2012 California Cherry Research Reports

University of California
California Cherry Board
University of California Cooperative Extension

CALIFORNIA CHERRY RESEARCH REVIEW

Friday, February 1, 2013

Evelyn Costa Assembly Room
San Joaquin County Agricultural Center
2101 E. Earhart Avenue, Stockton, California 95206

Sponsored by University of California Cooperative Extension and California Cherry Marketing & Research Board

1:00 pm	**Welcome** Joe Grant, UC Cooperative Extension, San Joaquin County
1:10	**Diagnosis, epidemiology & control of fungal canker diseases in sweet cherry** Dr. Doug Gubler, Dept. of Plant Pathology, UC Davis
1:40	**Managing pre- and post-harvest diseases of sweet cherries** Dr. Jim Adaskaveg, Dept. of Plant Pathology, UC Riverside
2:10	**The new Produce Safety Rule: How cherries can stay off the FDA radar screen** Dr. Trevor Suslow, Dept. of Plant Sciences, UC Davis
2:40	**BREAK**
3:00	**Developing an IPM program for managing pocket gophers and voles** Dr. Roger Baldwin, UC Cooperative Extension Statewide IPM Program
3:30	**Postharvest fumigation treatment of key fruit fly pests** Dr. Spencer Walse, USDA-ARS, Parlier, CA
4:00	**Biology and control of Spotted Wing Drosophila** Dr. Bob Van Steenwyk, Department of ESPM, UC Berkeley
4:30	**Experiences with Spotted Wing Drosophila in caneberries** Mark Bolda, Farm Advisor, UC Cooperative Extension, Santa Cruz County
5:00	**ADJOURN**

3.0 hours continuing education credit pending (Other)

2012 CCAB RESEARCH PROJECTS Approved Funding (4/6/2012)

ITEM	CCAB PROJECT NUMBER	PROJECT LEADER	PROJECT TITLE	FIRST FUNDED PROJECT YEAR	ORIGINAL ESTIMATED DURATION	CURRENT YEARS REMAINING	TOTAL COST TO DATE	2011 FUNDING	2012 PROPOSED FUNDING	2012 REQUESTED FUNDING
PRE-HARVEST PROPOSALS										
1	10-12-99	Doug Gubler UCCE	Diagnosis, epidemiology and control of canker diseases in sweet cherry.	2010	2 years	N/A	$52,500	$20,000	$30,200	**$30,200**
2	12-12-102	Al-Khatib	UC IPM Update and Maitenance for Cherries	2012	1 year	N/A	$4,122	$0	$4,122	**$4,122**
	POST HARVEST PROPOSALS									
3	ARS 12-12-104	Spencer Walse	The treatment of U.S. cherries with methyl bromide to eliminate the spotted wing drosophila,	2012	2 years	2 years	$0	$0	$90,431 ***Funded by USDA TASC Grant***	**$90,431**
4	ARS 12-12-105	Spencer Walse	Phosphine-Oxygen Mixtures on SWD/OFF	2012	2 years	2 years	$0	$0	$16,410 ***Funded by USDA TASC Grant***	**$16,410**
5	11-12-103	Bob Van Steenwyk	Post-Harvest Treatments, Ground Spray and Monitoring	2011	2 years	1 year	$27,488	$12,159	$15,289	**$15,289**
JOINT PROPOSALS										
6	08-12-95	J. Adaskaveg J. Grant	Management & Epidemiology of Pre & Postharvest Foliar and Fruit Diseases of Sweet Cherry	2008	4 years	On going	$153,000	$28,000	$28,000	**$28,000**
								TOTAL	$184,452	**$184,452**

First two digits indicate year project began.
Second two digits indicate current year or year project concluded.
Third two digits indicate unique project number, in numeric order from 1987.

CALIFORNIA CHERRY BOARD

2012 FINAL RESEARCH REPORTS

ANNUAL REPORT: CALIFORNIA CHERRY ADVISORY BOARD
September 2012

Project year: 2012 **Anticipated duration of the project:** 2 years

Project leader: W. Douglas Gubler, C.E. specialist
(530) 752-0304, wdgubler@ucdavis.edu

Location: University of California, Davis, CA 95616,

Cooperating personnel:
Janet Hanstad, Post Doctoral Researcher, Department of Plant Pathology, UC Davis, CA 95616; (530) 752-4982,

Joe Grant, Farm advisor, UCCE, San Joaquin County, (209) 468-2085; jagrant@ucdavis.edu

Project title: CONTROL OF CANKER DISEASES IN SWEET CHERRY

Keywords: Sweet cherry, canker diseases, Calosphaeria, Cytospora, Leucostoma, Eutypa dieback

Commodity: Sweet Cherry **Relevant AES/CE Project No.**

Objective 1: Implement cultural practices to reduce risk of infection with Calosphaeria canker, Eutypa dieback, and Leucostoma (Cytospora) canker.

Objective 2: Implement chemical control methods against Calosphaeria canker, Eutypa dieback, and Leucostoma (Cytospora) canker.

Problem and Significance:

California is the second largest sweet cherry producer in the US with approximately 10,800 ha and an average annual crop value of about $200 million. Perennial canker diseases constitute major threats to the cherry industry productivity by reducing tree health, longevity and yields. Recently, we described Calosphaeria canker caused by *Calosphaeria pulchella* as a new and widespread canker disease of sweet cherry (*Prunus avium* L.) in California (Trouillas et al., 2010). Additional pathogens reported to occur in cankers in sweet cherry in California have included *Eutypa lata* and *Leucostoma persoonii* (*Cytospora*). The epidemiology of these pathogens has been studied and there is evidence that spores are released in response to wetting caused by rain or irrigation, while dispersed by wind or rain splashing. Infection normally occurs during the pruning seasons when fresh pruning wounds become exposed to wind-dispersed spores. In California, release and dispersal of spores of *L. persoonii* occur during rain and in all seasons (Bertrand and English, 1976). *Eutypa lata* spreads to new pruning wounds by wind-driven ascospores released during fall and winter rains (Ramos et al., 1975). Similarly, high spore concentrations of *C. pulchella* are found in California cherry orchards throughout the rainy season and during sprinkler irrigation events in the spring and summer months (Trouillas et al.,2012)

Systematic pruning in summer and winter is widely implemented in sweet cherry orchards in California to keep trees to a suitable size, promote branching and early maturing of sweet cherries. Sprinkler irrigation also is broadly utilized. Based on previous studies, we postulated that the implementation of tree pruning and generalized use of sprinkler irrigation in sweet cherry orchards in California have favored an outbreak of canker diseases.

Protection of pruning wounds with fungicides may reduce infection with fungal pathogens. However, this can be problematic because of the limited number of effective registered products. The objectives of this study are (i) to identify effective chemical products to control sweet cherry canker diseases using laboratory assays and field experiments, and (ii) to investigate the susceptibility of sweet cherry pruning wounds to infection by *E. lata*, *L. persoonii* (*Cytospora*) and *C. pulchella* according to pruning date and age of pruning wound.

Plans and Procedures:

Objective 1:

Growth chamber experiment

Growth chamber trials were set up to evaluate the effect of temperature on infection and lesion expansion caused by *Eutypa lata*, *Leucostoma persoonii* (Cytospora), and *Calosphaeria pulchella*. Small branches from sweet cherry trees were cut into 12-inch segments. All leaves were removed. The branches were soaked for 15 minutes in a 10% bleach solution and then rinsed with sterile distilled water. Near the middle of each branch, a 4 mm wound was made. Mycelial agar plugs of 3 isolates of each *E. lata*, *L. persoonii* (Cytospora) and *C. pulchella* were placed into wounds. The inoculated area of the branches were wrapped with parafilm and placed in crispers. The crispers were placed in growth chambers at 5, 10, 15, 20, 25 and 30°C. Each isolate was inoculated on 4 different branches per temperature trial. These trials were started in Summer 2012. Results will be available in 2013.

Objective 2: Implement effective chemical and biological control methods against Calosphaeria canker, Eutypa dieback and Leucostoma (Cytospora) canker.

Fungicide efficacy experiment

The Automated Spiral Plater, Autoplate 400, was used to conduct the Spiral Gradient Endpoint test which measured suceptibility of spore germination to a gradient of fungicides on an agar plate. A solution of 50 ppm of the fungicide was spiral plated onto a 150 mm PDA plate. Then the plates were radially streaked with a conidial suspension of the fungal isolates. After incubation for one week, the fungi grew on parts of the plate where fungicide did not inhibit their growth. EC 50's (Effective Concentrations) were measured. EC is determined by the point on the plate where the fungal growth is inhibited by the fungicide. Four strains of each of the following species: *Eutypa lata*, *Leucostoma persoonii* and *Calosphaeria pulchella* were tested against Mertect, Rally, Scholar, Topsin, Orbit and Luna Experience. Two replications per isolate were conducted.

Results

Figure 1 shows the average results for each pathogen from the Fungicide Resistance experiment. Initial reults show Scholar and Orbit may be effective fungicides against *E. lata*, *L. persoonii* and *C. pulchella.* Luna Experience was also effective against *E. lata* and *L. persoonii*.

Pruning wound experiment

A field trial was established in September 2011 in Davis, CA and February 2012 in Linden, CA in sweet cherry orchards (*Prunus avium* cv. Bing). The experiment evaluated pruning wound protection by various fungicides against the invading canker pathogens *Eutypa lata*, *Leucostoma persoonii* (Cytospora) and *Calosphaeria pulchella*. Fungicides used in Lincoln included Trichoderma, Cannonball, Luna Experience, Mertect, Rally, Tilt, Topsin, Vitiseal, Vitiseal 1:10 dilution, Vitiseal 1:10 dilution+Orbit, Vitiseal 1:10 dilution+Rally+Topsin, Vitiseal 1:10 dilution+Scholar (.75g/L), Vitiseal 1:10 dilution+Scholar (1.5g/L), inoculated control and untreated control. Fungicides used in Davis included Trichoderma, Enable, Rally, Rally+Topsin, Vitiseal 1:10 dilution, Topsin, and inoculated control.

Fresh pruning wounds were made on 2 to 3 year-old wood in Davis and Linden cherry orchards. Liquid formulations of fungicides were sprayed in a single application with 500 ml spray bottles immediately after pruning. Pruning wounds were artificially inoculated with 0.5ml of an aqueous spore suspension of each fungus, approximately 1 hour after fungicide treatments. Inoculated, but water-only treated controls, were included for statistical comparison. In Linden, untreated controls (branches pruned and left open for natural infection) were also included. After several months, treated branches were collected and returned to the laboratory for assessment of fungal colonization and wound protection. Wood samples were surface sterilized using ethanol and flaming. Sixteen wood chips from necrotic lesions or vascular discoloration just below the pruning wounds were plated onto PDA-tetracycline plates. Fungicide efficacy was estimated by the number of fungal colonies of the various pathogens developing from plated tissues.

Results

As shown in Figure 2, nearly all branches in the Linden orchard had cankers. Figure 3 however, shows few were infected with the inoculated fungi, including the inoculated control branches. While there were some differences in fungicide efficacy against cankers, it is unclear if the fungicide sprays were effective, since other organisms caused most of the cankers. Few of the cankers were caused by *Eutypa lata*, *Leucostoma persoonii* or *Calosphaeria pulchella* (Figure 3). A variety of canker causing pathogens is present in this orchard. Molecular identification techniques are currently being used to identify the fungi isolated from the cankers.

In the Davis orchard, lesion length formation was also high compared to reisolation rates; however, the inoculated fungi, *E. lata*, *L. persoonii* and *C. pulchella* were reisolated more frequently than from the Lincoln trials (Figure 4). Although not statistically significant, Enable and Topsin were more effective at preventing infection, although Topsin and Trichoderma treatments had the shortest lesion lengths (Figure 5).

In vitro experiment

Fungicide efficacy against *Eutypa lata*, *Leucostoma persoonii* or *Calosphaeria pulchella* was tested *in vitro* as described by Rolshausen and Gubler (2005). In this experiment we used two-year-old dormant sweet cherry wood, freshly cut into 3 cm pieces. After sterilization by autoclaving, wood pieces were dipped in various fungicide solutions, dried, and then placed on sterile glass rods inside 250 ml French square bottles containing 15 ml of potato dextrose agar. The rods with the wood were placed next to actively growing 5 day-old colonies of the 3 fungal pathogens. Fungicides tested included: Trichoderma, Cannonball, Luna Experience, Mertect, Rally, Tilt, Topsin, Vitiseal, Scholar (.75g/L)+Vitiseal 1:10 dilution and a control, each fungicide treatment was replicated 3 times. Control wood blocks were dipped in sterile water only. Following four weeks incubation period at room temperature (24°C), cherry wood blocks will be removed from the bottle to be inspected for percent of mycelium coverage; mycelial growth will be visually assessed as percentage coverage of the total wood surface. The wood blocks will be inspected for two more weeks and then bark will be stripped off and blocks will be surface sterilized by flaming, prior to isolation. Isolations will be made from the inside of each wood block (below the cut edges) to estimate fungal colonization of the wood. Ten wood chips will be taken from each edge of wood blocks and plated on PDA-tet. Fungicide efficacy will be evaluated as the percentage of mycelium coverage of wood blocks as well as percentage of wood chips from which each fungal species will be recovered.

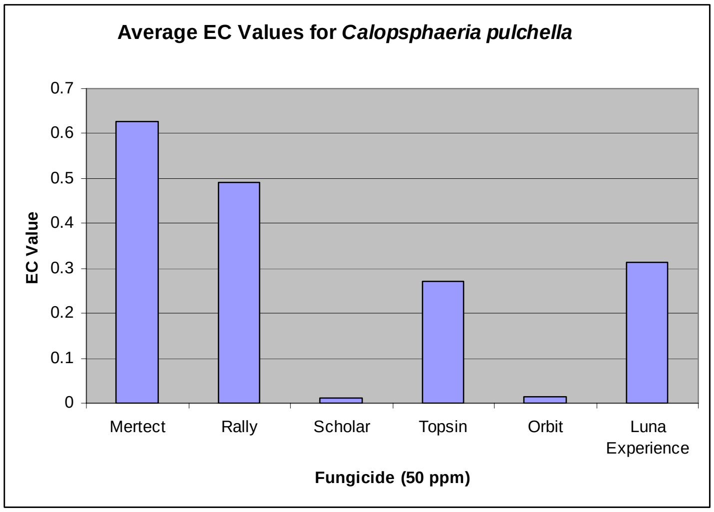
Results

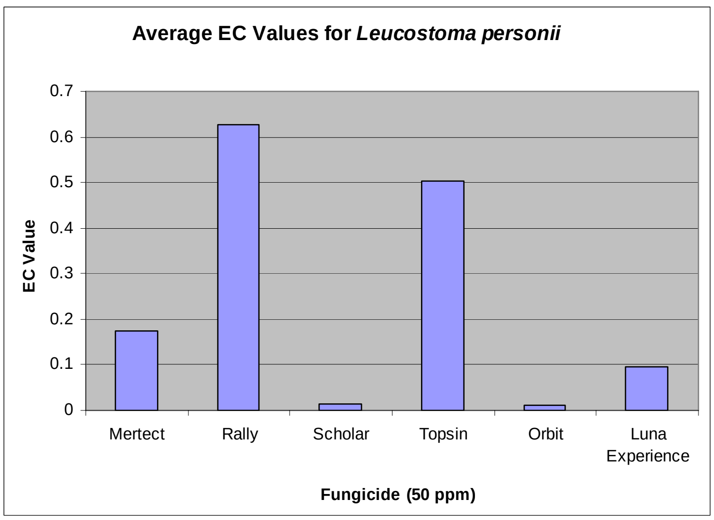
Figure 6 shows initial results from in vitro bottle trials. At two weeks, Scholar+Vitiseal 1:10 dilution, Topsin, Trichoderma and Tilt appear most effective at preventing wood colonization by *E. lata*, *L. persoonii* or *C. pulchella.* Results for this experiment will be collected at weekly intervals for one month.

Further Research

Growth chamber experiments, in vitro bottle assays, pruning wound experiments and molecular analysis has been started. The pruning wound experiments show a wide range of other pathogens are also causing discolorations in cherry wood. Whether these are true cankers is yet to be proven. Further research into these pathogens is needed. Molecular analysis has been started for some of the canker causing organisms found in Linden. We plan to look at several orchards this fall and winter where we follow pruning at 4 week intervals in an attempt to show which fungi colonize the wood first and over time. At the same time we will look at lesion expansion. We are also in the process of working to get more products registered for use against canker diseases.

Figure 1. Average EC Values for fungal pathogens against different fungicides using an automated sprial plater.





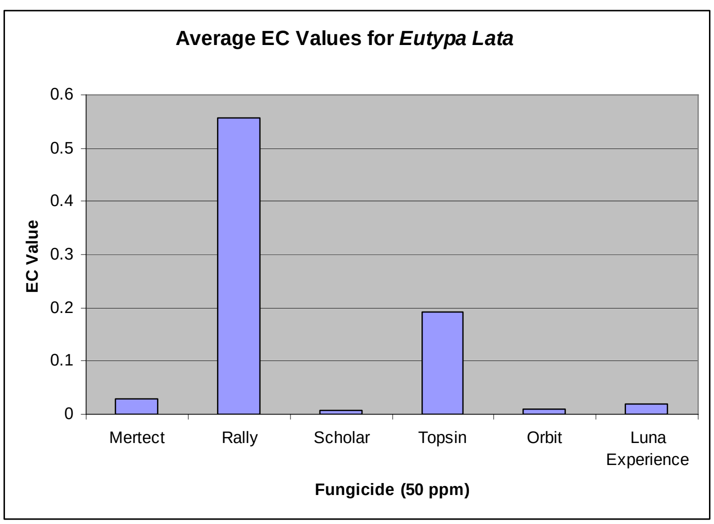
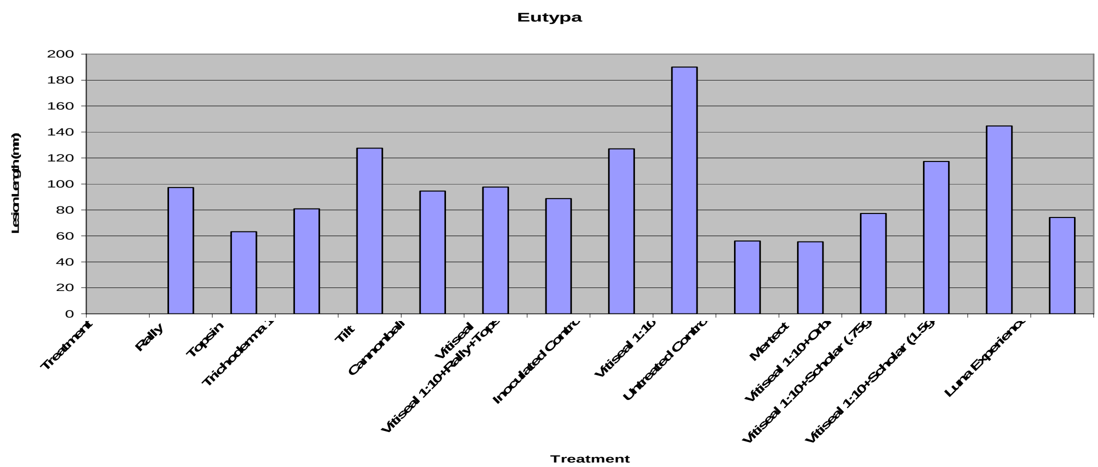
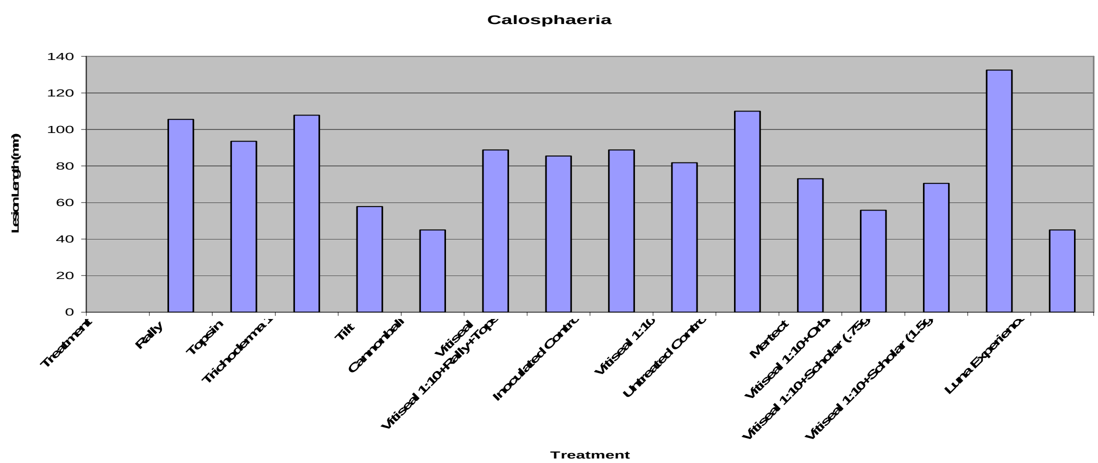


Fig 2. Lesion length development of pruned branches treated with different fungicides and inoculated with *Eutypa lata*, *Leucostoma persoonii* or *Calosphaeria pulchella* in February 2012 in Linden, CA. Lesion lengths were measured in July 2012. Important to note that Rally does not stop mycelia growth. It stops germ tuber elongation in spore germination.





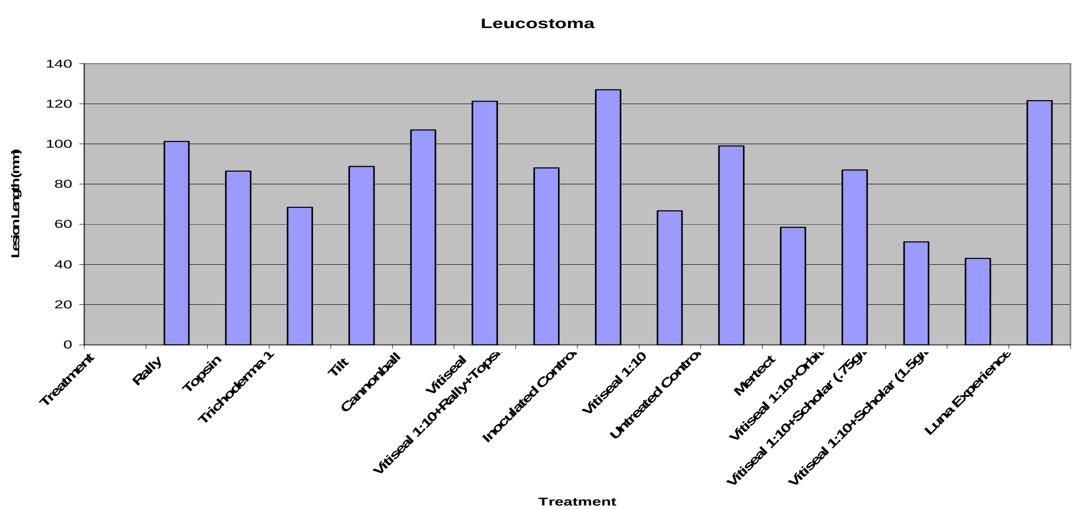


Fig 3. Percent successful reisolation from stub cuts treated with different fungicides and inoculated with *Eutypa lata*, *Leucostoma persoonii* (Cytospora) or *Calosphaeria pulchella* in February 2012 in Linden. Fungi were reisolated July 2012.

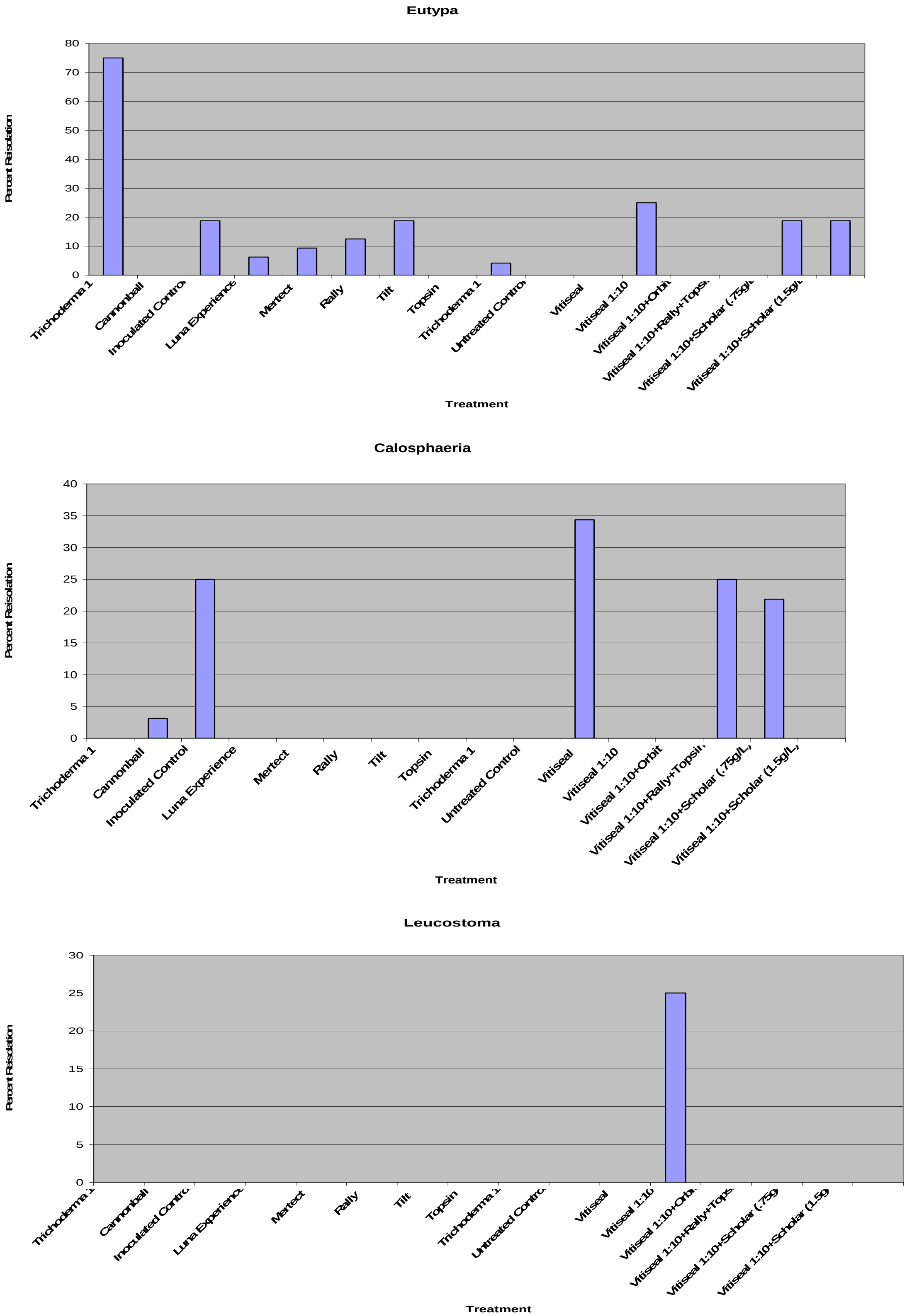
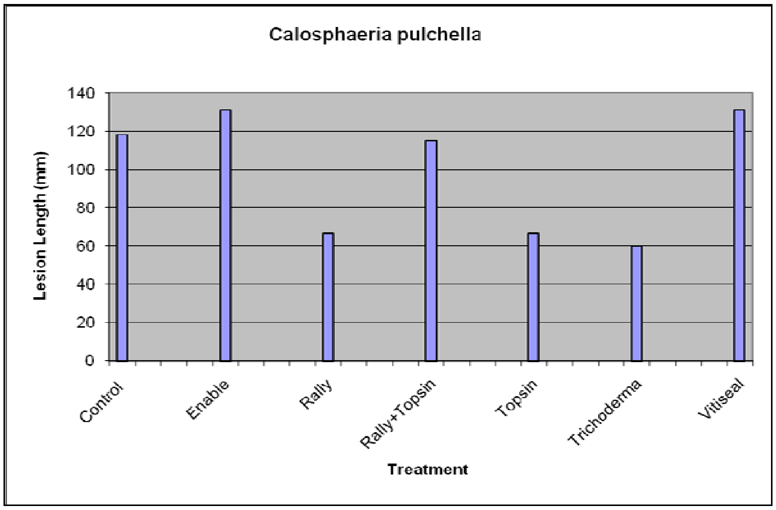
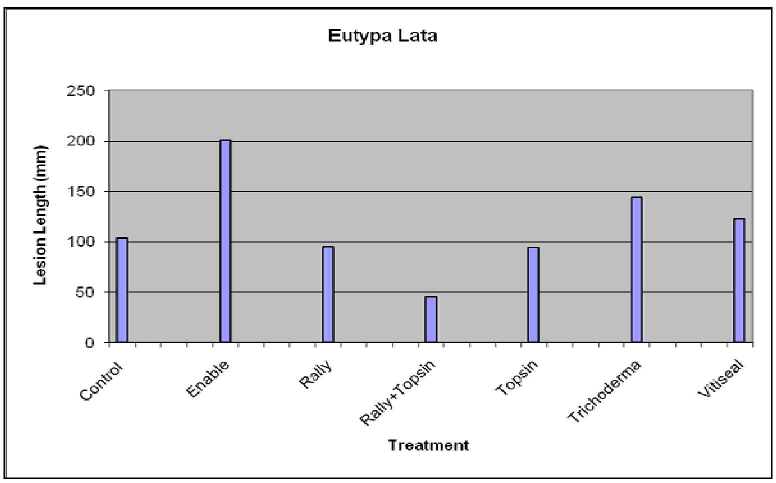


Fig 4. Lesion length development of pruned branches treated with different fungicides and inoculated with *Eutypa lata*, *Leucostoma persoonii* or *Calosphaeria pulchella* in September 2011 in Davis, CA. Lesion lengths were measured in September 2012.





