-CALIFORNIA APPLE COMMISSION-

ANNUAL REPORT

2016-2017

2016-2017

ANNUAL REPORT

OFFICE

CALIFORNIA APPLE COMMISSION
2565 ALLUVIAL AVE., SUITE 182
CLOVIS, CA 93611
(559) 225-3000 TEL.
(559) 456-9099 FAX

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MESSAGE FROM THE EXECUTIVE DIRECTOR

Alexander J. Ott
Executive Director

The California Apple industry finished its 2016-2017 season on a positive note. After a four year severe drought, the winter and spring brought the much needed rain to our dry state. Additionally, with legislative and regulatory challenges, the California apple industry continues to stay competitive while complying with all the new rules passed at the local, state, and federal level. With a new presidential administration, discussions are already beginning on new trade talks and renegotiations of other past trade deals, including the North American Free Trade Agreement (NAFTA). New appointments to key offices will also change the way agriculture and the California Apple industry will approach issues. Despite all of these challenges and changes, the California Apple Commission continues to look at "doing those things that an individual grower or packer cannot do…"

This past year, the Commission continued to keep California markets open through the oversight of the Taiwan and Mexico program. In fact, thanks to the Commission's efforts, the Mexico oversight program has been reduced, making the 2017-2018 season the first season that a Mexico inspector will come to California, check operations, and return home. This new work plan saves the industry over $80,000 a year. Also, Mexico sought an anti-dumping lawsuit against all U.S. Apples. The Commission worked with several of its industry members to show that California was not dumping, and since the filing, the Mexico plaintiffs have dropped the action. In addition, the Commission worked with several other apple producing states and the U.S. Apple Association to prevent a potential tariff on apples into Canada due to several concerns over the Country of Origin Labeling (COOL). Had this tariff gone into place, the industry would have probably lost an important trading partner.

In addition to its export work, the Commission continued its shade cloth research, receiving over $300,000 in grant funds over the last two years. The results look promising and may assist the growers in developing new tools to reduce sun burn, orchard temperatures, and reduction in water consumption. Research also continues to develop organic tools to combat fire blight. This upcoming year, research will continue on these and other important issues that directly impact the California apple industry.

Lastly, the Commission continues to work with the U.S. Apple Association and several other agricultural organizations in gathering information and assisting growers in adhering to the latest Food Safety Modernization Act (FSMA) law. This law will change how apples are grown, handled, and shipped, and places several new mandates on the industry.

Overall, the 2016-2017 season was a year of innovation, challenges, and successes. On behalf of the California Apple Commission, I am pleased to present to you the 2016-2017 Annual Report. As always, it is a pleasure representing you and I look forward to a successful 2017-2018 season.

High Regards,

Alexander J. Ott
Executive Director

CHAIRMAN'S MESSAGE

Dr. Steve Blizzard
Chairman

It continues to be a pleasure to serve as your Chairman of the California Apple Commission. From Taiwan apple training protocols and oversight of the export market activities, to research, pest and disease issues, and market access issues, the Commission continues to fill the role that many growers and handlers cannot. In the spirit of our strategic plan and our mission, the Commission is assisting the industry in reducing red tape, in addition to reducing the costs to growers through its activities. With such limited resources and in a state that has some of the highest production costs, the Commission has done an amazing job in assisting the individual growers and companies that produce apples in the Golden State.

Research activities are becoming more important for the apple industry. With fire blight continuing to be problematic for the industry, the Commission continues to conduct research for both conventional and organic apple growers. The purpose is to develop cultural practices that will assist the growers in combating this deadly plant disease and lower cultural costs by decreasing the need for pruning or replanting apples due to loss. Additionally, for the past two years the Commission has conducted a shade cloth study which is looking at ways to lower field heat, reduce sunburn, use less water, and lower lenticel breakdown in the orchard. The results look promising. Also, the Commission is looking at research methods to replace methyl bromide, which if successful, will extend shelf life for apples that are exported, not to mention assist in reducing ozone depleting materials for our environment.

Export markets continue to be an important component for the California apple industry. Canada, along with Mexico and Southeast Asia, are still priorities when it comes to shipping outside of the U.S. Thanks to the Commission, and partnerships with other associations, the Commission continues to be diligent in making sure these markets remain open for export. As the old saying goes, "every apple shipped is another apple earned." As export markets remain open, there is less pressure on the domestic market and that is beneficial for everyone.

Lastly, food safety will continue to be a main issue over the next several years. As the industry starts to settle in on the new rules and regulations under FSMA, the Commission will continue to monitor and assist the industry in getting the necessary information to the growers and handlers.

The industry continues to do amazing things with such limited resources. As we go into the 2017-2018 season, please do not hesitate to utilize your Commission. It continues to be an honor to serve you and the industry.

Sincerely,

Dr. Steve Blizzard
Chairman

CALIFORNIA APPLE COMMSSION STAFF

ALEXANDER OTT

EXECUTIVE DIRECTOR
AOTT@CALAPPLE.ORG

TODD SANDERS

DIRECTOR OF TRADE & TECHNICAL AFFAIRS
TSANDERS@CALAPPLE.ORG

JANETTE RAMOS

OFFICE MANAGER
JRAMOS@CALAPPLE.ORG

TABITHA FRANCIS

INTERN
INTERN@CALAPPLE.ORG

OFFICE

CALIFORNIA APPLE COMMISSION
2565 ALLUVIAL AVE., SUITE 182
CLOVIS, CA 93611
(559) 225-3000 TEL.
(559) 456-9099 FAX

BOARD OF DIRECTORS

DISTRICT 1	DISTRICT 2	DISTRICT 3
Producer Member David Rider Bruce Rider & Sons Term: 7/2016-6/2020	**Producer Member** Chris Britton BK Partners Term: 7/2017-6/2018	**Producer Member** Jeff Colombini Lodi Farming Term: 7/2013-6/2017
Producer Member Lance Shebelut Trinity Fruit Sales Term: 7/2016-6/2020	**Producer Member** Virginia Hemly Chhabra Greene and Hemly Term: 7/2014-6/2018	**Producer Member** Steve Chinchiolo Riverbend Orchards Term: 7/2014-6/2018
Handler Member Bill Denevan Viva Tierra Term: 7/2013-6/2017	**Handler Member** VACANT Term: 7/2013-6/2017	**Handler Member** Tim Sambado Prima Fruitta Term: 7/2013-6/2017
Alternate Member VACANT Term: 7/2016-6/2017	**Alternate Member** Doug Hemly Greene and Hemly Term: 7/2016-6/2017	**Alternate Member** VACANT Term: 7/2016-6/2017
Public Member Dr. Steve Blizzard Term: 7/2013-6/2017	**Alternate Public Member** VACANT Term: 7/2014-6/2018	

DISTRICT MAP

CALIFORNIA APPLE ACREAGE TOTALS

County	
Butte	47.00
Calaveras	12.00
Colusa	5.00
Contra Costa	51.00
El Dorado and Alpine	852.00
Fresno	590.00
Glenn	0.00
Inyo and Mono	20.00
Kern	611.00
Kings	3.00
Lake	2.00
Los Angeles	20.00
Madera	43.00
Mariposa	10.00
Mendocino	215.00
Merced	1.00
Monterey	179.00
Napa	1.00
Nevada	32.00
Placer	0.00
Plumas and Sierra	2.00
Riverside	20.00
Sacramento	419.00
San Benito	279.00
San Bernardino	311.00
San Diego	231.00
San Joaquin	2,320.00
San Luis Obispo	169.00
San Mateo	0.00
Santa Barbara	306.00
Santa Cruz	2,050.00
Shasta	26.00
Siskiyou	3.00
Sonoma	2,229.00
Stanislaus	600.00
Sutter	15.00
Tehama	47.00
Tulare	144.00
Tuolumne	156.00
Ventura	390.00
Yolo	132.50
Yuba	10.70
Total:	**12,554.20**

STATEMENT OF ACTIVITIES

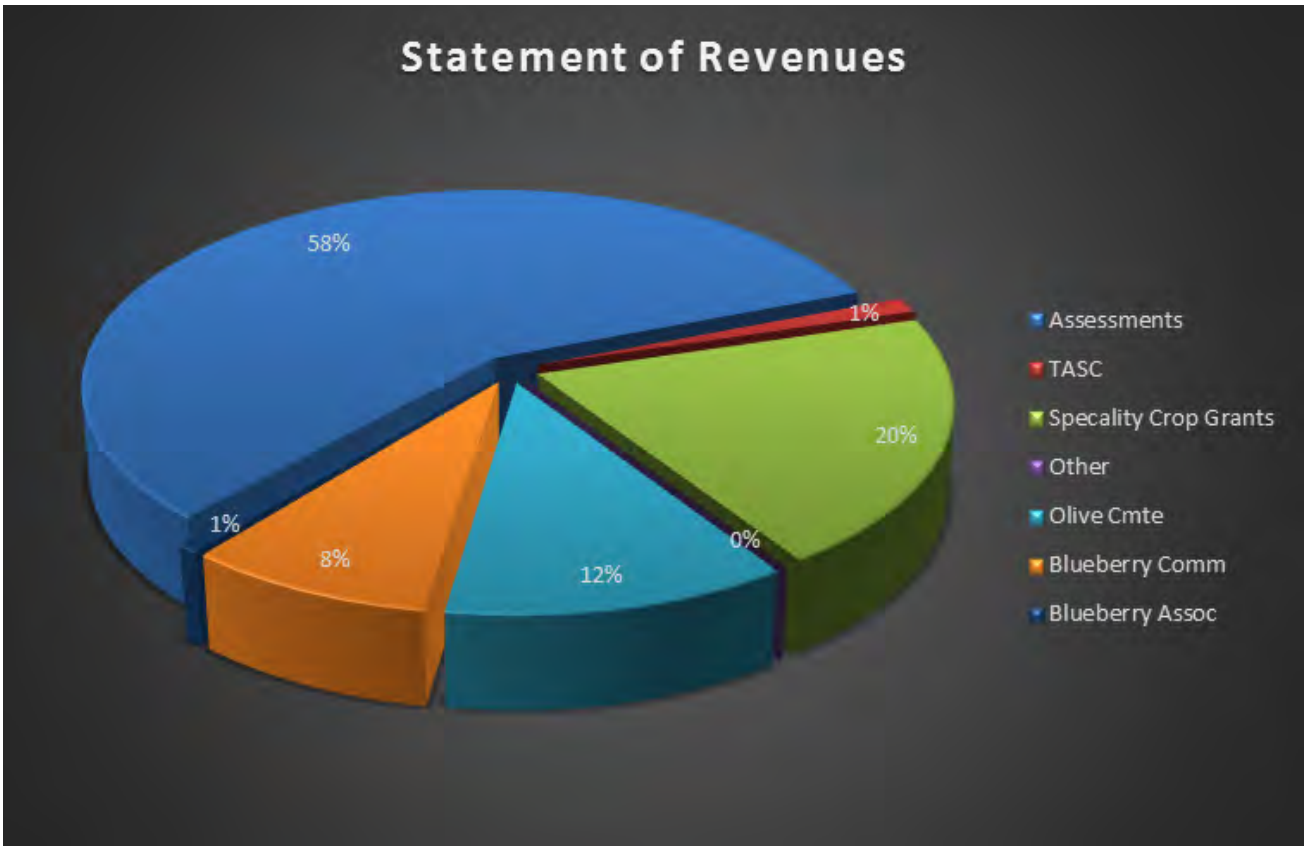
FISCAL YEAR ENDED JUNE 30, 2016

ASSETS	
•CASH	$35,542
•ACCOUNTS RECEIVABLE	$58,140
•PREPAID EXPENSES	$3,832
•RESTRICTED CASH DUE TO PENDING LAWSUIT	$1,725,821
•PROPERTY AND EQUIPMENT NET OF ACCUMULATED DEPRECIATION OF $37,234 IN 2013 AND $33,786 IN 2013	$7,265
TOTAL ASSETS	**$1,830,600**
LIABILITIES	
•ACCOUNTS PAYABLE	$97,693
•ACCRUED COMPENSATED ABSENCES	$16,599
TOTAL CURRENT LIABILITIES	**$114,292**
NET ASSETS	
•RESTRICTED	
- ESCROW ACCOUNT	$1,725,821
•UNRESTRICTED	($9,513)
NET ASSETS	**$1,716,308**
TOTAL LIABILITIES AND NET ASSETS	**$1,830,600**

STATEMENT OF REVENUES

REVENUES

•ASSESSMENTS	$441,274*
•GRANT INCOME – TASC	$9,344
•SPECALITY CROP BLOCK GRANT	$156,086
•OLIVE MANAGEMENT FEES	$90,000
•BLUEBERRY MANAGEMENT FEES	$65,000
•BLUEBERRY ASSOCIATION MANAGEMENT FEES	$6,000
•OTHER	$1,164
TOTAL REVENUES	**$767,704**



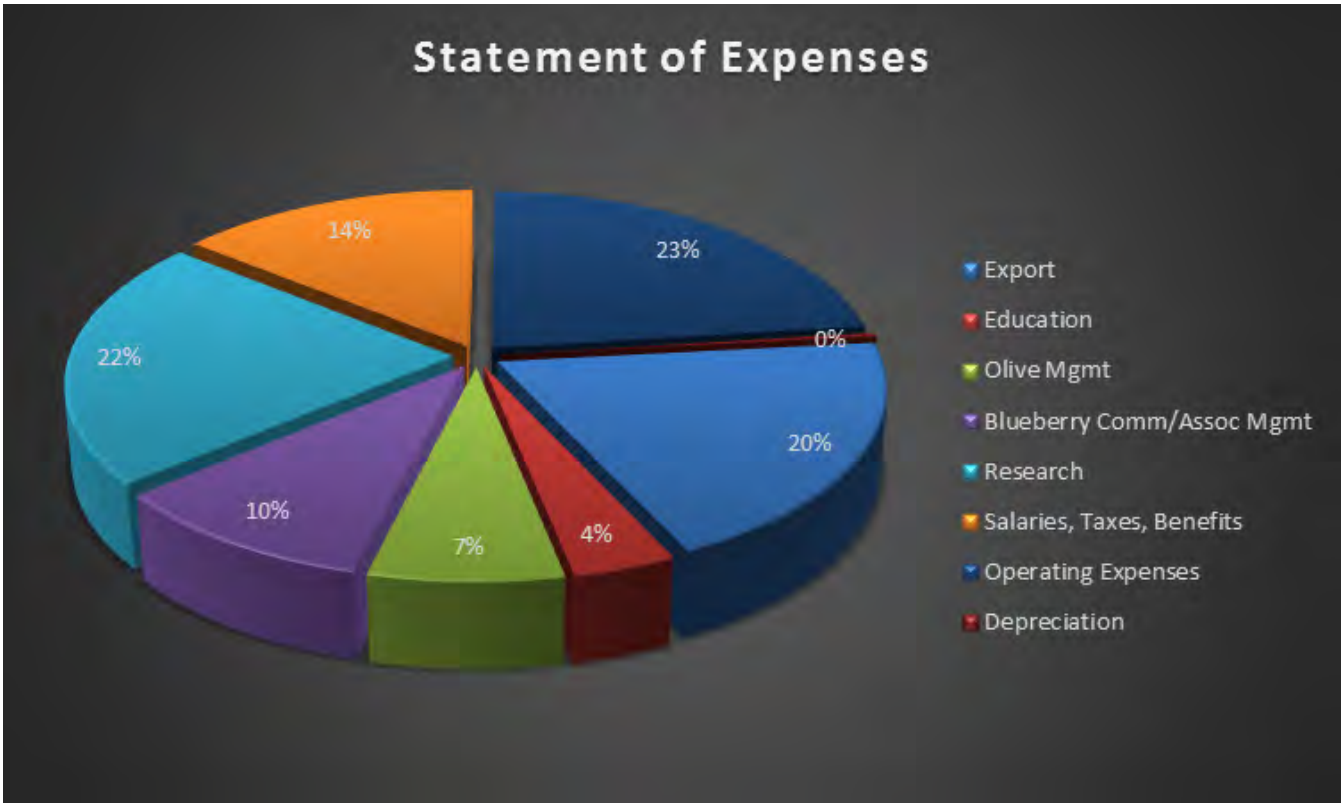
*Includes restricted revenues received pending current lawsuit. Restricted funds shall not be used in operating budget and are stored in a separate escrow account. These funds may not be released until the lawsuit is finalized.

