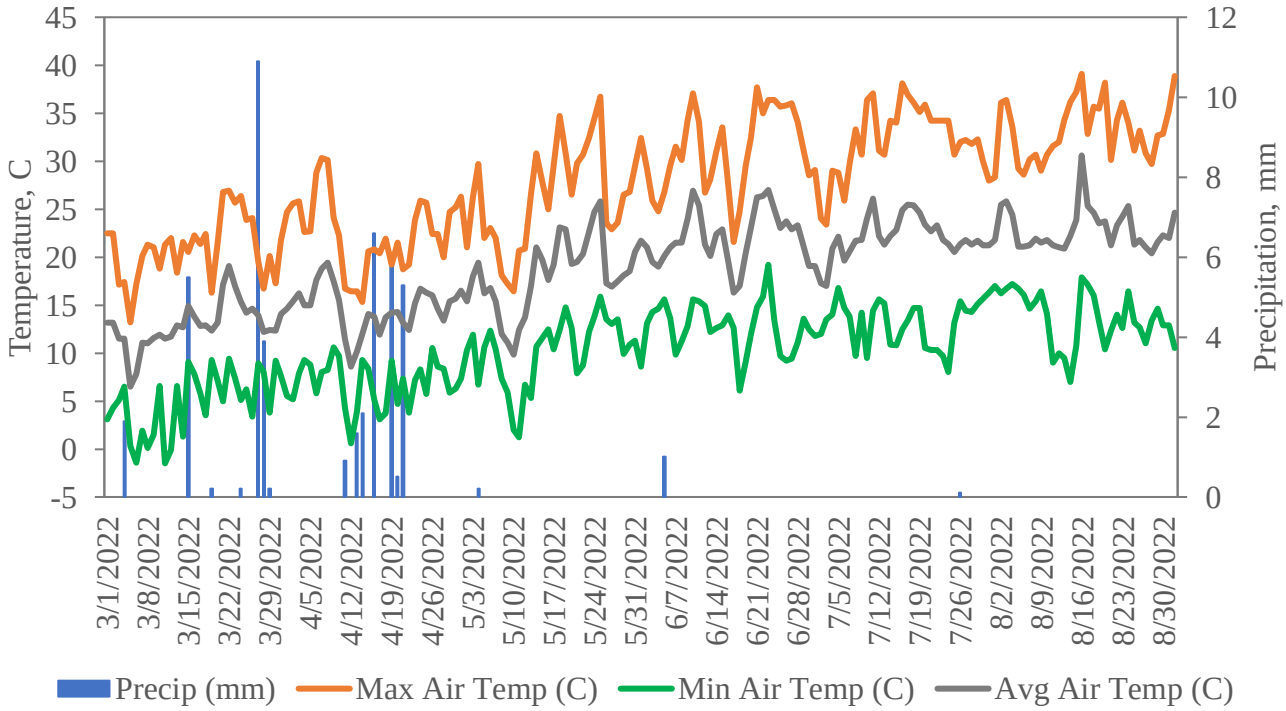


**Figure 1.** Average daily temperature (°C) and precipitation (mm) from March 1st to September 1st, 2022 from CIMIS station 243 Sacramento Valley CA.

## F. Pictures of Treatments

Pictures of each treatment can be reached by clicking on the active link on each trial number in the result tables.

## G. Results

**Table 1.** Disease incidence and severity. Product names are followed by rate (per acre) Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05