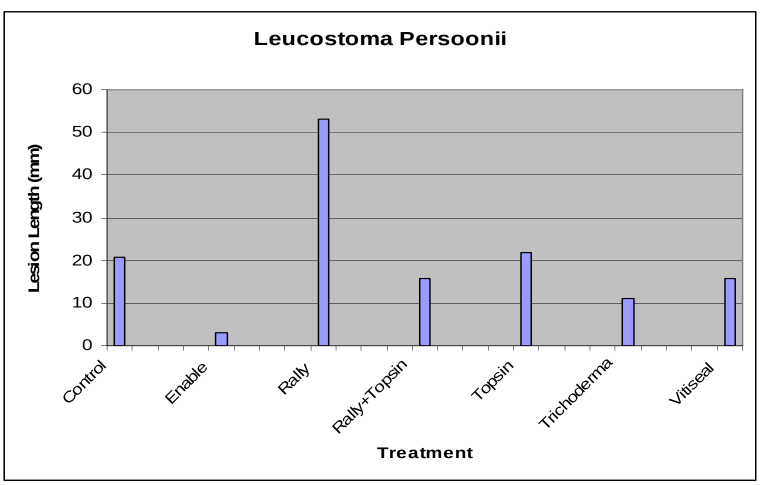
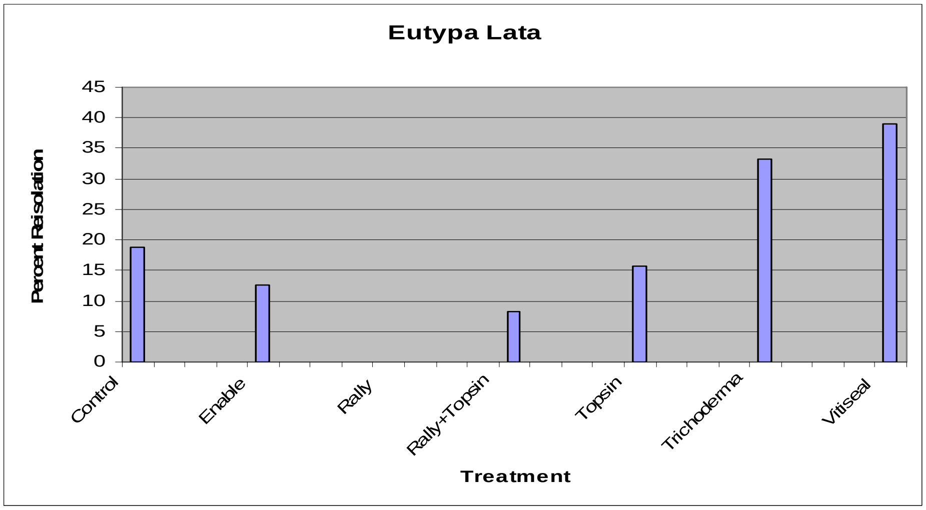
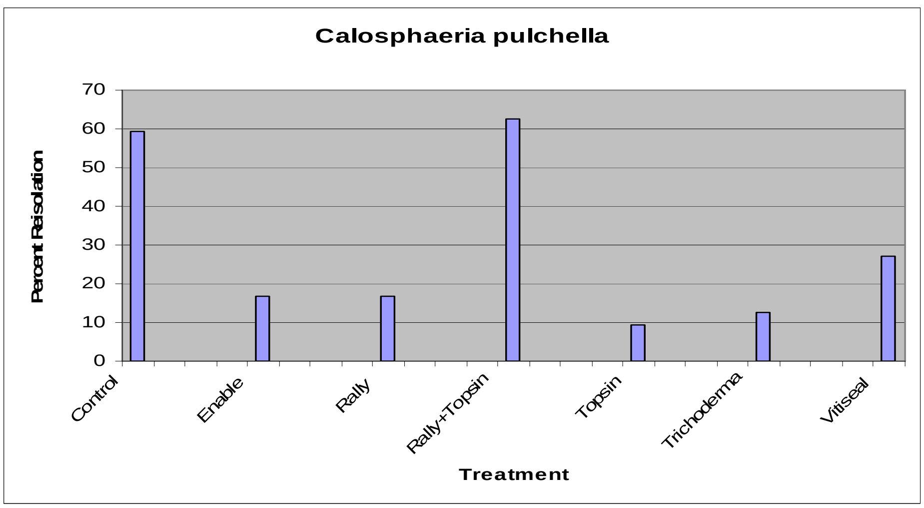


Fig 5. Percent successful reisolation (disease severity) of pruned branches treated with different fungicides and inoculated with *Eutypa lata, Leucostoma persoonii* or *Calosphaeria pulchella* in September 2011 in Davis. Fungi were reisolated in September 2012.





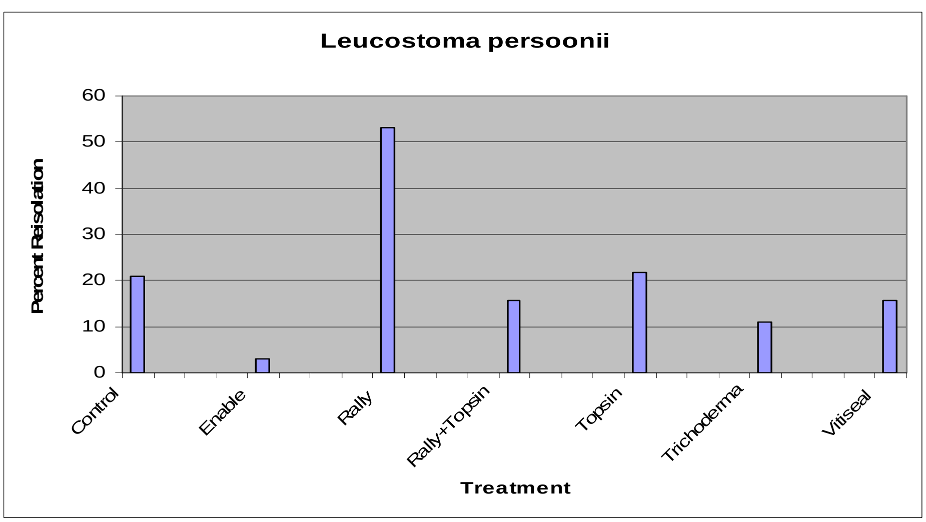
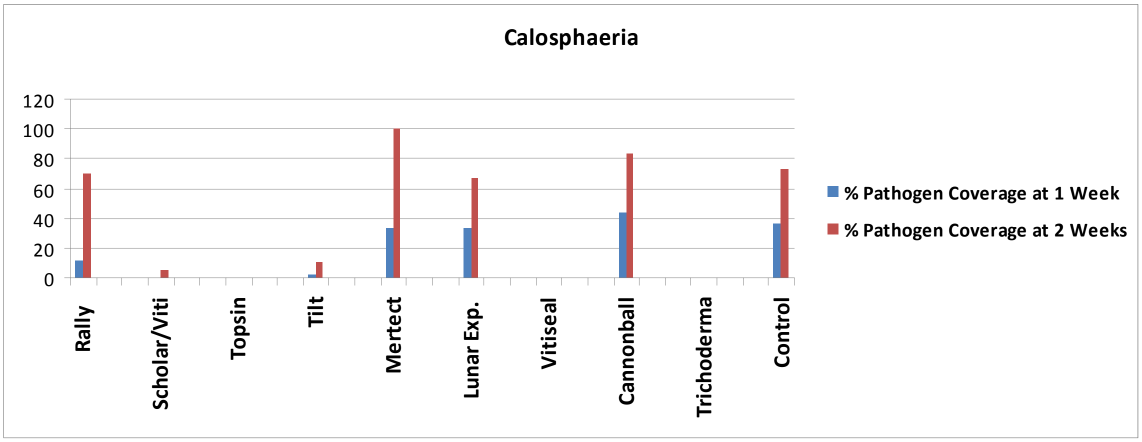
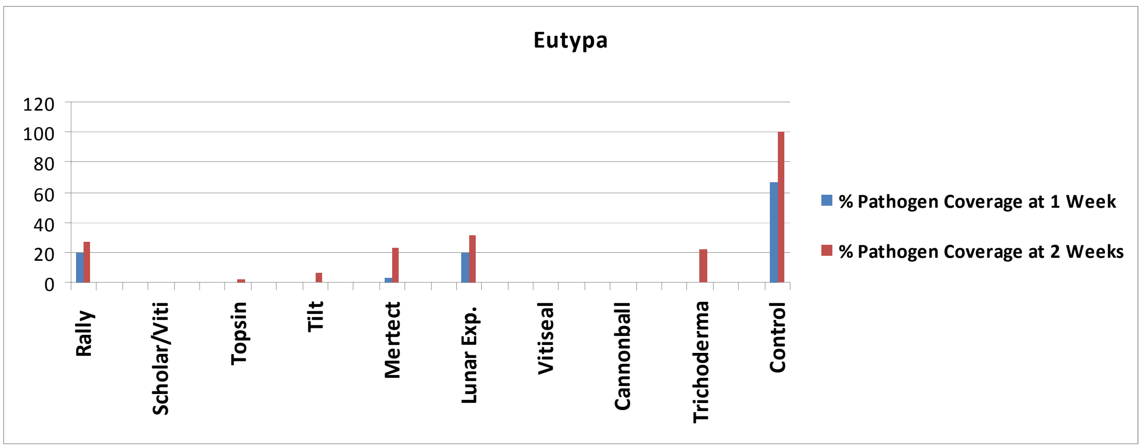
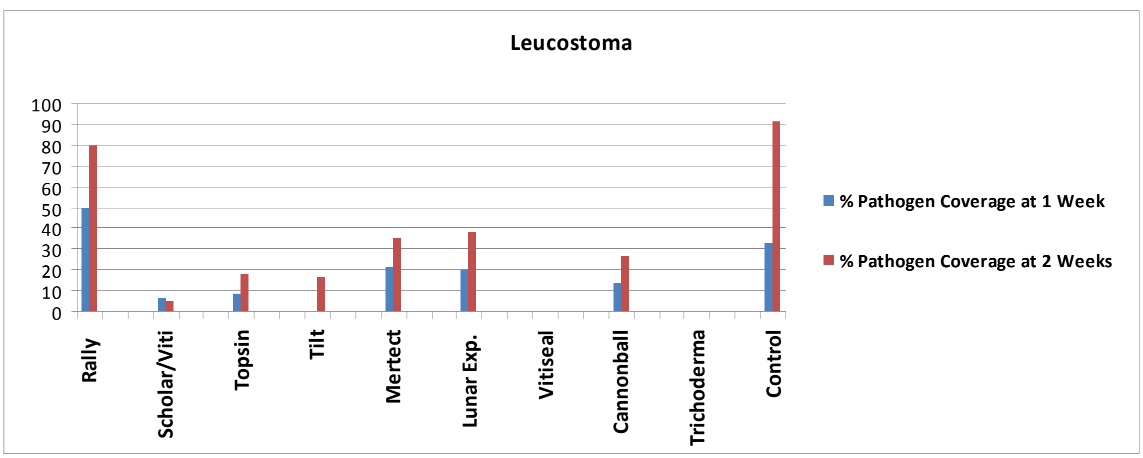


Fig 6. Sterilized wood blocks were treated with different fungicides and placed in bottles with *Eutypa lata*, *Leucostoma persoonii* or *Calosphaeria pulchella*, Important to note that Rally does not stop mycelia growth. It stops germ tuber elongation in spore germination.







Annual Report - 2012

Prepared for the California Cherry Advisory Board

Project Title:	Management and Epidemiology of Pre- and Postharvest Foliar and Fruit Diseases of Sweet Cherry
Project Leader:	Dr. James E. Adaskaveg, Department of Plant Pathology, University of California, Riverside, CA 92521 (951) 827-7577
Cooperators:	Dr. H. Förster, D. Thompson, and J. Grant (Farm Advisor)

SUMMARY

In 2012, dormant, blossom, preharvest, and postharvest management studies were done on major diseases of sweet cherry in California. Major accomplishments are summarized below by the diseases studied or by fungicide usage strategies.

In bacterial blast and canker studies, we continued using the antibiotic kasugamycin (Kasumin) and the biocontrol Actinovate, and we initiated evaluation of the antimicrobial AgriTitan in several field studies with inoculated flowers and branches and naturally infected flowers. Highlights were:

- Treatments with copper had little effect on the incidence of blossom blast, reflecting the widespread occurrence of copper resistance in the pathogen *P. syringae*.
- The antibiotic Kasumin was the most effective treatment in reducing bacterial blast, whereas the biocontrol Actinovate showed consistent intermediate efficacy. These two treatments were also effective in commercial applications.
- The antimicrobial AgriTitan also showed very good efficacy in reducing blossom blast and thus, is a very promising new treatment approach.
- Only Kasumin effectively prevented canker formation of inoculated branches in pre-and post-infection studies; whereas, most of the treatments evaluated were ineffective in preventing canker formation. Actinovate, AgriTitan, the sanitizer Deccosan, and Kocide however, did significantly reduce canker size from the control when used as a pre-infection treatment.

In our powdery mildew trials, eighteen fungicide treatments were evaluated with a wide range of effectiveness. Highlights were:

- The most effective treatments included the new FRAC Group (FG) 7/11 Group fungicides - Luna Sensation, Merivon, Q8Y78, the FG 7 Fontelis, the FG 13 Quintec, the FG 3/11 Quadris Top and Adament, and the FG 3 TopGuard.
- Development of fungicides with unique modes of action (such as the new SDHI fungicides - FG 7 and BAS560-metrafenone FG U8) needs to be continued to prevent overuse of quinolines (FG 13), DMIs (FG 3), and QoIs (FG 11).

In pre- and post-infection studies for control of brown rot and Botrytis blossom blight, highly effective fungicides with excellent pre- and post-infection activity against both blossom diseases were identified. Top materials included:

- FG 3/11fungicides (e.g., Adament, Quadris Top)
- FG 7/11 fungicides (e.g., Pristine, Luna Sensation, Merivon, and Q8Y780)
- FG 3 (DMI) fungicides (e.g., Quash, Topguard)

Treatments that performed well in evaluations of preharvest treatments for fruit decay control after harvest (without washing) and for postharvest decay control after postharvest washes of fruit:

- Treatments containing a DMI fungicide (Quash, TopGuard, Quash mixed with the new compound S-2200, Quadris Top) had high efficacy against brown rot on non-washed, non-wound inoculated fruit.
- Quash, Quash mixed with other fungicides, and Quadris Top were highly effective washed and non-washed and wounded and non-wound inoculated fruit.

- None of the fungicides was very effective against gray mold except for Scholar on non-washed fruit applied as a 0-day PHI treatment; whereas, some of the new FG 7/11 fungicides suppressed gray mold.
- The activity of the fungicides on non-washed, non-wound inoculated fruit was also evaluated. In addition to the compounds that were effective on wound-inoculated fruit, the new fungicide YT669, as well as Ph-D, Quadris Top, Luna Sensation, Pristine, Merivon reduced the incidence of decay to very low levels on non-wound inoculated fruit.
- Overall, DMI-containing fungicides were most effective against brown rot. These fungicides penetrate into the fruit, persist after postharvest washes, and subsequently help to protect fruit from infections occurring after harvest.

Efficacy of new and registered postharvest treatments for managing decays. New developments in 2012 were:

- The postharvest fungicide fludioxonil (Scholar) received an MRL and food additive tolerance (FAT) in Japan.
- An organic formulation of polyoxin-D was evaluated as postharvest treatments and was highly efficacy against brown rot and gray mold. Thus, this potentially is a promising new postharvest fungicide for organic fruit production.
- Tebuzol is the new alternative for Elite, maintaining the tebuconazole postharvest registration on sweet cherry. Tebuzol has a higher labeled rate than the old Elite label that provides improved performance. Additionally, Mentor was federally approved for postharvest use on all stone fruit crops. The California registration is pending and should be available for use by the 2013 season.
- The effect of post hydrocooling washes on the performance of Scholar drenches to reduce decays and on fruit residues was evaluated. A low rate of Scholar performed exceptionally in drench treatments even after hydrocooling washes. Thus, Scholar, which is approved in Japan as a postharvest fungicide treatment, can be used in a variety of applications systems to treat fruit destined for international markets.

INTRODUCTION

Overview. The goals of this project are to evaluate new fungicides, natural products, biologicals, and other treatments for the management of pre- and postharvest diseases of sweet cherry. In the last few years, numerous new fungicides were registered and additional ones are being developed. Compounds used in our 2012 studies, including their trade names, active ingredients, and FRAC groups (FG) are summarized in Table 1. Most of the newer fungicides (picoxystrobin and other QoIs, fluopyram – Luna Privilege, fluxapyroxad - Xemium, penthiopyrad - Fontelis, metrafenone - Vivando, metconazole - Quash, polyoxin-D - Ph-D, etc.) have a single-site mode of action. This emphasizes the implementation of resistance management strategies to avoid the development of resistant pathogen populations. One of these strategies is the use of pre-mixtures with at least two ingredients of different mode of action that are both active against the pathogen(s). Following the introduction of Pristine, Adament (tebuconazole + trifloxystrobin), Luna Sensation (fluopyram + trifloxystrobin), Quilt Xcel (azoxystrobin + propiconazole), Quadris Top (azoxystrobin + difenoconazole), Merivon (fluxapyroxad + pyraclostrobin), and Q8Y78 (picoxystrobin+ penthiopyrad) have been developed and are continued to be evaluated in our studies under different environmental conditions that occur each year. Goals are to identify and develop treatments to: 1) Prevent overreliance on any one fungicide class and develop treatments that allow for rotations and high levels of control of brown rot; 2) Develop new treatments for managing blossom and fruit diseases caused by *Botrytis cinerea*; and 3) Identify additional modes of action against powdery mildew. Natural products/biocontrols are also being evaluated to possibly provide organic growers with alternative treatments for managing major diseases of sweet cherry. In an additional objective, we are evaluating new treatments for the management of bacterial blossom blast and canker caused by *Pseudomonas syringae* where previously only copper was available. The antibiotic kasugamycin (Kasumin) that is currently being registered in the United States for management of other bacterial diseases, as well as the biological Actinovate that is already registered on a number of crops have been the most promising treatments in our studies and these experiments were continued in our current research.

For postharvest management, our accomplishments over the years include the development of several products with unique modes of action. These are: Elite and Tebuzol (tebuconazole), Scholar (fludioxonil), Judge (fenhexamid), Penbotec (pyrimethanil), and Mentor (propiconazole). These products could be used alone or in mixtures to manage all major decays of sweet cherry. In 2012 we also evaluated Mentor that is registered on

Table 1: Fungicides used in 2012 studies*.

Type of fungicide	Fungicide trade name	Active ingredient	FRAC group
Single active ingredients			
	Bumper, Tilt, Mentor	propiconazole	3
	Elevate	fenhexamid	17
	Elite, Tebuzol	tebuconazole	3
	Fontelis	penthiopyrad	7
	Judge	fenhexamid	17
	Ph-D	polyoxin-D	19
	Quash	metconazole	3
	Quintec	quinoxyfen	13
	Rovral, Iprodione	iprodione	2
	S-2200	unknown	unknown
	Scholar	fludioxonil	12
	TopGuard	flutriafol	3
	Vivando	metrafenone	U8
	Xemium	fluxapyroxad	7
	YT669	picoxystrobin	11
Pre-mixtures of multiple active ingredients			
	Adament	tebuconazole + trifloxystrobin	3 + 11
	Luna Sensation	fluopyram + trifloxystrobin	7 + 11
	Merivon	fluxapyroxad + pyraclostobin	7 + 11
	Pristine	boscalid + pyraclostrobin	7 + 11
	Q8Y78	penthiopyrad + picoxystrobin	7 + 11
	Quadris Top	difenoconazole + azoxystrobin	3 + 11

* - Alphabetical by trade name.

stone fruit in California specifically for the management of sour rot. This decay is an occasional problem on cherry in wet years or when fruit are bruised during handling. An organic formulation of polyoxin-D (Ph-D) is also being evaluated and is proving to be a promising treatment and the most effective organic compound ever evaluated in our program. With the establishment of MRLs in many export countries in the last five years and with the establishment of a food additive tolerance (FAT) for fludioxonil in Japan in 2011, Scholar is the first postharvest fungicide that the North American cherry industry can use for domestic and international markets including Japan. Scholar is very stable in the presence of chlorine in re-circulating drench or flooder treatments and in combination with other postharvest fungicides, and can be used at reduced rates, making it cost-effective. The availability of several fungicides belonging to different chemical classes and of different sanitizers for wash treatments is essential for managing the major diseases occurring on sweet cherry after harvest in California. The development of integrated strategies will also be critical for preserving the efficacy of these fungicides against postharvest fruit decays and for the successful marketing of sweet cherry in global markets where maximum residue limits (MRLs) will be important factors in the future.

Objectives

1. Evaluate kasugamycin and other new products (e.g., Actinovate, polyoxin-D, AgriTitan) against bacterial blast in flower inoculation studies and canker in stem inoculation studies. (Cooperate with J. Grant on copper sensitivity of *P. syringae* in canker orchards).
2. Evaluate, under field conditions, bloom and preharvest applications of new experimental compounds (e.g., fungicides such as Fontelis, fenpyrazamine, S-2200, Inspire XT, Luna Sensation, Merivon, Quadris Top, Q8Y78,

and biological products such as Actinovate and Ph-D) as compared to registered fungicides for control of brown rot and Botrytis blossom blight, powdery mildew, and pre- and postharvest brown rot and gray mold fruit decay.

   a. Continue to identify new treatments such as fenpyrazamine or S-2200 for gray mold (a weakness of DMI fungicides) and for brown rot (to prevent resistance from developing to DMI fungicides in orchard populations of *Monilinia* species with potential overuse of these fungicides).

b. Evaluate new powdery mildew fungicides (i.e., Vivando - BAS560) and SDHI compounds (fluopyram, fluxapyroxad, and penthiopyrad) using different rates and timings and develop a powdery mildew fungicide program that integrates newly registered materials with current single- and multi-site mildew fungicides.
c. Evaluate biologicals and OMRI approved organic treatments such as polyoxin-D (Ph-D).

3. Evaluate new fungicides as postharvest treatments and develop cost-effective application methods:
   a. Continue to evaluate the generic tebuconazole formulation Tebuzol 45WP as compared to Elite.
   b. Continue to evaluate Scholar, Penbotec, Mentor, as well as Scholar-Mentor and Tebuzol-Elevate mixtures with an emphasis on Scholar due to its recent approved food additive tolerance (FAT) in Japan.
   c. Continue to develop EC_{50} values, baseline sensitivities, and monitor resistance in target pathogen populations to newly developed fungicides.
   d. Evaluate biologicals and OMRI approved organic treatments (Ph-D).
4. Evaluate postharvest sanitation treatments (e.g., Perasan, potassium hypochlorite) as compared to standard sodium hypochlorite treatments (if product is available).

MATERIALS AND METHODS

Evaluation of treatments for control of bacterial blossom blast and canker. Several trials on bacterial blossom blast were done in a cv. Coral cherry on Colt rootstock orchard in San Joaquin Co. where rest-breaking treatments were applied to induce an early bloom. Blossoms of flower clusters (eight single-branch replications on different trees for each treatment) were partially emasculated by cutting pistils, stamens, and part of the petals using scissors. Bactericide applications (Kocide 3000, kasugamycin - Kasumin, oxytetracycline - Mycoshield, *Streptomyces lydicus* – Actinovate, and zinc titanium dioxide - AgriTitan) were made using a hand sprayer. After air-drying for 2 h, blossoms were inoculated with *Pseudomonas syringae* (10^7 cfu/ml) by hand-spraying. Inoculated branches were covered with white plastic bags for 18 h (except for AgriTitan in the 2nd experiment where clear plastic bags were used). The incidence of disease (based on the number of diseased blossoms per total number of blossoms) was evaluated after approximately 2 weeks.