STATEMENT OF EXPENSES

EXPENSES

•EXPORT/MARKET DEVELOPMENT	$157,204
•EDUCATION	$30,323
•OLIVE MANAGEMENT	$56,723
•BLUEBERRY MANAGEMENT	$79,607
•RESEARCH	$174,708
•SALARIES, PAYROLL TAXES, BENEFITS	$115,469
•OPERATING EXPENSES	$181,952
•DEPRECIATION	$2,596

TOTAL EXPENSES **$798,582**



CHANGES IN NET ASSETS **($31,328)**

NET ASSETS, BEGINNING OF YEAR **$1,747,636**

NET ASSETS, END OF YEAR **$1,716,308**

CALIFORNIA APPLE RESEARCH PROJECTS

2016-2017 RESEARCH SUMMARY

In 2016-2017, the California Apple Commission focused on three areas of research. Two of which were continuations of prior research, and one that is a new area of research. All three will continue to be areas of research for the future.

In September 2014, the Commission received $313,707 through the CDFA Specialty Crop Block Grant Program to explore the effect of shade cloth on apples. This project began on October 1, 2014, and will continue until February 2018. The full report will be availible and dissiminated to the industry in February 2018.

In summary, our current projects are as follows:

1) Evaluation of New Bactericides for Control of Fire Blight of Apples Caused by Erwinia Amylovora and Evaluation of New Postharvest Fungicides for Pome Fruits - Dr. Jim Adaskaveg

2) Fire Blight Management for Apples in California – Spring 2017 - Dr. Jim Adaskaveg

3) Shade Cloth Benefits for Apples - Facilitated by CAC staff and research analyzed by Fruit Dynamics

4) Postharvest Quality and Physiology of 'Gala', 'Granny Smith,' and 'Fuji' Apples Subjected to Phytosanitary Irradiation. - Dr. Anuradha Prakash

Annual Report - 2017

Prepared for the California Apple commission

Project Title:	Evaluation of new biological controls for management of fire blight of apples caused by *Erwinia amylovora* and evaluation of new natural products as organic postharvest fungicides for pome fruits
Project Leader:	Dr. J. E. Adaskaveg, Department of Plant Pathology and Microbiology, University of California, Riverside CA 92521.
Cooperators:	D. Thompson, D. Cary, and H. Förster

SUMMARY

Fire blight management

1. Additional strains of *E. amylovora* were collected in commercial orchards in 2016-17 and results showed a range of sensitivities to copper from low (10-20 ppm) to moderate resistant (20-30 ppm). Spontaneous mutants were also found with high copper resistance (>30 ppm) when the pathogen was continuously exposed to copper.
2. Field trials on the management of fire blight were conducted under high disease pressure on cvs. Granny Smith and Fuji.
   a. Among biological treatments, Blossom Protect (BP) + buffer and Serenade Opti + Badge X2 significantly reduced fire blight from the control. Badge X2, Cueva, Veg'Lys, LifeGard, Serenade Opti, Serenade Opti + sugar, BP + polylysine, and the experimental WX-16005, as well as a rotation of Badge X2-Badge X2 + Lime sulfur-Cueva were ineffective.
   b. Kasumin and Kasumin mixed with FireLine or FireWall continued to be highly effective. Mixtures of Kasumin with lactic acid also significantly reduced the incidence of fire blight from the control.
   c. In a split-plot test using the systemic acquired resistance (SAR) materials Actigard or LifeGard as the main plots and Double Nickel, BP + buffer, or Kasumin as the subplots, the main plots were not significantly different from the untreated control. The subplot treatments BP + buffer and Kasumin significantly reduced fire blight in each of the main plots. Double Nickel (*Bacillus amyloliquefaciens* strain D747) reduced disease compared to the control and was intermediate in comparison to Kasumin and BP + buffer.

Postharvest decay control

1. Laboratory and experimental packingline studies confirmed our previous trials where the bio-fungicide natamycin (pimaricin) was identified as an effective broad-spectrum postharvest treatment for apple decays. Natamycin was registered as a soluble concentrate (SC) formulation in the summer of 2016 under the trade name BioSpectra. Because it is a fermentation product, it is being proposed to the National Organic Standards Board (NOSB) as an organic treatment (PI submitted a letter of support to the NOSB).
   a. Mixtures of the fungicide with a postharvest carnauba-based fruit coating reduced the performance of the fungicide against blue mold but not against gray mold. Mixtures with chlorine numerically improved performance; whereas mixtures with a wetting agent were numerically less effective than BioSpectra by itself.
   b. BioSpectra was highly effective when mixed with a low rate of Scholar, and this presents an excellent resistance management strategy.
   c. BioSpectra and Scholar were effective against Mucor rot.
2. The new pre-mixture Academy (fludioxonil + difenoconazole) continued to perform very well as a broad-spectrum conventional postharvest treatment against major decays of apple. It is scheduled for registration in 2017 and will be another important tool to decrease the risk of fungicide resistance.
3. The experimental fungicide EXP-AD was ineffective against blue mold but very effective against gray mold, whereas EXP-SW was effective against both decays.
4. In continuing baseline sensitivity studies with natamycin, EC_{50} values for inhibition of mycelial growth of *R. stolonifer* ranged from 0.175 to 0.698 mg/L (mean 0.481 mg/L). Sensitivity against eight isolates of

Mucor spp. ranged from 0.482 to 1.60 mg/L. These values are in a similar range as those for other postharvest pathogens of apple that we reported on previously.

INTRODUCTION

Epidemiology and management of fire blight. Fire blight, caused by the bacterium *Erwinia amylovora,* is one of the most destructive diseases of pome fruit trees including apples. The disease causes a blackening of twigs, flowers, and foliage and is indigenous to North America but has since spread worldwide. In addition to cankers, the pathogen overwinters in flower buds, diseased fruit, small twigs, and branches. In the spring, blossoms are infected through natural openings in nectaries and pistils. After destroying the blossom, the bacteria spread into the peduncle, spur, and twig. Warm wet environments favor disease development. Inoculum may ooze as droplets from cankers or infected flowers, peduncles, and other infected tissues. Inoculum is spread by wind, rain, insects, birds, or by man, e.g., by means of contaminated pruning tools. Secondary infections may occur throughout the growing season.

Current chemical control programs for fire blight are based on protective schedules, because available compounds are contact treatments and are not systemic except for the antibiotic streptomycin. Control with conventional copper compounds is only satisfactory when disease severity is low to moderate. Historically, these treatments are only used during dormant and bloom periods because phytotoxicity commonly occurs on fruit as russeting. Subsequently, labeled rates of copper are at low amounts of metallic copper equivalent (MCE) that are at the limit of effectiveness. Additionally, in 2016-17, low to moderate levels of copper insensitivity in pathogen populations was again detected.

The antibiotics streptomycin and oxytetracycline have been used for many years for the management of fire blight, but they were removed from the approved list of organic treatments of apples and other pome fruits by the National Organic Standards Board (NOSB). Resistance to streptomycin was present at high incidence in populations of the fire blight pathogen in California between 2006 and 2011, but since then has declined to low levels in most orchards. Resistance to oxytetracycline only has been found sporadically, and resistant populations did not persist. The new federally-registered kasugamycin (Kasumin) is pending registration in California in late 2017. Registration was delayed because of new requirements with legislation requiring new bee toxicology tests for new registrations such as Kasumin. The antibiotic will not be registered as an organic treatment and thus, organic growers have very limited choices for disease control.

New re-formulated copper products that can be used at reduced MCE rates and that have less contamination in their formulations that may cause phytotoxicity are available. Some of the coppers are OMRI-approved and these include Badge X2 (Gowan), CS-2005 (Magna Bon, Inc.), and Cueva (Certis). They have been reported to be effective against fire blight without causing phytotoxicity. Thus, research on OMRI-approved coppers needs to be continued especially if antibiotics are no longer approved, and these treatments were included in our 2017 field studies.

Several mechanisms have been described for biocontrol agents that lead to the reduction of a pathogenic agent. (1) Competition for vital resources on the plant surface that limits growth of the pathogen (competition); (2) the biocontrol may produce compounds involved in antibiosis (biochemical inhibition); (3) the biocontrol may increase in biomass and physically block infection sites of the pathogen (site exclusion); (4) the biocontrol agent may directly parasitize the pathogen; and (5) the biocontrol may induce host resistance mechanisms (systemic-acquired resistance). The bio-pesticide Blight Ban A506 (*Pseudomonas fluorescens* strain A506), the fermentation product of *Bacillus subtilis* Serenade (strain QST 713), and the bio-pesticide Bloomtime Biological (*Pantoea agglomerans* strain E325) over the years have been very inconsistent in their performance in our trials and were most effective under low inoculum levels and less favorable micro-environments. The latter product is no longer distributed by the registrant. The biocontrol Blossom Protect (*Aureobasidium pullulans*) was evaluated for the last several years and shown to be very effective under less to moderately favorable disease conditions and it is one of the most consistent biologicals that we have evaluated. In general, biocontrols are most effective when they are actively growing on the plant. Additives that can be used under field conditions are currently being evaluated. To increase the efficacy of biocontrols, we are evaluating the natural fermentation compounds lactic acid and ε-poly-L-lysine that have known anti-bacterial activity and are used as natural preservatives in food. They potentially could qualify for organic production. Our goal is to develop effective rotational programs for either organic farming practices with the use of copper and biologicals or conventional

programs with the use of antibiotics alone or in mixtures with fungicides, copper, biologicals, or possibly SAR compounds during bloom or as cover sprays during early fruit development.

Management of postharvest decays. Apples like other pome fruit can be stored for some period of time using optimum fruit storage environments. Still, postharvest decays caused by fungal organisms can result in economic crop losses during storing and marketing of fruit. The major postharvest pathogens of apples include *Penicillium expansum, Botrytis cinerea, Alternaria alternata, Mucor piriformis,* and *Neofabraea* spp. causing blue mold, gray mold, Alternaria rot (black mold), Mucor decay, and bull's eye rot, respectively. There is a deficiency in postharvest biocontrols and natural products for preventing decays in storage. BioSave 100 is one of the only materials currently available in the United States; whereas the product Aspire has been discontinued. Still, other biological products are registered in other countries and these potentially could be evaluated for California conditions if registrants decide to market their products in the U.S.

In our previous studies, we found that the bio-fungicide polyoxin-D (Ph-D, Oso, Tavano) was very effective in reducing the incidence of gray mold and Alternaria rot, but it was not effective against blue mold. We also demonstrated the efficacy of another bio-fungicide, natamycin (formerly pimaricin or EXP-13). This compound was registered in late 2016 as BioSpectra as a postharvest treatment for pome fruits and some other fruit crops. Natamycin showed very good to good efficacy against decays caused by *Penicillium*, *Botrytis*, and *Mucor* spp. For many years, it has been a federally-approved food additive to prevent mold growth, including *Penicillium* species, on dairy and meat products in the United States and other countries. Over this time, resistance in *Penicillium* species against natamycin has not occurred. Natamycin has an exempt registration status and it has been submitted to the NOSB for organic registration. Therefore, we continued to evaluate this and other experimental fungicides (e.g., EXP-Ad, EXP-SW) as well as Academy (pre-mixture of fludioxonil and difenoconazole) in 2016/17 with the goal of having additional postharvest fungicides for the apple industry of California.

OBJECTIVES

Fire blight research

1. Evaluate the efficacy of treatments for managing fire blight.
   - A. Laboratory in vitro tests to identify and evaluate growth enhancers of biological control agents.
   - B. Laboratory in vitro tests on copper and zinc products (registered copper products and new nano-particles) with newly identified additives (lactic acid, poly-L-lysine, and an experimental called SDH) that enhance the activity of these bactericides.
   - C. Small-scale hand-sprayer tests using different treatment-inoculation schedules to evaluate coppers (e.g., Badge X2, CS-2005, Cueva, Champ), and biological treatments (e.g., Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55) by themselves or in selected combinations (e.g., copper and Blossom Protect).
   - D. Field trials with protective air-blast spray treatments:
     - i. New formulations of copper (e.g., Badge X2, CS-2005, Cueva) possibly supplemented with nano-copper oxide (if laboratory assays show activity) with and without newly identified additives (lactic acid, poly-L-lysine, and an experimental called SDH).
     - ii. Biological treatments (Blossom Protect, Serenade, Double Nickel 55) with and without the addition of growth enhancers.
     - iii. Plant defense activators or SARs alone of in mixtures with other biological control treatments.

Postharvest research

2. Comparative evaluation of new postharvest fungicides
   - A. Evaluate polyoxin-D (Oso) and pimaricin (BioSpectra) at selected rates against gray mold, blue mold, Alternaria decay, and bull's eye rot and compare to pyrimethanil and fludioxonil.
   - B. Evaluate mixtures of these compounds.
   - C. Determine baseline sensitivities. Baseline sensitivities for natamycin (pimaricin) will be continued to be developed for additional fungal pathogens that are collected.

PLANS AND PROCEDURES

Isolation and culturing of* E. amylovora *and sensitivity testing against antibiotics and copper. Fire blight samples were obtained from pome fruit trees in the spring of 2016 and 2017 from commercial orchards. Infected plant material was surface-disinfested for 1 min using 400 mg/L sodium hypochlorite,

rinsed with sterile water, cut into small sections, and incubated in 1 ml of sterile water for 15 to 30 min to allow bacteria to stream out of the tissue. Suspensions were streaked onto yeast extract-dextrose-$CaCO_3$ agar (YDC). Single colonies were transferred and the identity of the isolates as *E. amylovora* was verified by colony morphology and by PCR using primers specific for *E. amylovora* (Appl. Environ. Microbiol. 58:3522-2536). Strains were tested for their sensitivity to streptomycin using the spiral gradient dilution (SGD) method. A genetic analysis was performed on selected strains moderately resistant to streptomycin to determine the mechanism of resistance. PCR amplifications were performed using primers AJ507 (located at the 3' end of *strB*) and pEU30R (located in plasmid pEU30). Amplifications were done at an annealing temperature of 56C, and amplification products were separated in agarose gels. Presence of a band indicated that *strB* is located on plasmid pEU30. Copper sensitivity of strains was determined by streaking bacterial suspensions (70% transmission at 600 nm) on CYE (casitone, yeast extract, glycerol) or nutrient agar amended with 0, 10, 20, or 30 ppm MCE. Growth was recorded after 2 days of incubation at 25C and was rated as +++ (growth not inhibited, similar to the control), ++ (growth inhibited as compared to the control), or + (growth sparse).

