Annual Report - 2017

Prepared for the Dried Plum Board of California

Title:	Epidemiology and management of blossom, leaf, and fruit diseases of prune
Status:	3rd Year
Principal Investigator:	J. E. Adaskaveg Department of Plant Pathology, University of California, Riverside 92521
Cooperating:	D. Thompson, H. Forster (UC Riverside), F. Niederholzer (UCCE-Sutter/Yuba Co.), and K. Pope (UCCE-Yolo Co.)

SUMMARY OF RESEARCH ACCOMPLISHMENTS IN 2017

1. ***Bacterial canker caused by* Pseudomonas syringae *pv.* syringae.** Branches of French prune trees were inoculated and treated with selected bactericides in the dormant period and evaluated for canker development in early spring. Kasumin, ZTD, and both rates of DAS-2 significantly reduced canker size as compared to the control, but ZTD did not overcome copper resistance when mixed with copper.

   Kasumin (active ingredient kasugamycin) is set for full registration on cherry in January 2018 based on the US EPA PRIA date. Oxytetracycline has been submitted to the EPA through the IR-4 program for registration on cherry with support from the registrants, the California Cherry Board, and other researchers in the North Central and Northeastern regions of the United States. Oxytetracycline is registered on peach and Kasumin's registration on peach is pending.

2. ***Fruit brown rot***. In applications done 7 days PHI at 130 gal/A, addition of a summer oil provided significantly (i.e, Quadris Top and Bumper) or numerically (i.e., Luna Experience and Merivon) better decay control of wound-inoculated fruit than addition of a non-ionic surfactant. Bumper used without any additive was not effective in these wound-inoculation studies where wound sites are approximately 2 mm deep under the broken fruit skin. Overall, Bumper applied with 2% agricultural summer oil resulted in the lowest incidence of brown rot.

   In another study with 11-day PHI applications of registered and new fungicides in combination with a non-ionic surfactant, fungicides containing a DMI compound (e.g., Rhyme, Indar, Luna Experience, Quadris Top) as well as the experimentals UC-1, UC-2, and IL-5412 significantly reduced the incidence of brown rot from that of the control after wound-inoculation. Indar, Luna Experience, UC-1, and IL-5412 were most effective. In contrast, the SDHI compounds Fontelis, Pyraziflumid, and Pydiflumetofen had no effect, thus, they do not penerate into the fruit and are contact materials. All fungicides previously were shown to be very effective when treated fruit were non-wound inoculated with the brown rot pathogen.

3. ***Rust***. In a late-season study on the management of rust, most fungicides were highly effective. Very low disease ratings were observed after treatment with Rhyme, Fontelis+Tebucon, Luna Experience, Merivon, and IL-5412, whereas Kenja, UC-1, and EXP-AD were among the least effective treatments. These latter treatments, however, still significantly reduced the severity of disease as compared to the control. Because UC-1 and EXP-AD contain DMI fungicides, the individual formulation concentrations perhaps are too low.

4. ***In vitro sensitivity of* M. laxa*, and* M. fructicola *to new SDHI fungicides.*** All 25 isolates of *M. laxa* were determined to be highly sensitive to fluopyram, fluxapyroxad, isofetamid, pydiflumetofen, and pyraziflumid, each belonging to a different SDHI sub-group. Two of the 32 isolates of *M. fructicola* were less sensitive to pydiflumetofen, isofetamid, and pyraziflumid or fluopyram, respectively, as compared to the remaining isolates. Still, all isolates evaluated are considered sensitive to the SDHI fungicides tested. The results indicate possible cross-resistance patterns among the sub-groups and a risk of selection of isolates with lower sensitivity or resistance. All isolates of *M. fructicola* were found to be highly sensitive to the new fungicide cyflufenamid (FG U 06), whereas those of *M. laxa* were not affected in growth at 40 mg/liter. The two species are sometimes difficult to differentiate in culture, and this differential sensitivity to cyflufenamid could therefore be used for species separation.

INTRODUCTION

Brown rot, caused by *Monilinia* species is the most important blossom and preharvest fruit disease of prune in California. In many growing areas of the state, *M. laxa* is the primary pathogen on blossoms, whereas *M. fructicola* is the main pathogen on fruit. Still, both species can be found causing blossom blight and fruit rot depending on the geographical production areas in California. Currently, fungicide treatments that are properly timed are the most effective method to control this disease. Highly effective fungicides of different classes have been identified over the years: the currently registered FRAC group (FG) 2 Rovral/Nevado/Iprodione; FG 3 Tebucon/ Toledo, Indar, Tilt/Bumper, Quash, and Rhyme; the FG 7 Fontelis; FG 9 Scala and Vangard; FG 11 Abound and Gem; FG 17 Elevate, and FG 19 Ph-D (Table 1). Pre- mixtures also provide excellent control, and products evaluated include: FG 3/9 (Inspire Super); FG 3/11 (Quadris Top, Quilt Excel); FG 7/11 (Pristine, Merivon, Luna Sensation), and FG 3/7 (Luna Experience). A pending registration on dried plum includes FG 7 Kenja. Several experimental pre-mixtures such as UC-2, EXP-AD, -AF, IL compounds, and Pyraziflumid (formerly R-106506) are also planned for registration. Pre-mixtures are highly effective, consistent, and provide resistance management on stone fruit crops because they have two modes of action and are ideal for California production where overall a minimal number of applications is needed for disease management.