For evaluation of treatments to control the natural incidence of blossom blast, applications to trees were done at 50% bloom using a backpack air-blast sprayer at 100 gal/A on 3-8 or 3-21-12. The same treatments as in the hand-sprayer trial above were used. Additional treatments consisted of a kasugamycin-polyoxin-D (Kasumin-Ph-D) mixture and a Deccosan 321-Actinovate treatment. In this latter treatment, the sanitizer Deccosan 321 (diluted 1:20) was applied ca. 1 h before the biocontrol Actinovate. The efficacy of Kasumin and Actinovate was also evaluated in commercial applications. For each single-tree replication, 150 spurs were evaluated for disease after 5 to 18 days, and the incidence of blast was determined based on the number of diseased spurs of the total number of spurs evaluated.

Treatments for the management of bacterial canker were done to inoculated branches by hand-spraying or by commercial applications in mid-December of 2011. For inoculation, the bark of 2-year-old twigs was puncture-wounded using a 12-gauge needle (3 wounds per twig). For Treated-Inoculated, wounds were sprayed to run-off using a hand sprayer and spray-inoculated after 2 h with *Pseudomonas syringae* (10^7 cfu/ml). Wounds were then wrapped or not wrapped with Parafilm. For Inoculated-Treated, wounds were first inoculated and then treated after 1 h. Treatments included Kocide 3000, Actinovate, AgriTitan, Deccosan, and Kasumin in the hand-sprayer trial and Actinovate and Deccosan-Actinovate in the commercial applications. In the latter treatment, Deccosan at 1% was first applied, and was followed by Actinovate after ca. 2 h. Inoculated branches were sampled on March 26, 2012 and canker lengths were measured.

Evaluation of new fungicides for control of powdery mildew of sweet cherry. A field trial in San Joaquin Co. was conducted to evaluate fungicides for powdery mildew control. Treatments were done at full bloom (protection from primary inoculum or ascospores from overwintering chasmothecia), and were followed by two additional treatments (protection from secondary infection from conidia) with selected fungicides (see Fig. 7) to shift the disease progress curve to later in the growing season. Additionally, three rotation programs were evaluated. The incidence of powdery mildew was evaluated on leaves from five shoots from inside the tree and on five shoots from the outer tree perimeter for each of the four single-tree replications on June 6, 2012. Data were analyzed using analysis of variance and LSD mean separation procedures of SAS 9.1.

Evaluation of new fungicides for control of brown rot and Botrytis blossom blight and fruit decay. Laboratory experiments were conducted to evaluate the pre-and post-infection activity of fungicides against brown rot and gray mold blossom blight. For pre-infection activity (protection), blossoms were collected at white bud, allowed to open in the laboratory, and treated using a hand sprayer. After 12 h, blossoms were inoculated with a spore suspension of *M. fructicola* or *B. cinerea* (15,000 conidia/ml) until water droplets formed on anther filaments. To evaluate the post-infection activity ("kick-back'), blossoms were collected, inoculated, and treated after 24 h with a hand-sprayer. Blossoms were evaluated for stamen infection after 4-5 days of incubation at 20 C, >95% relative humidity. Disease incidence was evaluated as the number of stamens infected divided by the total number of stamens per blossom. Three replications of 8 blossoms were used for each treatment and data were analyzed using analysis of variance and LSD mean separation procedures (SAS 9.1).

To evaluate preharvest fungicide applications for control of fruit decay, orchards were used in San Joaquin Co. (commercial orchard) and at UC Davis (experimental orchard). In the San Joaquin trial, fungicides were applied to trees 7 or 0 days before harvest using a back-pack sprayer calibrated to deliver 100 gal/A. Fruit were harvested, 8 fruit from each of four single-tree replications were wounded with a glass rod (1 x 1 x 0.5 mm; 8 fruit from each of four single-tree replications), and inoculated with 20 μl of a conidial suspension of *M. fructicola* or *B. cinerea* (40,000 conidia/ml). In non-wound inoculations, approximately 50 to 60 fruit from each replication were sprayed with conidia of *M. fructicola* and incubated at 20C. In the UC Davis trial, treatments were applied 7 or 1 day PHI, also using a back-pack sprayer. Fruit (8 fruit from each of three single-tree replications) were harvested and wound-inoculated with *M. fructicola* or *B. cinerea* as described above or non-wound, drop-inoculated with a spore suspension of *M. fructicola* (50,000 spores/ml). All fruit were incubated for 3-7 days at 20 C, >95% RH. Percent incidence of infection was determined as the number of fruit infected of the total number of fruit evaluated. Data were analyzed as described above.

Evaluation of preharvest treatments for postharvest decay control. To evaluate preharvest fruit treatments for postharvest decay management and the persistence of the fungicides on the fruit, treated, harvested fruit from the San Joaquin orchard were washed in a commercial hydrocooler for 4 to 6 min. Fruit were wound- or non-wound-inoculated with *M. fructicola* or *B. cinerea* as described above. In another trial in San Joaquin Co., the efficacy of preharvest and commercial postharvest treatments with Scholar was compared using non-washed and hydrocooled-washed fruit. Fruit were wound-inoculated with *M. fructicola* or *R. stolonifer* or non-wound-inoculated with *M. fructicola*. Fludioxonil residue levels in fruit were also determined in this latter trial. Percent incidence of decay was determined as the number of fruit infected of the total number of fruit evaluated. Data were analyzed as described above.

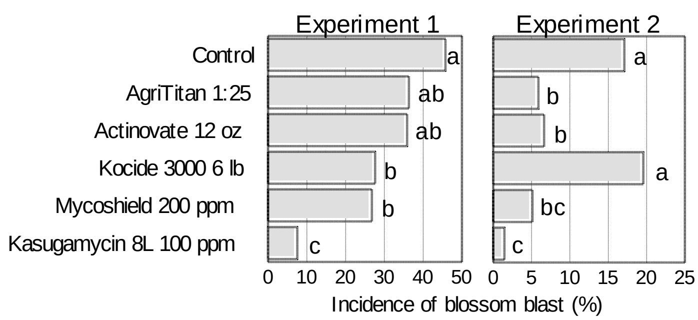
Efficacy of new and registered postharvest treatments for control of brown rot, gray mold, Rhizopus rot, and sour rot of sweet cherry. Three laboratory studies focused on the efficacy of two formulations of polyoxin-D, including an organic formulation, against brown rot, gray mold, and Rhizopus rot. Polyoxin-D was either used by itself or in mixtures with Judge (fenhexamid). Also included was the numbered compound S-2200, that currently does not have a chemical class assigned. The efficacy of these treatments was compared to that of Scholar, Tebuzol (an Elite replacement), or Penbotec. In another experiment, the efficacy of Mentor was evaluated against the three major decays, as well as against sour rot that sometimes can cause losses of sweet cherry fruit. Fungicides were applied as aqueous solutions using an air-nozzle sprayer either 11-14 h after (Inoculated-Treated) or before (Treated-Inoculated) inoculation with the respective fungal pathogens. Fruit were wound-inoculated with 20 μl of a spore suspension of *M. fructicola*, *B. cinerea*, *R. stolonifer* (30,000 spores/ml each), or with *Geotrichum candidum* (500,000 spores/ml). Fruit were incubated for 4-7 days at 20 C, >95% RH. Incidence of decay was determined as the number of fruit infected of the total fruit evaluated. Data were analyzed using analysis of variance procedures of SAS 9.1.

In another study, the efficacy of drench or T-Jet applications with Scholar 230SC (16 fl oz/100 gal) was evaluated on fruit that were wound-inoculated with *M. fructicola*, *B. cinerea*, or *R. stolonifer* 4 h before treatment. For each treatment, 30 fruit were used for each of three replications. Inoculations were done as described above. Drench treatments for 10 or 20 sec were done in combination with 1-minute pre-washes and simulated 5-minute hydrocooler post-treatment washes. T-jet applications were done using a hand-held T-jet system. Wash and Scholar drench treatments were done using a small-scale drench system. For the hydrocooler wash, water was cooled to 3.2C. After treatment, fruit were incubated at 20C until decay developed in the control treatment (5-7 days). Incidence of decay was determined as the number of fruit infected of the total fruit evaluated. Data were analyzed using analysis of variance procedures of SAS 9.1. Scholar residues in fruit were also determined for each treatment.

RESULTS AND DISCUSSION

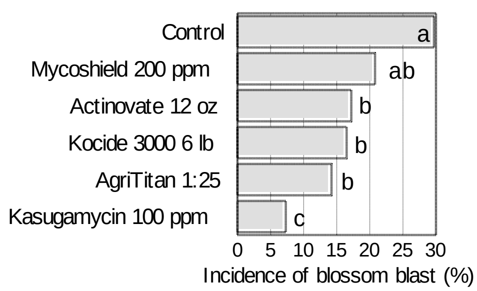
Evaluation of treatments for control of blossom blast and bacterial canker. Three approaches were done on the evaluation of new treatments against blossom blast. In two experiments, individual branches with *P. syringae*-inoculated blossoms were treated by hand-spraying; in two additional tests, back-pack air-blast treatments were applied to non-inoculated trees to evaluate the effect against natural infections; and commercial treatments on a larger scale were done using two treatments. Eight different treatments were used in the tests. Kasumin and Actinovate were included in all trials, whereas copper (Kocide 3000 or Badge), oxytetracycline (Mycoshield), and AgriTitan were included in all experiments, except the commercial application.

Fig. 1. Evaluation of antibacterial treatments for protection of inoculated blossoms of cv. Coral cherry on Colt rootstock against bacterial blast in 2012



Blossoms were partially emasculated by cutting off pistils, stamens, and part of the petals. Applications were made using a hand sprayer. After 2 h, blossoms were inoculated with *Pseudomonas syringae* (10^7 cfu/ml) by hand-spraying. Inoculated branches were covered with white plastic bags for 18 h except for AgriTitan in the 2nd experiment where clear bags were used. Disease was evaluated after ca. 2 weeks.

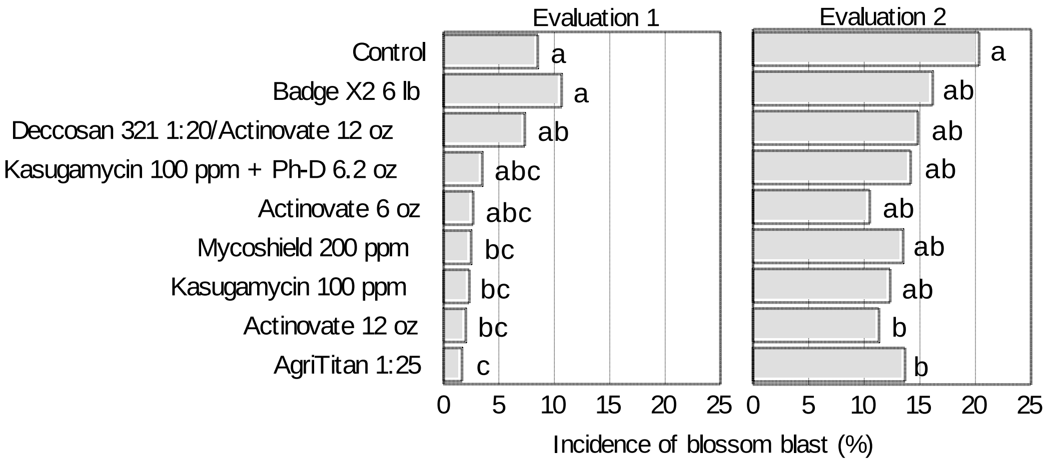
Fig. 2. Evaluation of antibacterial treatments for protection of blossoms of cv. Coral cherry on Colt rootstock from natural infections of bacterial blast in 2012



Applications were made at 50% bloom using a backpack airblast sprayer at 100 gal/A on 3-8-12. 150 spurs of each tree were evaluated for disease on 3-26-12.

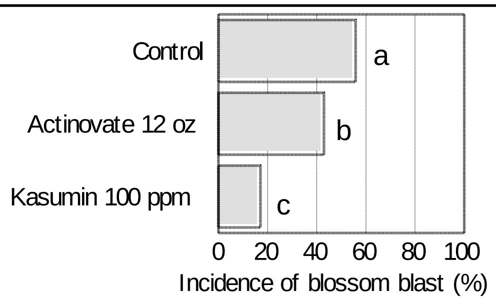
Treatments with copper had little or no effect on the incidence of blossom blast in all experiments where it was included (Figs. 1,3). This reflects the widespread occurrence of copper resistance in the pathogen *P. syringae*. After hand-spraying inoculated blossoms, kasugamycin had the highest efficacy in both experiments (Fig. 1). Mycoshield and AgriTitan showed an intermediate efficacy, whereas Actinovate was inconsistent in these hand-sprayer trials on inoculated blossoms. The lack of efficacy of AgriTitan in the first test can be attributed to the fact that this antimicrobial agent is light-activated and white plastic bags where used to provide high humidity in this experiment. In contrast, clear bags were used in the second test and a significant reduction in blossom blast by AgriTitan was observed from that of the control (Fig. 1).

Fig. 3. Evaluation of antibacterial treatments for protection of blossoms of cv. Coral cherry on Colt rootstock from natural infections of bacterial blast in 2012



Applications were made at 50% bloom using a backpack airblast sprayer at 100 gal/A on 3-21-12. In the Deccosan 321/Actinovate treatment, the sanitizer Deccosan 321 was applied ca. 1 h before the biocontrol Actinovate. 150 spurs of each tree were evaluated for disease after 5 days (evaluation 1) or 12 days (evaluation 2).

Fig. 4. Evaluation of commercial applications with Kasumin or Actinovate for protection of blossoms of cv. Coral cherry on Colt rootstock from natural infections of bacterial blast in 2012

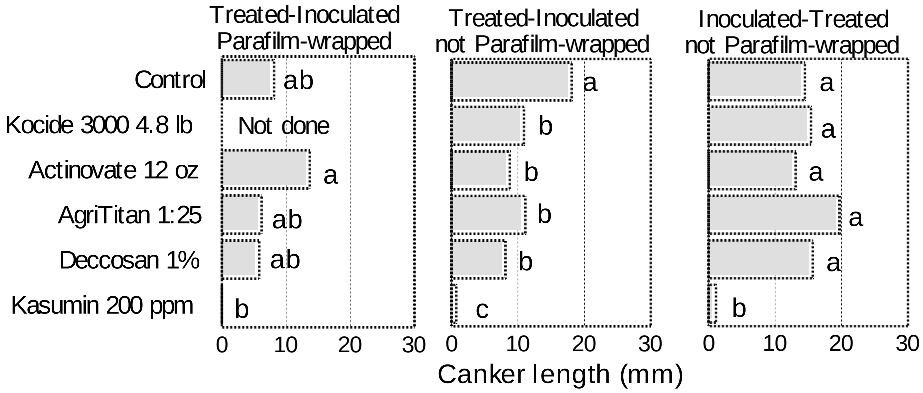


Applications were made at 50% bloom using a commercial airblast sprayer at 100 gal/A. 150 spurs of each tree were evaluated for disease on April 2, 2012.

AgriTitan also showed very good efficacy in reducing the natural incidence of disease after back-pack air-blast application (Figs. 2,3) and thus, this is a very promising new treatment approach. Natural incidence of disease was most effectively and consistently reduced after application of kasugamycin, including in the commercial application test (Figs. 2,3,4). Actinovate had consistent intermediate efficacy in these natural incidence studies. Addition of polyoxin-D to kasugamycin did not result in an increased efficacy (Fig. 3). Similarly, sanitizing trees before application of Actinovate did not improve the effectiveness of the biocontrol (Fig. 3). The strategy of this pre-treatment was to reduce natural populations of competing microorganisms, so that the biocontrol agent *Streptomyces lydicus* would have an advantage in colonizing plant tissues. In the second back-pack airblast trial (Fig. 3), reduction of disease by most treatments was higher in the first evaluation as compared to the second evaluation. This may indicate that a two-application program would result in a prolonged and more effective reduction of disease.

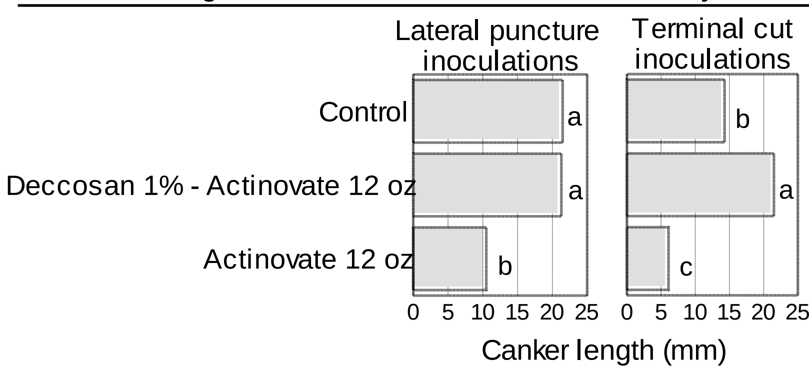
In studies on bacterial canker, interestingly, canker growth in the non-treated control was higher when inoculation sites were not wrapped with Parafilm as compared when they were wrapped (Fig. 5). Among the treatments tested on freshly wound-inoculated branches, Kasumin had the highest efficacy and was effective as a protective pre-infection, as well as a post-infection treatment (Fig. 5). The remaining treatments tested (Kocide 3000, Actinovate, AgriTitan, Deccosan) only reduced canker growth when used as protective applications. Actinovate also reduced canker development of inoculated branches after commercial applications (Fig. 6). As for blossom blast, a sanitizing pre-treatment with Deccosan did not improve the efficacy of the biocontrol.

Fig. 5. Evaluation of antibacterial treatments for protection of inoculated twigs of cv. Coral on Colt rootstock cherry trees against bacterial canker in 2012



The bark of 2-year-old twigs was puncture-wounded using a 12-gauge needle (3 wounds per twig) on Dec. 13, 2011. For Treated-Inoculated, wounds were sprayed to run-off using a hand sprayer and spray-inoculated after 2 h with *P. syringae* (10^7 cfu/ml). Wounds were then wrapped or not wrapped with Parafilm. For Inoculated-Treated, wounds were first inoculated and treated after 1 h. Inoculated branches were sampled on March 26, 2012 and canker lengths were measured.

Fig. 6. Evaluation of commercial applications with Actinovate and Deccosan for protection of inoculated twigs of cv. Coral on Colt rootstock cherry trees against bacterial canker in 2012



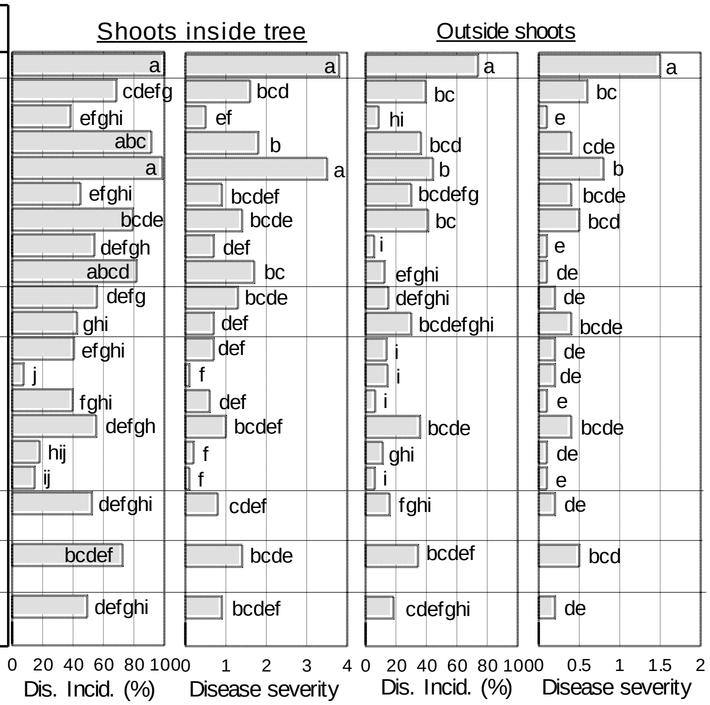
The bark of 2-year-old twigs was puncture-wounded using a 12-gauge needle (3 wounds per twig) and stub cuts were made on Dec. 14, 2011. Wounds were spray-inoculated with *P. syringae* (10^7 cfu/ml). Treatments with were applied using a commercial airblast sprayer at 100 gal/A immediately afterwards. For the Deccosan-Actinovate treatment, Deccosan was applied first and followed by Actinovate after 2 h. Inoculated twigs were sampled on March 26, 2012 and canker lengths were measured.

In summary, in the three years of our research on the management of bacterial blossom blast, we identified Kasumin and Actinovate as effective treatments to reduce this disease. This is important progress because rest-breaking treatments are being used widespread by the cherry industry to achieve an early harvest, but shifting the bloom period to an earlier date when disease-predisposing cold, rainy weather conditions are more likely to occur. Additionally, the cultivar Coral Champaign is increasingly being planted due to resistance of the fruit to rain cracking. In a two-application program, Actinovate and Kasugamycin likely can be used in a rotation, although compatibility of these treatments still needs to be tested (i.e., tolerance of the biocontrol agent to kasugamycin). Actinovate is currently registered on a number of crops against several diseases and the label can be amended. Kasugamycin is planned for registration for pome fruits and walnuts in late 2012; registration for cherry is planned in a second tier. The antimicrobial AgriTitan also gave promising results and further evaluation is warranted. Mycoshield was included in the study because it is known to be effective against bacterial diseases, but no new registrations for this antibiotic are planned.

Some progress was also made on the management of bacterial canker. However, the control of this stage of the disease is still a long-term goal. Due to the long infection period for woody tissues, application timings are difficult to determine and most likely will focus on the most favorable infection periods (e.g., after pruning). The use of a biocontrol agent will likely provide a longer residual efficacy as compared to organo-chemical treatments such as Kasumin that are quickly metabolized.

Fig. 7. Efficacy of preharvest fungicide applications for management of powdery mildew of Bing sweet cherries in San Joaquin Co. - 2012

Treatment	Rate	3-26 FB	4-10 PF	5-3
Control	---	---	---	---
TopGuard	7 fl oz	@	@	@
TopGuard	14 fl oz	@	@	@
Quash 50WG	2.5 oz	@	@	@
Quash 50WG	3.5 oz	@	@	@
S-2200 WG	3 oz	@	@	@
Fontelis/NIS	14 fl oz/8 fl oz	@	@	@
Fontelis + Surf.	20 fl oz/8 fl oz	@	@	@
YT669 2.08SC + Surf.	12 fl oz	@	@	@
S2200 + Quash	2 oz + 2 oz	@	@	@
S2200 WG + Quash	3 oz + 3 oz	@	@	@
Adament WG	6 oz	@	@	@
Luna Sensation SC	5 fl oz	@	@	@
Quadris Top	14 floz	@	@	@
Pristine 38WG	14.5 oz	@	@	@
Merivon	6.58 fl oz	@	@	@
Q8Y78 240SC	18 fl oz	@	@	@
Iprodione 4F	32 fl oz	@	---	---
Quintec 2L	7 fl oz	@	@	@
Merivon SC	6.5 oz	@	---	---
Apogee + AMS	16 oz + 16 oz	---	@	@
Xemium (BAS700)	3.4 fl oz	@	---	---
Vivando (BAS560)	10 fl oz	@	@	@

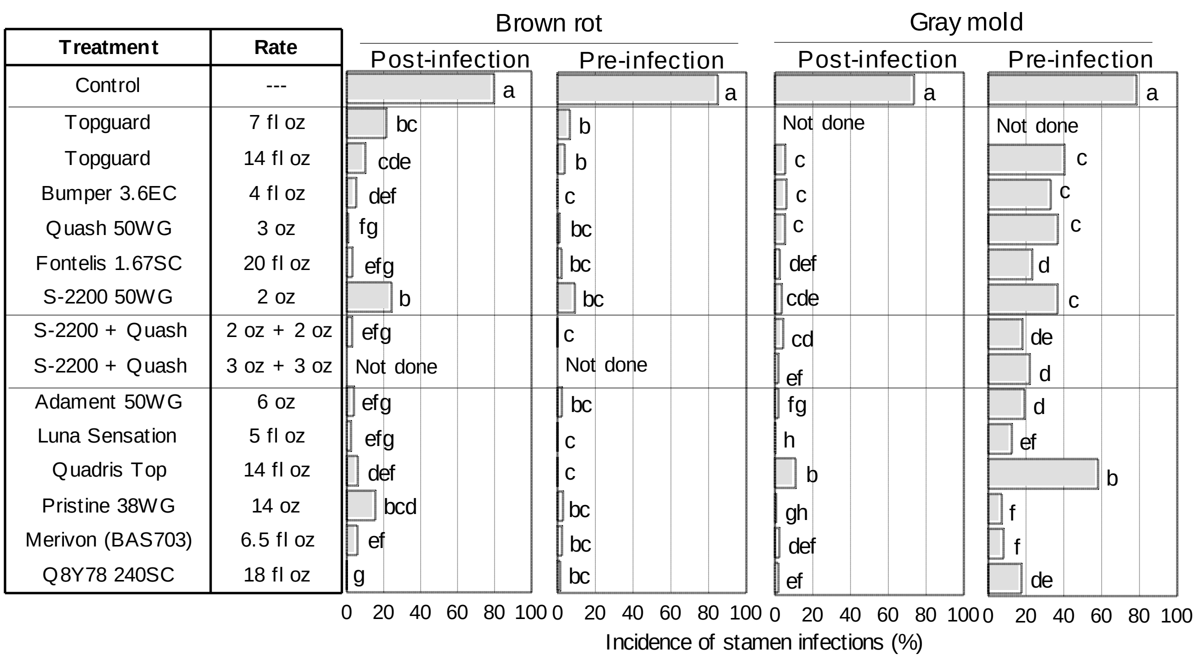


Treatments were applied in the field using an air-blast sprayer (100 gals/A). Evaluation was done on 6-6-12. For this, 20 leaves from 5 random shoots from inside or outside of the tree were sampled. Disease was evaluated using the following rating: 0=healthy, 1 = 1-3 lesions, 2 = <25%, 3 = up to 50%, 4 = >50% of leaf area affected. Q8Y78 240SC is a pre-mix of picoxystrobin and penthiopyrad.