Field studies on the management of fire blight using protective treatments during the growing season. Air-blast field studies on the relative efficacy of protective treatments were conducted in experimental cvs. Granny Smith and Fuji apple orchards at the Kearney Agricultural Research and Extension Center (KARE). Three applications were done at selected bloom stages to 'Granny Smith'. On 'Fuji' apple, a split-plot trial was performed with the systemic acquired resistance (SAR) materials Actigard or LifeGard that were applied at pink bud as the main plots. Double Nickel (*Bacillus amyloliquefaciens* strain D747), BP + buffer, or Kasumin treatments were applied subsequently in the subplots at 20%, 90%, and 100% bloom. Application timings were determined based on temperature, rainfall, and host development. Incidence of blight was assessed based on the number of infected flower clusters of 100-400 clusters evaluated for each of the four single-tree replications. Additionally, potential phytotoxic effects of the treatments (e.g., fruit russeting caused by copper) were evaluated. Data were analyzed using analysis of variance and LSD mean separation procedures of SAS 9.4.

Efficacy of new postharvest fungicides for managing apple decays in storage. 'Granny Smith' fruit were treated similar to commercial practices concerning harvest, handling, packing, and temperature-management of fruit. Fruit were wound-inoculated with conidial suspensions of several decay fungi (*B. cinerea, P. expansum,* and *Mucor piriformis*) and treated on an experimental packingline at KARE after 14 to 17 h with test fungicides by T-Jet applications. Treatments included natamycin (BioSpectra), Scholar, Penbotec, EXP-Ad, or EXP-SW. To evaluate the stability of selected treatments in the presence of sodium hypochlorite, fungicide solutions were prepared 24 h before use. Selected treatments were also evaluated in combination with a wetting agent (i.e., Tween 80 at 0.01%). Fungicide T-Jet treatments were sometimes followed by a CDA application with a carnauba-based fruit coating (i.e., Decco 230). For each of four replications, 24 fruit were used. Data were analyzed using analysis of variance and averages were separated using least significant difference mean separation procedures of SAS 9.4.

Determination of baseline sensitivities. Baseline sensitivities for natamycin were determined for 63 isolates of *R. stolonifer* and eight isolates of *Mucor* spp. including four isolates of *M. piriformis*. Concentrations to inhibit mycelial growth by 50% were determined on amended potato dextrose agar using the spiral gradient dilution method as described previously.

RESULTS AND DISCUSSION

Antibiotic and copper sensitivity of* E. amylovora *strains collected in California. Among 68 strains collected from orchards in Sacramento Co. in 2016, 51 were found to be resistant to streptomycin and resistance was present in 17 of the 19 orchards sampled. Among resistant strains, 48 were rated as moderately resistant (MR) with MIC values of <30 ppm. Three strains that grew at >2000 mg/L streptomycin were rated as highly resistant (HR). After several years with a low to very low incidence of streptomycin resistance, this find was surprising. Streptomycin usage in these orchards is not known to us and spray records from the Sacramento Co. orchards could provide useful information on improving chemical usage. 2015 was a high-disease year, and possibly more applications of streptomycin were done that year and/or in 2016. This would have put the pathogen populations under selection pressure, allowing the resistant sub-population to re-emerge. Results for fire blight samples collected in 2017 are still pending.

A genetic analysis of 24 MR strains from 14 locations was conducted to determine the mechanism of resistance, i.e., if the previously described mechanism in California strains of *E. amylovora* was responsible for resistance. Amplification of a DNA fragment spanning the 3' end of *strB* into pEU30 using primers AJ507 and pEU30R indicated that resistance was conferred by the *str* genes and that these genes are located on plasmid pEU30. This is the previously described main mechanism (Förster et al., Phytopathology 105:1302-1310). Therefore, resistance likely did not develop newly. With reduced streptomycin usage, resistant strains were out-competed by wild-type strains over the past few years at these locations, survived at low incidence, and were readily selected for in 2016. In contrast, highly resistant strains only occurred at low incidence. The re-emergence of streptomycin resistance in California orchards stresses the need for new effective rotational fire blight management tools, such as the registration of kasugamycin. Furthermore, continued resistance monitoring in the fire blight populations is important to determine best usage of streptomycin.

In evaluation of copper sensitivity, most strains showed reduced growth on CYE (a medium with a low copper-binding capacity) amended with 20 ppm MCE, and only three strains still grew at 30 ppm MCE. All strains grew well on the nutrient-rich nutrient agar amended with 20 ppm MCE and some showed growth at 30 ppm MCE. Thus, as in 2015, we conclude that current *E. amylovora* populations are moderately copper-resistant. Additionally, we again frequently observed the occurrence of spontaneous mutants growing at higher copper concentrations, especially when using nutrient agar. These mutants were not stable when sub-cultured on copper-free media and reverted back to sensitivity. If these mutants also occur in the field, however, under continued presence of selection pressure (i.e., copper sprays) they may successfully compete and cause disease.

We consider several factors that can contribute to the failure of copper applications to control fire blight: 1) Highly conducive disease conditions were present in 2015 at many locations; 2) Low rates of copper are registered for fire blight management (approx. 170 MCE for the 0.5 lb rate of Kocide 3000); 3) There is moderate copper resistance in *E. amylovora;* and 4), Selection of populations (spontaneous mutants) with higher copper resistance after repeated applications. Additionally, copper is bacteriostatic and does not kill the pathogen. Applying a contact will only provide marginal benefits because the pathogen causes a deep internal infection (i.e. cankers) and the bacterium has a high reproductive capacity. This means that the pathogen will ooze out of cankers (unaffected by copper) and disseminate to unprotected tissue if copper is not routinely applied. Numerous copper applications, however, cause russetting of apples.

Field studies on fire blight using protective treatments during the growing season. Fire blight incidence in our research plots in the spring of 2017 was very high, i. e. 75-78% based on infected flower clusters of untreated control trees. Following conventional and organic treatments on cv. Granny Smith apple, disease incidence was evaluated four to five weeks after the last application. In the first trial, 20 treatments were evaluated most of them biological (Fig. 1). Among these, only Blossom Protect (BP) + buffer and Serenade Opti + Badge X2 resulted in a significant reduction of fire blight from the control. Badge X2, Cueva, Veg'Lys, LifeGard, Serenade Opti, Serenade Opti + sugar, BP + polylysine, and the experimental WX-16005, as well as a rotation of Badge X2-Badge X2 + Lime sulfur-Cueva were not effective. The most effective treatments in this trial were Kasumin and Kasumin mixed with FireLine or FireWall. Disease incidence after these latter treatments, however, was still over 50%. Therefore, to obtain commercial levels of control, treatments would have to be done in closer intervals. Our application schedule, however, was able to identify the most effective treatments.

In a split-plot test using the systemic acquired resistance (SAR) materials Actigard or LifeGard as the main plots and Double Nickel, BP + buffer, or Kasumin as the subplots, the main plots were not significantly different from the untreated control and the SAR materials were not effective (Fig. 2). The subplot treatments BP + buffer and Kasumin significantly reduced fire blight in each of the main plots. Double Nickel (*Bacillus amyloliquefaciens* strain D747) also reduced disease compared to the control and was intermediate in comparison to Kasumin and BP + buffer.

In conclusion, among biological treatments for the management of fire blight, Blossom Protect was again the most effective one. Although the addition of molasses to biocontrol treatments significantly improved growth of the biocontrol agents relative to the fire blight pathogen in laboratory studies in 2016, this nutrient additive did not provide benefits in our field studies. Treatments containing kasugamycin provided overall best levels of control. The performance of biocontrols may also be dependent on other pesticides used in pome fruit

production. In toxicity studies, chemicals used for fire blight control such as, streptomycin, oxytetracycline, kasugamycin, captan, copper, and mancozeb, were all inhibitory to *Streptomyces lydicus* (Actinovate) and *Bacillus amyloliquifaciens* (Double Nickel 55). In contrast, *Aureobasidium pullulans* (Blossom Protect) was not inhibited in growth by the three antibiotics at 40 ppm or by copper, but was inhibited by captan, mancozeb, and sulfur. The SAR compounds Actigard and LifeGard did not provide benefits in disease management in 2017. In previous years' studies, inconsistent results were obtained with Actigard and a reduction in disease was only sometimes observed. A summary on the use of biological treatments for the management of fire blight has recently been prepared for the California Apple Commission.

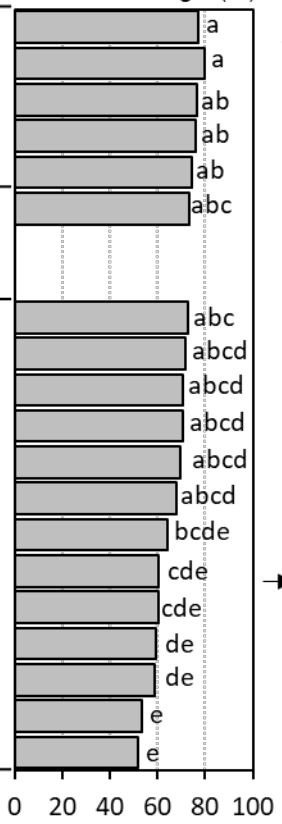
Evaluation of postharvest treatments using single-fungicides, mixtures, and pre-mixtures. Postharvest studies focused on the efficacy of the new natural compound natamycin (pimaricin) that is currently exempt-from-tolerance and registered as BioSpectra. The compound was submitted to the NOSB and a letter was written by Dr. Adaskaveg in support of an OMRI listing. In experimental packingline trials using T-Jet application methods, BioSpectra was highly effective against gray mold and Mucor rot, as well as other decays such as Alternaria rot that were previously evaluated. In contrast, BioSpectra was moderately effective against blue mold (Fig. 1). Treatments in combination with a postharvest carnauba-based fruit coating reduced the performance of the fungicide against blue mold but not against gray mold (Fig. 1). Mixtures with chlorine numerically improved performance (Fig. 4); whereas mixtures with a wetting agent were numerically less effective than BioSpectra by itself (Fig. 5). In previous studies, we showed that BioSpectra was highly effective when mixed with a low rate of Scholar, and this presents an excellent resistance management strategy. Resistance has not been reported previously to any *Penicillium* species, although the fungicide has been registered for food uses for over 20 years. Still, the most efficacious treatments were Scholar and Penbotec against Penicillium and gray mold decays. In trials with Mucor rot, BioSpectra and Scholar were both effective (Fig. 5).

The new pre-mixture Academy continued to perform very well as a broad spectrum conventional postharvest treatment. It is effective against most postharvest decays of apple. It is scheduled for registration in 2017 (delayed from 2016) and will be another important tool to decrease the risk of fungicide resistance to develop in populations of *Penicillium* spp. Gray mold, blue mold, bull's eye rot, and Alternaria rot are also controlled by Penbotec, but the fungicide is not effective against Rhizopus rot, Mucor decay, or bitter rot. Resistance against pyrimethanil has developed in populations of *Penicillium, Botrytis*, and *Neofabraea* spp. at some locations and thus, this fungicide needs to be rotated or mixed with different MOAs. The experimental fungicide EXP-Ad was ineffective against blue mold but very effective against gray mold (Fig. 3), whereas EXP-SW was effective against both decays (Fig. 4).

Determination of baseline sensitivities. In continuing baseline sensitivity studies with natamycin, EC_{50} values for inhibition of mycelial growth of *R. stolonifer* ranged from 0.175 to 0.698 mg/L (mean 0.481 mg/L) (Fig. 6). A Scott's distribution of EC_{50} values is shown in Fig. 7A. Sensitivity against eight isolates of *Mucor* spp., including four isolates of *M. piriformis,* ranged from 0.703 to 1.60 mg/L. These values are in a similar range as those for other postharvest pathogens of apple that we reported on previously. Thus, EC_{50} values for *B. cinerea* ranged from 0.25 to 1.98 mg/L (mean 0.79 mg/L), values for *A. alternata* ranged from 0.38 to 1.64 mg/L (mean 0.92 mg/L), and those for *P. expansum* ranged from 0.77 to 1.55 ppm (average 1.14 ppm) as shown in Fig. 7B.

Fig. 1. Efficacy of new bactericide treatments for managing fire blight of Granny Smith apple in a field trial at KARE 2017

Treatment	Rate/A	Incidence of blight (%)
Control	---	a
→ WXF-16005	0.35%	a
→ Serenade Opti + sugar	16 oz + 32 oz	ab
→ Blossom Protect + molasses	20 oz + 60 fl oz	ab
→ Serenade Opti	16 oz	ab
→ Badge X2 (Rotation)	16 oz	abc
Badge X2 + Lime sulfur (Rotation)	16 oz + 6%	
Cueva (Rotation)	3 qt	
LifeGard*	4.5 oz	abc
→ Blossom Protect + ε Poly-L-lysine	20 oz + 13.2 oz	abcd
→ Veg'Lys	6 fl oz	abcd
→ Cueva	3 qts	abcd
→ Magna Bon**	56/27 fl oz	abcd
→ Blossom Protect + Lactic Acid (1:1)	20 oz + 16 fl oz	abcd
Kasumin 2L + Lactic Acid (1:1)	64 fl oz + 16 fl oz	bcde
→ Blossom Protect + Buffer	20 oz + 8 lbs	cde
→ Serenade Opti + Badge X2	16 oz + 16 oz	cde
Kasumin 2L + ε Poly-L-lysine	64 fl oz + 13.2 oz	de
Kasumin 2L + Fireline	64 fl oz + 12 oz	de
Kasumin 2L	64 fl oz	e
Kasumin 2L + Firewall	64 fl oz + 8 oz	e



Applications were done on 3-19-17 (25% bloom), 4-1-17 (80% bloom), and 4-6-17 (95% bloom) using an air-blast sprayer at 100 gal/A. Disease was evaluated on May 5, 2017. Blight incidence is based on the number of diseased flower cluster of a total of 200 clusters evaluated for each replication.

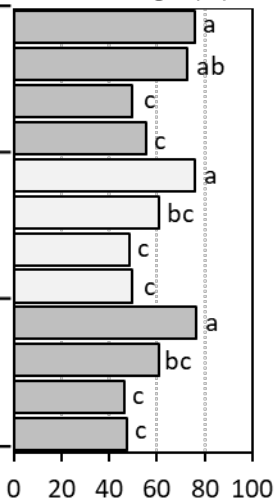
*LifeGard was only applied on 3-19-17.