We also continued our evaluations of natural products (e.g., Fracture), and biocontrols (e.g., Serenade Opti, Botector). Results obtained in 2013-2016 demonstrated good to intermediate brown rot blossom blight control. Additionally, the bio-fungicide Ph-D showed intermediate efficacy against blossom blight, and in mixture with Scala, was also very effective against fruit brown rot. Products such as Ph-D (active ingredient polyoxin-D) and EXP-13 have exempt status in the United States. Potentially, the National Organic Standards Board and the Organic Materials Review Institute (OMRI) could certify some formulations for use in the organic production of stone fruit including prune. Thus, these products could be critical developments for the organic production segment of the dried plum industry, as well as to conventional growers because preharvest rotation programs need to be designed that prevent the overuse of any one fungicide mode of action (FG).

Laboratory inoculation and field studies provide information on the protective and local systemic action of compounds and should help growers and PCAs in the selection of materials and treatment timing to optimize individual management programs. Fungicides that have post-infection activity (i.e., 'kick-back action') could be applied as a single, delayed bloom application when environmental conditions are not favorable for disease. Under high disease pressure, a two-spray bloom program should be followed using protective or locally systemic fungicides. This information can also be applied to preharvest treatments when unexpected rains delay fungicide applications for 1-2 days and materials with post-infection activity are needed. Having several highly effective fungicides belonging to different FRAC Groups for managing diseases of prune allows for rotations and reduces the risk of selecting for resistance. The overall objective is to rotate products representing different FGs and using any one of the FGs only once (or twice) per season. Rotations of pre-mixtures that alternate at least one of the FGs in the mixture are part of resistance management strategies. Baseline sensitivities for new fungicides are being established to serve as references for resistance monitoring and to detect possible cross-resistance patterns among fungicides. In 2017, we focused on several new SDHI fungicides, and we evaluated their activity against *M. laxa* and *M. fructicola*.

In our fungicide field programs, we are also demonstrating how to improve the efficacy of preharvest fungicide treatments. The addition of a summer spray-oil significantly increases the efficacy of most fungicides in reducing brown rot. We also demonstrated that preharvest fungicide applications at higher water volumes (i.e., 160 vs. 80 gal/A) in most cases significantly improved fungicide efficacy on fruit developing in clusters inside the tree canopy.

In some years with spring and summer rainfall, early-season (e.g., early summer) epidemics of prune rust caused by the fungus *Tranzschelia discolor* can cause defoliation and subsequent direct (e.g., sunburn) and indirect (e.g., re-foliation of trees and reduced bloom in the subsequent season) crop losses. In the last few years, we have identified new effective materials in FGs 3, 7, 11 and 19, as well as pre-mixture FGs 3/11, 3/7, 3/19, and 7/11. Fungicides and integrated approaches need to be evaluated in season-long disease management programs that take into account the control of multiple diseases such as brown rot and prune rust.

Another disease that we are studying is bacterial blast of blossoms and bacterial canker of woody tissues of prune and other stone fruit crops caused by *Pseudomonas syringae* pv. *syringae* and other pathovars. Bacterial blast and canker are associated with nematode root damage and cold, wet environments. Blossom blast is associated with cold injury. Copper treatments have been used with inconsistent results for years. Copper can be phytotoxic to blossoms, and we have shown that pathogen populations have developed copper resistance. We will continue experiments to validate that the new antibiotic kasugamycin is effective on prune. Kasugamycin registration is pending in California for pome fruits, almond, cherry, and walnut. Unfortunately, no disease was detected in our field studies last year, and we will repeat our efforts in the 2017/18 season. Our studies could potentially lead to a major advancement for the dried plum industry.

Objectives

1. Evaluate the efficacy of new fungicides (e.g., polyoxin-D, adepidyn, UC-1, EXP-A), pre-mixtures (Viathon, UC-2B, EXP-AD, -AF, IKF-5412, IL-54113, -54114), and biocontrols (Botector, Fracture) representing different modes of action for brown rot blossom blight and brown rot fruit rot in laboratory and field trials, as well as rust in field trials.
   a. Pre- and post-infection activity of selected fungicides against brown rot blossom blight and fruit rot.
   b. Evaluation of preharvest fungicides in combination with selected spray adjuvants
   c. Evaluation of fungicide efficacy against prune rust.
2. Continue to develop baseline sensitivity data for new fungicides (e.g., pydiflumetofen, isofetamid, UC-1,).
3. Evaluate the efficacy of new products against bacterial blast and bacterial canker in flower and twig inoculation studies, respectively.
   a. New bactericides – ZTD and SDH for bacterial blast and canker
   b. Antibiotics – kasugamycin and other antibiotics.
   c. Biologicals/natural products, *Bacillus*-containing products, Botector-*Aureobasidium* sp.).