Evaluation of new fungicides for control of powdery mildew of sweet cherry. The efficacy of new fungicides and new pre-mixtures was evaluated in our research plot in San Joaquin Co. Three applications were done over a 6-week period starting at full bloom with blossom blight applications. At evaluation time, leaves on trunk shoots (water sprouts) and the older outside canopy showed symptoms of powdery mildew in the untreated control. The average incidence was 75-100%; whereas the average severity rating was 1.5 to 3.9 (of a maximum rating of 4). The most effective treatments included all SDHI-containing pre-mixture fungicides (FG 7/11) Luna Sensation, Merivon, and Q8Y780, as well as the SDHI Fontelis (high rate), and selected DMI (FG 3) or DMI-containing fungicides (FG 3/11) such as Adament, TopGuard, and Quadris Top (Fig. 7). Quintec (FG 13) performed well, reducing the incidence of the disease on both inside and outside shoots (and the severity of disease on the outside shoots); but there was a higher severity on inside shoots than in other years. The experimental QoI (FG 11) YT669 performed poorly on inside shoots but was very effective on outside shoots. S-2200 was intermediate on both inside and outside shoots. Tank mixtures of Xemium (FG 7) and Vivando (FG U8) or S2200 (FG non-disclosed) and Quash (FG 3) were intermediate in their performance. The use of the growth regulator Apogee that was applied following a bloom application of Merivon reduced new shoot growth and helped to reduce the incidence and severity of disease to moderate levels especially on outer shoots.

This research demonstrated the excellent activity of several new fungicides against powdery mildew and we show that the disease can be reduced to acceptable levels by properly timed applications. Development of fungicides with unique modes of action (such as SDHI fungicides and others) needs to be continued to provide options in rotation programs and to prevent overuse of quinoline (i.e., Quintec), DMI, and QoI fungicides. The FG 7/11 fungicides Luna Sensation, Merivon, and Q8Y780, as well as the FG Group 7 Fontelis are excellent powdery mildew fungicides. Because of the potential of resistance to single-site mode of action fungicides, FG 7 materials should be tank mixed with FG 3 or FG 11 compounds. Pre-mixtures and tank mixtures should be used in rotation with other fungicides with different modes of action. Similarly, Vivando (FG U8) is potentially an excellent mix partner because of its unique mode of action and specificity against powdery mildew fungi. Mildew fungicides should be applied during bloom and again during petal fall periods. Materials could be selected that are very effective against blossom blight and powdery mildew diseases. Rotation of these different mode-of-action fungicides potentially may off-set resistance selection by limiting the use of any single-site mode of action fungicide (i.e., single FG number) and thus, this reduces the selection pressure. Limiting any one fungicide product will also reduce the residue and ensure that MRLs are not exceeded with any of the trade partners of the cherry industry.

Fig. 8. Efficacy of pre- and post-infection treatments with selected fungicides for management of brown rot and gray mold blossom blight of Bing sweet cherry



For evaluation of the pre-infection activity, closed blossoms were collected in the field, allowed to open, and treated in the laboratory using a hand sprayer. After 12 h blossoms were inoculated with a spore suspension of *M. fructicola* (15K/ml). For post-infection activity, blossoms were inoculated and treated after 24 h. Blossoms were evaluated for stamen infections after 4-5 days of incubation at 20 C.

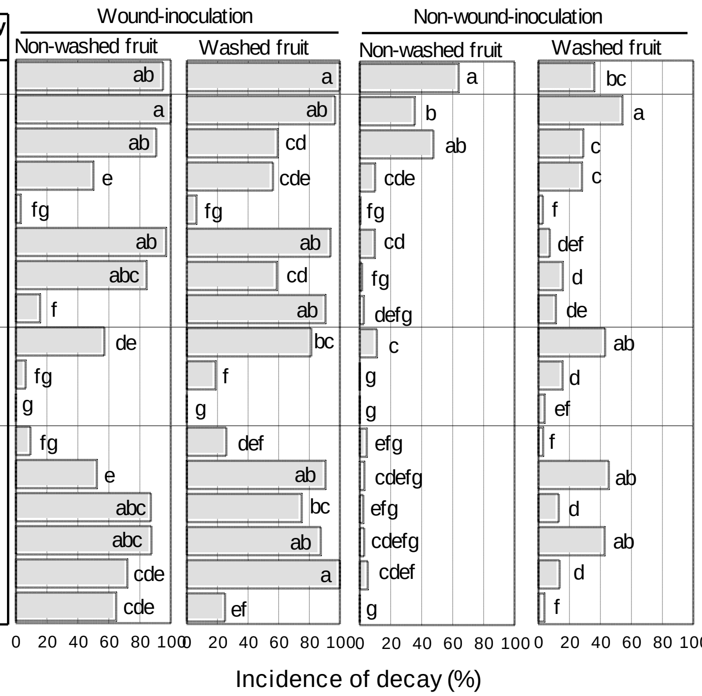
Efficacy of new fungicides for control of brown rot and Botrytis blossom blight. Fungicide treatments were evaluated on detached opened blossoms in comparative laboratory studies. In pre- and post-infection studies, new and registered fungicides were very effective against brown rot and Botrytis blossom blights (Fig. 8). Highly effective fungicides with excellent pre- and post-infection activity against both blossom diseases included: FG 7/11 fungicides (e.g., Pristine, Luna Sensation, Merivon, and Q8Y780), FG 7 Fontelis, FG 3/11 fungicides (e.g., Adament, Quadris Top); as well as the FG 3 (DMI) fungicides Quash, TopGuard, and Bumper. S-2200 was inconsistent in is performance. Due to the good pre- and post-infection activity of most fungicides, the practice of a single delayed-bloom application when environmental conditions are not favorable for disease development is an excellent strategy for obtaining highly effective blossom disease management and result in a minimal number of blossom treatments on sweet cherry.

Evaluation of preharvest treatments for fruit decay control without postharvest washes and for postharvest decay control after postharvest washes. Two preharvest efficacy trials were done in 2012. In wound inoculation studies, most fungicides performed poorly on washed and non-washed fruit. DMI fungicides (FG 3) and mixtures that included DMI fungicides such as Quash, Quash + S-2200, or Quadris Top had the highest efficacy against brown rot of non-washed fruit in these applications that were made seven days before harvest (Fig. 9). Scholar applied as a preharvest treatment did well on non-washed fruit and poorly on washed fruit, demonstrating non-systemic activity when applied in the field to dry fruit. Compounds with intermediate efficacy were Adament and the FG 7/11 fungicides. Thus, the DMI (FG 3) fungicides with their locally systemic action are still unrivaled for management of brown rot decay. All of the fungicides were very effective against brown rot when non-wounded fruit were not washed and inoculated (Fig. 9), however, when non-wounded fruit were washed using a postharvest hydrocooler treatment, decay increased for most of the treatments. DMI (FG 3) and SDHI/QoI (FG 7/11), as well as DMI/QoI (FG 3/11) fungicides performed the best. This is probably because fungicides that are active against

Fig. 9. Efficacy of 7- and 0-day preharvest fungicide treatments for management of postharvest brown rot and gray mold of Bing cherries - Orchard 1

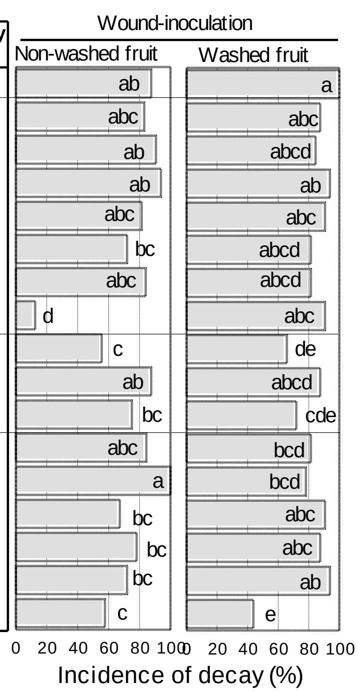
A. Brown rot

	Treatment	Rate	7 day PHI	0 day PHI	Wound-inoculation: Non-washed fruit	Wound-inoculation: Washed fruit	Non-wound-inoculation: Non-washed fruit	Non-wound-inoculation: Washed fruit
	Control	---	---	---	ab	a	a	bc
Single fungicides	Ph-D 11.2DF	6.2 oz	@	---	a	ab	b	a
	TopGuard	7 fl oz	@	---	ab	cd	ab	c
	TopGuard	14 fl oz	@	---	e	cde	cde	c
	Quash 50WG	2.5 oz	@	---	fg	fg	fg	f
	Fontelis + Surf.	20 fl oz	@	---	ab	ab	cd	def
	YT669 + Surf.	12 fl oz	@	---	abc	cd	fg	d
	Scholar	16 fl oz	---	@	f	ab	defg	de
Mixtures	Ph-D + Elevate	6.2 oz + 24 oz	@	---	de	bc	c	ab
	S-2200 + Quash	2 fl oz/2 oz	@	---	fg	f	g	d
	S-2200 + Quash	3 fl oz/3 oz	@	---	g	g	g	ef
Pre-mixtures	Quadris Top	14 fl oz	@	---	fg	def	efg	f
	Adament	6 oz	@	---	e	ab	cdefg	ab
	Luna Sensation	5 fl oz	@	---	abc	bc	efg	d
	Pristine	14.5 oz	@	---	abc	ab	cdefg	ab
	Merivon	6.58 fl oz	@	---	cde	a	cdef	d
	Q8Y78 240SC	18 fl oz	@	---	cde	ef	g	f



B. Gray mold

	Treatment	Rate	7 day PHI	0 day PHI	Wound-inoculation: Non-washed fruit	Wound-inoculation: Washed fruit
	Control	---	---	---	ab	a
Single fungicides	Ph-D 11.2DF	6.2 oz	@	---	abc	abc
	TopGuard	7 fl oz	@	---	ab	abcd
	TopGuard	14 fl oz	@	---	ab	ab
	Quash 50WG	2.5 oz	@	---	abc	abc
	Fontelis + Surf.	20 fl oz	@	---	bc	abcd
	YT669 + Surf.	12 fl oz	@	---	abc	abcd
	Scholar	16 fl oz	---	@	d	abc
Mixtures	Ph-D + Elevate	6.2 oz + 24 oz	@	---	c	de
	S-2200 + Quash	2 fl oz/2 oz	@	---	ab	abcd
	S-2200 + Quash	3 fl oz/3 oz	@	---	bc	cde
Pre-mixtures	Quadris Top	14 fl oz	@	---	abc	bcd
	Adament	6 oz	@	---	a	bcd
	Luna Sensation	5 fl oz	@	---	bc	abc
	Pristine	14.5 oz	@	---	bc	abc
	Merivon	6.58 fl oz	@	---	bc	ab
	Q8Y78 240SC	18 fl oz	@	---	c	e



Treatments were applied on 5-30 or 6-5-12 using an air-blast sprayer at a rate of 100 gal/A. Fruit washes were done for 4 to 6 min fruit in a commercial hydrocooler. Fruit were wound-inoculated with *M. fructicola* or *B. cinerea* (30,000 spores/ml) or non-wound-inoculated with *M. fructicola* (50,000 spores/ml) and incubated at 20C for 6 days. Q8Y78 240SC is a pre-mix of picoxystrobin and penthiopyrad.

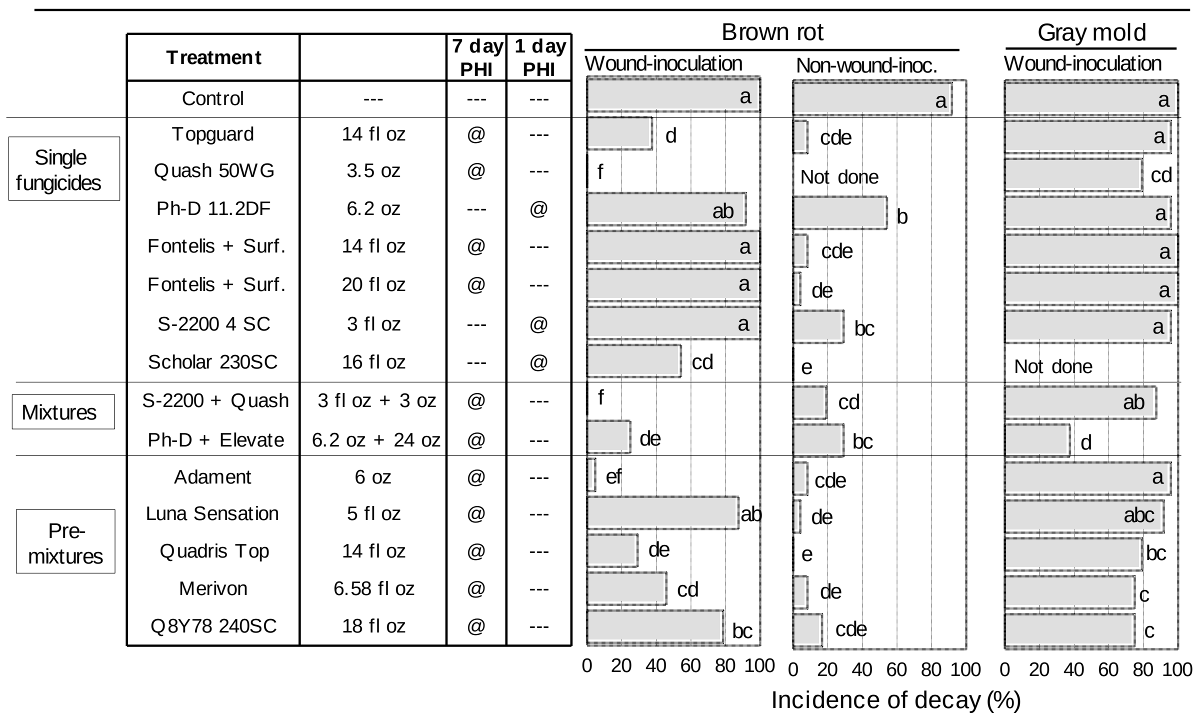
this decay (e.g., Elevate, Pristine, and Ph-D) do not penetrate into the fruit (i.e., are non-systemic) and residues on the fruit were removed by washing.

In trials to evaluate the effect against gray mold fruit rot, only a preharvest application of Scholar applied at 0-day PHI provided excellent control on non-washed fruit. Significant reductions of gray mold also occurred with treatments of Elevate+Ph-D and Q8Y78 (Fig. 9). Most fungicides performed poorly in preventing gray mold once fruit were washed using a postharvest hydrocooler treatment. Only fruit treated with Q8Y78 significantly reduced decay in these trials (Fig. 9).

The activity of the fungicides on wound- and non-wound-inoculated fruit was also evaluated at the UC Davis location. In this trial, the DMI (FG 3) fungicides alone or in mixtures as FG 3/11 (e.g., Adament and Quadris Top), as well as Elevate + Ph-D and Scholar were highly effective; whereas the FG 7/11 fungicides were generally intermediate to poor in reducing brown rot decay in wound-inoculated fruit.

In non-wound inoculated fruit, all of the fungicides significantly reduced brown rot. Most of the fungicides performed poorly against gray mold in wound-inoculated fruit. Still, Quash, Elevate+Ph-D, Quadris Top, Merivon, and Q8Y78 significantly reduced gray mold in these studies (Fig. 10). As indicated above, DMI fungicides (FG 3) and Elevate (FG 19) are locally systemic in fruit and provide protection to wounded and non-wounded fruit. These fungicides penetrate into the fruit, persist after postharvest washes, and subsequently help protect fruit from infections occurring after harvest without additional postharvest fungicide application. Fontelis and Luna Sensation appear to be contact fungicides on cherry fruit, and once fruit are wounded, the protective layer is breached. Ph-D was consistent in all trials with reducing brown rot of non-wounded fruit. This is an important finding because of the fungicide's potential to be formulated as an organic fungicide. In trials over the last several years, this compound also showed consistent control of brown rot.

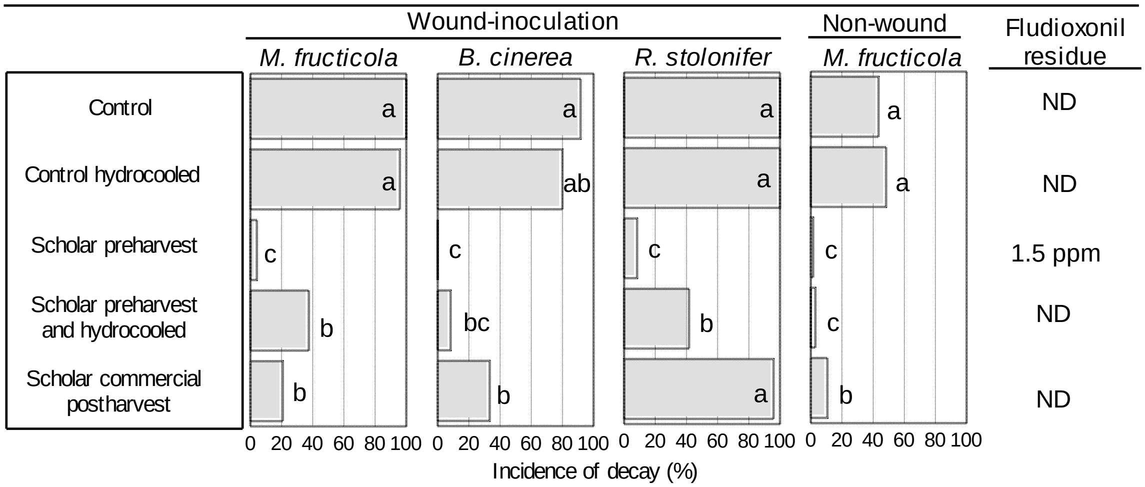
Fig. 10. Efficacy of 7- and 1-day preharvest fungicide treatments for management of postharvest brown rot and gray mold of Bing cherries - Orchard 2



Treatments were applied on 6-5-12 using an air-blast sprayer at a rate of 100 gal/A. Fruit were wound-inoculated with *M. fructicola* or *B. cinerea* (30,000 spores/ml) or non-wound-inoculated with *M. fructicola* (50,000 spores/ml) and incubated at 20C for 6 days. Q8Y78 240SC is a pre-mix of picoxystrobin and penthiopyrad.

Additional investigations were done with pre- and postharvest applications of Scholar for managing postharvest decays. In fruit that were non-wounded or wound-inoculated after treatment, the Scholar preharvest application for both non-washed and hydrocooled fruit significantly reduced decay caused by the three major postharvest decay fungi – *Monilinia fructicola, Botrytis cinerea,* and *Rhizopus stolonifer*. The commercial postharvest application of Scholar reduced brown rot, gray mold, but not Rhizopus rot. This can be explained because the packer used the lowest rate of fludioxonil (4 fl oz/100 gal) that resulted in non-detectable residues (< 0.2 ppm) on fruit as compared to the 16 fl-oz rate that was applied preharvest and that resulted in a 1.5-ppm residue on fruit (tolerance is 5 ppm) (Fig. 11).

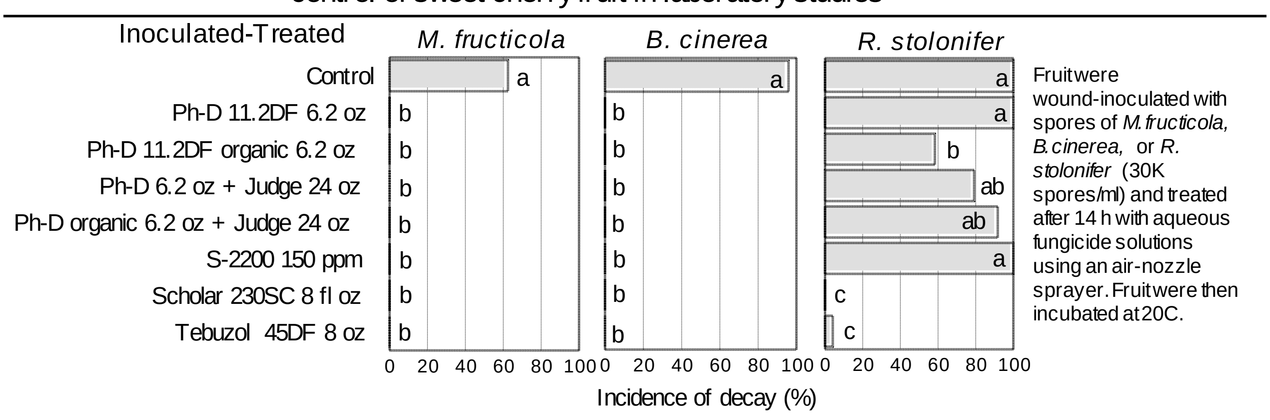
Fig. 11. Efficacy of preharvest and commercial postharvest Scholar treatments for management of postharvest brown rot of Bing cherries



Field treatments of Scholar 230SC were applied using an air-blast sprayer (16 fl oz/100 gal/A) approximately 1 h before harvest. Hydrocooling was done in a commercial packinghouse. The commercial postharvest rate of Scholar was approximately 4 fl oz/100 gal. Fruit were then wound-inoculated with spore droplets or non-wound inoculated by spraying with 100,000 spores/ml. Fruit were then incubated at 20C for 5 to 7 days. ND = not detected (< 0.2 ppm).

Efficacy of new and registered postharvest treatments for control of brown rot, gray mold, Rhizopus rot and sour rot of sweet cherry. In postharvest decay management in 2012, several studies were done for the possible development of a postharvest fungicide with a new mode of action, polyoxin-D, that potentially could be registered as an organic treatment. Additionally, a numbered compound (S-2200) was also evaluated for its potential use as a postharvest fungicide. In trials evaluating Ph-D and an organic formulation of Ph-D mixed or not mixed with Judge, S-2200, Scholar, and Tebuzol, only Scholar and Tebuzol controlled all three major postharvest pathogens of cherry (Fig. 12). S-2200, Ph-D, and Ph-D in mixtures were highly effective against brown rot and gray mold; whereas only the organic formulation helped to reduce Rhizopus rot but not to a commercially acceptable level (Fig. 12). Similar results were obtained in a study comparing Ph-D to Penbotec (Fig. 13). Thus, Ph-D, Judge, and Penbotec are effective against brown rot and gray mold and are generally not effective against Rhizopus rot.

Fig. 12. Postharvest treatments with registered and new fungicides for decay control of sweet cherry fruit in laboratory studies



In additional studies, the protective and curative effects of postharvest fungicide treatments were evaluated in studies using different inoculation methods. Both formulations of Ph-D performed well, reducing brown rot and gray mold in inoculated-treated and treated-inoculated studies (Fig. 14). S-2200 performed similar to Ph-D in the inoculated-treated studies but was ineffective against brown rot in the treated-inoculated studies. This

Fig. 13. Postharvest treatments with registered and new fungicides for decay control of sweet cherry fruit in laboratory studies

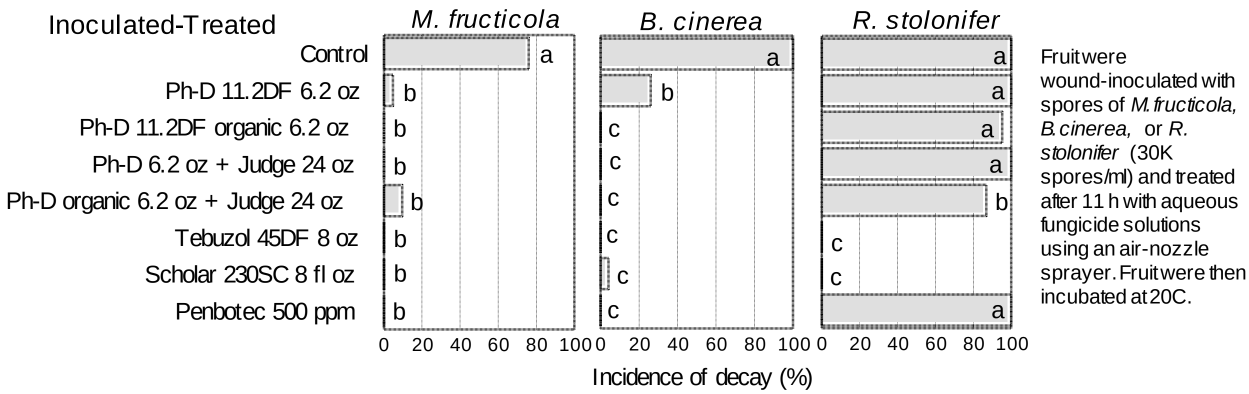
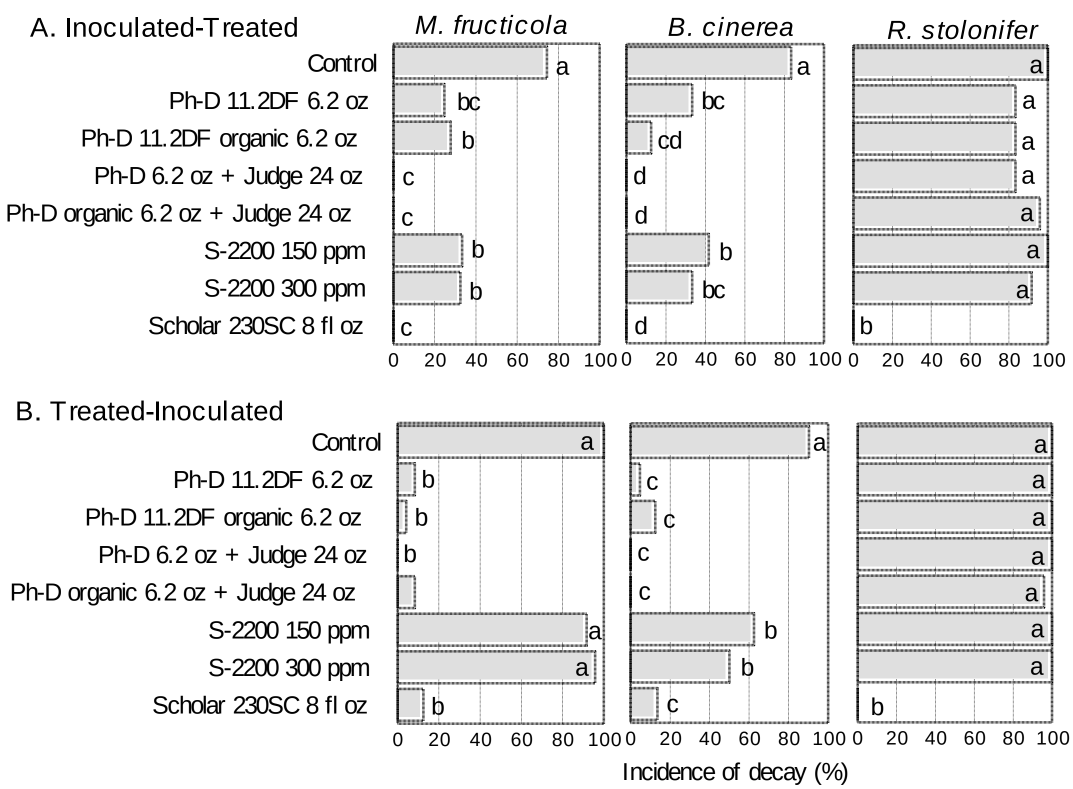


Fig. 14. Postharvest treatments with registered and new fungicides for decay control of sweet cherry fruit in laboratory studies

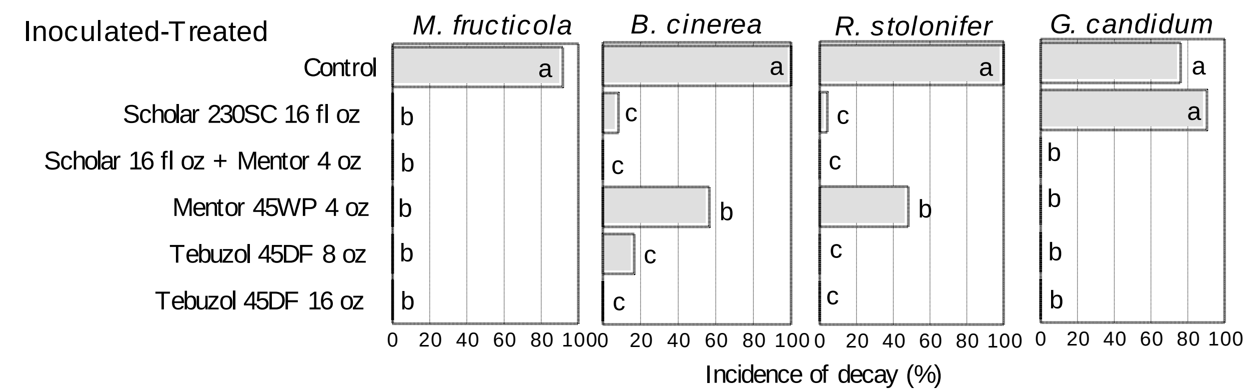


Fruit were wound-inoculated with spores of *M. fructicola*, *B. cinerea*, or *R. stolonifer* (30K spores/ml) and treated after 14 h with aqueous fungicide solutions using an air-nozzle sprayer. Fruit were then incubated at 20C.

reflects that the protective fungicide barrier can be by-passed and is indicative of the lack of fungicide penetration into the fruit epidermis. Thus, Ph-D and Ph-D mixed with Judge performed similarly to Scholar and provided protective and curative effects against brown rot and gray mold in these studies. Again, only Scholar reduced decay of all three decay fungi. Although Ph-D at 6.2 oz was effective as preharvest treatment against brown rot, the fungicide can be most effectively utilized as a postharvest treatment against brown rot and gray mold. Polyoxin-D (Ph-D) organic represents potentially the first postharvest fungicide that could be registered for organically grown fruit with performance similar to a conventional postharvest fungicide treatment.