**MagnaBon was applied at 56 fl oz in the first treatment and at 27 fl oz in the following treatments.

→ Biological/organic treatments

Fig. 2. Efficacy of new bactericide treatments for managing fire blight of Fuji apple in a field trial at KARE 2017

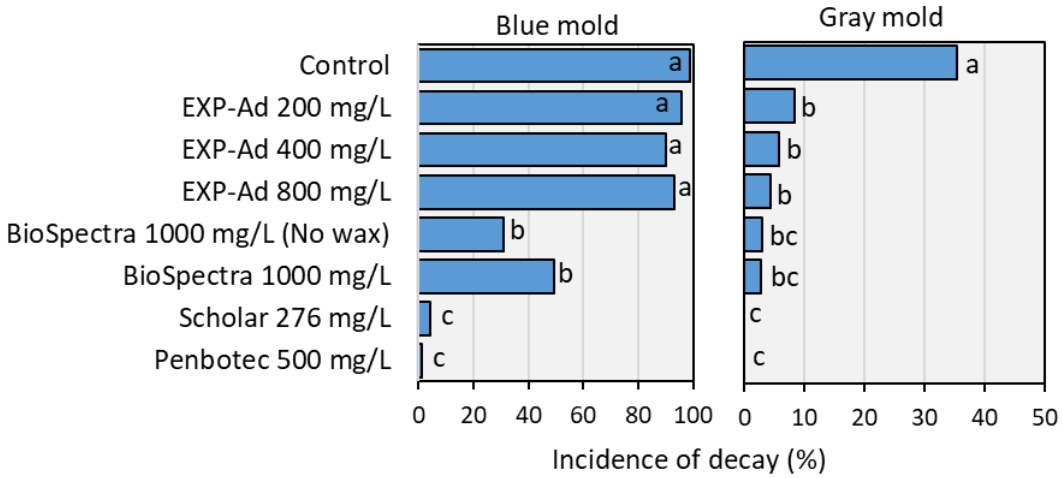
Green tip spray	2nd, 3rd, 4th spray	Rate/100 gal	Incid. of blight (%)
---	---	---	a
---	Double Nickel	6 qts	ab
---	Blossom Protect + Buffer	20 oz + 8 lbs	c
---	Kasumin 2L	64 fl oz	c
Actigard	---	---	a
Actigard	Double Nickel	6 qts	bc
Actigard	Blossom Protect + Buffer	20 oz + 8 lbs	c
Actigard	Kasumin 2L	64 fl oz	c
LifeGard	---	---	a
LifeGard	Double Nickel	6 qts	bc
LifeGard	Blossom Protect + Buffer	20 oz + 8 lbs	c
LifeGard	Kasumin 2L	64 fl oz	c



Applications were done on 3-20-17 (pink bud), 3-24-17 (20% bloom, 4-4-17 (90% bloom), and 4-10-17 (100% bloom) using an air-blast sprayer at 100 gal/A. Disease was evaluated on May 8, 2017. Blight incidence is based on the number of diseased flower cluster of a total of 100-400 clusters evaluated for each replication.

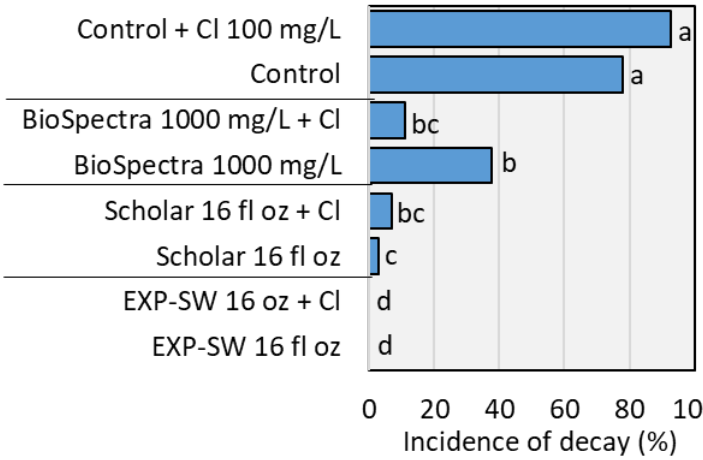
Actigard was applied at 1 oz/A, and LifeGard was applied at 4.5 oz/A.

Fig. 3. Postharvest efficacy of new and experimental fungicides for management of blue mold and gray mold of Granny Smith apples in an experimental packingline study



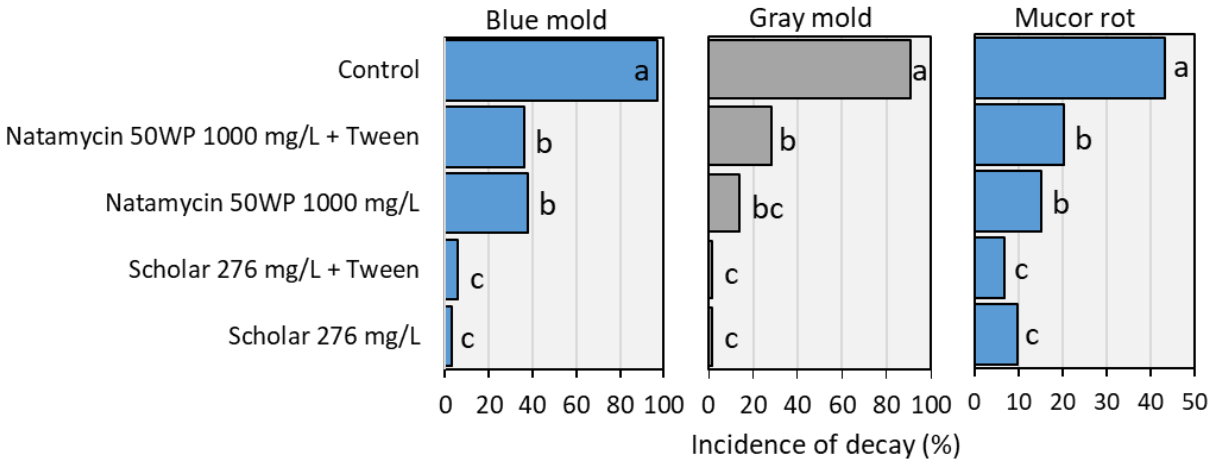
Fruit were wound-inoculated with conidia of *P. expansum* (5 x 10^5 conidia/ml) or *B. cinerea* (1 x 10^5 conidia/ml) and incubated for 14-15 h at 20C. Treatments were done as aqueous T-jet applications that were followed by a CDA application with carnauba fruit coating (Decco 230; except for one of the BioSpectra treatments). Fruit were incubated at 20C for 7 days.

Fig. 4. Postharvest efficacy of new and experimental fungicides for management of gray mold of Granny Smith apples in the presence of chlorine in an experimental packingline study



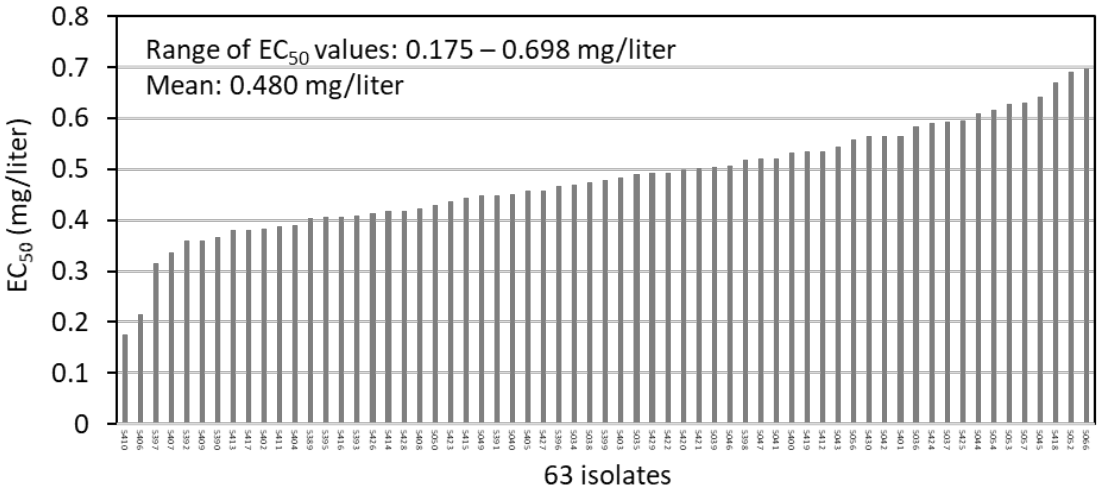
Fruit were wound-inoculated with conidia of *B. cinerea* (1 x 10^5 conidia/ml) and incubated for 15-17 h at 20C. Treatments containing chlorine (100 ppm) were prepared 24 h before treatment and all treatments contained 0.01% Tween 80. Treatments were done as aqueous T-jet applications. Fruit were incubated at 20C for 7 days and evaluated for the presence of decay.

Fig. 5. Postharvest efficacy of new and experimental fungicides for management of blue mold, gray mold, and Mucor rot of Granny Smith apples in an experimental packingline study



Fruit were wound-inoculated with conidia of *P. expansum* (5 x 10^5 conidia/ml), *B. cinerea* (1 x 10^5 conidia/ml), or *M. piriformis* (1 x 10^5 spores/ml) and incubated for 14-16 h at 20C. Treatments were done as aqueous T-jet applications that were followed by a CDA application with carnauba fruit coating (Decco 230). Fruit were incubated at 20C for 5 to 7 days.

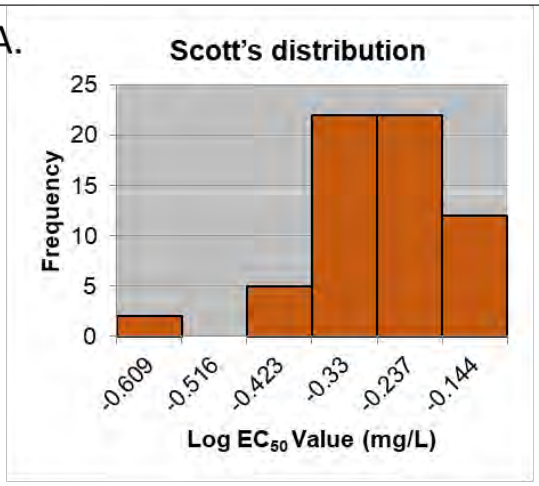
Fig. 6. Baseline sensitivities of mycelial growth of *Rhizopus stolonifer* isolates to natamycin



EC_{50} values were determined using the spiral gradient dilution method.

Fig. 7. Scott's distribution of EC_{50} values of natamycin for *Rhizopus stolonifer* and a summary of EC_{50} values for postharvest pathogens of apple

A.



B.

Decay Fungus	No. of Isolates	Ave. EC_{50} value (mg/L)	Range (mg/L)
Alternaria alternata	43	0. 92	0.38-1.64
Botrytis cinerea	58	0.79	0.25-1.98
Penicillium expansum	63	1.14	0.77-1.55
Rhizopus stolonifer	63	0.48	0.175-0.69

Fire blight management for apples in California – Spring 2017

J. E. Adaskaveg, Professor, Department of Plant Pathology and Microbiology, University of California, Riverside

Apple bloom is approaching quickly this spring with warmer temperatures initiating tree growth. As bloom nears, apple growers are always concerned with fire blight, a bacterial disease caused by *Erwinia amylovora*. The pathogen survives in cankers on the tree and with increasing temperatures, it is activated and oozes out from diseased tissues. Rain and insects can disseminate the bacteria and, once introduced onto flower tissues (nectaries, stamens, and stigmata), they can colonize and infect the open flower causing blight. Under California conditions, trees may continue to bloom (e.g., rat-tail flowering) into the spring season several weeks after the main bloom period. This ongoing flowering makes management of the disease very difficult. If conditions remain favorable with warm temperatures and rainfall or hail storms that create injuries, the pathogen is also known to infect immature green shoots, young succulent leaves, and developing fruit.

In the last several years, we have been evaluating bactericides, biological controls, and natural products for fire blight management in apples and pears. A number of products have become available and are effective in protecting trees against this aggressive disease. Table 1 shows the products registered, their Fungicide Resistance Action Committee (FRAC) group (FG - mode of action) or their classification (biological, natural product), their rating for controlling the disease, their potential to cause phytotoxicity, and growth regulator activity. Copper (FG M1) has long been used on apples for managing fire blight. Copper is a contact bactericide and can be applied as a treatment to kill the pathogen as it oozes out of cankers. It is not systemic and thus, cannot eradicate the pathogen from established, internal infections. Because copper can cause fruit russeting, applications are commonly done as dormant, delayed dormant, or as early bloom applications. A number of copper products are available including fixed coppers (e.g., copper hydroxide, -oxide, -oxychloride), products based on copper sulfate pentahydrate, or copper complexes with soap or other compounds. These latter products have lower metallic copper equivalent (MCE) than common fixed copper products and are less likely to cause russeting but need to be applied more frequently. Still, copper labels have warnings concerning potential phytotoxicity. Some products are OMRI approved and can be used for organic production, whereas others are not and thus, labels should be read carefully.

In conventional farming, antibiotics such as streptomycin (FG 24) and oxytetracycline (FG 41) are approved on apples. Streptomycin resistance is known in pathogen populations and thus, rotation to other modes of action and limiting the number of applications per season are essential usage strategies. We suggest one application per season and, if possible, in a mixture with oxytetracycline. No resistance has been reported to oxytetracycline on apples. The antibiotic does not persist very long and needs to be applied when infection periods occur. Products like mancozeb, and captan also have anti-bacterial properties and can be mixed with antibiotics for managing fire blight as well as fungal diseases such as apple scab. Other products that can be used in conventional farming include prohexadione calcium (Apogee), a plant growth regulator used to reduce vegetative growth and the recently registered acibenzolar-S-methyl (Actigard – FRAC P1), a stimulator of host plant resistance. Table 1 (Conventional chemistry) summarizes these products.

For organic farming and conventional farming, a number of biological and natural products have become available. These can be divided into Bio-1, -2, and -3 for bacterial biological controls, fungal biological controls, and natural products (plant extracts or fermentation products approved by the national organic standards board and certified by OMRI), respectively. Some biocontrol agents (e.g., *Pseudomonas fluorescens* - Blightban) grow better at cooler temperatures (15-20C or 59-68F); others (e.g., *Bacillus amyloliquefaciens* - Double Nickel 55) do better at warmer temperatures (20-35C or 68-95F); whereas still others (e.g., *Pantoea agglomerans* - Bloomtime Bio, *Aureobasidum pullulans* - Blossom Protect) grow over a wide range of temperatures (15 to 30C or 59-86F). Because of the environmental effects on biocontrol organisms and their disease control performance, ratings range from moderately effective (++) to limited (+) (*see* Table 1 – Soft chemistry). The variable results make the use of biologicals more difficult requiring frequent applications. Some biological products can be applied with buffers to improve growth of the biocontrol agent on the plant surface. These buffers are nutrient sources but may have a negative effect

causing russeting of the developing fruit. Our research emphasis with biological agents is to improve growth and performance with addition of nutrient additives without causing russeting. Additionally, new formulations of natural products are being evaluated (e.g., Serenade, Regalia).