MATERIALS AND METHODS

Evaluation of treatments for control of bacterial canker. In winter of 2017, the bark of 2-year-old twigs of French prune trees was puncture-wounded using a 12-gauge needle (3 wounds per twig). Wounds were sprayed with bactericides to run-off using a hand sprayer, allowed to air-dry, and spray-inoculated with a copper-resistant strain of *Pseudomonas syringae* pv. *syringae* (2×10^8 cfu/ml). Treatments included ChampION^{++}, copper mixed with ZTD or pre-mixed with a copper activity-enhancing compound (i.e., DAS-2), ZTD by itself, and Kasumin. In May, inoculated branches were sampled and evaluated for the severity of canker formation by measuring canker length (in mm). Data were analyzed using analysis of variance and mean separation

Evaluation of fungicides for management of blossom blight and preharvest fruit decay. Field studies were conducted on the management of brown rot blossom blight and bacterial blossom blast, as well as fruit decay in 2017. For blossom blight, four single tree replications were sprayed with four biologicals (Fracture, WX-16005, Botector and MBI-110AF5), seven single ai's (UC-1, Rhyme, Indar, Fontelis, Pyraziflumid, Kenja, and Pydiflumetofen) and six pre-mixtures (UC-2, IL-5412, EXP-AD, Luna Experience, Luna Sensation, and Merivon). Field trials to evaluate preharvest fungicide applications for control of fruit brown rot were done in a commercial orchard in Yuba Co. with 11-day PHI treatments (using the same fungicides as described above) and in an experimental orchard at UC Davis with 7-day PHI treatments using Luna Experience, Quadris Top, Bumper, and Merivon). Treatments were applied using an air-blast sprayer calibrated at 130 gal/A. In the commercial orchard a surfactant was used with each fungicide; whereas in the Davis trial, fungicides were applied in combination with 2.0% of a spray oil (i.e., Omni Oil) or a non-ionic surfactant (i.e., Breakthru at 8 fl oz/A). Single fruit (12 fruit from each replication) were collected at harvest and wound-inoculated with conidia of *M. fructicola* (3×10^4 conidia/ml). After inoculation, fruit were incubated for 7-10 days at 20 C. Data were analyzed using analysis of variance and mean separation procedures of SAS 9.4.

Evaluation of fungicides for management of prune rust. A field trial was established in a commercial orchard in Yuba Co. to evaluate the efficacy of new fungicides (using the same fungicides except the biologicals as described above). Fungicides were applied on 8-3-17 (as a preharvest application for management of fruit brown rot) and on 9-13-17 specifically for fall season rust management. Disease was evaluated on 10-27-2017. Disease severity was determined for four quadrants of each tree using a scale from 0 (= no disease) to 4. Data were analyzed using analysis of variance and mean separation procedures of SAS 9.4.

In vitro sensitivity of* M. laxa*, and* M. fructicola *to new SDHI fungicides. 25 isolates of *M. laxa* and 32 isolates of *M. fructicola* (collected 2010 or before) were used to determine inhibitory concentrations for mycelial growth using the spiral gradient dilution method. In the assay, conidial suspensions were streaked along fungicide concentration gradients and mycelial growth was measured after 3 days. EC_{50} values were calculated as described previously, and data were summarized in histograms.

RESULTS AND DISCUSSION

Evaluation of fungicides for management of bacterial blast and canker. Field studies were conducted on the management of bacterial blast, however, only very low levels of disease developed at our trial sites. For bacterial canker, treated, injured branches inoculated with a copper-resistant strain of the pathogen developed disease, and treatment efficacy could be statistically separated by measuring canker length. Kasumin, ZTD, and both rates of DAS-2 significantly reduced canker size as compared to the control (Fig 1). Copper mixed with ZTD, however, was not effective and thus, copper resistance of the bacterial strain used for the inoculation was not overcome by ZTD.