Studies were also done to evaluate new postharvest DMI fungicides including Mentor and a tebuconazole formulation (e.g., Tebuzol 45DF from UPI as a substitute for the product Elite) as compared to Scholar (Fig. 15) for their activity against the sour rot pathogen *Geotrichum candidum*, as well as to the three major postharvest fungal decays (i.e., brown rot, gray mold, and Rhizopus rot). The sour rot pathogen is an occasional decay organism of cherry in wet years or when fruit are bruised during handling. Scholar is known to be not

Fig. 15. Postharvest treatments with registered and new fungicides for decay control of sweet cherry fruit in laboratory studies



Fruit were wound-inoculated with spores of *M. fructicola, B. cinerea,* or *R. stolonifer* (30K spores/ml) or *G. candidum* (500,000 spores/ml) and treated after 13-14 h with aqueous fungicide solutions using an air-nozzle sprayer. Fruit were then incubated at 20C.

effective against this pathogen and thus, the DMI fungicides were evaluated for their effectiveness against this decay. On peaches and nectarines in California for the last seven years, an emergency registration of Mentor prevented losses from sour rot. In these studies, both DMI fungicides and the Mentor-Scholar mixture were highly effective against brown rot and sour rot providing 100% control (Fig. 15). Mentor was effective but not as effective as Tebuzol against gray mold and Rhizopus rot; whereas Scholar was highly effective against all decays except sour rot. Tebuzol was evaluated at two rates (8 and 16 oz) as permitted on the label. Both rates were highly effective against all decays evaluated. In summary, we have numerous options for postharvest decay management of cherry. Currently, Scholar, Tebuzol, Judge, and Penbotec are registered for use on cherry. Recently, Mentor received a stone fruit (including sweet cherry) registration and the fungicide will be available for use in the 2013 season in California.

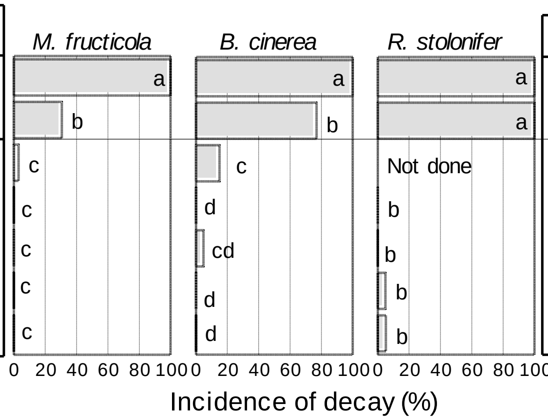
Effect of pre- and post-fungicide treatment washes on the performance of Scholar drench applications and fungicide residue levels on fruit. Based on last year's results, Scholar 230SC at 6 fl oz/100 gal (= 112 ppm) is highly effective as a drench treatment. This demonstrated that fungicide dip and drench application systems optimize fungicide coverage of fruit, and high fungicide performance can be obtained using lower rates as compared to a spray application system. Following a 1-min pre-wash at ambient temperature (28 C), fruit were either treated with Scholar using a T-Jet sprayer or drenched for 10 or 20 sec, and were either not washed or washed in a hydrocooler at 3.2 C for 5 min. The Scholar drench treatments were highly effective regardless of drench time and hydrocooler treatment (Fig. 16). Fungicide residues were less than 1.5 ppm when fruit were hydrocooled following fungicide treatment; however, when fruit were not washed, residues ranged from 0.8 to 2.9 ppm (all within the tolerance of 5 ppm). The T-jet application treatment was also highly effective against brown rot, but a reduced effectiveness was obtained against gray mold. For this treatment where fruit were not washed after treatment, residues were 0.4 ppm and thus, were lower than in the comparable Scholar drench treatments (Fig 16). This may indicate that although the T-jet application was very effective in reducing decay in our study, that under favorable conditions for decay such as after long-distance transport, drench applications will outperform a T-jet application.

Thus, in these experiments we showed that a postharvest fungicide drench application of Scholar was highly effective in managing decay. Post-treatment hydrocooler washes did not affect the efficacy of the fungicide while an effective fungicide residue was maintained. This provides packers important information on a number of methods for handling and treating fruit in the packinghouse.

Fig. 16. Evaluation of postharvest drench treatments of Bing cherry with Scholar for management of fruit decays and persistence of residues after hydrocooling

Inoculated-Treated

Prewash	Fungicide	Hydrocool wash 3.2C, 5 min	Residue
-	-	-	ND
1 min at 28C	-	-	ND
1 min at 28C	Scholar T-Jet	-	0.4 ppm
1 min at 28C	Scholar drench 20 sec	-	2.9 ppm
1 min at 28C	Scholar drench 20 sec	+	1.5 ppm
1 min at 28C	Scholar drench 10 sec	-	0.8 pmm
1 min at 28C	Scholar drench 10 sec	+	1 ppm



Fruit were wound-inoculated with *M. fructicola, B. cinerea,* or *R. stolonifer* (30,000 spores/ml) and incubated at 25C for 4 h. Pre-washes, Scholar (6 fl oz) drenches, and simulated hydrocool washes were done using a small-scale drench system. One Scholar treatment was done using a T-Jet spray system. Fruit were then incubated at 24C.

FOR INTERNAL USDA CIRCULATION ONLY

Postharvest treatment of sweet cherries with methyl bromide to control oriental fruit fly, *Bactrocera dorsalis*

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Confirmatory trials.

Methyl bromide (MB) chamber fumigations were evaluated for postharvest control of oriental fruit fly (OFF), *Bactrocera dorsalis*, in fresh sweet cherry exports from Western USA. Sweet cherries were infested with OFF, infested cherries containing the most MB-tolerant OFF life stage (2nd instar larvae) were buried amongst uninfested fruit in fruit bins consistent with commercial practice (30% load factor), and then the fruit bins were fumigated at 17.2 (± 0.5) ºC (63 ºF). Results from efficacy trials are summarized in the table below; complete mortality is observed with CT exposures of ~250 (mg h/L).

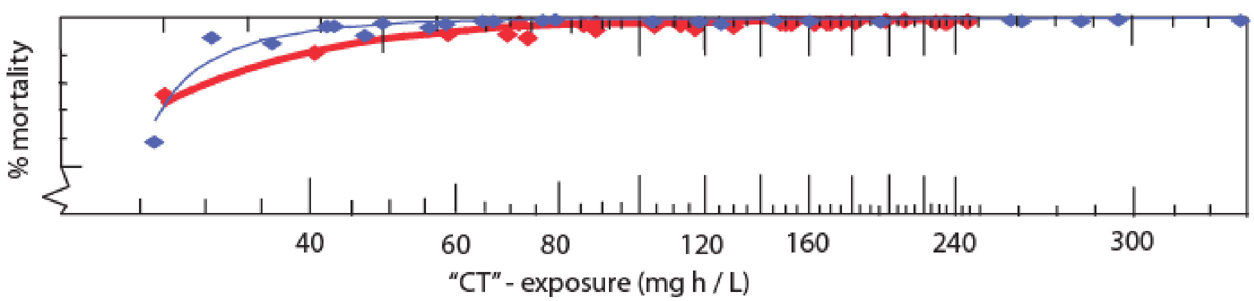
Trial #	# treated (± rel. STDEV)			Applied (mg/L)	Time (h)	Temp. (± 0.5 °C)	Temp. (± 0.8 °F)	Load (%)	Bin type	CxT Exposure ± 2.8 ($mg L^{-1} h$)	survivors	mortality (%)	Probit (95% LOC)
1	36241	±	20%	80.0	2	17.2	63.0	30.0	wood	148.8	13	99.9642	8.28
2	16798	±	20%	80.0	2	17.2	63.0	30.0	wood	151.5	11	99.9345	8.10
3	17464	±	20%	80.0	2	17.2	63.0	30.0	wood	153.8	16	99.9084	8.01
4	19495	±	20%	64.0	3	17.2	63.0	30.0	wood	169.5	30	99.8461	7.88
5	34327	±	20%	64.0	3	17.2	63.0	30.0	wood	170.5	4	99.9883	8.52
6	6,019	±	20%	72.0	4	17.2	63.0	30.0	wood	236.4	2	99.9667	8.18
7	6,918	±	20%	72.0	4	17.2	63.0	30.0	wood	227.8	1	99.9855	8.37
8	5,868	±	20%	80.0	3.5	17.2	63.0	30.0	wood	251.2	0	100	8.28
9	6,912	±	20%	80.0	3.5	17.2	63.0	30.0	wood	249.2	0	100	8.33

Dose-Response.

As fumigation temperature is lowered, it becomes more difficult to control 2nd instar OFF larvae in infested sweet cherries with postharvest methyl bromide fumigation. The figure below shows the number of specimens treated, the regression heterogeneity (H), the projected CT exposures to cause 50, 90, 99, and 99.9968% mortality in the treated population (respectively LE_{50}, LE_{90}, LE_{99}, and LE_{P9}), and the corresponding estimates of the upper (UL) and lower limits (LL) at the 95% level of confidence (LOC). Future confirmatory trials are ongoing at 54 ºF, and a greater exposure will be required than at 63 to achieve the same level of control. It is interesting to note the marked effect on the LE 99 when temp is dropped to 47 ºF (see table below).

Probit Regression Parameters

	2nd instar larvae @ 54 °F			2nd instar larvae @ 63 °F		
		95% L.O.C.			95% L.O.C.	
	"CT"$_x$	LL	UL	"CT"$_x$	LL	UL
LE50	3.9	2.1	5.9	6.2	3.7	9.0
LE95	27.5	22.3	32.3	28.9	23.1	34.4
LE99	61.9	54.5	70.8	54.7	47.7	62.0
LEP9	455.0	325.4	729.2	262.3	208.0	359.2
Slope	1.9 (+/-) 0.1			2.5 (+/-) 0.08		
Heterogeneity	3.3			7.1		
Treated	43,756 ± 2,358			186,366 ± 5,420		



Relative MB-tolerance of OFF life stages. To directly diagnose the most MB-tolerant SWD age, discrete developmental stages and ages were concomitantly fumigated over a range of applied doses at 47 ºF. Probit regressions (Polo Plus, LeOra Software, 2002-2007) of the dose-mortality response were used to quantify the relative MB-tolerance of SWD across age increments that span egg through larval development in infested sweet cherry. The table below shows the number of specimens treated, the regression heterogeneity (H), the projected CT exposures to cause 50, 95, and 99% mortality in the treated population (respectively LE_{50}, LE_{95}, and LE_{99}), and the corresponding estimates of the upper (UL) and lower limits (LL) at the 95% level of confidence (LOC). Likelihood ratio-based hypothesis testing of equality and parallelism were rejected ($P < 0.5$), indicating that the slopes and intercepts of the respective regression lines are not the same. Lethal exposure ratios (LERs) (dashed box) were calculated with 95% LOC intervals and used to identify 96 to120 h-old specimens , predominately 2nd instar larvae, as being significantly more tolerant toward MB than the other investigated life stages in infested sweet cherries when subject to exposures projected to cause 99 % mortality in the treated population.

2nd instar OFF_47F subjects 18239
slope=1.853+-0.048 heterogeneity=35.47

LD50=18.075 95% limits: 8.421 to 27.011
LD95=139.513 95% limits: 109.226 to 208.779
LD99=325.341 95% limits: 215.442 to 714.144

LD99
1OFF_47F ratio=2.024 95% limits: 1.854 to 2.209
3OFF_47F ratio=2.330 95% limits: 2.125 to 2.555
EOFF_47F ratio=1.856 95% limits: 1.678 to 2.054

1st instar OFF_47F subjects 13555
slope=4.471+-0.090 heterogeneity=99.00

LD50=48.506 95% limits: 29.333 to 60.675
LD95=113.167 95% limits: 93.481 to 164.242
LD99=160.752 95% limits: 123.401 to 303.825

3rd instar OFF_47F subjects 32074
slope=2.406+-0.055 heterogeneity=50.03

LD50=15.063 95% limits: 6.761 to 22.675
LD95=72.725 95% limits: 60.326 to 90.023
LD99=139.631 95% limits: 108.552 to 219.345

Eggs OFF_47F subjects 7120
slope=3.171+-0.083 heterogeneity=12.63

LD50=32.369 95% limits: 25.286 to 38.569
LD95=106.853 95% limits: 92.063 to 130.179
LD99=175.258 95% limits: 141.792 to 238.990

Biology, Monitoring and Control of the Spotted Wing Drosophila

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Abstract:

This report includes the impact of post-harvest pyrethroid applications on spotted wing drosophila (SWD), *Drosophila suzukii*, populations throughout the year, trap and bait development studies, pre-harvest insecticidal control of SWD, infestation of cherry by canopy height, cover crop/trunk applications of Malathion to suppress SWD populations in addition to post-harvest insecticidal efficacy trials. Post-harvest applications of pyrethroids control post-harvest SWD populations, but have limited impact the following spring as SWD populations plummet over the winter. Traps with large diameter openings and shorter distances between the bait and opening of the trap increase SWD catches. Trap opening size appears to have a greater impact on catch than bait distance. Monterey Insect Bait shows promise as an attractant in an "Attract and Kill" control strategy. A mixture of merlot and apple cider vinegar (ACV) attracts more SWD than the ACV alone. Larval infestation was greater in lower portions of the cherry canopy, indicating sprays should be focused on the lower portions of the canopy. Malathion cover crop/trunk applications and pre-harvest insecticidal trials yielded inconclusive results. Insecticidal efficacy trials conducted post-harvest showed Success 2SC and high rates of Malathion 57% and CHA-3189 to have the best initial knock down and all but Success 2SC provided moderate to excellent control at 3 DAT. Danitol 2.4EC and Lambda-Cy + Assail 30SG provided adequate control at 7 DAT and Danitol 2.4EC + Belay 2.13SC and Lambda-Cy + Assail 30SG provided some measure of control out to 15 DAT.

CCAB Funded Research

Impact of post-harvest pyrethroid applications on SWD populations

Methods and Materials:

Five 'Bing' cherry orchards were divided approximately in half. One half of each orchard was treated with a maximum rate of pyrethroid insecticides at monthly intervals starting in August and the other half of the orchard was an untreated check (Table 1). Spotted wing drosophila (SWD), *Drosophila suzukii*, populations were monitored weekly in each half of each orchard with four standard traps baited with ACV. A standard trap consisted of a white opaque plastic 1 qt container (Consolidated Plastics Company, Inc. 4700 Prosper Dr. Stow, OH 44224) filled with approximately 4 oz liquid bait, topped with a 1/8 inch screen mesh, and fitted with card stock rain shields (Pherocon® 1C Trap top, Trécé Inc, P.O. Box 129, Adair, Oklahoma 74330) to prevent flooding or bait dilution in event of precipitation. In all studies reported here ACV was 4% acidity (Amerifoods Trading Co., P.O. Box 512377, Los Angeles, CA) and included 4mL color- and fragrance-free dish soap (Palmolive brand "pure+clear" concentrated liquid dish soap) per gallon of ACV. The traps were placed on 11 July 2011 and monitored weekly through 9 April 2012. All SWD were counted and sexed and all other drosophila were counted, but not sexed, under magnification in the laboratory. Due to variation among application dates between orchards, all SWD counts were organized in relation to material applications as well as calendar date. Additionally, because of the wide variation in SWD populations between the orchards, the SWD data was reported both as the percentage of the total population and number of total flies captured. Data were analyzed using Student "T" Test at $P \leq 0.05$.

Results and Discussion:

There was a high SWD population present in all orchards at the initiation of the trial (Table 2). The number of flies remained fairly constant between 45 to 80 flies per trap per week in the untreated portions of the orchards but the insecticide applications caused a decline from 45 to 20 flies per trap per week in the treated portions of the orchards (Fig. 1). The flies then dramatically decreased in both the treated and untreated portions of the orchards in October, before resurging to over 400 flies per trap per week in the untreated portions and 100 flies per trap per week in the treated portions. The flies then decreased to near zero during the winter months. However, the treated portions of the orchards had fewer flies than the untreated portions of the orchards.

There was no significant difference in the mean number of female, male or total SWD between the treated and untreated portions of the orchards in the samples preceding the first applications (Tables 3-5). After the first application on 14 September to 3 October, the female SWD populations were significantly suppressed as compared to the untreated check. The female populations were suppressed throughout the study, but were not significantly suppressed again until 5 and 7 weeks following the Baythroid XL application. Female SWD populations were also significantly suppressed in the 13th week following the final treatment.

Male SWD populations were more susceptible to the pyrethroid applications compared to the females. Male SWD populations were significantly suppressed by the pyrethroid applications from the initial Danitol 2.4 EC application through 2 weeks post Lambda-Cy 1EC, and were again significantly depressed for two weeks following the Baythroid XL application, and from 5-7 weeks following the Baythroid XL application.

Total SWD populations were significantly suppressed in treated portions of the orchards from the initial Danitol 2.4 EC application through the application of Lambda-Cy EC. Populations were again significantly suppressed at 7 and 13 weeks following the Baythroid XL application and tend to reflect the males flies compared to the females flies.

The post-harvest applications of Danitol 2.4EC, Lambda-Cy 1E and Baythroid XL resulted in the suppression of the SWD population. These applications were timed to simulate a treatment regime for Western X-disease control. The post-harvest pyrethroid program suppressed the SWD through the fall and winter months. This suppression continued into the following spring. However, the numbers of SWD were very low. Thus it is recommended that if a growers is going to conduct a post-harvest Western X-disease control program that they switch from the neonicotinoid insecticides to pyrethroid insecticides. However, because of the marginal suppression of the SWD population in the following spring, post-harvest control of SWD is not recommended.

Table 1. Number of treated and untreated acres and grower's material application dates in Northern CA, 2011 – 2012

Orchard	Acres: Treated	Acres: Untreated	Acres: Total	Application Date: Danitol 2.4EC	Application Date: Lambda-Cy EC	Application Date: Baythriod XL
Sacramento County	12	7	19	27 Jul	14 Sep	3 Oct
San Joaquin County	12	21	33	27 Jul	24 Aug	27 Sep
Santa Clara County A	6	3	9	20 Jul	21 Aug	1 Oct
Santa Clara County B	6	10	16	20 Jul	21 Aug	28 Sep
Stanislaus County	12	19	31	4 Aug	24 Aug	23 Sep

Table 2. Mean total SWD caught per trap each calendar week in Northern CA, 2011 – 2012

	Mean total SWD captured per week														
Treatment	18 Jul	25 Jul	1 Aug	8 Aug	15 Aug	23 Aug	30 Aug	6 Sep	13 Sep	19 Sep	27 Sep	4 Oct	11 Oct	18 Oct	25 Oct
Treated	21.1	4.6	13.0	5.6	6.1	34.0	29.0	20.9	4.5	4.9	3.0	13.9	5.4	6.7	17.7
Untreated	19.3	7.4	27.6	30.8	23.6	116.8	49.1	32.3	28.4	8.2	3.3	20.0	6.9	7.4	23.6

Table 2 cont.

	Mean total SWD captured per week														
Treatment	1 Nov	15 Nov	30 Nov	13 Dec	20 Dec	4 Jan	18 Jan	1 Feb	14 Feb	28 Feb	13 Mar	20 Mar	27 Mar	3 Apr	9 Apr
Treated	108.7	108.5	44.5	11.2	8.2	5.0	2.4	1.0	0.6	1.1	0.6	0.2	0.3	0.3	1.7
Untreated	176.3	482.1	75.1	36.9	30.5	16.5	13.1	2.7	3.7	3.9	0.7	0.2	0.6	1.2	3.2

Table 3. Mean percent female SWD captured per trap each week in Northern CA, 2011 – 2012

Treatment	First spray: Danitol 2.4EC 1 wk pre	Spray wk	1 wk post	2 wks post	Second spray Lambda-Cy EC 1 wk pre	Spray wk	1 wk post	2 wks post	Third spray: Baythroid XL 1 wk pre	Spray wk	1 wk post	2 wks post	3 wks post	4 wks post
Treated	44.8 a	24.9 a	27.7 a	33.8 a	43.6 a	48.5 a	45.3 a	43.2 a	58.8 a	39.4 a	38.0 a	49.8 a	43.6 a	38.3 a
Untreated	55.2 a	75.1 b	72.3 a	66.2 a	56.4 a	51.5 a	54.7 a	56.8 a	41.2 a	60.6 a	62.0 a	50.2 a	56.4 a	61.7 a

Mean[a] percent female SWD captured per week

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Table 3.cont.

Mean[a] percent female SWD captured per week

Treatment	5 wks post	6 wks post	7 wks post	8 wks post	9 wks post	10 wks post	11 wks post	12 wks post	13 wks post	14 wks post	15 wks post	16 wks post	17 wks post	18 wks post
Treated	22.2 a	34.1 a	26.2 a	31.7 a	36.9 a	53.5 a	44.9 a	38.6 a	21.2 a	41.0 a	46.7 a	33.0 a	30.3 a	40.6 a
Untreated	77.8 b	65.9 a	73.8 b	68.3 a	63.1 a	46.5 a	55.1 a	61.4 a	78.8 b	59.0 a	53.3 a	67.0 a	69.7 a	59.4 a

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Table 4. Mean percent male SWD captured per trap each week in Northern CA, 2011 – 2012

Mean[a] percent male SWD captured per week

Treatment	First spray: Danitol 2.4EC 1 wk pre	Spray wk	1 wk post	2 wks post	Second spray Lambda-Cy 1EC 1 wk pre	Spray wk	1 wk post	2 wks post	Third spray: Baythroid XL 1 wk pre	Spray wk	1 wk post	2 wks post	3 wks post	4 wks post
Treated	48.6 a	18.8 a	12.0 a	8.6 a	14.7 a	15.4 a	15.1 a	37.3 a	19.7 a	28.5 a	22.3 a	20.3 a	38.1 a	31.0 a
Untreated	51.4 a	81.2 b	88.0 b	91.4 b	85.3 b	84.6 b	84.9 b	62.7 b	80.3 a	71.5 a	77.7 b	79.7 b	61.9 a	69.0 a

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Table 4 cont.

Treatment	Mean[a] percent male SWD captured per week 5 wks post	6 wks post	7 wks post	8 wks post	9 wks post	10 wks post	11 wks post	12 wks post	13 wks post	14 wks post	15 wks post	16 wks post	17 wks post	18 wks post
Treated	18.4 a	27.8 a	27.9 a	32.2 a	31.0 a	27.0 a	39.0 a	22.9 a	39.3 a	59.0 a	60.0 a	45.0 a	40.0 a	53.0 a
Untreated	81.6 b	72.2 b	72.1 b	67.8 a	69.0 a	73.0 a	61.0 a	77.1 a	60.7 a	41.0 a	40.0 a	55.0 a	60.0 a	47.0 a

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Table 5. Mean percent total SWD captured per trap each week in Northern CA, 2011 – 2012

	Mean[a] percent total SWD captured per week													
	First spray: Danitol 2.4EC				Second spray Lambda-Cy 1EC				Third spray: Baythroid XL					
Treatment	1 wk pre	Spray wk	1 wk post	2 wks post	1 wk pre	Spray wk	1 wk post	2 wks post	1 wk pre	Spray wk	1 wk post	2 wks post	3 wks post	4 wks post
Treated	47.1 a	21.9 a	16.0 a	17.1 a	22.4 a	22.4 a	30.0 a	35.0 a	29.3 a	32.2 a	24.7 a	33.8 a	38.2 a	34.4 a
Untreated	52.9 a	78.1 b	84.0 b	82.9 b	77.6 b	77.6 b	70.0 a	65.0 a	70.7 a	67.8 a	75.3 a	66.2 a	61.8 a	65.6 a

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Table 5 cont.

Treatment	Mean[a] percent total SWD captured per week 5 wks post	6 wks post	7 wks post	8 wks post	9 wks post	10 wks post	11 wks post	12 wks post	13 wks post	14 wks post	15 wks post	16 wks post	17 wks post	18 wks post
Treated	19.9 a	30.3 a	25.0 a	32.9 a	34.0 a	45.9 a	43.5 a	24.3 a	21.2 a	36.2 a	56.7 a	34.7 a	30.0 a	44.7 a
Untreated	80.1 a	69.7 a	75.0 b	67.1 a	66.0 a	54.1 a	56.5 a	75.7 a	78.8 b	63.8 a	43.3 a	65.3 a	70.0 a	55.3 a

[a]Means followed by the same lowercase letter within a column for each orchard are not significantly different (Student "T" Test, P ≤ 0.05).

Figure 1a. Mean total SWD caught per trap per week in Northern CA, 2011-12.