Lime sulfur is currently registered for scab management. The fungicide also has a Section 24c registration for flower thinning in the state of Washington but is not labeled for this use in California. Based on the flower thinning label, the scab fungicide is used at a rate to cause flower injury that results in blossom drop. This is done to save labor costs for fruit thinning. With less flowers, the indirect effect is less fire blight infection sites and potentially, less disease.

Treatment timing focuses on the main bloom period, but additional cover sprays are often needed to protect rat-tail flowers or other tissues if additional warm rainfalls occur. Treatment applications before or during bloom are generally for multi-site materials or sanitizers to reduce inoculum levels on cankers (Table 2). Sanitizers such peroxyacetic acid are oxidizers that act immediately on contact and are non-persistent. Several models, including Maryblyt and Cougar Blight, are available for forecasting fire blight infection periods and treatment timings.

Suggested fire blight treatments for developing a management program are shown in Table 3 by FRAC groups and by characteristic codes of biological and natural product treatments at each timing or host phenological stage. Biologicals (Bio) can be divided into Bio-1, -2, and -3 subgroups based on their active ingredients of bacteria, fungi, and plant extracts, respectively. In general, sulfur compounds are fungicidal and may affect applications of fungal biocontrols (e.g., Blossom Protect); whereas copper may affect applications of bacterial biocontrols (e.g., Actinovate, Bloomtime Biological, Blight Ban, Double Nickel 55, and Serenade). Rotations must consider these factors. Two examples are provided: one for conventional and one for organic farming (Table 4). Treatments were selected from Table 3 and were designed following guidelines to prevent overuse of any one FG (mode of action), biological control, or natural product. As mentioned above, selection of biocontrols is based on environmental temperatures and rotations with other treatments that may be inhibitory to selected biocontrol agents (see above).

Table 1. PERFORMANCE RATINGS OF FIRE BLIGHT TREATMENTS

Bactericides-Conventional Chemistry	**Resistance risk[1]**	**Fire blight**		**Phyto-toxicity**	**Growth Regulator/SAR**
		Contact	**Systemic**		
Ag Streptomycin/Agri-Mycin /Firewall	very high (25)	++++	+++	+/-	----
Kasumin*	high (24)	++++	++++	+/-	----
MycoShield/FireLine	high (41)	+++	+++	+/-	----
Captan[2]	low (M4)	++	----	----	----
Dithane/Manzate/Penncozeb[2]	low (M3)	++	----	----	----
Copper[3]	low (M1)	++	----	+	----
Actigard[4]	low (P1)	----	+	----	+
Apogee[5]	low	----	----	----	++
Soft Chemistry-Biologicals, Natural Products					
Actinovate	low (Bio-1)[8]	+/++	----	**+/-**	**----**
Blight Ban	low (Bio-1)[8]	+/++	----	+/-	----
Bloomtime Bio	low (Bio-1)[8]	+/++	----	+/-	----
Blossom Protect	low (Bio-2)[8]	++	----	+/-	----
Double Nickel 55	low (Bio-1)[8]	+/++	----	+/-	----
Regalia	low (Bio-3)[8]	+/++	----	+/-	----
Serenade	low (Bio-1)[8]	+/++	----	+/-	----
Copper[3]	low (M1)	++	----	+	----
Lime sulfur[6]	low (M2)	----	----	+++	----
Sanitizers[7]	low	+/++	----	----	----

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and/or erratic, +/- = minimal and often ineffective, / = variable, ---- = ineffective, ND = no data.

*** Registration pending in California.**

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Bactericides, biocontrols, or natural products with a different group number are suitable to alternate in a resistance management program. Use labeled rates and limit the total number of applications per season.

[2] These materials show some efficacy and should be used in mixtures with antibiotics as a component of resistance management programs. Captan is registered on apples, whereas Dithane and Ziram are registered on apples and pears.

[3] Although copper may be effective for scab and fire blight control under low disease pressure, copper products may cause fruit scarring or russeting. Note that not all copper products are OMRI approved.

[4] Acibenzolar-S-methyl (FRAC P1) is a host plant defense inducer known to stimulate the salicylic acid pathway.

[5] Labeled on apple only in California. Plant growth regulators (PGR) such as prohexadione calcium (e.g., Apogee) reduce shoot growth and thus, indirectly reduce the number of infections sites for fire blight (indirect effects on disease).

[6] **CAUTION: LIME SULFUR IS INCOMPATIBLE WITH MOST OTHER PESTICIDES WHEN USED AFTER BUDBREAK. CHECK BEFORE USE.** Current use in Washington State includes flower thinning (24C registration) which indirectly reduces fire blight infection sites. Lime sulfur does not have antibiotic activity against fire blight and was not included in the fire blight activity ratings.

[7] Sanitizers such peroxyacetic acid are oxidizers that act immediately on contact. They are neutralized rapidly by reducing agents and are non-persistent.

[8] Biologicals (Bio) can be divided into Bio-1, -2, and -3 subgroups based on their active ingredients of bacteria, fungi, and plant extracts, respectively.

TABLE 2. FIRE BLIGHT TREATMENT TIMING

Note: Not all indicated timings may be necessary for disease control.

Disease	Fall	Delayed dormant	Green tip /White bud	Pink bud/Full Bloom	Petal Fall/ Cover Sprays
Fire blight	----	+	++	+++[1]	+++[2]

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Early applications are most effective; additional applications are made if rat tail bloom occurs.

[2] Start management program at the beginning of bloom and continue through bloom including "rat-tail" bloom throughout spring. Several models are available for forecasting infection periods and treatment timing. Models include: Maryblyt, Cougar Blight, etc.

TABLE 3. SUGGESTED FIRE BLIGHT MANAGEMENT PROGRAMS BY FRAC[1] GROUPS

Note: Not all indicated timings may be necessary under less favorable conditions; whereas additional applications may be necessary under favorable conditions for disease. Suggested bactericide groups biological, or natural product are listed for each timing based on host phenology, weather monitoring, inoculum models, or environmental-disease forecasting models.

How to use this table:

1) Select one of the suggested bactericide groups. Refer to the bactericide efficacy table for fungicides belonging to each FRAC group. Group numbers are listed in numerical order within the suggested disease management program.
2) Rotate groups for each application within a season and, if possible, use each group only once per season, except for multi-site mode-of-action materials (e.g., M2) or natural products/biological controls (NP/BC).

			Bloom			After bloom
Disease	Dormant	Delayed dormant	Green tip/ White bud	Pink bud/ Full bloom	Petal fall	Cover Sprays
Fire blight	M1a[1]	M1a[1]	M1a[1], (24), 25, 41, P1[4]	M1a[1], M2[2], 24[3], 25, 41, P1[4], Bio-1[5], Bio-2[5], Bio-3[5]	M1b[1], 24[3], 25, 41, 25+41, P1[4], Bio-1[5], Bio-2[5], Bio-3[5], M1b+Bio-2, Bio2+24 or 41, PGR[6]	M1b[1], 24[3], 25, 41, 25+41, Bio-1[5], Bio-2[5] Bio-3[5], Bio-2+24 or 41, PGR[6]

[1]- Fixed copper (M1a) bactericides may cause phytotoxicity (russetting) when applied after full bloom. Other copper products (M1b) with lower metallic copper equivalent (i.e., MCE) such as copper complexes (e.g., Cueva, Copper Count-N, etc.) and copper sulfate pentahydrate (e.g., CS-2005, Phyton 27AG, etc.) have been reported to be less phytotoxic with applications following bloom because of lower MCE (*see* specific registrant label concerning product rates and number of times each material can be applied during the growing season).

[2] - M2 fungicides (e.g., liquid lime sulfur) that are registered for scab control have been used to thin flowers in Washington state (Section 24c label) with one to two applications between 20-and 80% full bloom. This treatment reduces the total number of flowers and potential infections sites for fire blight. **No label is available in CA for this usage.**

[3] - The antibiotic kasugamycin is pending registration in CA but is registered federally.

[4] - Acibenzolar-S-methyl (Actigard –FRAC P1) is a host plant defense inducer known to stimulate the salicylic acid pathway.

[5] - Biologicals (Bio) can be divided into Bio-1, -2, and -3 subgroups based on their active ingredients of bacteria, fungi, and plant extracts, respectively. In general, sulfur compounds are fungicidal and may effect applications of fungal biocontrols (e.g., Blossom Protect); whereas copper may effect applications of bacterial biocontrols (e.g., Actinovate, Bloomtime Biological, Blight Ban, Double Nickel 55, and Serenade). Rotations must consider these factors.

[6] - Plant growth regulators (PGR) such as prohexadione calcium (e.g., Apogee) reduce shoot growth and thus, indirectly reduce the number of infections sites for fire blight (indirect effects on disease).

TABLE 4. User Worksheet - Possible Examples based on Table 3.

			Bloom			After bloom
Disease	**Dormant**	**Delayed dormant**	**Green tip/ White bud**	**Pink bud/ Full bloom**	**Petal fall**	**Cover Sprays**
Fire blight- ***Conventional***	M1a[1]	M1a[1]	M1a[1]	M2[2]+ 25	41+P1	Bio-2[5]+25, PGR[6]
Fire blight- ***Organic***	M1a[1]	M1a[1]	M1a[1]	M2[2]+Bio-1	M1b+Bio-2	Bio-3[5]

*- Selection of materials may vary depending on environmental conditions and rotational treatments that may affect biological agents (see text). Multiple cover sprays may be required under favorable conditions for disease.

ACKNOWLEDGEMENTS

Tables were based on information in the UC IPM publication - 2017 Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops (http://ipm.ucanr.edu/PMG/crops-agriculture.html).

California Apple Commission Shadecloth Project

Specialty Crop Block Grant 14009
Final Report
January 25, 2017

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Table of Contents, cont'd

Executive Summary

Fruit Dynamics, Inc. staff collected apple fruit samples during the 2015 and 2016 seasons from California apple orchards designated by the CAC to conduct testing and determine any difference in fruit quality between those grown under shadecloth (treated) and those without shadecloth (control). Fruit quality was measured in visible color differences, size, firmness, brix, titratable acidity, packout grade, and absence of defects. Further analysis to determine the effects of the shadecloth included the collection of orchard temperatures and packout totals from the respective packing sheds. A cost-benefit analysis is also provided. This report covers 2 years, as outlined in the SCB grant awarded to the CAC, though data was very limited in the first year and thus the information represented here is largely the result of one year.

The orchards participating in this study are located throughout the Sacramento, Linden and West Modesto areas. The apple varieties analyzed included Gala (from 2 orchards), Fuji, Granny Smith and Pink Lady. Not all varieties were analyzed in all respects, due to some challenges in logistics of sample collection. In most of the orchards, the apples were grown on V-trellis systems, where the interior had more sun exposure than the exterior. Samples were collected from both interior and exterior sides of the tree. One orchard had two different treatments, continuous and non-continuous shade, and the temperature data from these are reported both combined and separately.

Executive Summary, cont'd

The temperature at each site varied due to location and micro climate, but overall the high temperatures under shadecloth stayed about 3°F cooler than that of the control.

Across varieties, control had more consistent color than the treated, and received more of the highest color rating at packout.

Also across varieties there were no major differences in size, though in the case of Pink Lady and Granny Smith, the treated produced slightly more large sizes at packout.

There were no major differences in firmness, except for Granny Smith which had a lower firmness under shadecloth.

Brix was more variable across treatments; the Gala 2 treated was about 1 point higher than control, but the Fuji control was about 1 point higher than the treated, and the others were either very close or lacked sufficient data.

There was no major difference in titratable acidity across treatments.

In defects at packout, treated Granny Smith had lower incidence of bitter pit, cork spot, sun burn and bruising (93% less than control); but it had almost 7 times the incidence of scab. In Pink Lady, treated fruit had lower incidence of sunburn, russeting, growth crack and San Jose Scale; but it had higher incidence of bruising, bitter pit, insect damage and windfalls.

Shadecloth Applications

Shadecloth Project Report 1-25-17

Shadecloth Applications
Tent / T-Pee

Light reduction capacity: 20%
Used on: Gala 1, Fuji, and Granny Smith

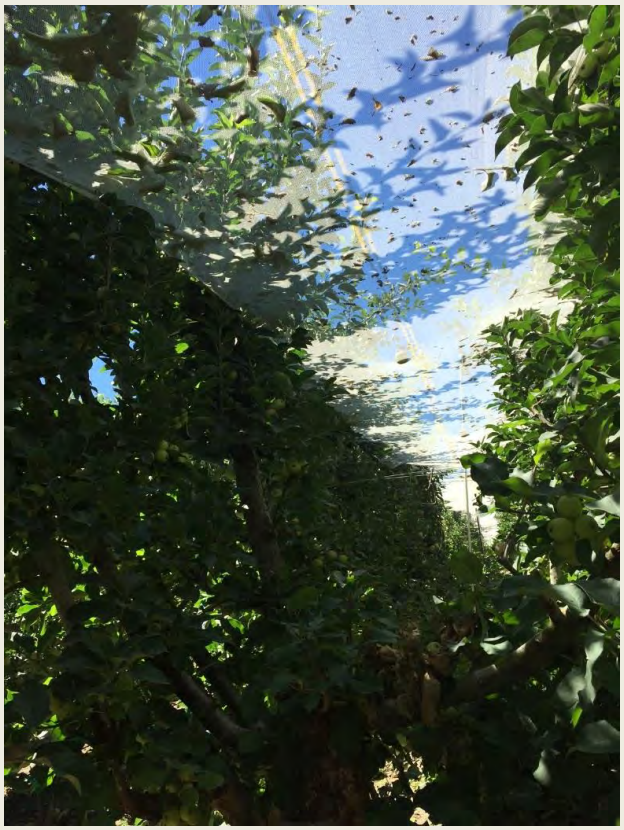
Shadecloth Project Report 1-25-17

Shadecloth Applications
Tent/T-Pee
Non-Continuous vs Continuous

Light reduction capacity: 20%
Non-Continuous shade used on: Gala 1,
Fuji and Granny Smith
Continuous shade used on: Gala 1