| Treatment [x] | | | Application time [y] | Bunch rot on the clusters [z] | |
|---|---|---|---|---|---|
| **No.** | **Flag** | **Rate/A** | | **Incidence, %** | **Severity, %** |
| **4** | KS | Mevalone 55 fl oz + Kinetic 0.125% v/v | A, B, C, D | 44.0 n.s. | 7.4 a |
| **14** | YS | ASFBIOF01-02 48 oz + Activator-90 16 fl oz<br>Switch-62.5 WD 14 oz /<br>Pristine 23 oz /<br>Elevate 50 WDG 16 oz | A<br>B<br>C<br>D | 48.0 | 10.5 ab |
| **11** | ONS | ASFBIOF01-02 48 oz<br>Pristine 23 oz<br>Elevate 50 WDG 16 oz | A<br>B<br>C, D | 38.4 | 11.6 a-c |
| **6** | O | Mevalone 55 fl oz + Kinetic 0.125% v/v<br>Luna Experience 8.5 fl oz | A, C<br>B, D | 45.6 | 12.3 a-d |
| **16** | YKD | ASFBIOF01-02 48 oz + Activator-90 16 fl oz | A, B, C, D | 33.6 | 12.4 a-e |
| **40** | BKC | AGS-FunThyme 0.5%v/v + DynAmic 0.1%v/v | A, B, C | 47.2 | 13.1 a-f |
| **15** | YC | ASFBIOF01-02 48 oz | A, B, C, D | 50.4 | 13.7 a-f |
| **13** | YD | ASFBIOF01-02 48 oz<br>Swithch-62.5 WD 14 oz<br>Pristine 23 oz<br>Elevate 50 WDG 16 oz | A<br>B<br>C<br>D | 56.8 | 13.7 a-g |
| **18** | YKC | Luna Tranguility 14 oz + Syl-Coat 4 oz/100 gal<br>Scala 18 oz + Syl-Coat 4 oz/100 gal | A, B, C<br>D | 52.8 | 14.6 a-g |
| **26** | RKS | OR-491 50 fl.oz/100 gal + OR-009E 32 fl.oz/100 | A, B, C, D | 47.2 | 14.7 a-h |
| **10** | OKS | Pristine 23 oz<br>Elevate 50 WDG 16 oz | B<br>C, D | 57.6 | 14.8 a-i |
| **29** | GD | OR-009E 32 fl.oz/100 | A, B, C, D | 50.4 | 15.2 a-j |
| **46** | PKS | OxiDate 5.0 1% v/v + Kinetic 0.125% v/v | A, B, C, D | 44.8 | 15.5 a-k |
| **47** | PKC | Luna Experience 8.5 fl oz /<br>Pristine 23 oz<br>OxiDate 5.0 1% v/v + Kinetic 0.125% v/v | A<br>B<br>C, D | 52.8 | 16.1 a-l |
| **5** | KC | Mevalone 55 fl oz + Kinetic 0.125% v/v<br>Elevate 50WDG 1 lb | A, C<br>B, D | 54.4 | 16.4 a-l |
| **24** | RC+R | Howler 2.5 lb + Theia 1.5 lb + Kinetic 0.125%v/v | A, B, C, D | 52.7 | 16.5 a-l |
| **38** | BKD | Berezi at 5 lb/A. | A, B, C | 49.6 | 17 a-l |
| **12** | Y | ASFBIOF01-02 48 oz + Activator-90 16 fl oz<br>Pristine 23 oz<br>Elevate 50 WDG 16 oz | A<br>B<br>C, D | 50.4 | 17.1 a-l |