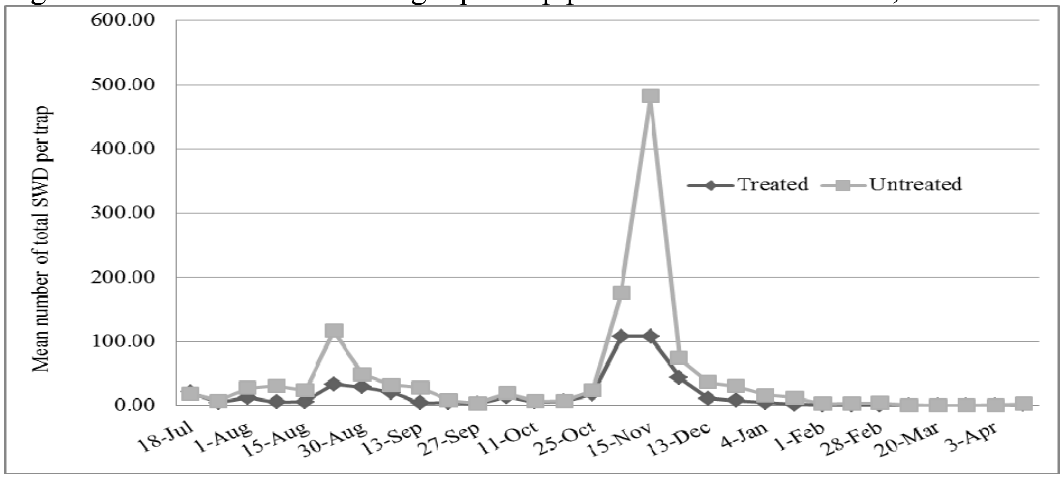
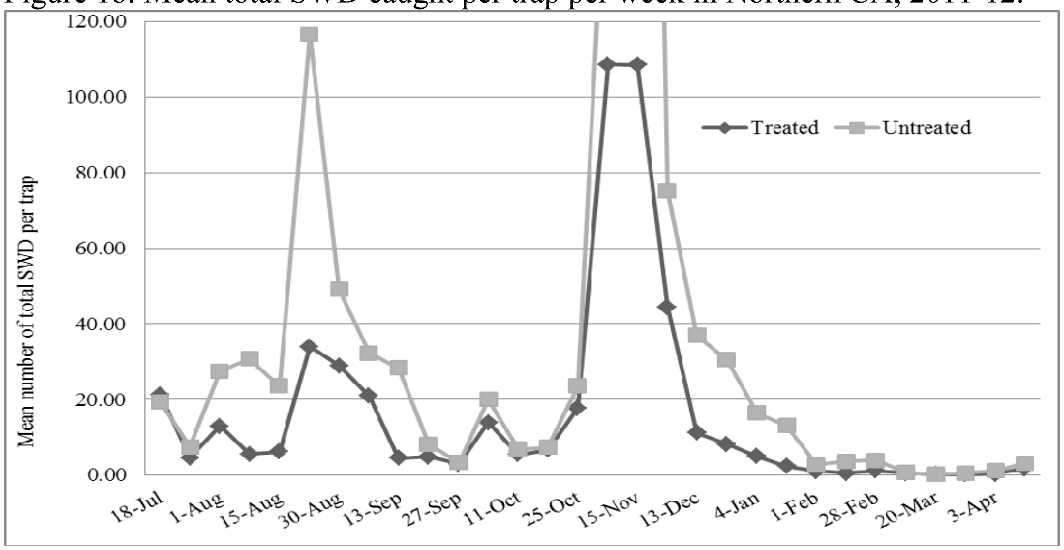


Figure 1b. Mean total SWD caught per trap per week in Northern CA, 2011-12.



Cover crop/trunk applications of Malathion

Materials and Methods:

This study was conducted in 6 commercial cherry orchards in CA. Treatment plots were a minimum of 3.5 acres each and arranged in a randomized complete block (RBC) design. Each orchard contained 4 treatments and a grower's standard control. The experimental Malathion treatments were applied over the grower standard treatments. The first treatment consisted of 4 applications of Malathion to the lower trunk area and cover crop, weekly from straw/blush to 3 days before harvest. The second treatment was initiated a week later and consisted of 3 applications, with the third and fourth treatments each being initiated a week after the next and consisting of one fewer application. Treatment efficacy was evaluated by placing a standard ACV trap in the center of each plot. The traps were placed the last week of March and monitored weekly until 3 July 2012, three weeks after harvest. Trap contents were examined each week. SWD were sexed and counted under magnification. All other drosophila species were not sexed. The larval infestation of the fruit was monitored weekly beginning with pink fruit until 3 weeks after commercial harvest. Larval infestation was determined by the sugar solution floatation method.

Results and Discussion:

Due to the high efficacy of spray programs implemented by cooperating growers (Table 6), all adult drosophila populations, including SWD were suppressed and there was no significant difference among treatments (Tables 7-8). In addition, larval infestation remained close to zero in all orchards. Even several weeks after harvest and there was no significant difference among treatments (Table 9). This prevented crop loss during the trial, but so greatly reduced the SWD populations in the orchards that both adult SWD populations and larval infestation in all treatments was far too low to allow any meaningful statistical analysis. Thus it is not possible to determine the effectiveness of the Malathion trunk/cover crop applications.

Table 6. Orchard material application schedules in Northern CA, 2012

Orchard	Date	Material	Rate form/acre	
San Joaquin	22 April	Warrior II	2.86	fl oz
	1-2 May	Danitol 2.4 EC	16.00	fl oz
	10-12 May	Success	8.00	fl oz
Sacramento	30 Apr	Diazinon 50 WP	2.00	lbs
	9 May	LambdaStar	5.12	fl oz
	18 May	Danitol 2.4 EC	12.00	fl oz
	24 May	Danitol 2.4 EC	12.00	fl oz
	31 May	Success	8.00	fl oz
Stanislaus	4 May	Lambda-Cy	5.12	fl oz
	16 May	Success	7.80	fl oz
	26 May	Danitol 2.4 EC	18.00	fl oz
	13 Jun	Movento	9.00	fl oz
San Benito	1 May	Warrior II	2.50	fl oz
	1 May	Prey 1.6	4.00	fl oz
	16 May	Warrior II	2.50	fl oz
	22-May	Success	8.00	fl oz
Santa Clara A	20 April	Diazinon 50 WP	2.00	lbs
	11 May	Warrior II	2.40	fl oz
	20-21 May	Warrior II	2.40	fl oz
	2 June	Malathion 8 Aquamul	25.60	fl oz
Santa Clara B	1 Mar	Asana XL	11.00	oz
	8 Mar	Asana XL	11.00	oz
	6 May	Diazinon 50 WP	2.00	lbs
	13 May	Lamcap	5.00	oz
	21 May	Success	8.00	fl oz
	28 May	Malathion 8 Aquamul	26.00	fl oz

Table 7. Mean number of other Drosophila caught per week in Northern CA, 2012

No. of Applications	Mean[a] other Drosophila spp. per week										
	27 Apr	3 May	10 May	15 May	24 May	28 May	6 Jun	13 Jun	20 Jun	26 Jun	3 Jul
4	28.8 a	55.3 a	31.7 a	18.0 a	48.0 a	29.5 a	21.0 a	21.3 a	21.0 a	14.0 a	43.0 a
3	21.3 a	34.5 a	41.3 a	26.0 a	25.7 a	28.0 a	15.8 a	13.8 a	13.2 a	10.3 a	22.0 a
2	18.2 a	57.7 a	28.5 a	14.5 a	17.2 a	15.3 a	17.7 a	16.8 a	18.5 a	12.8 a	23.5 a
1	23.7 a	38.5 a	25.3 a	23.0 a	41.7 a	24.2 a	15.3 a	15.2 a	16.7 a	19.5 a	37.3 a
Treated check	31.8 a	54.5 a	46.5 a	34.3 a	35.7 a	27.7 a	23.5 a	21.7 a	15.5 a	15.3 a	36.8 a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 8. Mean total number of SWD caught per week in Northern CA, 2012

No. of Applications	Mean[a] total SWD per week										
	27 Apr	3 May	10 May	15 May	24 May	28 May	6 Jun	13 Jun	20 Jun	26 Jun	3 Jul
4	7.0 a	11.8 a	18.8 a	1.0 a	0.0 a	0.0 a	0.0 a	0.5 a	0.2 a	0.0 a	1.5 a
3	3.8 a	9.8 a	24.3 a	0.8 a	0.5 a	0.0 a	0.2 a	0.0 a	0.2 a	0.5 a	0.2 a
2	7.5 a	14.3 a	14.7 a	1.0 a	0.7 a	0.0 a	0.0 a	0.2 a	0.0 a	0.0 a	0.3 a
1	4.2 a	13.2 a	8.8 a	0.7 a	0.3 a	0.0 a	0.2 a	0.5 a	0.3 a	0.7 a	0.8 a
Treated check	9.0 a	16.0 a	25.5 a	2.5 a	0.3 a	0.0 a	0.3 a	0.2 a	0.0 a	0.5 a	1.3 a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 9. Mean number of larvae per 100 fruit in Northern CA, 2012

No. of Applications	Mean[a] number of larvae per 100 fruit[b]									
	26 May	3 May	10 May	16 May	22 May	30 May	5 Jun	13 Jun	19 Jun	26 Jun
4	0.0	3.0	0.0	0.2 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.4 a
3	---	---	0.0	0.0 a	0.2 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
2	---	---	---	0.0	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
1	---	---	---	---	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.2 a
Treated check	0.0	0.0	0.0	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.4 a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)
[b] When fruit was collected from a single replicate, no statistical analysis was preformed

SCRI Funded Research

The following trials are related in content and aim to the CCAB funded trials, though these trials were funded through the SCRI grant.

Drosophila suzukii Trap Development: Opening Diameter

Materials and Methods:

Three treatments were replicated six times in a randomized, complete block design in a commercial citrus orchard. Each replicate was a single trap. There were at least 2 buffer trees and rows between each replicate. Each trap consisted of a standard poly propylene trap (a clear poly propylene deli container: Fabri-Kal, Inc. 600 Plastics Place Kalamazoo, MI 49001) filled with 4 oz of apple cider vinegar (ACV). Three different size trap top openings (3.00, 1.75 and 0.5 inch) were used. All standard traps were also fitted with card stock rainshields to prevent flooding or bait dilution in event of precipitation. The openings in the top of the traps were covered with 1/8 inch screen. Traps were initially placed on 10 February 2012. They were monitored weekly until 29 March 2012. Trap baits were replaced and the trap locations were rotated weekly. All SWD were sexed and all other drosophila were counted, but not sexed, under magnification in the laboratory at UCB.

Results and Discussion:

On 17 February, 3.00 inch openings captured significantly more female, male, and total SWD than 1.75 inch openings, which in turn captured significantly more than 0.50 inch openings (Tables 10-12). On 24 February, 1 March, and 9 March the 3.00 and 1.75 inch openings captured significantly more female SWD than 0.50 inch opening while on 24 February 3.00 inch openings captured caught significantly more male and total SWD than either 1.75 or 0.50 inch openings. On 1 March 3.00 and 1.75 inch openings captured significantly more total SWD than 0.50 inch openings. In both male and total SWD season totals, 3.00 inch openings captured significantly more than 1.75 inch openings, which captured significantly more than 0.50 inch openings. In season total female 3.00 and 1.75 inch openings captured significantly more than 0.50 inch openings. The size of the opening greatly influenced the captures of SWD with the larger the trap opening the greater the trap catch. Traps with larger openings are therefore recommended for SWD monitoring within IPM control programs.

Table 10. Mean female SWD caught per trap per week in Newman, CA – 2012

Entrance diameter	Mean[a] female SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
3.00”	14.7	a	24.3	a	2.6	a	2.5	a	0.8	a	0.5	a	0.5	a	45.5	a
1.75”	9.2	b	15.2	a	2.2	a	2.8	a	1.0	a	0.7	a	0.3	a	31.3	a
0.50”	1.5	c	3.2	b	0.2	b	0.8	b	0.3	a	0.2	a	0.0	a	6.2	b

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Table 11. Mean male SWD caught per trap per week in Newman, CA – 2012

Entrance diameter	Mean[a] male SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
3.00”	29.0	a	34.2	a	3.0	a	2.3	a	0.3	a	0.2	a	0.5	a	69.0	a
1.75”	16.2	b	16.2	b	1.8	a	2.7	a	0.2	a	0.3	a	0.2	a	37.5	b
0.50”	3.3	c	6.7	b	0.2	a	1.0	a	0.2	a	0.2	a	0.2	a	11.7	c

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Table 12. Mean SWD caught per trap per week in Newman, CA – 2012

Entrance diameter	Mean[a] total SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
3.00”	43.7	a	58.5	a	4.7	a	4.8	a	1.2	a	0.7	a	1.0	a	114.5	a
1.75”	25.3	b	31.3	b	4.0	a	5.5	a	1.2	a	1.0	a	0.5	a	68.8	b
0.50”	4.8	c	9.8	b	0.3	b	1.8	a	0.5	a	0.3	a	0.2	a	17.8	c

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Drosophila suzukii Trap Development: Bait Depth

Materials and Methods:

Three treatments were replicated six times in a randomized, complete block design in a commercial citrus orchard. Each replicate was a single trap. There were at least 2 buffer trees and rows between each replicate. Each trap consisted of a standard poly propylene trap filled with 4 oz ACV. The distance between the trap opening and the bait surface (bait depth) was varied by using 8, 16, and 32 oz deli containers. This achieved 0.75, 1.63 and 3.75 inch bait depths, respectively. The bait surface areas varied insignificantly. They were 40.8, 40.4 and 39.3 sq. inch, respectively. Traps were initially placed on 10 February 2012. They were monitored weekly until 29 March 2012. Trap baits were replaced and the trap locations were rotated weekly. All SWD were sexed and all other drosophilae were counted, but not sexed, under magnification in the laboratory at UCB.

Results and Discussion:

There was no significant difference on a weekly basis among the different distances between the bait and trap opening in female, male and total SWD (Tables 13-15). However, in the season total traps with the 3.75 inch distance between bait and opening captured significantly fewer females SWD than traps with 1.63 and 0.75 inch depths. There was no significant difference in trap catch with male SWD. In total season for female and male combined the 0.75 inch distance between bait and opening captured significantly more than the 3.75 inch distance between bait and opening. However, it was observed that under high winds that the bait and flies splashed out of the trap with the 0.75 inch distance between entrance and liquid bait. Traps with shorter distances between entrance and liquid bait caught higher numbers of SWD. It is recommended that about 1 inch distance between bait and opening be used for SWD monitoring in IPM control programs.

Table 13. Mean female SWD caught per trap per week in Newman, CA – 2012

Bait Depth	Mean[a] female SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
0.75"	26.5	a	39.0	a	2.8	a	5.2	a	0.3	a	1.0	a	0.2	a	75.0	a
1.63"	23.7	a	31.5	a	3.3	a	3.8	a	2.3	a	1.3	a	1.2	a	67.2	a
3.75"	14.7	a	24.3	a	2.6	a	2.5	a	0.8	a	0.5	a	0.5	a	45.5	b

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Table 14. Mean male SWD caught per trap per week in Newman, CA – 2012

Bait Depth	Mean[a] male SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
0.75"	37.0	a	48.7	a	2.8	a	3.7	a	0.5	a	0.3	a	0.2	a	93.2	a
1.63"	43.5	a	31.2	a	1.7	a	4.2	a	0.8	a	0.2	a	0.2	a	81.7	a
3.75"	29.0	a	34.2	a	3.0	a	2.3	a	0.3	a	0.2	a	0.5	a	69.0	a

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Table 15. Mean total SWD caught per trap per week in Newman, CA – 2012

Bait Depth	Mean[a] total SWD per week															
	17 Feb		24 Feb		1 Mar		9 Mar		15 Mar		22 Mar		29 Mar		Season Total	
0.75"	63.5	a	87.7	a	5.7	a	8.8	a	0.8	a	1.3	a	0.3	a	168.2	a
1.63"	67.2	a	62.7	a	5.0	a	8.0	a	3.2	a	1.5	a	1.3	a	148.8	ab
3.75"	43.7	a	58.5	a	4.7	a	4.8	a	1.2	a	0.7	a	1.0	a	114.5	b

[a]Means followed by the same letter within a column are not significantly different (Two-Way ANOVA, P≤0.05).

Bait Attractiveness Trial A

Materials and Methods:
This study was conducted in a commercial citrus orchard in spring 2012, with six single tree replicates. There was minimum of one buffer tree between each trap. Each trap consisted of a standard trap baited with 4 oz liquid bait. Traps were placed on 10 February. They were monitored weekly until 29 March. Trap baits were replaced and trap locations were rotated weekly. All SWD were sexed and all other drosophila were counted, but not sexed, under magnification in the laboratory at UCB.

Baits/Treatments:
The ACV was standard. ACV + Eth was 4 oz of ACV + 5 g ai Ethephon (Makhteshim Agan of North America, Inc. 4515 Falls of Neuse Road, Suite 300 Raleigh, NC 27609). The SY bait was prepared approximately 24 hrs prior to trap placement by combining 1 cup white granulated sugar (Domino Foods, Inc., Yonkers, NY 10705) and 2.5 oz baker's yeast (Fleischmann's Yeast Inc, 1350 Timberlake Manor Parkway, Suite 550, Chesterfield, MO 63017) per 1 gal warm water. This solution was then left to ferment overnight at room temperature. The MIB was 99.7% corn steep liquor (Monterey AgResources, P.O. Box 3500, Fresno, CA 93745). The GF-120 (Dow AgroSciences LLC 9330 Zionsville Road Indianapolis, IN 46268) + ACV bait was in 1 to 4 ratio and the GF-120 + ACV + water was in a 1 to 3 to 1 ratio. All baits included 4 ml color- and fragrance-free dish soap (Palmolive brand "pure+clear" concentrated liquid dish soap) per gallon of ACV or water. Treatment abbreviations are described in Table 16.

Table 16. Treatments tested in bait trial A in Newman, CA – 2012

Treatments	
1	Apple Cider Vinegar (ACV)
2	Apple Cider Vinegar + Ethephon (Eth)
3	Sugar Yeast (SY)
4	Monterey Insect Bait (MIB)
5	GF-120 + ACV
6	GF-120 + ACV + Water

Results and Discussion:
MIB consistently caught more female, male and total SWD than any other bait throughout the trial (Tables 17-19). On 17 February, MIB, SY and ACV + Eth caught significantly more female SWD than GF-120 + ACV + water and ACV alone. On 24 February, MIB and SY captured significantly more SWD females than ACV, ACV + Eth and GF-120 + ACV and ACV. ACV + Eth and GF-120 + ACV captured significantly more females than GF-120 + ACV + water. On 1 and 9 March, MIB caught significantly more female SWD than all other treatments. There was no significant difference among the treatments for the remainder of the season as the SWD population decreased to near zero. In the trial total, MIB captured significantly higher SWD females than SY. SY captured significantly higher SWD females than ACV, ACV + Eth and GF-120 + ACV. ACV, ACV + Eth and GF-120 + ACV captured significantly higher SWD

females than GF-120 + ACV + water. The male SWD shows a very similar pattern to female SWD except that more males were captured than females. The total SWD captured (males and females combined) show a very similar pattern to the capture of females.

In the percent SWD of the total drosophila captured, MIB consistently had a higher percent SWD throughout the trial (Table 20). On 17 February, GF-120 + ACV + water had a significantly higher percent SWD than ACV, ACV + Eth and SY but not MIB or GF-120 + ACV. MIB and GF-120 + ACV had a significantly higher percent SWD than ACV and SY. On 24 February and 9 March, MIB had a significantly higher percent SWD compared to other drosophila than all other treatments. In the average percent SWD of the total drosophila, MIB had significantly higher percent than all other treatments and ACV + Eth, SY, GF-120 + ACV and GF-120 + ACV + water captured significantly higher percent than ACV. ACV had significantly lower percent SWD compared to all other treatments.

MIB had the highest SWD catch and lowest catch of other drosophila of all baits. MIB maintained a high catch when the weather turned cool (1 and 9 March). MIB also maintained a relatively high capture rate when the SWD population decreased from 14 to 29 March. Thus MIB appears to be a promising SWD attractant. Because MIB is opaque (dark brown to black in color) and has a very low viscosity, it will not be suitable as a trap bait. It may be useful when mixed with a toxicant in "Attract and Kill" formulations. Further research is required to determine the best possible method to utilize MID's attractiveness within a commercial IPM program.

Table 17. Mean total female SWD caught per trap per week in Newman, CA – 2012

	Mean[a] female SWD															
Treatments	17 Feb		24 Feb		1 Mar		9 Mar		14 Mar		22 Mar		29 Mar		Total	
ACV	14.8	a	18.0	b	3.2	a	3.3	a	1.3	a	0.2	a	1.3	a	42.2	b
ACV + Ethephon	25.7	b	22.0	b	1.7	a	3.5	a	0.8	a	0.3	a	0.7	a	54.5	b
Sugar Yeast	23.7	b	32.2	c	3.8	a	0.4	a	1.0	a	0.0	a	1.0	a	62.0	c
Monterey Insect Bait	25.2	b	28.8	c	14.5	b	13.4	b	2.8	a	0.3	a	2.0	a	84.8	d
GF-120 + ACV	17.2	ab	20.0	b	1.3	a	2.8	a	0.7	a	0.5	a	0.5	a	43.0	b
GF-120 + ACV + H_2O	11.3	a	10.7	a	1.3	a	1.7	a	0.7	a	0.2	a	0.3	a	26.2	a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 18. Mean total male SWD caught per trap per week in Newman, CA – 2012

	Mean[a] male SWD															
Treatments	17 Feb		24 Feb		1 Mar		9 Mar		14 Mar		22 Mar		29 Mar		Total	
ACV	29.0	ab	22.3	b	2.8	ab	2.2	a	0.3	a	0.2	a	0.2	a	57.0	bc
ACV + Ethephon	34.7	b	25.2	bc	4.0	b	1.7	a	0.3	a	0.0	a	0.7	ab	66.5	c
Sugar Yeast	33.0	b	32.7	cd	3.5	ab	0.2	a	0.3	a	0.0	a	0.0	a	69.7	c
Monterey Insect Bait	51.7	c	40.0	d	13.8	c	13.2	b	2.3	a	0.7	a	1.3	b	120.8	d
GF-120 + ACV	22.0	ab	18.3	ab	0.7	a	1.5	a	0.2	a	0.3	a	0.0	a	43.0	ab
GF-120 + ACV + H_2O	15.5	a	12.0	a	1.3	ab	0.5	a	0.3	a	0.2	a	0.2	a	30.0	a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 19. Mean total SWD caught per trap per week in Newman, CA-2012

Treatments	Mean[a] total SWD															
	17 Feb		24 Feb		1 Mar		9 Mar		14 Mar		22 Mar		29 Mar		Total	
ACV	43.8	b	40.3	b	6.0	a	5.5	a	1.7	a	0.3	abc	1.5	a	99.2	bc
ACV + Ethephon	60.3	bc	47.2	b	5.7	a	5.2	a	1.2	a	0.2	bc	1.3	a	121.0	cd
Sugar Yeast	56.7	bc	64.8	c	7.3	a	0.5	a	1.3	a	0.0	a	1.0	a	131.7	d
Monterey Insect Bait	76.8	c	68.8	c	28.3	b	22.2	b	5.2	b	1.0	c	3.3	a	205.7	e
GF-120 + ACV	39.2	ab	38.3	b	2.0	a	4.3	a	0.8	a	0.8	bc	0.5	a	86.0	ab
GF-120 + ACV + H_2O	26.8	a	22.7	a	2.7	a	2.2	a	1.0	a	0.3	abc	0.5	a	56.2	a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD P ≤ 0.05)

Table 20. Mean percent SWD caught per trap per week in Newman, CA – 2012

Treatments	Mean[a] percent SWD															
	17 Feb		24 Feb		1 Mar		9 Mar		14 Mar		22 Mar		29 Mar		Avg.	
ACV	9.2	a	14.2	a	7.9	a	2.9	a	3.1	a	0.5	a	2.2	a	5.8	a
ACV + Ethephon	34.6	bc	25.1	b	5.2	a	9.3	a	4.2	a	0.9	a	4.9	a	12.6	b
Sugar Yeast	19.9	ab	37.8	c	12.7	a	5.0	a	2.7	a	0.0	a	4.1	a	12.2	b
Monterey Insect Bait	48.9	cd	54.6	d	29.0	a	18.4	b	6.8	a	1.2	a	5.4	a	23.6	c
GF-120 + ACV	43.2	cd	19.3	ab	22.6	a	2.0	a	1.0	a	1.8	a	2.3	a	13.2	b
GF-120 + ACV + H_2O	52.0	d	21.2	ab	10.1	a	1.8	a	2.8	a	1.1	a	3.5	a	13.3	b

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD P ≤ 0.05)

Bait Attractiveness Trial B

Materials and Methods:
This study was conducted in a commercial citrus orchard in spring 2012, with six single tree replicates. There was minimum of one buffer tree between each trap. Each trap consisted of a standard poly propylene trap. Traps were initially placed on 24 February and monitored weekly until 11 April. Trap baits were replaced and trap locations were rotated weekly. All SWD were sexed and all other drosophila were counted, but not sexed, under magnification in the laboratory at UCB.

Baits/Treatments:
The ACV was standard. The ACVRo bait contained 2 ml rosewater (Cortas USA Ltd. 5925 McShann Rd. Dallas, TX 75230) per 1L ACV. The ACVRa bait contained 1.5 ml raspberry extract (McCormick & CO. INC., Hunt Valley, MD) per 1L ACV. The ACVS bait contained 340 g white granulated sugar (Domino Foods, Inc., Yonkers, NY 10705) per 1L ACV. The ACVM bait contained 254 uL Bird Shield (EPA # 66550-1, Bird Shield Repellent Corporation, P.O. Box 785, Pullman Washington) contributing 0.07 g Methyl anthranilate per 1 L of bait solution. The MACV bait consisted of a 3:2 solution of merlot (Franzia Vineyards, Ripon, CA) and ACV. The MACVRoRaSM bait combined MACV with the addition of rosewater, raspberry extract, and sugar, all at the rates described above. All baits included 4mL color- and fragrance-free dish soap (Palmolive brand "pure+clear" concentrated liquid dish soap) per gallon of ACV, water, or wine. Treatment abbreviations are described in Table 21.

Table 21. Treatments tested in bait trial A in Newman, CA – 2012

Treatments	
1	Apple Cider Vinegar (ACV)
2	ACV + Rosewater (ACVRo)
3	ACV + Raspberry (ACVRa)
4	ACV + Sugar (ACVS)
5	ACV + Methyl anthranilate (ACVM)
6	Merlot + ACV (MACV)
7	Merlot + ACV + Sugar + Methyl anthranilate + Rosewater + Raspberry (MACVRoRaSM)

Results and Discussion:
SWD populations were low during the study. But MACV and MACVRoRaSM caught significantly more female SWD than any other treatments on 9 March and the total female for the study (Table 22). MACV caught significantly more male SWD than all treatments other than MACVRoRaSM on 15 March and caught significantly more than all other treatments in total males for the study (Table 23). On 9 March MACV caught significantly more SWD than all treatments other than MACVRoRaSM (Table 24). MACVRoRaSM caught significantly more than ACV, ACVRa, and ACVM. On 1 March, as well as in the season average, MACV had a significantly higher percentage of SWD than all other treatments, closely followed by MACVRoRaSM (Table 25.). Despite the low SWD population MACV and MACVRoRaSM

caught more SWD than other treatments. MACV was also more selective for SWD than the other baits.