Shadecloth Project Report 1-25-17

Shadecloth Applications
Row-Interior Drape



Light reduction capacity: 25%
Used on: Fuji

Shadecloth Project Report 1-25-17

Shadecloth Applications
Enclosed Tarp

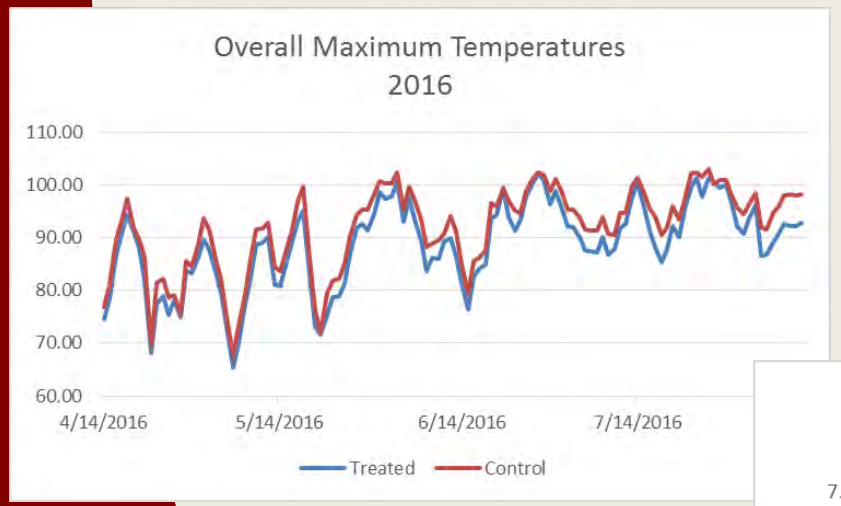
Light reduction capacity: 22%
Used on: Gala 2 and Pink Lady

Orchard Temperatures

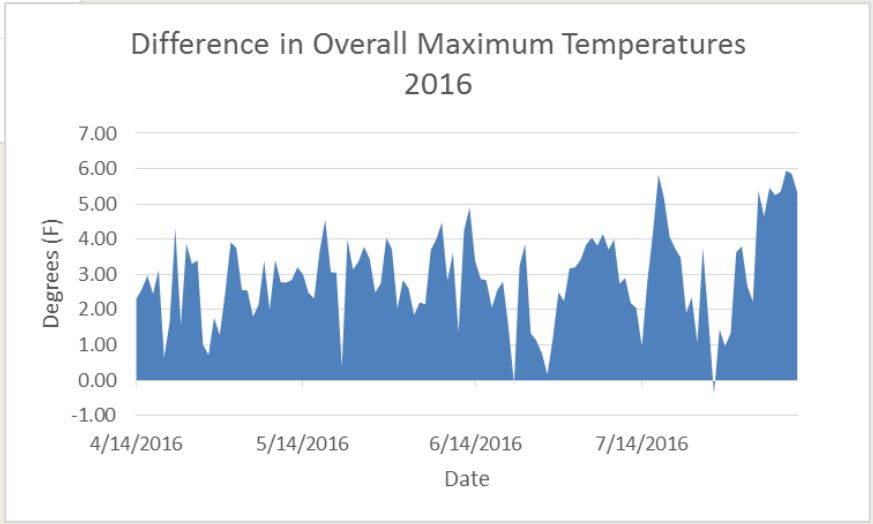
While this was a comprehensive study over the course of 2 years, there is only 1 set of temperature data from each site due to: 1) most sites not having shadecloth installed the first year, and 2) one site with temperature sensors which we were unable to locate the second year.

Shadecloth Project Report 1-25-17

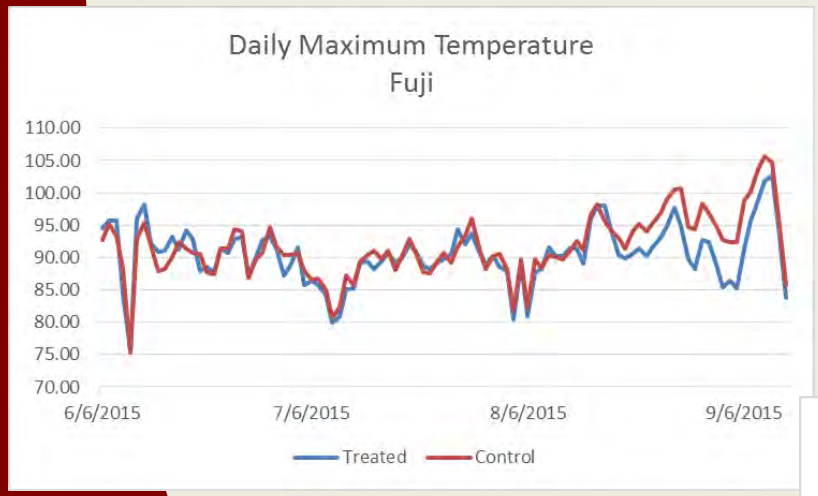
Apple Orchard Temperature – Average All Sites 2016
Treated vs Control



The daily maximum temperature in the treated blocks was an average of about 3°F lower than those in the control. In some cases it was up to 6°F lower.

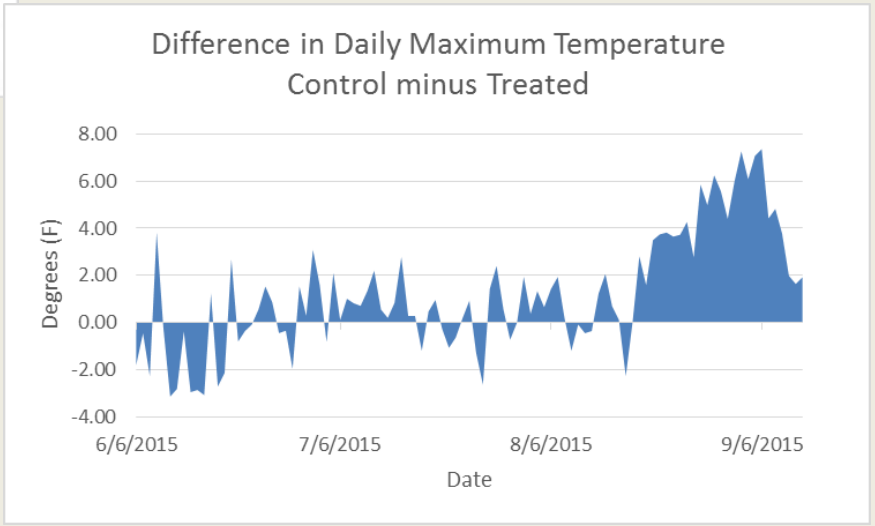


Shadecloth Project Report 1-25-17
Apple Orchard Temperature
Site A – Fuji – Tent
Treated vs Control: 2015 Season*

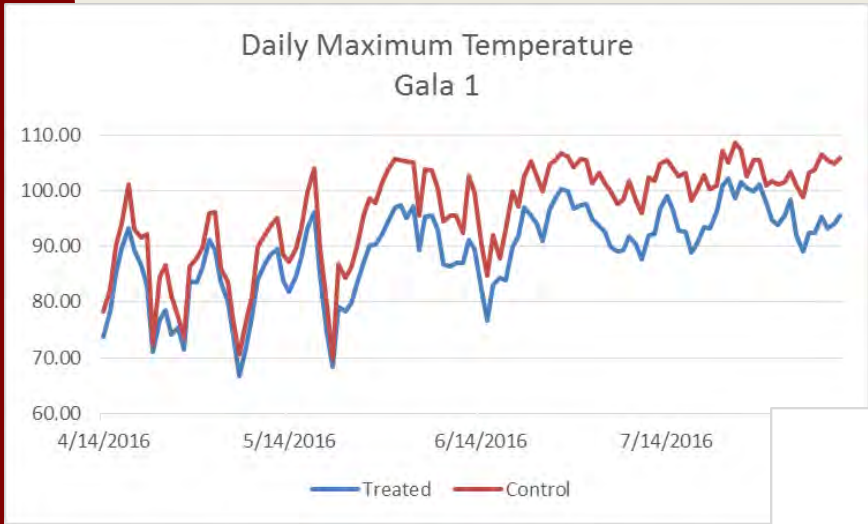


At this site there were four sensors installed: two in control and two under shade (treated). The shadecloth was not installed until around August 18, 2015. The temperature differential becomes graphically evident at this point. Afterward, the daily maximum temperature in the treated block was an average of about 4°F lower than in the control block.

*All the sensors from the control area at this site could not be located post-harvest during 2016, so only 2015 data is shown.



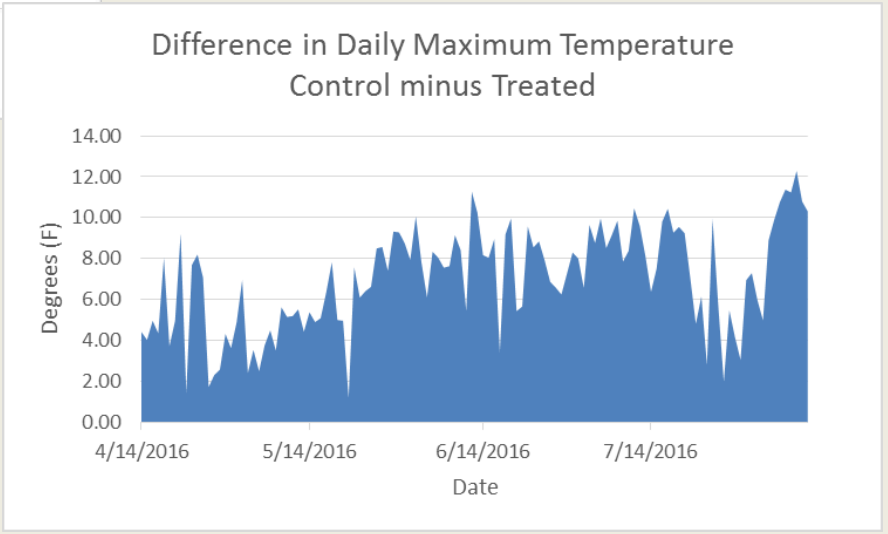
Shadecloth Project Report 1-25-17
Apple Orchard Temperature
Site B – Gala 1 – Tent
Treated vs Control: 2016 Season*



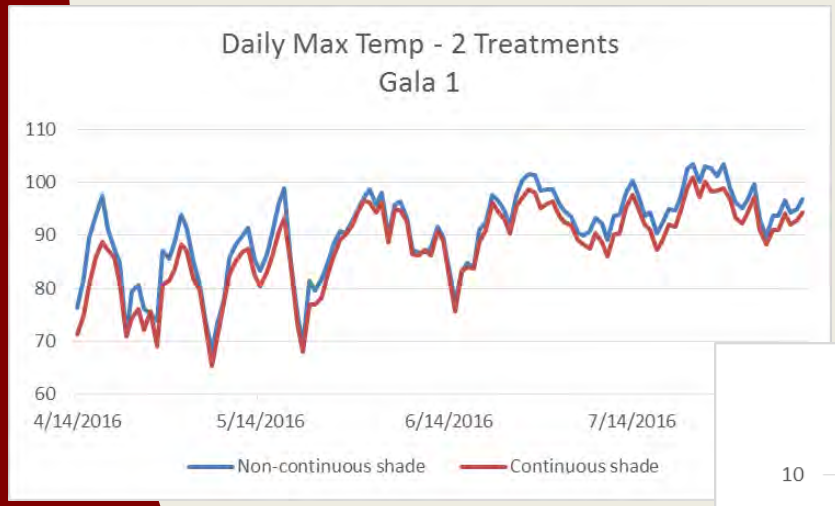
At this site there were four sensors installed: two in control and two in shade (treated). Of the two in shade, one was placed under a treatment of continuous shade and one was placed under a treatment of non-continuous shade.

The daily maximum temperature in the treated block was an average of 6.97°F lower than in the control. In some cases it was as much as 11°F lower.

*There was no comparison data available from this site for 2015, due to the delay in shadecloth installation.

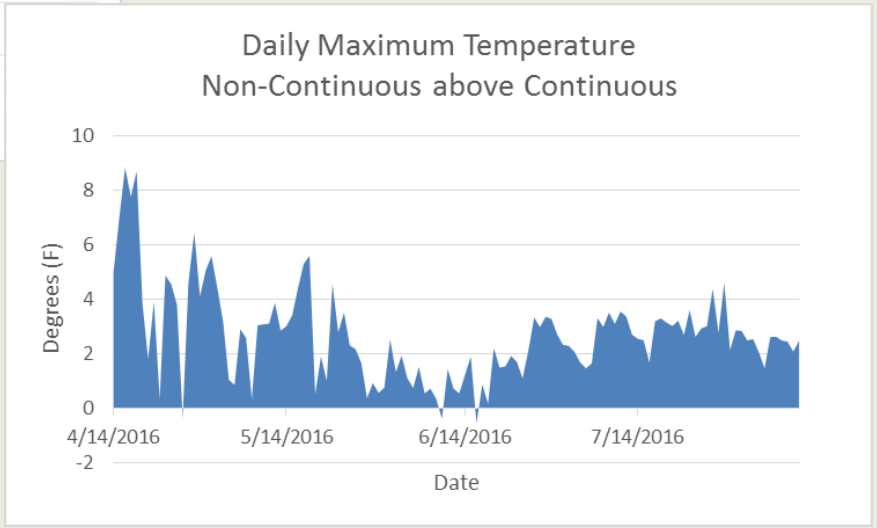


Shadecloth Project Report 1-25-17
Apple Orchard Temperature
Site B – Gala 1 – Tent
Continuous Shade vs Non-Continuous Shade

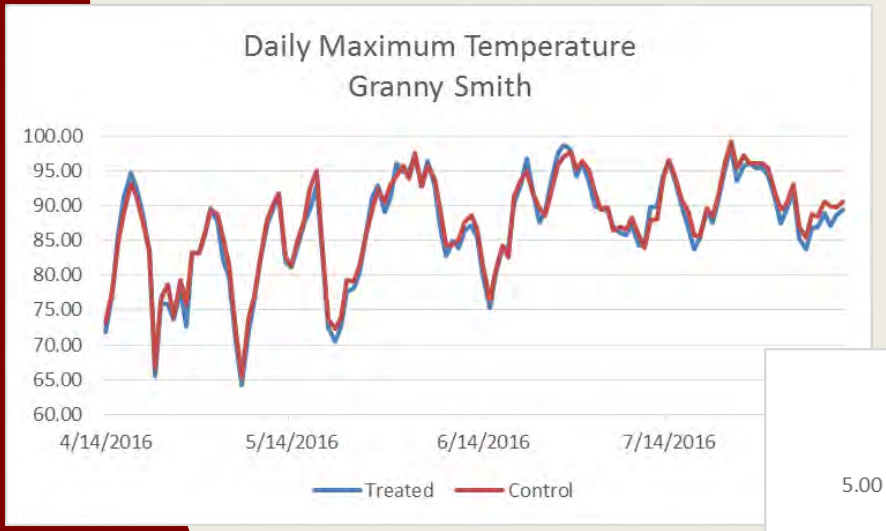


The daily maximum temperature under continuous shade was an average of 2.68°F lower than under non-continuous shade, and reached as much as 9°F lower.

The daily maximum temperature under continuous shade was an average of 8°F lower than the control, and reached as much as 13.5°F lower (not shown in graphs).