Based on recent reviews by EPA specifically requested by us to find alternatives chemical for managing bacterial diseases of plants, ZTD is unlikely to be registered in the US, and thus, Kasumin and DAS compounds are some of the few chemicals that have potential for bacterial canker and blast management. With widespread copper resistance in the bacterial pathogen *Pseudomonas syringae* pv. *syringae*, new effective treatments are needed to manage bacterial canker and blast of *Prunus* spp. These are important diseases of stone fruit crops that can impact production in seasons with favorable environmental conditions and can also have long-term effects on tree health. In our studies over the years on various crops, Kasumin was the most effective and consistent treatment against both phases of the disease. Oxytetracycline was evaluated previously and also was identified as a promising bactericide against *P. syringae*. Registrants of both of these antibiotics are supportive of a registration on sweet cherry and this is currently pursued. Oxytetracycline (i.e., Mycoshield) and kasugamycin (i.e., Kasumin) have been submitted to EPA by the IR-4 program and are being reviewed both federally and by the state for use on sweet cherry. Kasumin is set for full registration on cherry in January 2018 based on the US EPA PRIA date. The antibiotic is federally registered on pome fruit since 2014 for management of fire blight and was registered on pome fruit in California in November 2017. Over the years of our evaluations, Actinovate also showed good efficacy in reducing blossom blast (but was less effective against canker), and Blossom Protect/Botector also reduced the disease.

Evaluation of fungicides for management of brown rot blossom blight. A field trial was conducted in a commercial prune orchard in the spring of 2017, however, disease development on untreated control trees was very low. Currently registered fungicides with high pre- and post-infection activity for brown rot include single active ingredients such as the FG 2 dicarboximide Rovral (-oil) and generics; the FG 3 DMIs Tilt (and generics), Indar, Rhyme, Tebucon (and other generics), and Quash; the FG 7 SDHI Fontelis; the FG 9 anilinopyrimidines (APs) Vangard and Scala; and the FG 17 hydroxyanilide Elevate. Pre-mixtures include the FG 7/11 Pristine, Merivon, and Luna Sensation; the FG 3/11 Quilt Xcel and Quadris Top, the FG 3/9 Inspire Super, and the FG 3/7 Luna Experience (Table 1). The pre-mixtures provide consistent, broad-spectrum high efficacy with built-in resistance management.

Evaluation of fungicides for management of fruit brown rot. We previously demonstrated that the efficacy of preharvest fungicide applications to prevent losses from fruit brown rot is considerably improved when used in combination with an agricultural spray oil. Additionally, applications at an increased volume of 130 gal/A generally provide better protection of fruit inside clusters. Because some growers are reluctant to use a spray oil that removes the bloom on the fruit, we evaluated if a non-ionic surfactant might provide the same efficacy, and this was done with several fungicides. The efficacy of additional fungicides was compared with using a surfactant (i.e., Breakthru).

Table 1. Efficacy of fungicides and pre-mixtures against major diseases of prunes (dried plum)

Fungicide	Resistance risk (FRAC#)	Brown rot Blossom	Brown rot Fruit	Rust
Bumper/Tilt	high (3)	++++	++++	+++
Elite/Tebucon/Teb/Toledo	high (3)	++++	++++	+++
Fontelis	high (3)	++++	+++	+++
Indar	high (3)	++++	++++	+++
Inspire Super	high (3/9)	++++	++++	+++
Luna Experience	medium (3/7)	++++	++++	++++
Luna Sensation	medium (7/11)	++++	++++	ND
Merivon	medium (7/11)	++++	++++	ND
Pristine	medium (7/11)	++++	++++	ND
Quash	high (3)	++++	++++	+++
Quadris Top	medium (3/11)	++++	++++	++++
Quilt Xcel/Avaris 2XS	medium (3/11)	++++	++++	++++
Rovral + oil	low (2)	++++	NR	NR
Scala	high (9)	++++	+++	ND
Topsin-M /T-Methyl/Incognito/Cercobin + oil	high (1)	++++	++++	----
Vangard	high (9)	++++	+++	ND
Elevate	high (17)	+++	+++	----
Rhyme	high (3)	+++	+++	+++
Rovral/Iprodione /Nevado	low (2)	+++	NR	NR
Topsin-M/T-Methyl/Incognito	high (1)	+++	+/-	----
Abound	high (11)	++	+	+++
Botran	medium (14)	++	++	ND
Bravo/Chlorothalonil/Echo/Equus	low (M5)	++	++	---
Captan	low (M4)	++	++	----
Ph-D	high (19)	++	++	ND
Gem	high (11)	++	+	+++
Rally	high (3)	++	++	----
Sulfur	low (M2)	+/-	+/-	++

Rating: ++++= excellent and consistent, +++= good and reliable, ++= moderate and variable, += limited and erratic, +/- = often ineffective, ---- = ineffective, ? = insufficient data or unknown, NR=not registered after bloom, and ND=no data

In comparing oil and surfactant additives, applications were done 7 days PHI. Wound-inoculation of harvested fruit with *M. fructicola* overall resulted in a high to moderate brown rot decay incidence because only fungicides with local systemic activity penetrate into the fruit and can inhibit infection by the pathogen. Addition of oil provided significantly (i.e., Quadris Top and Bumper) or numerically (i.e., Luna Experience and Merivon) better decay control than addition of a non-ionic surfactant (Fig. 2). Bumper used without any additive was not effective in these wound-inoculation studies where wound sites are approximately 2 mm deep under the broken fruit skin. Overall, Bumper applied with 2% agricultural oil resulted in the lowest incidence of brown rot (i.e., 27% as compared to 100% in the control).