Table 22. Mean total female SWD caught per trap per week in Newman, CA – 2012

Treatments	Mean[a] female SWD						
	1 Mar	9 Mar	15 Mar	29 Mar	5 Apr	11 Apr	Total
ACV	2.7 a	3.5 a	1.0 a	0.3 a	0.3 a	0.6 a	8.3 a
ACVRo	3.5 a	5.8 a	0.8 a	0.2 a	0 a	0.7 a	11.0 a
ACVRa	3.7 a	4.7 a	0.7 a	0.3 a	0.3 a	0.3 a	10.0 a
ACVS	1.5 a	4.7 a	0.7 a	0.6 a	0.5 a	0.2 a	8.0 a
ACVM	2.3 a	3.0 a	1.2 a	0 a	0.7 a	0.2 a	6.8 a
MACV	4.8 a	9.8 b	2.3 a	0.8 a	1.0 a	0.7 a	19.5 b
MACVRoRaSM	2.5 a	10.5 b	1.3 a	0.2 a	1.2 a	1.0 a	16.7 b

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 23. Mean total male SWD caught per trap per week in Newman, CA – 2012

Treatments	Mean[a] male SWD						
	1 Mar	9 Mar	15 Mar	29 Mar	5 Apr	11 Apr	Total
ACV	2.3 a	1.8 a	0.2 a	0.0 a	0 a	0.4 a	4.7 a
ACVRo	3.7 a	2.7 a	0.2 a	0.2 a	0 a	0.5 a	7.2 a
ACVRa	3.2 a	2.3 a	0.5 a	0.0 a	0.2 a	0.3 a	6.5 a
ACVS	2.3 a	3.0 a	0.3 a	0.0 a	0.8 a	0.0 a	6.5 a
ACVM	2.5 a	1.8 a	0.0 a	0.2 a	0.3 a	0.0 a	4.5 a
MACV	4.7 a	4.2 a	1.7 b	0.2 a	0.2 a	0.5 a	11.3 b
MACVRoRaSM	3.2 a	2.7 a	1.0 ab	0.3 a	0 a	0.3 a	7.5 a

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD $P \leq 0.05$)

Table 24. Mean total SWD caught per trap per week in Newman, CA 2012

Treatments	Mean[a] total SWD													
	1 Mar		9 Mar		15 Mar		29 Mar		5 Apr		11 Apr		Total	
ACV	5.0	a	5.3	a	1.2	a	0.3	a	0.3	ab	1.0	a	13.0	ab
ACVRo	7.2	a	8.5	ab	1.0	a	0.3	a	0.0	a	1.2	a	18.2	b
ACVRa	6.8	a	7.0	a	1.2	a	0.3	a	0.5	ab	0.7	a	16.5	ab
ACVS	3.8	a	7.7	ab	1.0	a	0.6	a	1.3	b	0.2	a	14.5	ab
ACVM	4.8	a	4.0	a	1.2	a	0.2	a	1.0	ab	0.2	a	11.3	a
MACV	9.5	a	14.0	c	4.0	b	1.0	a	1.2	ab	1.2	a	30.8	c
MACVRoRaSM	6.3	a	12.5	bc	3.3	b	1.2	a	1.0	ab	1.0	a	25.3	c

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD P ≤ 0.05

Table 25. Mean Percent SWD caught per trap per week in Newman, CA – 2012

Treatments	Mean[a] percent SWD													
	1 Mar		9 Mar		15 Mar		29 Mar		5 Apr		11 Apr		Ave.	
ACV	2.1	a	2.0	a	1.6	a	0.8	a	0.3	a	1.0	a	1.3	a
ACVRo	4.5	a	3.2	a	0.9	a	0.5	a	0.0	a	0.9	a	1.7	a
ACVRa	2.6	a	3.2	a	1.1	a	0.7	a	0.4	a	0.9	a	1.5	a
ACVS	3.0	a	3.3	a	1.6	a	1.3	a	0.5	a	0.1	a	1.6	a
ACVM	4.5	a	2.1	a	1.2	a	0.2	a	2.2	a	0.1	a	1.7	ab
MACV	14.8	c	2.1	a	2.3	a	0.3	a	0.1	a	0.3	a	3.3	c
MACVRoRaSM	8.9	b	2.7	a	3.0	a	0.4	a	0.3	a	0.4	a	2.6	bc

[a] Means followed by the same letter within a column are not significantly different (Fisher's LSD P ≤ 0.05)

SWD Infestation by Canopy Height

Materials and Methods:

Fruit infestation was determined at three heights in 'Bing' cherry trees in spring 2012. Low canopy was considered 5 ft. or less, mid canopy 5 to 8 ft. and the high canopy 8 to 12.5 ft. There were six single tree replicates. Samples of 100 fruit were collected from each height in each tree weekly from 21 May to 19 June. Samples were transported in ice chests to UC Berkeley for evaluation. Larval infestation was determined by the sugar solution floatation method by macerating 100 fruit per replicate in a sugar solution (7 lbs. brown sugar to 5 gal of water and several drops of defoamer) within 48 hours of sample collection. All larvae were placed on diet and reared to adults for species identification.

Results and Discussion:

Larval infestation was low throughout the study. There was significantly lower infestation in the high canopy fruit as compared to the low to mid canopy fruit on 29 May. On 6 June the lower canopy had significantly higher infestation compared to the middle and upper canopy. There was significantly lower infestation in the high canopy fruit as compared to the low to mid canopy fruit for total infestation for the season (Table 26). Over 97% of the larvae reared to adults were SWD. Despite the low SWD population observed, this study collaborates studies conducted last season that show fruit infestation decreases with tree height. Thus about 2/3 of the spray solution should be directed from the orchard floor to mid canopy and 1/3 of the spray solution should be directed from mid canopy to the top of the tree.

Table 26. Mean number of larvae per 100 fruit at three tree heights in Stockton, CA – 2012

	Mean[a] number larvae per 100 fruit					
Canopy Height	21 May	29 May	6 Jun	13 Jun	19 Jun	Total
Low	0.33 a	2.67 a	0.83 a	0.33 a	0.00 a	4.17 a
Medium	0.33 a	4.67 a	0.00 b	0.00 a	0.00 a	5.00 a
High	0.50 a	0.17 b	0.00 b	0.00 a	0.00 a	0.67 b

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

Pre Harvest Insecticidal Efficacy

Materials and Methods:

In a mixed cherry and walnut orchard in Stockton, CA., 16 treatments consisting of various insecticides and application timings (Table 27) were replicated six times in a RCB design in single tree replicates. Material applications occurred on 11 May, 24 May and 31 May. Larval infestation was determined weekly from 2 weeks before commercial harvest to 3 weeks after commercial harvest (25 May through 18 June) by the sugar solution floatation method. The fruit was transported to the laboratory at UCB in ice chests. Adult SWD were monitored weekly from 20 April to 3 July with three standard ACV traps. The entire plot was accidentally over-sprayed with lambda-cyhalothrin (Lambda-Cy) and chlorantraniliprole (Altacor) between 11 May and 17 May, which suppressed the larval infestation in all treatments to a very low level and prevented any meaningful statistical analysis.

Results and Discussion:

Larval infestation was extremely low throughout the trial (Table 28). The mean cumulative number of larvae was significantly greater in the untreated check compared to all experimental treatments and there was no significant difference among the experimental treatments. The low level of infestation is attributed to the cooperating grower unintentionally treating the experimental plot with Lambda cyhalothrin and chlortraniliprole between 11 May and 17 May. The ACV traps showed a mean of 74 SWD per trap on 11 May (Figure 2). The SWD population crashed to 2.3 SWD per trap on 17 May as a result of the over spray. The population never recovered during the trial. Due to the over spray that eliminated most of the SWD population there was little infestation within the plot and it was not possible to determine the relative efficacy among experimental treatments.

Table 27. Materials and application timing in pre-harvest insecticidal trial in Stockton, CA – 2012

				Spray Timings	
	Rate		Blush/Pink	Pink/Red	Red/Mag
Treatment	Form/ac		(24 DBH*)	(10 DBH)	(4 DBH)
1)	Baythroid XL	2.8 fl oz		X	
	Danitol 2.4EC	21.3 fl oz			X
2)	Success 2EC	8.0 fl oz		X	
	Danitol 2.4EC	21.3 fl oz			X
3)	Success 2SC	8.0 fl oz		X	
	Entrust 80WP	2.0 oz			X
4)	Lambda-Cy 1EC	5.12 fl oz	X		
	Success 2SC	8.0 fl oz		X	
	Malathion 57%	44.8 fl oz			X
5)	Lambda-Cy 1EC	5.12 fl oz	X		
	Success 2SC	8.0 fl oz		X	
	Danitol 2.4EC	21.3 fl oz			X
6)	Baythroid XL	2.8 fl oz		X	
	Entrust 80WP	2.0 oz			X
7)	Baythroid XL	2.8 fl oz		X	
	Sevin XLR	4 .0 qt			X
8)	Baythroid XL	2.8 fl oz		X	
	Perm-Up 3.2 EC	8.0 fl oz			X
9)	Assail 30SG	8.0 oz		X	
	Perm-Up 3.2EC	8.0 fl oz			X
10)	Danitol 2.4EC +	21.3 fl oz		X	
	Assail 30SG	8.0 oz		X	
	Perm-Up 3.2EC	8.0 fl oz			X
11)	Success 2SC	8.0 fl oz		X	
	Sevin XLR	4 .0 qt			X
12)	Entrust 80WP	2.0 oz		X	X
13)	Untreated check				

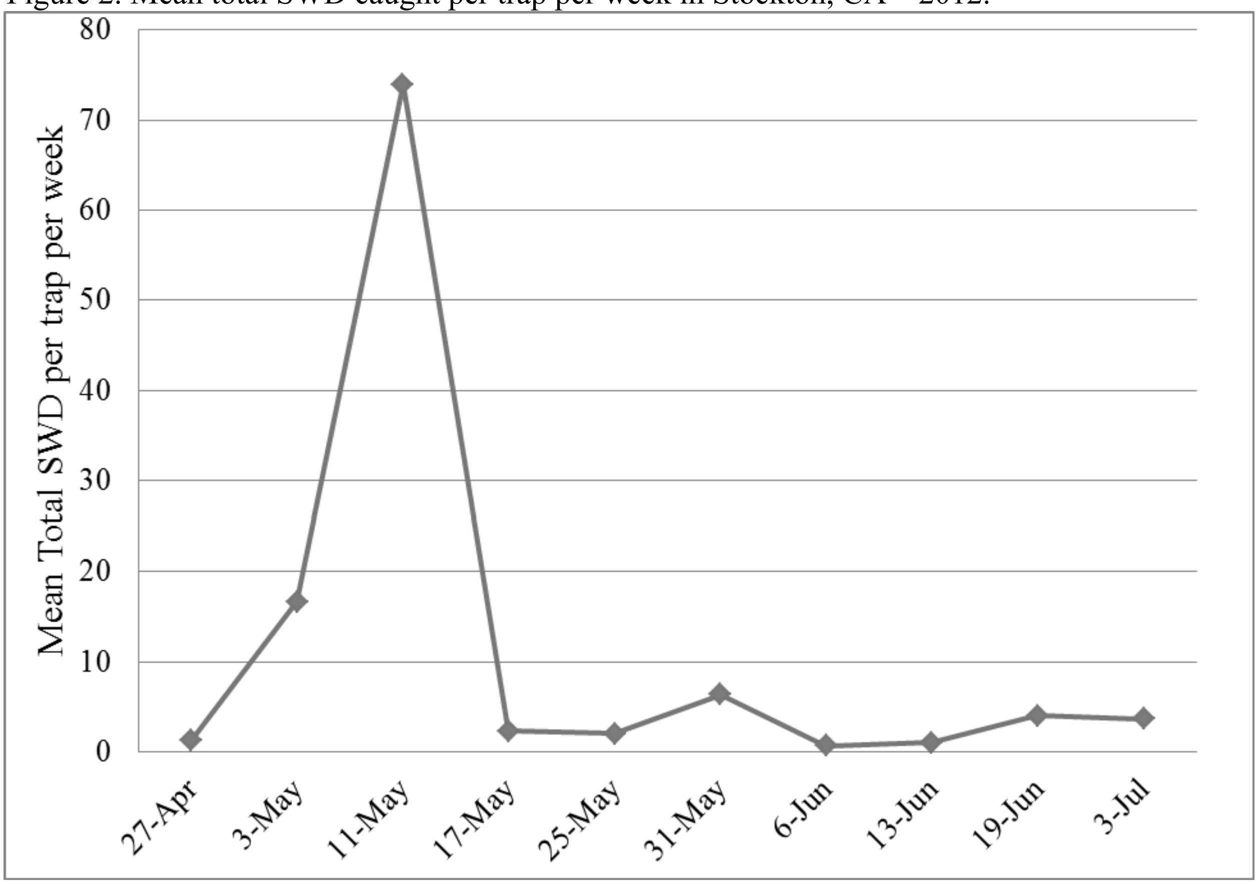
* DBH = Day before harvest

Table 28. Mean number of larvae per 100 fruit in Stockton CA - 2012

Treatment	Mean[a] larvae per 100 fruit					
	25 May	30 May	5 Jun	12 Jun	18 Jun	Total
1		0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
2		0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
3		0.0 a	0.0 a	0.2 a	0.0 a	0.2 a
4	0.0 a	0.2 a	0.0 a	0.0 a	0.0 a	0.2 a
5	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
6		0.0 a	0.0 a	0.3 a	0.0 a	0.3 a
7		0.7 a	0.0 a	0.0 a	0.0 a	0.7 a
8		0.2 a	0.0 a	0.0 a	0.0 a	0.2 a
9		0.0 a	0.2 a	0.0 a	0.0 a	0.2 a
10		0.0 a	0.0 a	0.0 a	0.2 a	0.2 a
11		0.0 a	0.2 a	0.0 a	0.0 a	0.2 a
12		0.0 a	0.0 a	0.0 a	0.0 a	0.0 a
13	1.3 a	0.2 a	0.0 a	0.5 a	0.2 a	2.2 b

[a]Means followed by the same letter within a column are not significantly different (Fisher's Protected LSD ≤ 0.05).

Figure 2. Mean total SWD caught per trap per week in Stockton, CA – 2012.



Post-Harvest Insecticide Efficacy Evaluations

Materials and Methods:
Three trials were conducted in a commercial 'Bing' cherry orchard in Tracy, CA. The trials were conducted sequentially to allow testing of a wide range of materials. Applications were 20 August for pyrethroids and neonicotinoids (treatments 1-4), 9 September for organophosphates (treatments 5-10) and 24 September for diamides and spinosads (treatments 11-14). Ten adult female *D. suzukii* were exposed to treated foliage at 1, 3, 7 and 15 days after treatment (DAT). Female *D. suzukii* were used in the evaluations since females are much more difficult to control as compared to males and thus females would provide a more rigorous evaluation of the experimental insecticides. A bouquet of treated foliage (5 leaves) was placed in a 1 gal plastic container. The leaf petioles were placed in a floral vial containing water to maintain leaf viability. Each container contained a water and food source for the flies. Mortality was determined after 24 hrs of exposure. The experiments were conducted at 75˚ F in a constant temperature cabinet with 16:8 (L:D). The leaves were collected and transported to the laboratory at UCB in ice chests. The data was transformed using Schneider-Orelli's correction and all analyses were performed on the transformed data across the three studies.

Results and Discussion:
At 1 DAT, the high rate of Malathion 57%, the mid and high rate of CHA-3189 and Success 2SC had significantly greater mortality compared to all other experimental treatments (Table 29). The mid and low rates of Malathion 57% provided significantly better control than Danitol 2.4EC + Belay 2.13SC, Lambda-Cy, the low and high rate of Exirel 10SE, but was not significantly different from the mid rate of Exirel 10SE, low rate of CHA-3189, Lambda-Cy + Assail 30SG or Danitol 2.4EC.

At 3 DAT, the high rate of CHA-3189 had significantly greater mortality compared to all other experimental treatments. The high and mid rate of Malathion 57% and mid rate of CHA-3189 had significantly greater mortality compared to all other experimental treatments except the low rate of CHA-3189. All rates of Exirel 10SE and Lambda-Cy provided little control and had the lowest mortality of all experimental treatments.

At 7 DAT, Lambda-Cy + Assail 30SG and Danitol 2.4EC had significantly greater mortality compared to all other experimental treatments. The high rate of both CHA-3189 and Malathion 57% provided moderate level of control and there was no significant difference among the high rate of CHA-3189, Malathion 57, Danitol 2.4EC + Belay 2.13SC, Lambda-Cy, mid and low rate of Exirel 10SE and Success 2SC. The mid and low rates of both CHA-3189 and Malathion 57% and the high rate of Exirel 10SE provided very little control. At 15 DAT, there was no significant difference among the various pyrethroid and neonicotinoid insecticides. Both Danitol 2.4EC + Belay 2.13SC and Lambda-Cy + Assail 30SG provided better control than Danitol 2.4EC.

The high rate of Malathion 57%, the mid and high rate of CHA-3189 and Success 2SC provided excellent knockdown effect. The mid and high rate of both CHA-3189 and Malathion 57%

provided moderate to excellent control at 3 DAT. Danitol 2.4EC and Lambda-Cy + Assail 30SG provided adequate control at 7 DAT and Danitol 2.4EC + Belay 2.13SC and Lambda-Cy + Assail 30SG provided some measure of control out to 15 DAT.

Table 29. Mean corrected[a] female SWD mortality in Tracy, CA – 2012

Treatment	Rate form/acre	Mean[b] corrected mortality 1 DAT		3 DAT		7 DAT		15 DAT	
Danitol 2.4EC	21.3 fl oz	51.9	abc	39.2	bcd	53.1	d	15.7	a
Danitol 2.4EC+Belay 2.13SC	21.3 fl oz +3.0 oz	39.5	ab	29.4	abc	22.9	abc	23.5	a
Lambda-Cy	5.12 fl oz	32.4	a	15.4	a	38.3	cd	19.3	a
Lambda-Cy +Assail 30SG	5.12 fl oz + 8.0 oz	57.8	abc	30.6	abc	53.9	d	28.0	a
Malathion 57%	22.4 fl oz	64.7	c	30.2	abc	0.3	a		
Malathion 57%	45.0 fl oz	63.8	c	62.7	e	5.9	ab		
Malathion 57%	90.0 fl oz	96.9	d	64.4	e	36.9	cd		
CHA-3189	13.4 fl oz	57.1	abc	45.4	cde	1.2	a		
CHA-3189	26.8 fl oz	88.5	d	60.4	de	1.8	ab		
CHA-3189	53.6 fl oz	93.2	d	89.0	f	24.8	bc		
Exirel 10SE	10.1 fl.oz	38.7	ab	15.0	a	16.9	abc		
Exirel 10SE	13.5 fl.oz	49.6	abc	18.7	ab	31.8	cd		
Exirel 10SE	20.5 fl.oz	39.7	ab	8.5	a	33.2	cd		
Success 2SC	8.0 fl.oz	87.7	d	27.3	abc	38.6	cd		

[a] Data was transformed using Schneider Orelli's correction ((Mortality % in treated plot - Mortality % in control plot)/(100 – Mortality % in control plot))*100

[b] Means followed by the same letter within a column are not significantly different (Fisher's LSD P ≤ 0.05)

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BIOLOGY AND CONTROL OF THE SPOTTED WING DROSOPHILA: 2012

PHENOLOGY IN UNSPRAYED CHERRIES
GF120 ENHANCEMENT TRIALS
DAMAGE SURVEY

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1. Seasonal Phenology in Unsprayed Cherry Orchards

Background: Monitoring flight patterns in unsprayed cherry orchards help to determine the normal flight pattern and population of this new pest. The second full year of monitoring in the Northern San Joaquin Valley was completed in spring of 2012. Two of the three original (2010) unsprayed orchards were monitored in the San Joaquin Valley in 2011 & 2012; the third 2010 orchard was sprayed beginning in 2011. As damage and awareness of this pest grows, it is getting increasingly difficult to find any unsprayed orchards.

Methods: Seasonal changes in natural SWD populations were monitored with standard deli traps. Four traps were hung in each orchard beginning in mid March 2010 and checked weekly through through late March 2012. Standard "Deli" traps made from white, 1 quart plastic yogurt containers with lids were used throughout the testing period. Traps were baited with 4 ounces of apple cider vinegar and amended with 2 teaspoons per gallon of unscented dish soap to reduce surface tension of the bait solution. Bait was changed weekly. Sixteen 3/16" entry holes were burned or drilled into the side of each container just below the lid. Traps were hung in the shade on the north or east side of the tree, 3 to 5 feet from the ground and at least 50 feet apart in the orchard. The SWD males were counted in the field and the spent bait and trap capture were put in labeled vials and brought back to the lab for further examination under a dissecting microscope. In the lab, SWD males were counted again to validate field counts. SWD females and non-SWD *Drosophila flies* were also counted, and other "contaminating" insects (that interfered with being able to see the male SWD in the traps in the field) were identified and visually rated for general abundance.

In addition to the untreated phenology sites, single traps were placed in a number of commercial orchards in each region to compare the impact of commercial sprays on the SWD population.

Results: The flight pattern in the No. San Joaquin Valley was similar in both 2010 and 2011 with the exception of the much larger fall flight in 2011. The flight began in late April, peaked about June 1st, slowly declined through June, dropping to very low levels by the end of July. Very low trap catches continued through the summer. In 2010, a small flight resumed in late October, peaked in November and again declined to very low levels through the winter until the following April when flight resumed. In 2011, the fall flight resumed at the same time but was much more significant than in the previous year and as large as the spring flight. In both fall flights, the males tended to be more prevalent than females while in the spring flights the females tended to predominate (Figures 1 & 2).

The damage in the unsprayed orchards varied from 0.5% to 77% and is reported in an inset in Figures 1 and 2. The damage varied somewhat by variety but generally increased over the approximately 10 day period from the beginning to the end of harvest and was unacceptably high for all varieties even on the earliest possible harvest date.

Figure 3 shows the comparative flight patterns for commercially sprayed cherry orchards in Contra Costa Co. over the last three years. The reduction of the spring flight due to the sprays is evident. The fall flight was much larger in the sprayed orchards than in the unsprayed orchards in 2010 and 2011and has not yet begun in 2012. The prevalence of male over females in the fall flight was evident in both sprayed and unsprayed orchards.

2. GF 120 Enhancement Trials

Background: GF120 NF Naturalyte is an organically approved, premixed, spinosad based fruit fly bait with a 4 hour re-entry interval. The active ingredient has been shown to be effective against SWD but the bait was formulated for tephritid fruit flies and does not appear to be as attractive to drosophilid fruit flies. The material might be a useful tool for SWD control, especially close to harvest, if the bait could be made more attractive. Two field trials were initiated. The first was to identify possible additives that would enhance the attraction of GF120 to SWD. The second was to determine if the best enhanced GF120 treatment could adequately control SWD.

Trial 1: Comparing GF120 additives in traps

Methods: Six bait treatments were mixed, portioned into traps, and placed in a high pressure orchard before any SWD sprays were applied. Enhancement materials included apple cider vinegar (ACV), baker's yeast and sugar, Monterey Insect Bait (MIB), or a combination used as a replacement for a portion of the dilution water in a 1:4 dilution of GF120, as shown in Table 1 below. Five ounces of the treatment bait was used per trap. Treatments were replicated 5 times. Traps consisted of 1 quart, white, opaque plastic containers with a 1/8" screen lid protected with a wing trap top as a rain shield. A 1"x1/2" piece of Herocon Vaportape was hung from the screen to maximize trap capture. Treatment traps were placed about 30 feet apart in a high pressure orchard in early May. Every 3-4 days the traps were rotated, the bait was changed, and the spent bait collected and strained for lab analysis. The number of SWD males, SWD females and non-SWD *Drosophila* species were counted and recorded under a microscope in the lab.

Table 1: GF120 Enhancement treatments mixed at a 1:4 dilution with 20 oz/A of GF120.

Treatment	GF120 (oz)	Water (oz)	ACV (oz)	MIB (oz)	Yeast (Tbsp)	Sugar (Tbsp)
1. GF 120 alone	20	80	0	0	0	0
2. GF 120 + ACV	20	60	20	0	0	0
3. GF 120 + Yeast	20	80	0	0	5	5
4. GF 120 + MIB	20	60	0	20	0	0
5. GF 120 + MIB + ACV + Yeast	20	40	20	20	5	5
6. MIB alone	0	80	0	20	0	0

Note: Baking soda was added as needed to the ACV treatments to bring the pH up to 6.2; Tripleline defoaming agent was added at label rates to the ACV and MIB treatments.

Results: GF 120 alone was not very attractive to SWD. The yeast and sugar additive improved catch but not always significantly. The MIB additive showed a greater degree of improvement and was usually better than MIB alone, but not always significantly so. The apple cider vinegar additive improved in attractiveness as the fruit got riper and by the last set performed statistically as well as the best treatment. The combination treatment with ACV and MIB and Yeast/sugar consistently outperformed all other treatments at a high level of significance.

Trial 2: Field control of SWD with the best enhanced GF 120 treatment

Methods: An unreplicated, demonstration trial was established in a quarter acre block of cherries (3 adjacent rows) in a mixed stonefruit planting. The best performing treatment #5 (GF 120 + MIB + ACV + Yeast/Sugar) was applied at a high label rate of 20 oz of GF120 per acre with a hand held, hand pumped sprayer every 3-4 days, from straw/first blush through harvest to the upper trunk and limbs in three timed "squirts" with coarse droplets. No other SWD control was used. An additional row of untreated cherries which was 100-200 feet away from the treated area was left as a control. Damage was evaluated by the visual inspection of 100 fruit samples under 5x magnification after letting the fruit sit at room temperature for 3-4 days, in closed bags.

Results: The enhanced GF 120 mixture suppressed SWD trap catch. The degree of suppression was apparent when compared to last year's trap catches in the same untreated cherry block (Figure 5).

Damage in the treated Bing ranged from 26% at the earliest possible color pick to 15-21% during the main harvest and beyond (Figure 6). The damage in the untreated Bings was about 10% higher (36% to 31%). As SWD is such a strong migrator, there is a question of whether the untreated area was far enough away from the treated area to actually be "untreated". Damage in the untreated Rainiers ranged from 11% at the earliest color pick to 6-13% during the main harvest and increased to 42% after harvest was complete (3 days after the last treatment application).