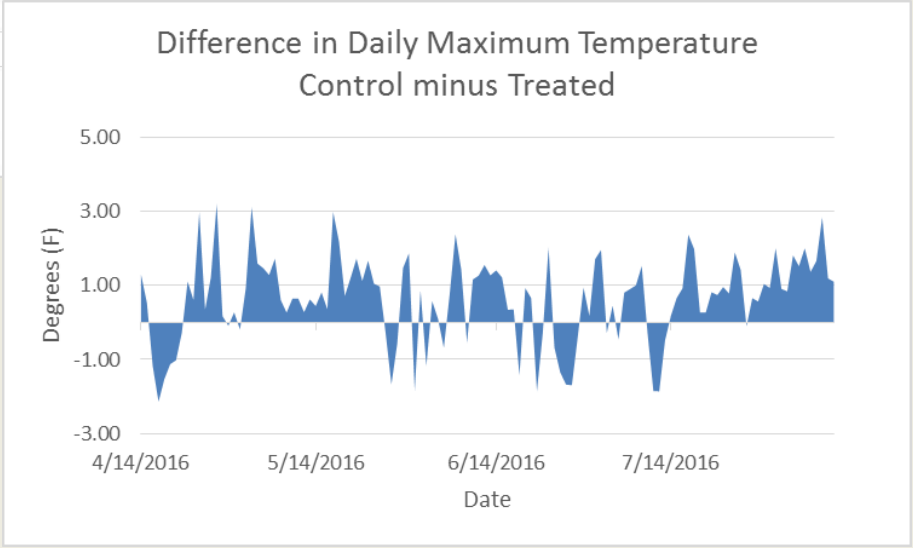


Shadecloth Project Report 1-25-17
Apple Orchard Temperature
Site C – Granny Smith – Tent
Treated vs Control: 2016 Season*



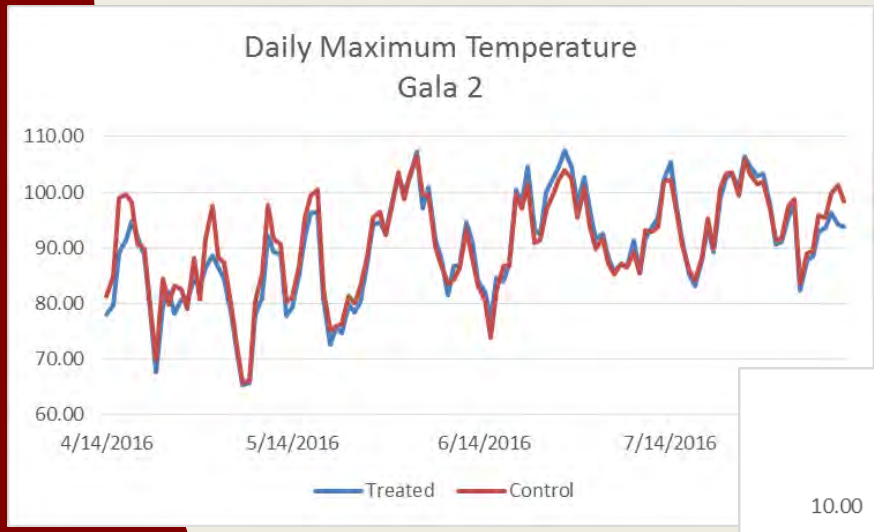
At this site there were four sensors installed: two in control and two under shade (treated).

There was very little difference in maximum temperature between treated and the control. This may be related to the slope and uneven terrain of the site.



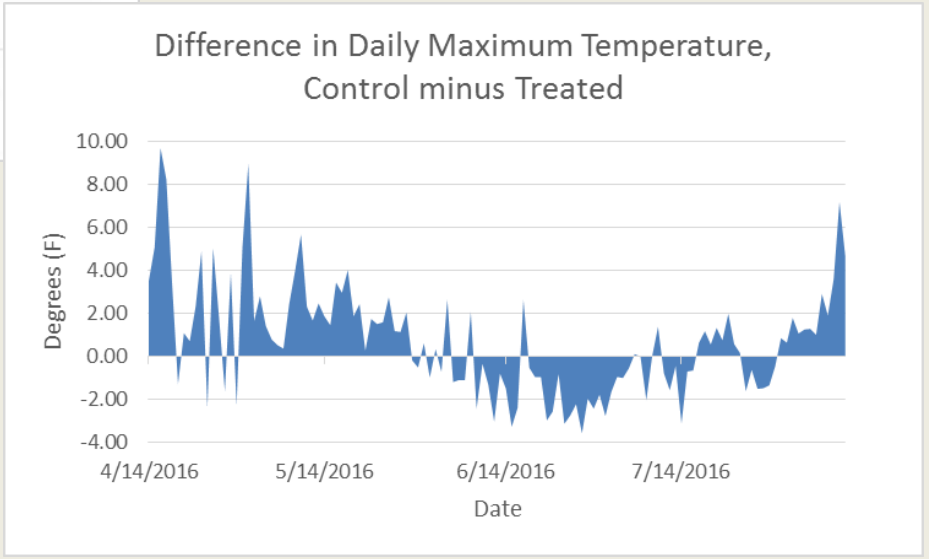
*There was no comparison data available from this site for 2015, due to the delay in shadecloth installation.

Shadecloth Project Report 1-25-17
Apple Orchard Temperature
Site D – Gala 2/Pink Lady – Enclosed Tarp
Treated vs Control: 2016 Season*



At this site there were four sensors installed: two in control and two under shade (treated), but one in the control block could not be located post-harvest.

The difference in maximum temperature varied throughout the season, ranging from almost 10°F lower to almost 4°F warmer.



*There was no comparison data available from this site for 2015, due to the delay in shadecloth installation.

Gala 1

Tent (Continuous and Non-Continuous) vs Control

Shadecloth Project Report 1-25-17

Gala 1 Images - Sampled from Field 8/11/16

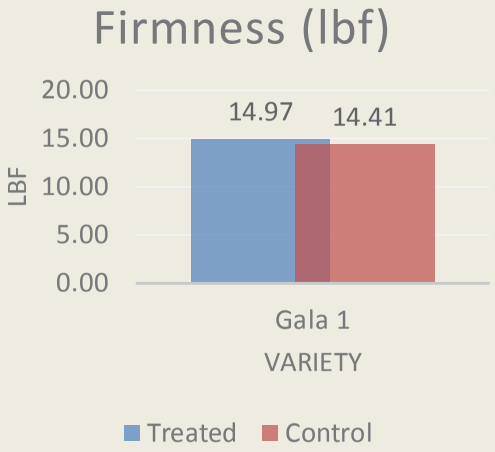
Treated vs Control

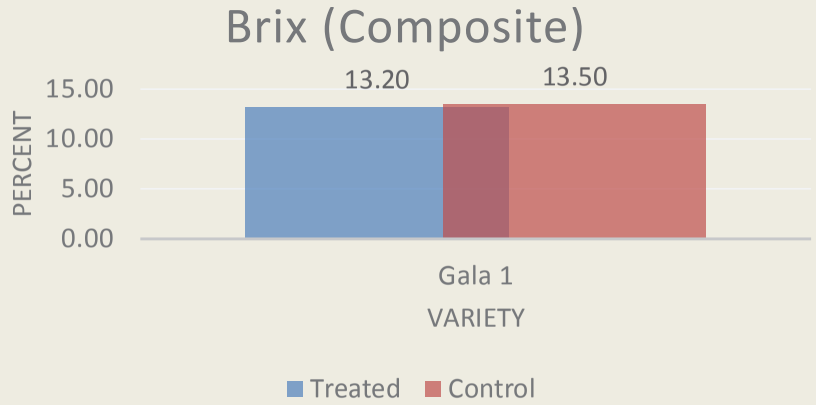
Treated		Control	
Observer comments: - *"Smaller size"* - *"Least color"* - *"Smaller size but more even"* - *"Smaller size (?)"*			Observer comments: - *"Larger size, color is the same"* - *"Color more consistent red"* - *"Size variations approx. the same"* - *"Better color and more consistent color"* - *"Better color"*

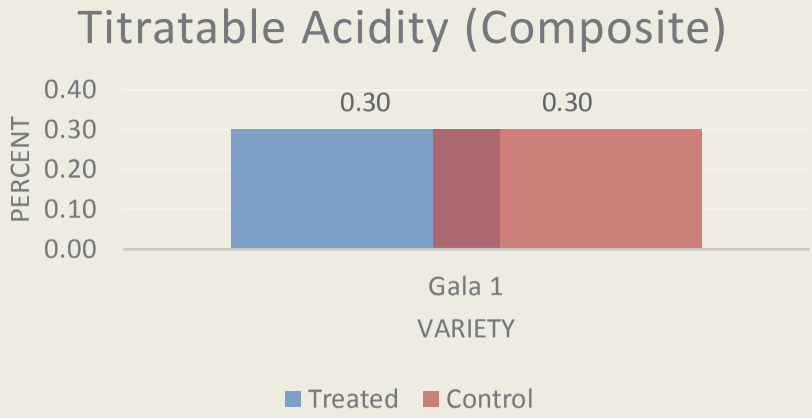
Shadecloth Project Report 1-25-17

Gala 1 – Sampled from Field 8/11/16

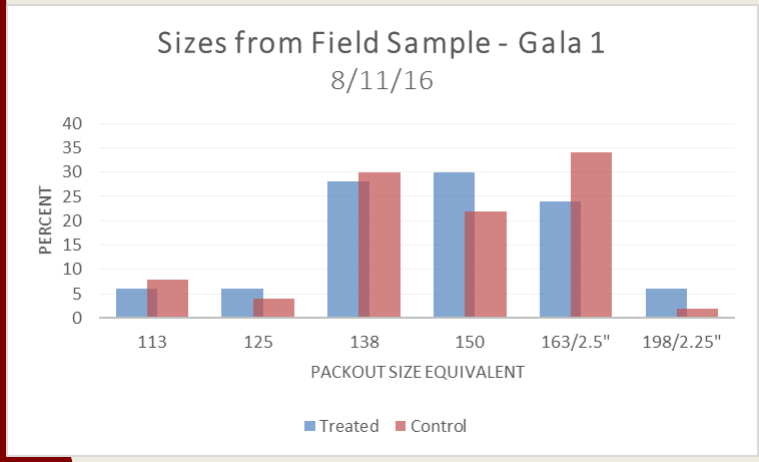
Treated vs Control

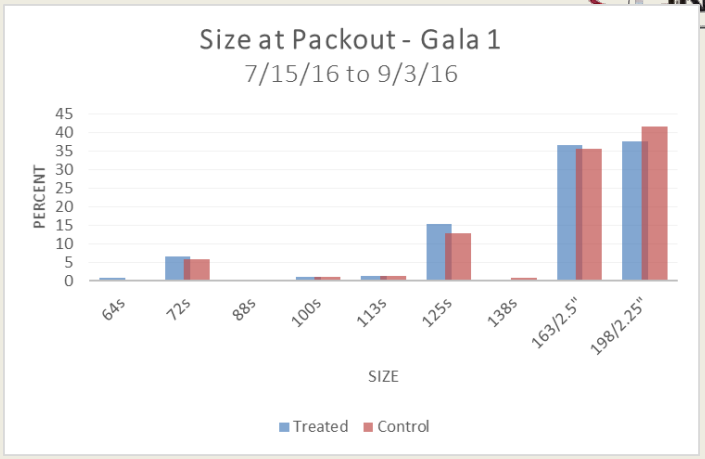






Shadecloth Project Report 1-25-17
Gala 1 Size
Treated vs Control





Packout Size Equivalents

Size	Dia. (in)	Dia. (cm)
48	3.875	9.833
56	3.75	9.5
64	3.625	9.208
72	3.5	8.89
80	3.375	8.573
88	3.25	8.255
100	3.125	7.938
113	3	7.62
125	2.875	7.303
138	2.75	6.985
150	2.625	6.668
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

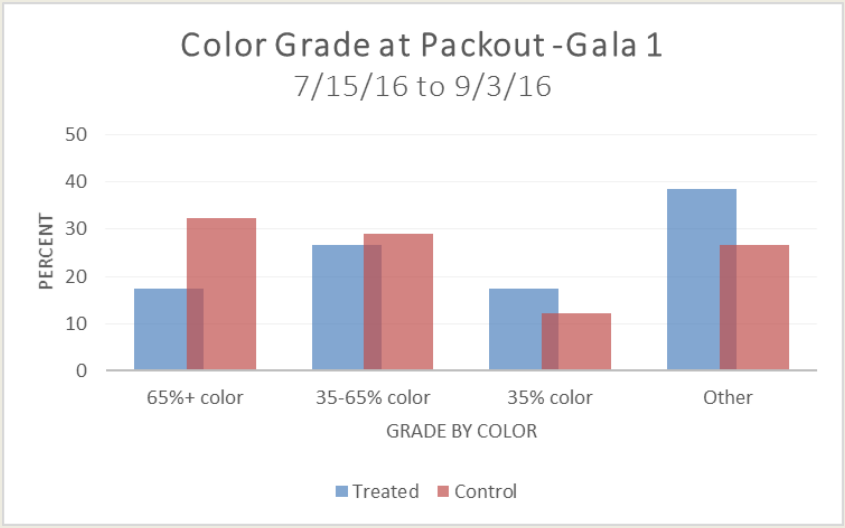
The graphs above show various size distributions, but the following mean fruit diameters from the field sample show no major size difference between treated and control:
6.54 cm (treated) vs 6.62 cm (control).

Note: This orchard was cropped very heavily.

Left: Chart adapted from information on the California Apple Commission website.

Shadecloth Project Report 1-25-17

Gala 1 Actual Packout Data
Treated vs Control



Treated Packout: 67%
Control Packout: 76.1%

The treated section produced fruit with less color than did the control.

The "Other" category may have included fruit with notable color but was sorted out due to defects.