In comparisons of 11-day PHI applications with registered and new fungicides, all in combination with a non-ionic surfactant, significant differences were observed after wound-inoculation of harvested fruit. Fungicides containing a DMI compound (e.g., Rhyme, Indar, Luna Experience, Quadris Top) as well as the experimentals

UC-1, UC-2, and IL-5412 significantly reduced the incidence of brown rot from that of the control (Fig. 3). Indar, Luna Experience, UC-1, and IL-5412 were most effective. In contrast, the SDHI compounds Fontelis, Pyraziflumid, and Pydiflumetofen had no effect, thus, they do not penerate into the fruit and are contact materials. In previous non-wound inoculations, however, these were also shown to be efficacious.

Several fungicides with high efficacy are currently available to the industry to protect fruit from brown rot decay even when applied 14- to 7-days before harvest (PHI). The highest treatment efficacy is obtained when fungicide-oil mixtures are applied at higher volumes. Spray oil provides improved coverage of fruit (acting as a spreader on waxy fruit surfaces) and likely also improves penetration of some fungicides into the fruit. Not all fungicides, however, may be compatible with oils. It is important to prevent fruit injuries during and after harvest. To reduce brown rot of mechanically harvested fruit in bins, fruit should be processed for drying within 48 h of harvest.

Evaluation of fungicides for management of prune rust. The severity of rust was moderate to high in the fall of 2017. In a late-season study, two applications of several fungicides (the first application was part of the pre-harvest brown rot fruit decay study and the second one was applied after harvest) all significantly reduced the severity of rust developing in the tree canopy as compared to the non-sprayed control trees (Fig. 4). Very low ratings were observed after treatment with Rhyme, Fontelis+Tebucon, Luna Experience, Merivon, and IL-5412, whereas Kenja, UC-1, and EXP-AD were among the least effective treatments. These latter treatments, however, still significantly reduced the severity of disease as compared to the control. Because UC-1 and EXP-AD contain DMI fungicides that are generally considered highly effective rust fungicides, the individual formulation concentrations perhaps are too low.

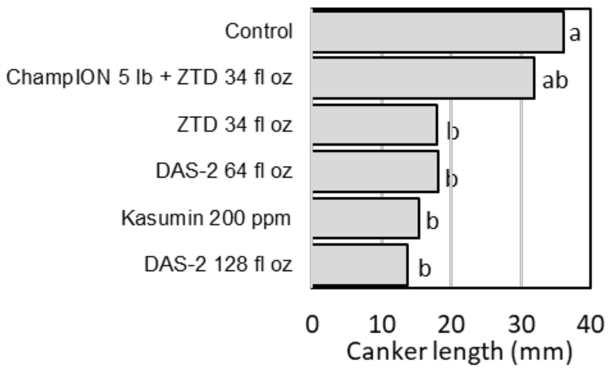
These results indicate that effective treatments for prune rust are available and that the disease can be managed. Over the years, treatments that include FGs 3, 7, or 11 have been the most effective. Prune rust occurs sporadically and protective treatments are generally not warranted. These fungicides, however, should still be very effective if applied when the very first rust lesions are detected in an orchard during regular scouting and monitoring of orchards during April through June.

In vitro sensitivity of* M. laxa*, and* M. fructicola *to new SDHI fungicides. Ranges and averages of EC_{50} values for inhibition of mycelial growth of 25 isolates of *M. laxa* and 32 isolates of *M. fructicola* by fluopyram, fluxapyroxad, isofetamid (active ingredient of Kenja), pydiflumetofen, and pyraziflumid, each belonging to a different SDHI sub-group, are presented in Figs. 5 and 6. All isolates of *M. laxa* were determined to be highly sensitive to the five fungicides with similar low ranges and average inhibitory concentrations (Fig. 5).

For *M. fructicola*, one isolate (No. 49, first isolate in the histograms of Fig. 6) was less sensitive against pydiflumetofen, isofetamid, and pyraziflumid (EC_{50} values 0.031, 0.132, and 0.027 mg/liter, respectively) as compared to the remaining isolates (Fig. 6). This latter isolate, however, was highly sensitive to fluopyram and fluxapyroxad. Another isolate (isolate 2542) that was highly sensitive to pydiflumetofen, isofetamid, and pyraziflumid showed reduced sensitivity to fluopyram with an EC_{50} value of 0.132 mg/liter. These two isolates were collected in 2003 or earlier, before field use of the newer SDHI compounds. Therefore, less sensitive isolates are present in natural field populations. Currently, all isolates evaluated are still considered sensitive to the SDHI compounds tested, but the results indicate possible cross-resistance patterns among the sub-groups and a risk of selection of isolates with lower sensitivity or resistance.