A comparison of the 2012 damage in the treated block to the damage in this same block which was untreated in previous years, shows that the 2012 damage was higher earlier in the season and lower later in the season than in previous years. This block did have a higher early season flight in 2012 than previously which may account for the earlier damage. Perhaps beginning the application a week earlier could have reduced this early damage. But the fact remains that while the enhanced GF120 treatment did seem to reduce damage over no treatment, it did not do so as a stand-alone treatment at an economic level.

It would be worthwhile to both continue to look for GF120 enhancements and to repeat the field demonstration beginning the application earlier and treating all the cherries in the block, leaving no untreated controls as potential source trees.

3. SWD harvest damage survey

Background: Fruit samples were collected from several orchards in Contra Costa County with varying SWD management practices to get a general overview of program effectiveness. Weekly SWD trap counts were also collected in each orchard as a measure of population pressure.

Methods: Fruit samples were collected as varieties became mature. In orchards with a prolonged or delayed harvest, samples were collected weekly until harvest was complete. In a few cases samples were collected after harvest when fruit was available, to determine the longevity of the SWD control program.

Each harvest sample consisted of 100 packinghouse quality fruits that were fully ripe, with stems, and without spurs, doubles, rain cracks or other defects that might obscure SWD damage. The samples were stored in ziplock plastic bags at room temperature for 3-4 days to allow eggs time to hatch and small larva time to grow so damage could be more accurately determined. After the waiting period, the fruit were examined and sorted with the aid of a 5X magnifying visor. Any fruit that appeared sound on the outside was pulled open and again checked for signs of SWD. The percent of damaged fruit was calculated from this data.

Results: A variety of management programs were employed and are shown in Table 2 along with any damage incurred and the cumulative trap catch through harvest for each orchard. The cumulative trap catch is included as a convenient relative comparison of pressure for the tabular data. However, weekly catch data gives a better indication of population pressure and spray longevity for management decisions.

Due to the prolonged bloom and ripening period several orchards incurred early season damage while waiting for optimum gibberlin timing to apply SWD sprays. Fruit that started to color after an application went on was protected. By harvest this earliest fruit had obvious decay and was easier to detect.

Malathion by ground and by air was used successfully in many orchards.

Surprisingly, the unsprayed block # 10 had very little damage in the Bings in comparison with 48% and 20% damage in 2011 and 2010, respectively.

Table 2: Summary of SWD damage at harvest in orchards with different management practices, varieties and pest pressure.

MANAGEMENT					**DAMAGE**				**PRES-SURE**
	Date	Material	Rate/A	AM[1]	Variety	Sample Date	% Fruit Damage	Harvest Timing[2]	Trap Catch[3]
CONVENTIONAL									
1	5/13	Lambda-Cy	4 oz	OS	Bing	5/30 6/5	1.8% 0.9%	E M	71
2	4/6 5/2 5/10 5/24	Delegate WG LambdaStar 1CS Malthion 8 Aquamul Fyfanon ULV AG	5 oz 5 oz 1.75 pt 16 oz	OS OS OS Air	Coral Bing Bing Bing Bing	5/25 5/31 6/7 6/14 6/22	5.1% 0.0 % 0.0% 1.9% 0.0%	M M PH PH PH	77
3	5/15 5/23	Danitol 2.4EC Danitol 2.4EC	18 oz 18 oz	OS OS	Bing Bing Bing Rainier Rainier Rainier	5/31 6/7 6/14 5/31 6/7 6/14	3.7% 0.9% 0.5% 1.8% 0.0% 0.0%	E M PH E M PH	156+
4	5/3 5/12	Danitol 2.4EC Danitol 2.4EC	13 oz 13 oz	OS OS	Coral	5/22 6/12	0.9% 0.0%	M 2 wk PH	111
5	5/17 5/27	Danitol 2.4EC Danitol 2.4EC	13 oz 13 oz	OS OS	Bing	6/1 6/7 6/14 6/22	0.0% 0.0% 0.0% 0.0%	E M 4 d PH 12 d PH	8
6	4/18 5/3 5/10 5/19 5/24	LambdaStar 1CS LambdaStar 1CS Success Fyfanon ULV AG Fyfanon ULV AG	5 oz 5 oz 6 oz 16 oz 16 oz	OS OS OS Air Air	Sweetheart	6/1 6/7 6/14	0.0% 0.0% 0.0%	7 d Pre E M	13
7	5/2 5/12 5/19 5/22	LambdaStar 1CS Entrust Fyfanon ULV AG Entrust	5 oz 2.5 oz 16 oz 2 oz	OS OS Air OS	Coral	5/22 5/30 6/5 6/12	5.7% 0.0% 0.9% 0.0%	3 d Pre 3 d PH 10 d PH 17 d PH	53
ORGANIC									
8	5/4 5/21	Entrust Entrust	2 oz 2 oz	OS OS	Bing	5/22 5/30 6/5 6/12	0.0 % 0.0 % 0.0 % 0.0 %	Pre E M PH	46
9	5/4 5/12	Entrust Entrust	2.0 oz 2.5 oz	OS OS	Coral	5/17 5/22 5/30 6/5	4.0 % 0.8% 0.9% 6.25 %	E M PH PH	94
10		UNSPRAYED			Burlat Bing Bing Bing Bing	5/22 5/30 6/5 6/12 6/19	24% 0.9% 2.7% 1.9% 0.0%	M E M L PH	146

[1] Application method: OS = by Orchard Sprayer   Air = by Helicopter
[2] Harvest Timing: E = early color pick M = Main harvest L = Late harvest   PH = Post Harvest
[3] Trap Catch: the cumulative number of SWD caught per week from April 2 through July 3, 2012

Figure 1: 2010 trap catches and damage in 3 unsprayed cherry orchards (12 traps) in the No. San Joaquin Valley.

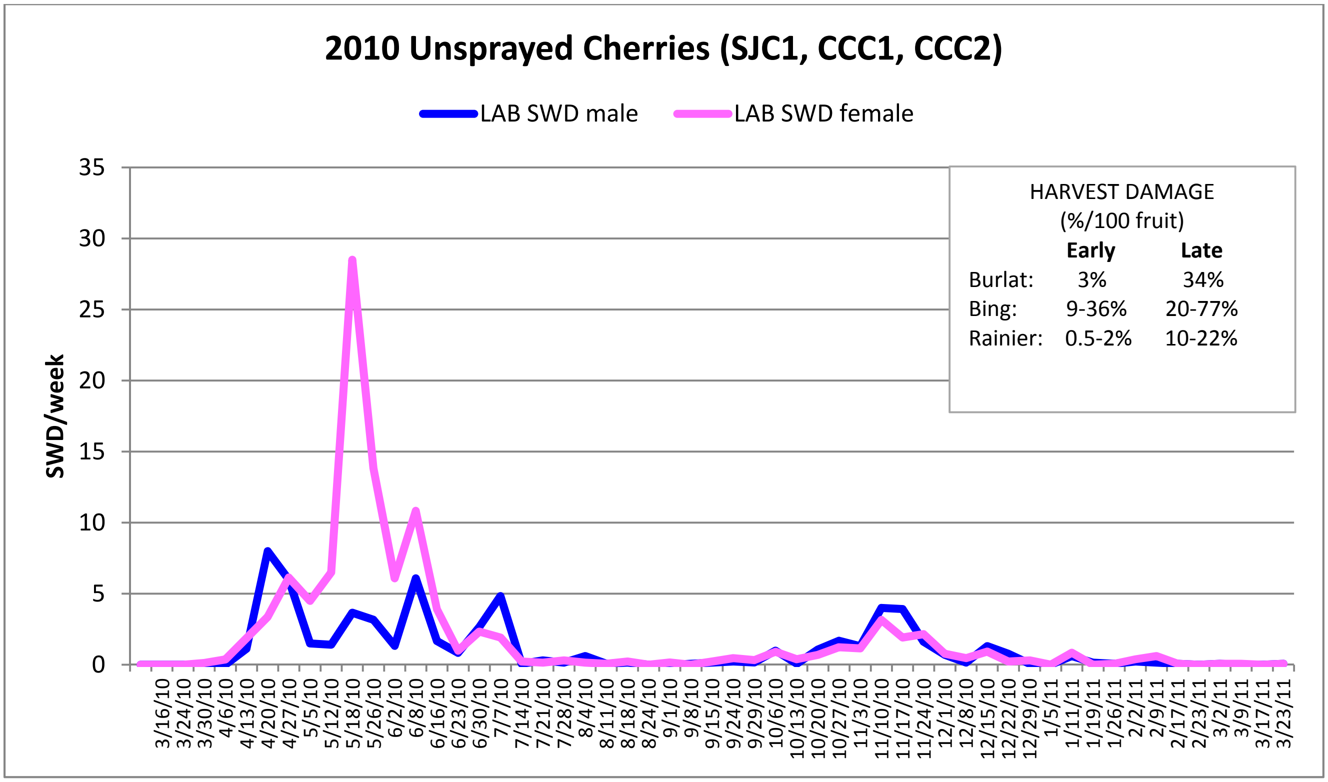


Figure 2: 2011 trap catches and damage in 2 unsprayed cherry orchards (8 traps) in the No.San Joaquin Valley.

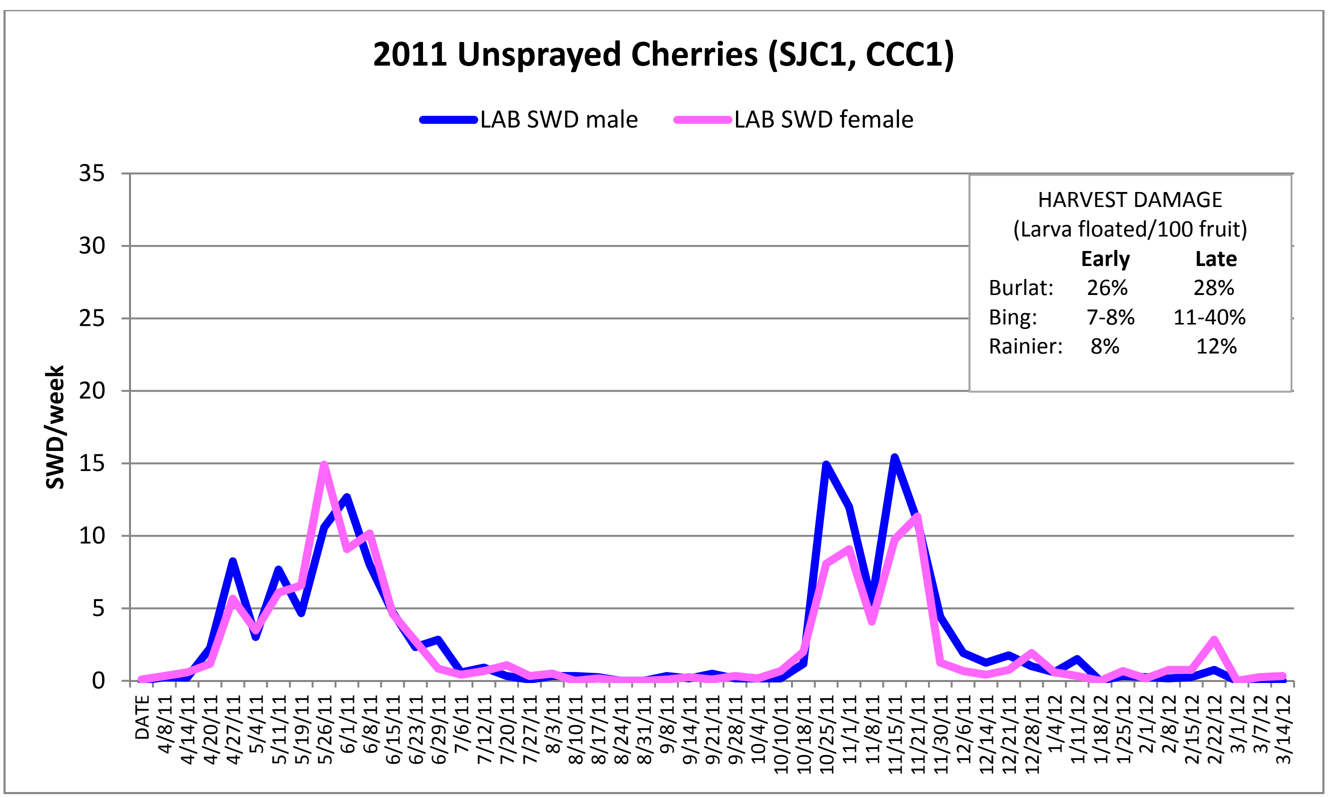
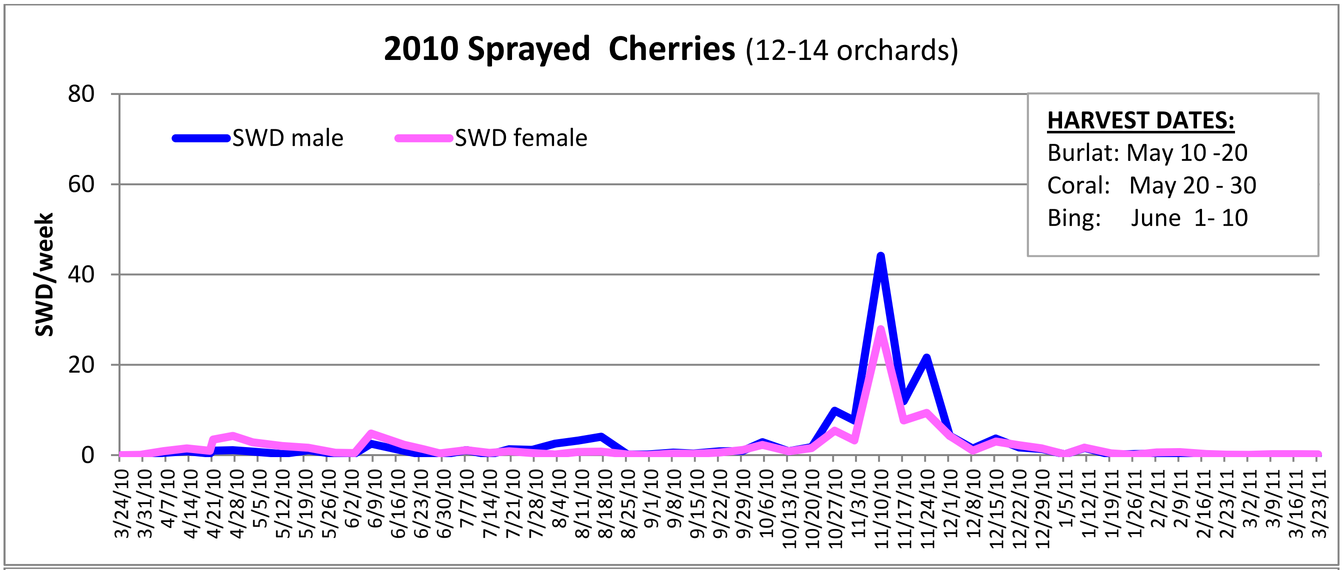
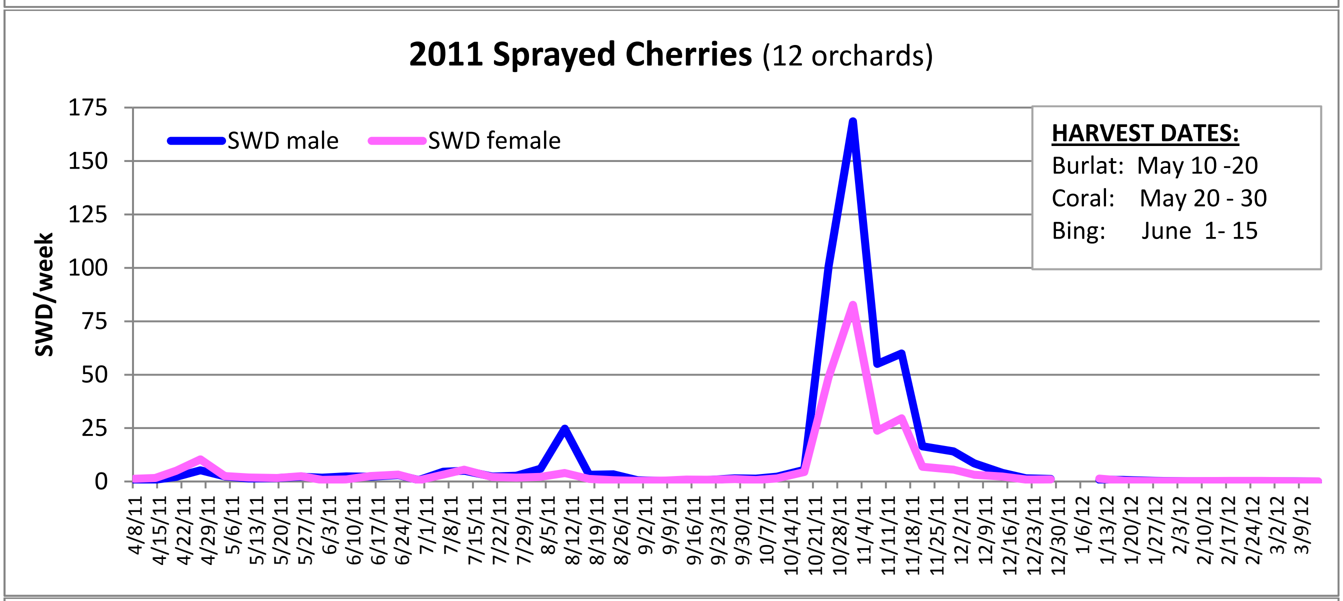


Figure 3: Trap catches in sprayed cherry orchards for the 2010, 2011, 2012 seasons in Contra Costa County.





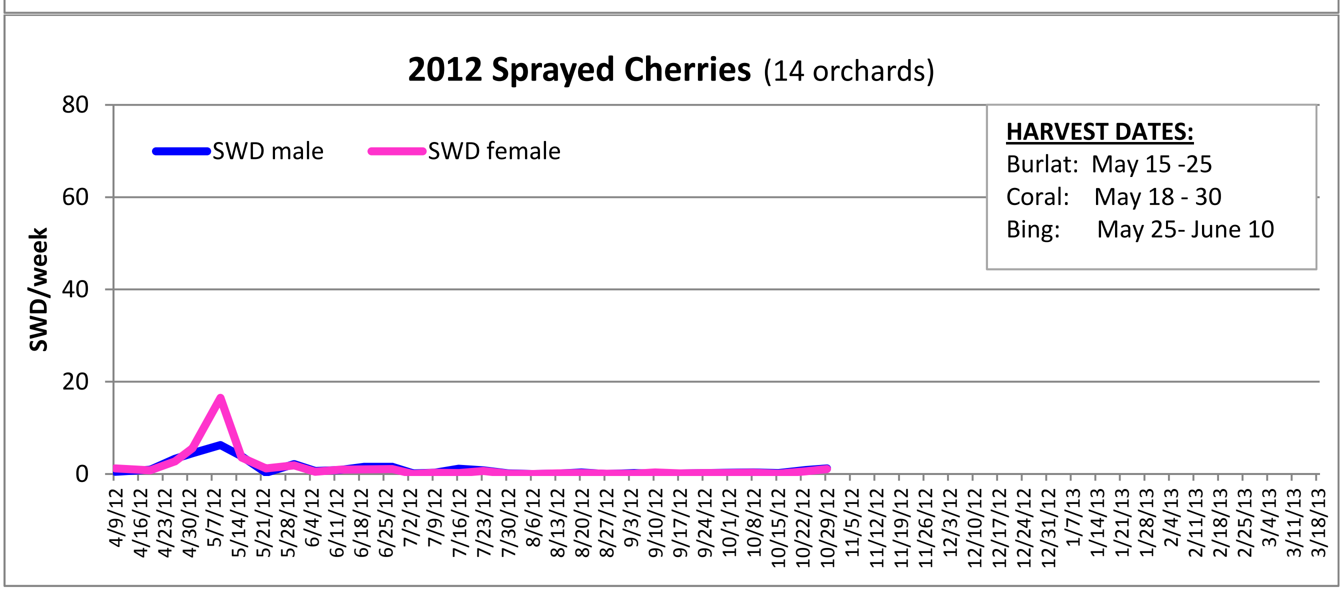


Figure 4: Average SWD caught per trap in the six GF 120 enhancement treatments over time.

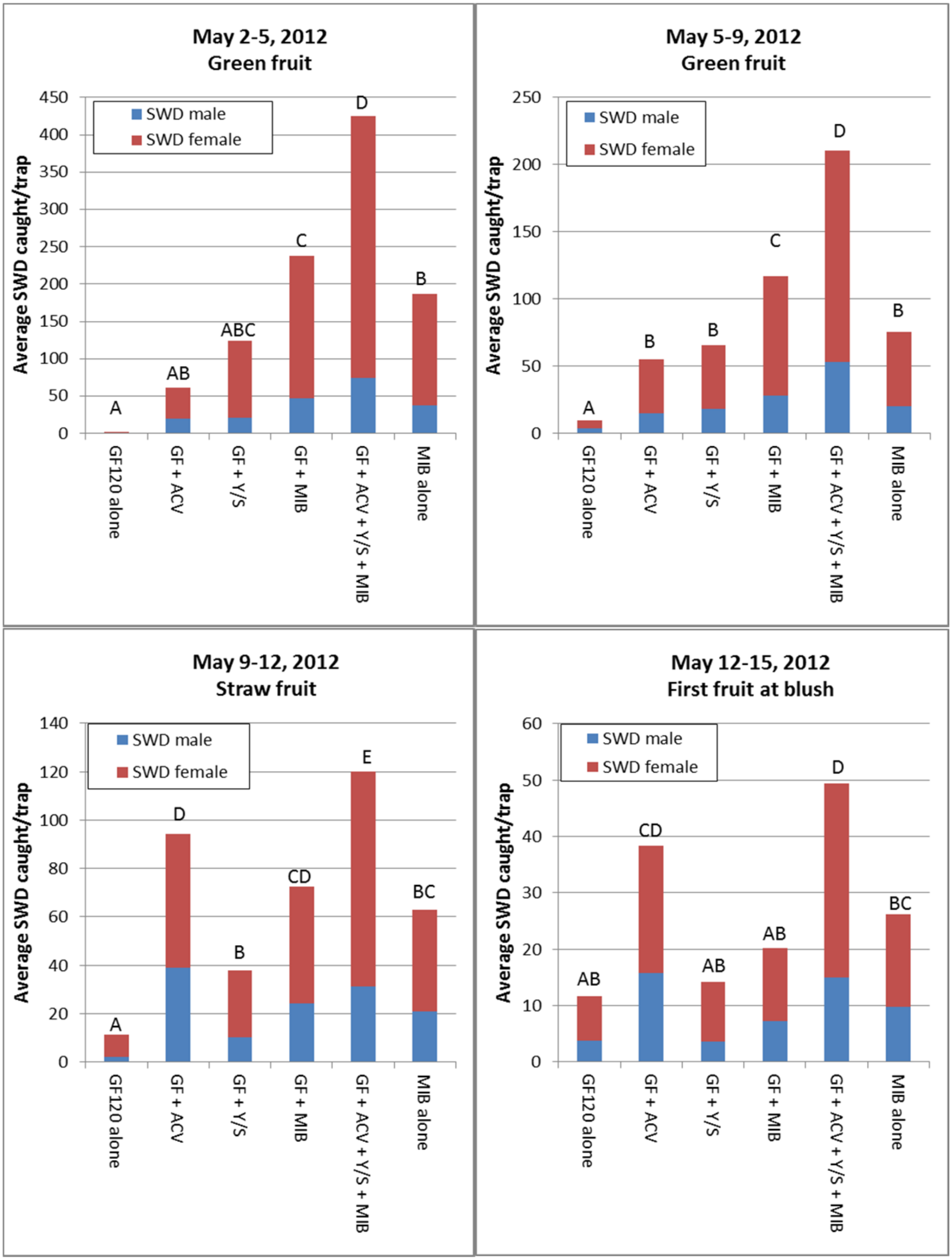


Figure 5: Total SWD trap catch in the spray trial block during the treatment year (2012) and the untreated year (2011)

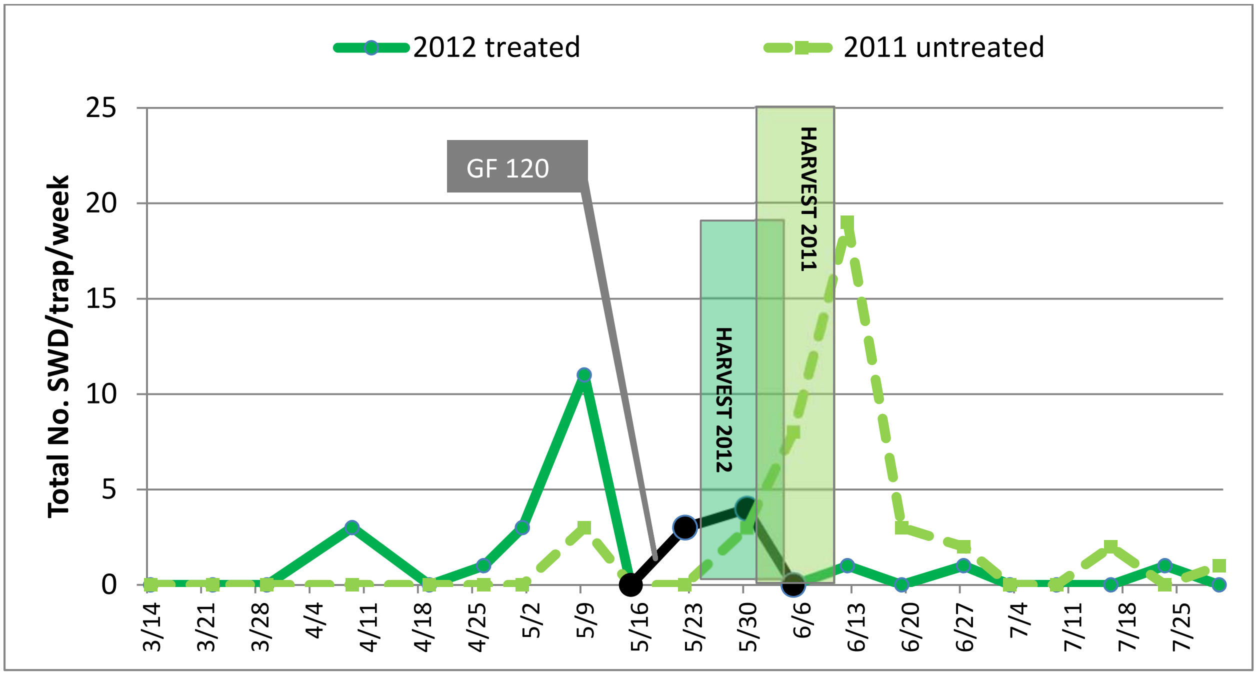


Figure 6: SWD damage in enhanced GF 120 treated and untreated cherries in 2012, 2011, 2010.