| | | | | | |
|---|---|---|---|---|---|
| **3** | KD | SA-0650004 28 fl oz | A, B, C, D | 52.0 | 17.5 a-l |
| **37** | BC | Berezi at 3 lb/A. | A, B, C | 52.0 | 17.7 a-l |
| **45** | PKD | NSA 1% v/v + Nordox 4 oz/100 gal + Silco 1 qt/100 gal<br>NSA 1% v/v + Potum 2.5 lb/100 gal + Silco 1 qt/100 gal<br>NSA 1% v/v + Nordox 4 oz/100 gal + Potum 5 lb/100 gal | A<br>B, D<br>C | 62.4 | 17.7 a-l |
| **2** | K | JMS Stylet-Oil 1% v/v | A, B, C, D | 48.8 | 17.8 a-l |
| **33** | GKC | BTS EXP 100 20.5 fl oz + Kinetic 0.05%v/v | A, B, C, D | 57.6 | 18.2 b-l |
| **39** | BKS | AGS-Fun 2 0.5%v/v + DynAmic 0.1%v/v | A, B, C | 53.6 | 19 c-m |
| **17** | YKS | Luna Experienve 8.6 oz + Syl-Coat 4 oz/100 gal<br>Scala 18 oz + Syl-Coat 4 oz/100 gal<br>Serenade ASO 4 qt + Syl-Coat 4 oz/100 gal | A<br>B, D<br>C | 65.6 | 19.7 c-m |
| **27** | RKC | OR-488 40 fl.oz/100 gal + OR-097A 32 fl.oz/100 | A, B, C, D | 56.8 | 20.1 c-m |
| **19** | YRD | LALSTOP-G46 3.5oz/acre + LALSTIM-OSMO 4.5oz/acre | A, B, C, D | 62.4 | 20.3 c-m |
| **9** | OKD | Switch 62.5WG 14 oz<br>Pristine 23 oz<br>Elevate 50 WDG 16 oz | A<br>B<br>C, D | 60.0 | 20.3 c-m |
| **20** | YRS | Boost Biomes BC18 (@1X label rate) | A, B, C, D | 58.4 | 20.4 c-m |
| **44** | PWC | NSA 1% v/v + Nordox 4 oz/100 gal + Silco 1 qt/100 gal<br>NSA1% v/v + Sulphur 3 lb/A+ Silco 1 qt/100 gal<br>NSA 1% v/v + Nordox 4 oz/100 gal + Potum 5 lb/100 gal<br>NSA 1% v/v + Potum 2.5 lb/100 gal + Silco 1 qt/100 gal | A<br>B<br>C<br>D | 56.8 | 20.9 d-m |
| **42** | PWD | NSA 1% v/v + Potum 5 lb/100 gal + Sulfur Dry Flowable 3lb/A + Silco 2 qt/100 gal | A, B, C, D | 68.0 | 20.9 d-m |
| **21** | R | Howler 5lb + Kinetic 0.125%v/v | A, B, C, D | 59.2 | 21.2 d-m |
| **35** | BD | Luna Experience 8.5 fl oz/<br>Pristine 23 oz/<br>BTS 100 20.5 fl oz + Kinetic 0.05%v/v / | A<br>B<br>C, D | 57.6 | 21.3 d-m |
| **23** | RS+R | Esendo 2.8lb + Kinetic 0.125%v/v | A, B, C, D | 56.0 | 21.4 e-m |
| **25** | RKD | microSURE (Agriwash) 4.36 ga/A | A, B, C, D | 57.6 | 23.1 f-m |
| **8** | OC+O | P18-16 2 oz + Embrace EA 16 fl oz/100 gallons | A, B, C, D | 53.6 | 23.6 f-m |
| **30** | GS | X7N68-R007 16 fl oz/A | A, B, C, D | 63.2 | 24.2 g-m |
| **36** | BS | Luna Experience 8.5 fl oz<br>Pristine 23 oz<br>BTS 100 27.4 fl oz + Kinetic 0.05%v/v | A<br>B<br>C | 62.4 | 25.3 g-m |
| **22** | RD | Theia 3 lb + Kinetic 0.125%v/v | A, B, C, D | 62.4 | 25.6 g-m |
| **28** | G | OR-009E 48 fl oz/100 | A, B, C, D | 62.4 | 25.9 h-m |
| **43** | PWS | NSA 1.4% v/v | A, B, C, D | 61.6 | 26.7 i-m |
| **31** | GKD | X7N68-R007 16 fl oz/A + Dyne-Amic 0.125%v/v | A, B, C, D | 64.0 | 26.8 j-m |
| **1** | W | Untreated Control | - | 63.2 | 27.7 j-m |

| | | | | | |
|---|---|---|---|---|---|
| **41** | Pu | NSA 1% + Potum 5 lb/100 gal + Nordox 8 oz/100 gal | A, B, C, D | 72.8 | 27.8 j-m |
| **34** | B | BTS EXP 100 27.4 fl oz + Kinetic 0.05% v/v | A, B, C, D | 68.0 | 29.1 k-m |
| **32** | GKS | CS-2005 32 ounce/A | A, B, C, D | 63.2 | 31.1 lm |
| **7** | OS+O | P18-16 1 oz + Embrace EA 16 fl oz/100 gallons | A, B, C, D | 67.2 | 31.5 m |

[x] Products with a '+' sign in between indicates a tank mix

[y] Fungicide application times were A= bloom (May 12), B = pre-bunch closure (June 11), C= veraison (July 21), D= pre-harvest (Aug 5), Trial was evaluated (Aug 29)

[z] Means followed by the same letter within a column are not significantly different according to Fisher's LSD with $\alpha$=0.05.