Interestingly, in evaluating sensitivities against the new fungicide cyflufenamid (FG U 06) that was made available to us for possible registration on stone fruit crops, all isolates of *M. fructicola* were found to be highly sensitive with EC_{50} values $\leq$0.014 mg/liter, whereas all isolates of *M. laxa* were not affected in growth at 40 mg/liter. The two species are sometimes difficult to differentiate in culture, and this differential sensitivity to cyflufenamid could therefore be used for species separation.

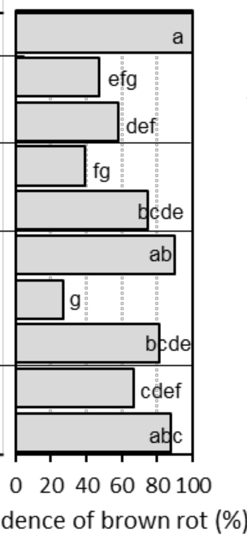
Fig. 1. Evaluation of antibacterial treatments for protection of inoculated French prune branches from bacterial canker – Field studies in 2017



Branches were puncture-wounded laterally in winter 2017 using a nail. Wounds were treated with bactericides, allowed to air-dry, and were then spray-inoculated with *P. syringae* (approximately 2 x 10^7 cfu/ml). Branches were evaluated for canker formation in May 2017.

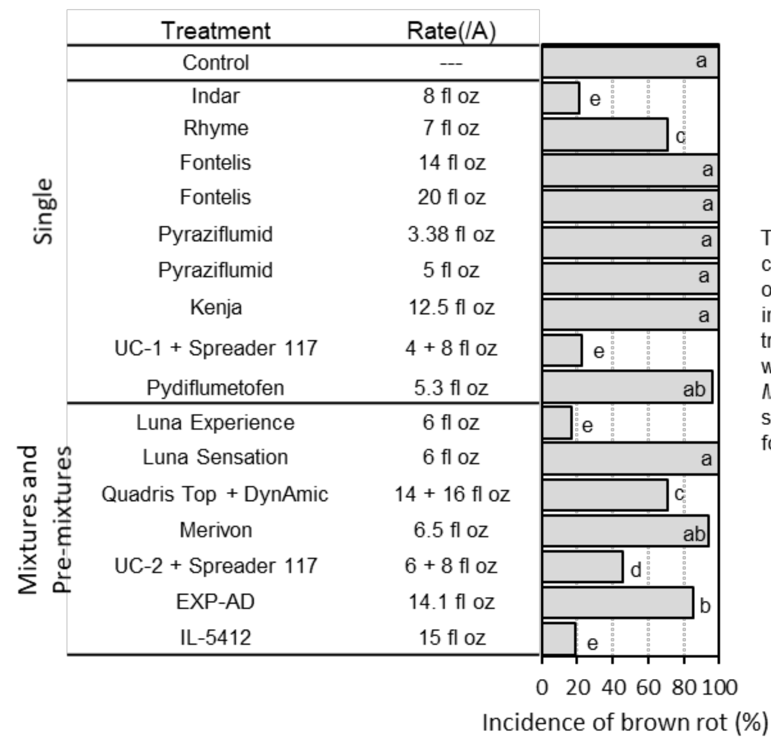
Fig. 2. Efficacy of 7-day preharvest fungicide treatments for management of postharvest brown rot of French prune – UC Davis 2017

Treatment	Rate(/A)	Oil	NIS
Control	---	---	
Luna Experience	8 fl oz	2%	---
Luna Experience	8 fl oz	---	8 fl oz
Quadris Top	14 fl oz	2%	---
Quadris Top	14 fl oz	---	8 fl oz
Bumper	4 fl oz	---	---
Bumper	4 fl oz	2%	---
Bumper	4 fl oz	---	8 fl oz
Merivon	6.5 fl oz	2%	---
Merivon	6.5 fl oz	---	8 fl oz



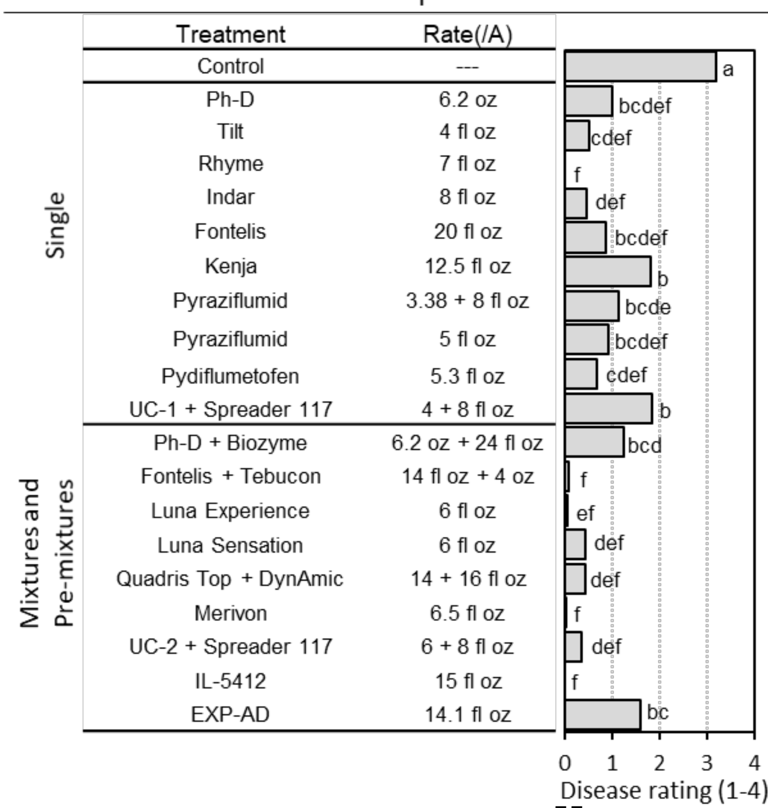
Treatments were applied in combination withOmni Oil or NIS (Breakthru) on 8-8-17. From each tree, 12 fruit were harvested and wound-inoculated with conidia of *M. fructicola* (500,000 spores/ml). Fruit were incubated for 7 days at 20 C.

Fig. 3. Efficacy of 11-day preharvest fungicide treatments for management of postharvest brown rot of French prune - Yuba Co. 2017



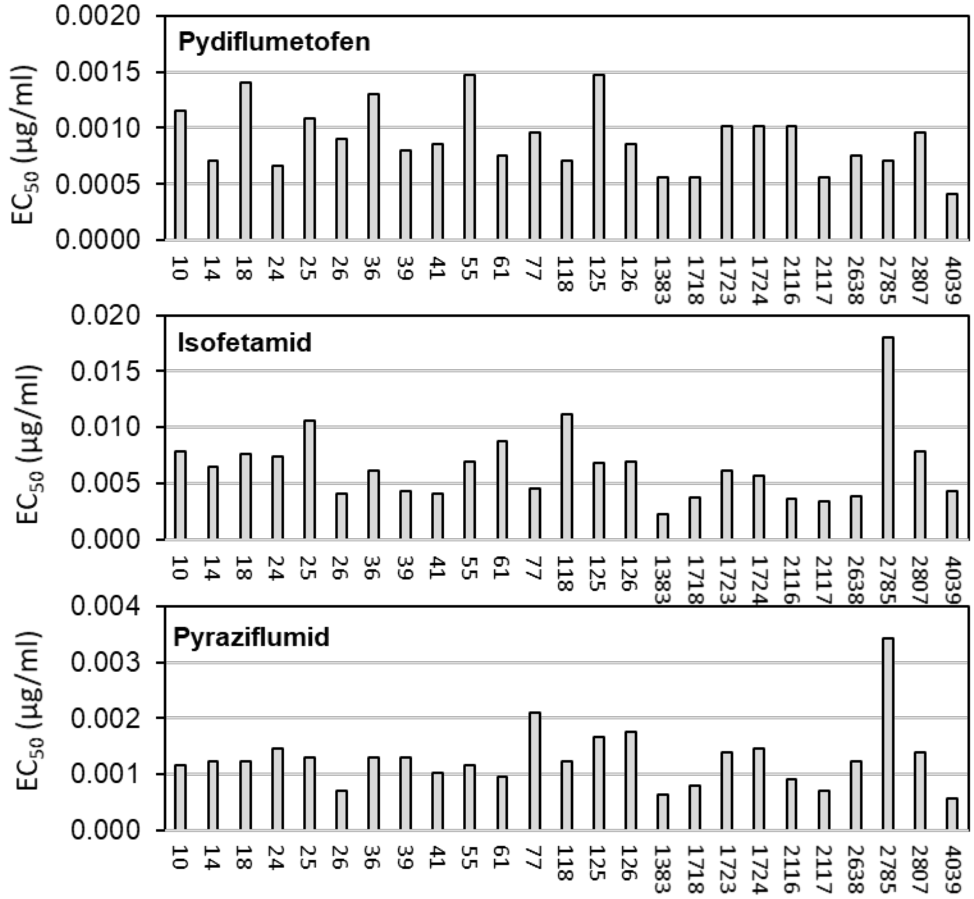
Treatments were applied in combination with Breakthru (8 fl oz/A) or another adjuvant as indicated on 8-3-17. From each tree, 12 fruit were harvested and wound-inoculated with conidia of *M. fructicola* (500,000 spores/ml). Fruit were incubated for 7 days at 20 C.

Fig. 4. Efficacy of fungicide applications for management of rust of French prune - Yuba Co. 2017



Treatments were applied on 9-13-17 using an air-blast sprayer at 130 gal/A. Evaluation was done on 10-27-17. Two disease severity readings were done on each of four quadrants of each tree using a scale from 0 (= no disease) to 4.