n.s.= not significant

## Acknowledgements

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# Appendix: Materials

| **Product** | **Active ingredient(s) and concentration** | **Manufacturer or distributor** | **Chemical class (Frac Code)** |
|---|---|---|---|
| Activator-90 | proprietary | Biotaly's | N/A |
| AGS-Fun 2 | proprietary | Agrospheres | N/A |
| AGS-FunThyme | proprietary | Agrospheres | N/A |
| ASFBIOF01-02 | proprietary | Biotaly's | N/A |
| Berezi | proprietary | NovaSource | N/A |
| Boost Biomes BC18 | proprietary | Boost Biomes | N/A |
| BTS-EXP-100 | proprietary | Botanical Solution Inc (BSI)_ | natural compound (P04) |
| CS-2005 | copper sulfate pentahydrate | Magna-Bon | inorganic (M01) |
| Dyne-Amic | polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of c16-c18 fatty acids (99%) | Helena Chemical Co. | adjuvant |
| Elevate 50 WG | fenhexamid | Arysta LifeScience North America LLC | KRI (17) |
| Embrace-EA | polyoxyalkylen polyol fatty acid ester, alcohol ethoxylate (78.92%) | Wilbur-Ellis | adjuvant |
| Esendo | proprietary | AgBiome Innovations | N/A |
| Howler | *Pseudomonas chlororaphis* strain AFS009 (50%) | AgBiome Innovations | microbial (BM 02) |
| JMS Stylet-oil | paraffinic oil | JMS Flower Farms | mineral oil (NC) |
| Kinetic | polyoxyethylene-polyoxypropylene copolymer, polyether modified (99%) heptamethyltrisiloxane | Helena Agri-Enterprises, LLC | adjuvant |
| LALSTIM-OSMO | Glycine betaine | Danster Ferment AG/ Lallemand Plant Care | soil and plant substance |
| LALSTOP-G46 | *Clonostachys rosea* strain j1446 (formerly known as *Gliocladium catenulatum* strain j1446) | Danster Ferment AG/ Lallemand Plant Care | microbial (BM 02) |
| Luna Experience | fluopyram (17.54%), tebuconazole (17.54%) | Bayer CropScience | SDHI (7)/DMI-triazole (3) |
| Luna Tranquility | Pyrimethanil (33.8 %), Fluopyram (11.3%) | Bayer CropScience | AP (9)/SDHI (7) |
| Mevalone | Geraniol, Eugenol, Thymoil | Sipcam | Biofungicide |
| microSURE™ | proprietary | Strategia Project Management Inc | N/A |
| Nordox | Cuprous Oxide | Brandt, Inc | N/A |
| NSA | proprietary | Henry Manufacturing Limited | N/A |

| | | | |
|---|---|---|---|
| OR-009E | proprietary | Oro-Agri | N/A |
| OR-097A | proprietary | Oro-Agri | N/A |
| OR-488 | proprietary | Oro-Agri | N/A |
| OR-491 | proprietary | Oro-Agri | N/A |
| OxiDate 5.0 | Peroxyacetic Acid (5%), Hydrogen Peroxide (27%) | BioSafe Systems | N/A |
| P18-16 | proprietary | Plant Health Care | microbial (BM 02) |
| Potum | proprietary | Henry Manufacturing Limited | N/A |
| Pristine | pyraclostrobin (12.8%), boscalid (25.2%) | BASF | QoI(11)/SDHI (7) |
| SA-0650004 | proprietary | Sipcam | N/A |
| Scala | Pyrimethanil (54.6%) | Bayer CropScience | AP (9) |
| Serenade ASO | *Bacillus subtilis* qst 713 (26%) | Bayer CropScience | microbial (44, NC) |
| Silco | proprietary | Henry Manufacturing Limited | N/A |
| Sulfur Dry Flowable | sulfur (80%) | Wilbur-Ellis | inorganic (M2) |
| Switch | cyprodinil (37.5%), Fludioxonil (25.0%) | Syngenta | AP (9)/ Phenylpyrroles (12) |
| Syl-Coat | polyether-polymethylsiloxane-copolymer and polyether-100% | Wilbur-Ellis | adjuvant |
| Theia | proprietary | Agbiome | N/A |
| X7N68-R007 | proprietary | FMC Corporation | N/A |