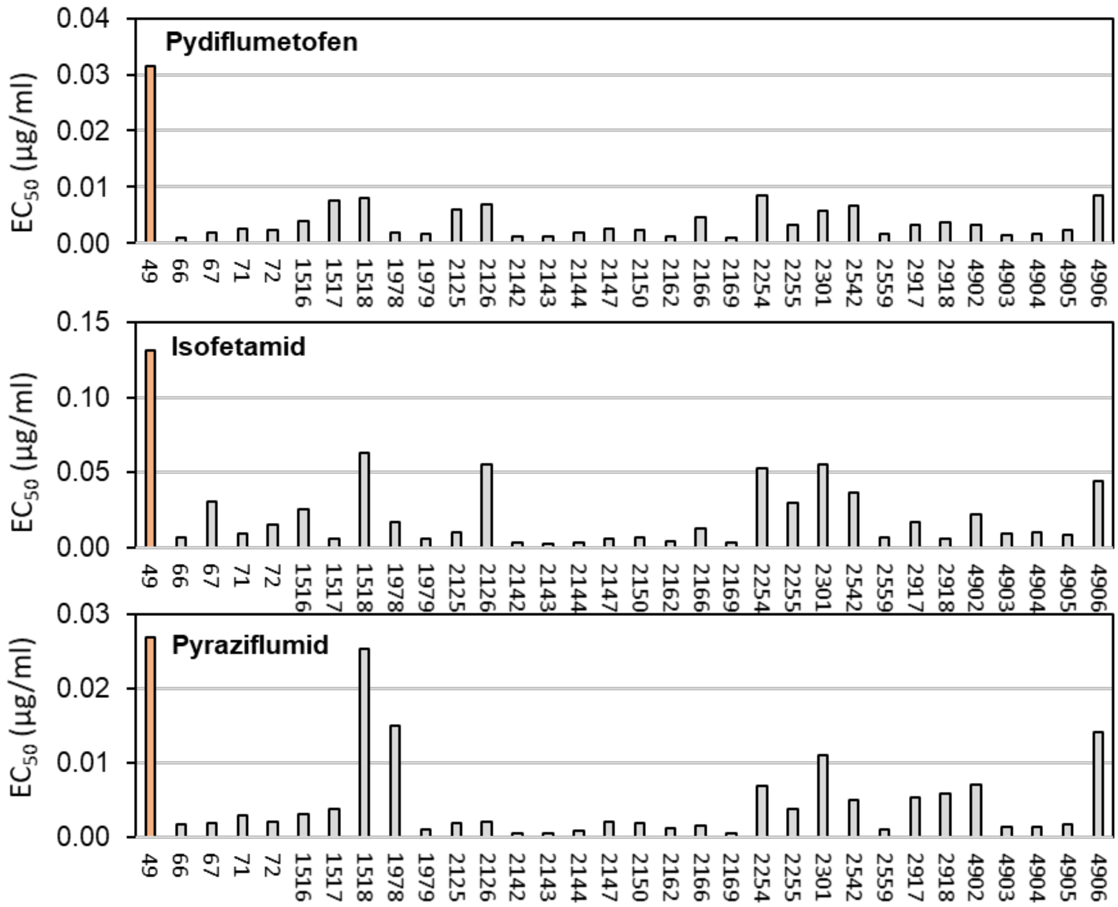
Fig. 5. Baseline sensitivities of 25 isolates of *Monilinia laxa* to SDHI fungicides



SDHI Subgroup	Fungicide	Range (µg/ml)	Average (µg/ml)
Pyridinyl-ethylbenzamide	Fluopyram	0.004 – 0.019	0.010
Pyrazole-4-carboxamides	Fluxapyroxad	0.001 – 0.007	0.004
Phenyl-oxo-ethyl thiophene amide	Isofetamid	0.002 – 0.016	0.007
N-methoxy-phenylethyl)-pyrazolecarboxamides	Pydiflumetofen	0.0004 – 0.0015	0.001
Pyrazinecarboxamide	Pyraziflumid	0.0006 – 0.0034	0.001

In vitro sensitivities were determined using the spiral gradient dilution method. In the histograms, isolates are in the same order for each of the three fungicides.

Fig. 6. Baseline sensitivities of 32 isolates of *Monilinia fructicola* to SDHI fungicides



SDHI Subgroup	Fungicide	Range (µg/ml)	Average (µg/ml)
Pyridinyl-ethylbenzamide	Fluopyram	0.005 – 0.132	0.022
Pyrazole-4-carboxamides	Fluxapyroxad	0.004 – 0.050	0.020
Phenyl-oxo-ethyl thiophene amide	Isofetamid	0.003 – 0.132	0.022
N-methoxy-phenylethyl)-pyrazolecarboxamides	Pydiflumetofen	0.001 – 0.031	0.004
Pyrazinecarboxamide	Pyraziflumid	0.001 – 0.027	0.005

In vitro sensitivities were determined using the spiral gradient dilution method. In the histograms, isolates are in the same order for each of the three fungicides.