Gala 2

Enclosed Tarp vs Control

Shadecloth Project Report 1-25-17

Gala 2 Images – Sampled from Field 8/11/16

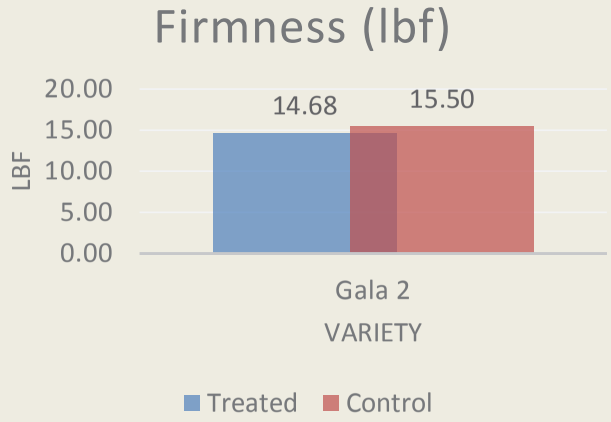
Treated vs Control

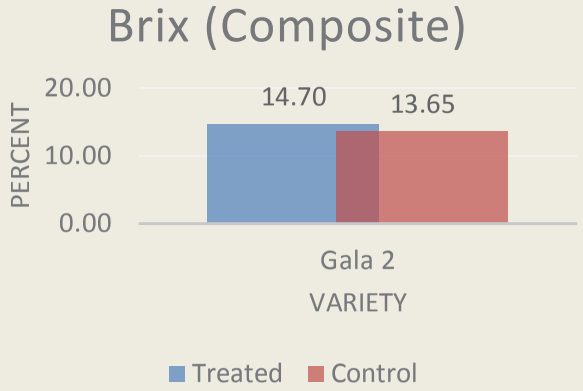
Treated		Control	
Observer comments: - *None available*			Observer comments: - *None available*

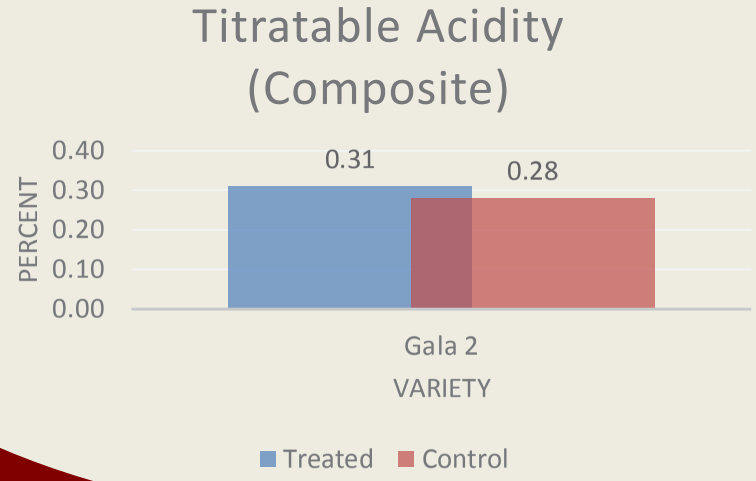
Shadecloth Project Report 1-25-17

Gala 2 – Sampled from Field 8/11/16

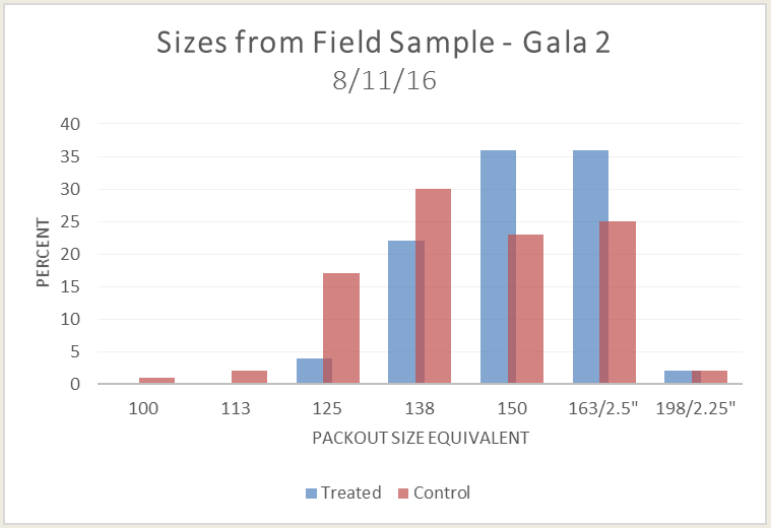
Treated vs Control







Shadecloth Project Report 1-25-17
Gala 2 Size
Treated vs Control



Packout Size Equivalents		
Size	Dia. (in)	Dia. (cm)
48	3.875	9.833
56	3.75	9.5
64	3.625	9.208
72	3.5	8.89
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138	2.75	6.985
150	2.625	6.668
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

The graph above shows various size distributions, but the following mean fruit diameters from the field sample show no major size difference between treated and control: 6.50 cm (treated) vs 6.63 cm (control).

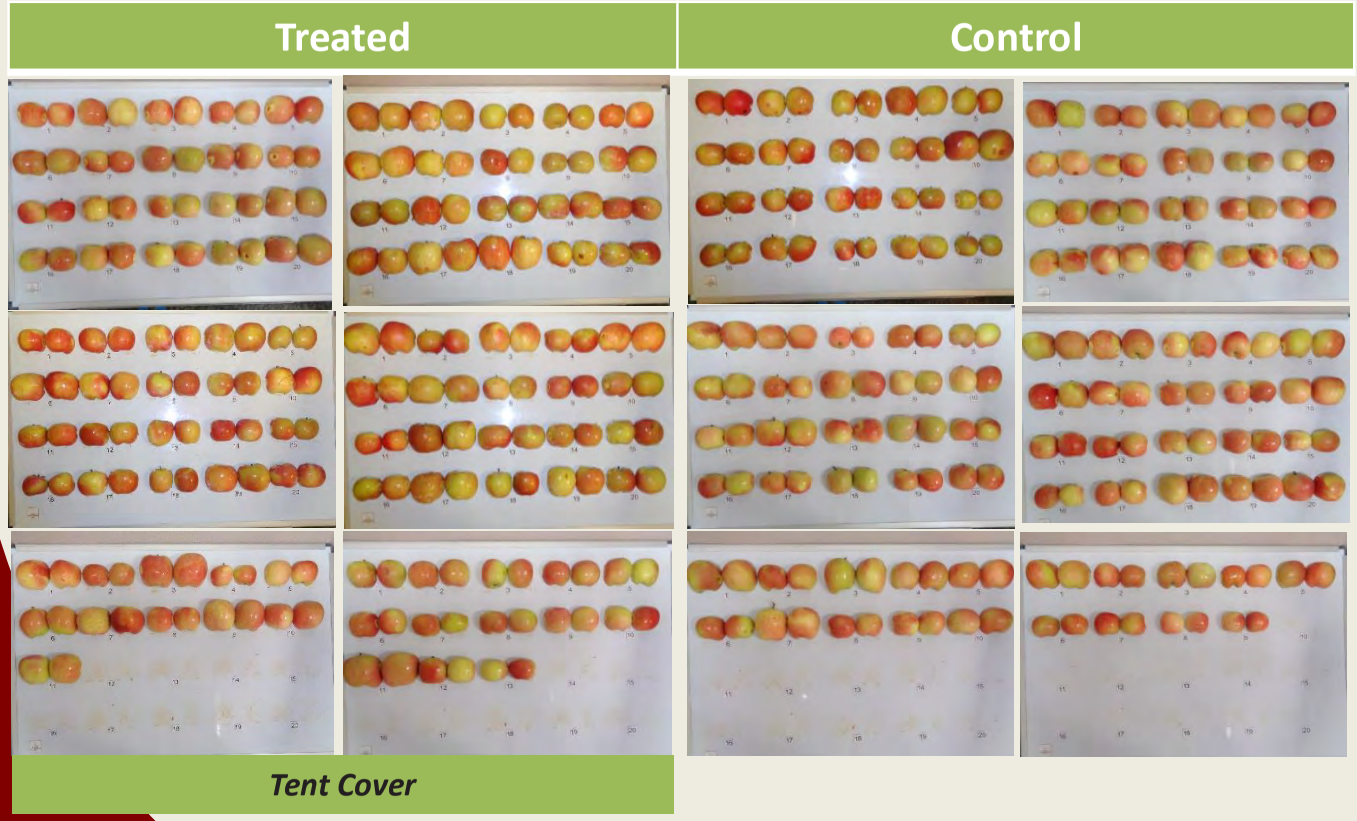
There was no packout data available from this orchard.

Fuji

Tent and Drape Treatments vs Control

Shadecloth Project Report 1-25-17

Fuji Images 2015 - Sampled from Field 8/21/15
Treated (Late Application) vs Control



Shadecloth Project Report 1-25-17

Fuji Images 2016 - Sampled from Field 8/18/16

Treated vs Control: Row <u>Exteriors</u>

Treated		Control
Observer comments: - *"A little more even on size and has more green apples"* - *"Yellow/ green color and blush is not as red (more pink)"* - *"Larger size, better color, and more defects"*		Observer comments: - *"More dark red pigment and more size variation"* - *"More red and has more defects"* - *"Higher red color, larger fruit size, brighter finish"*
	Drape Cover / ***Tent Cover***	

Shadecloth Project Report 1-25-17

Fuji Images 2016 – Sampled from Field 8/18/16

Treated vs Control: Row <u>Interiors</u>

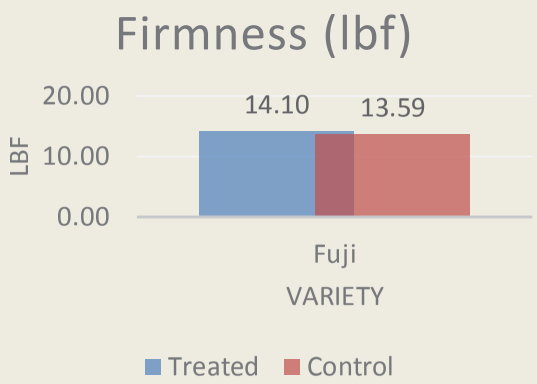
Fruit DYNAMICS, INC.

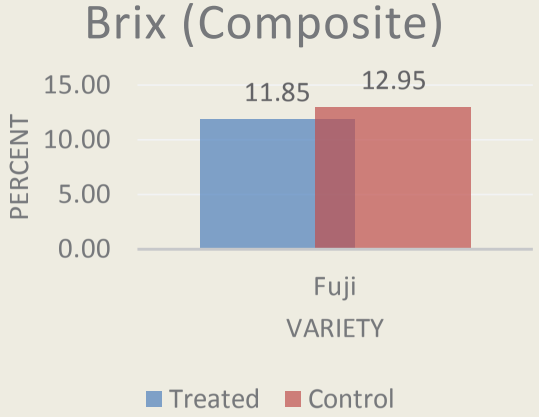
Treated		Control
Observer comments: - *"A little more even on size and has more green apples"* - *"Yellow/ green color and blush is not as red (more pink)"* - *"Larger size, better color, and more defects"*		Observer comments: - *"More dark red pigment and more size variation"* - *"More red and has more defects"* - *"Higher red color, larger fruit size, brighter finish"*
	Drape Cover ***Tent Cover***	

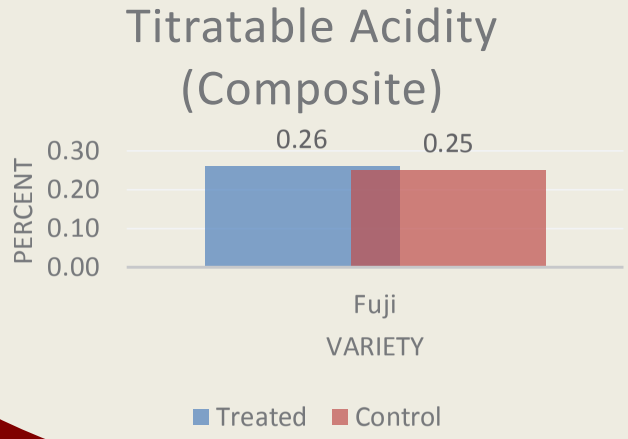
Shadecloth Project Report 1-25-17

Fuji – Sampled from Field 8/19/16

Treated (Combined) vs Control

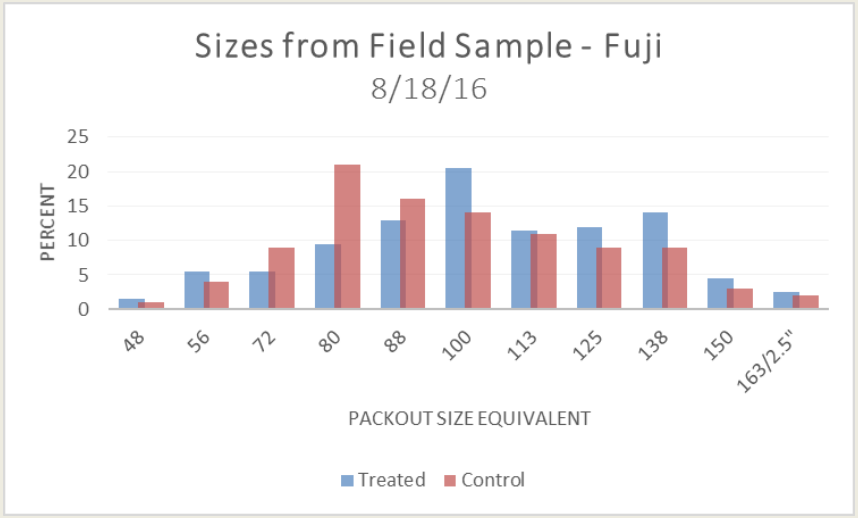






Shadecloth Project Report 1-25-17

Fuji Size
Treated (Combined) vs Control



Packout Size Equivalents

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56	3.75	9.5
64	3.625	9.208
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125	2.875	7.303
138	2.75	6.985
150	2.625	6.668
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

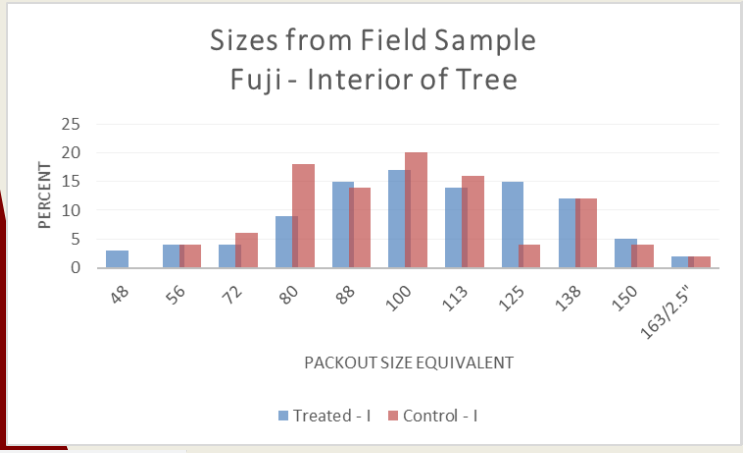
The graph above shows various size distributions, but the following mean fruit diameters from the field sample show no major size difference between treated and control: 7.75 cm (treated) vs 7.93 cm (control).

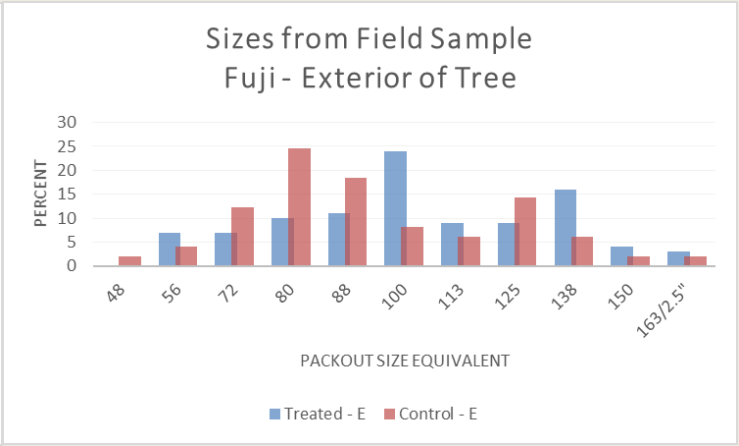
There was no packout data available from this orchard.

Shadecloth Project Report 1-25-17

Fuji Size – Interior and Exterior of Tree (8/18/16) Treated vs Control

The Interior part of the tree in a V-trellis system generally has more sun exposure, while the Exterior part of the row is generally more shaded. The data from each side of the tree at this site was calculated separately (as opposed to collectively on the previous page) to note any potential differences in impact by the shadecloth.





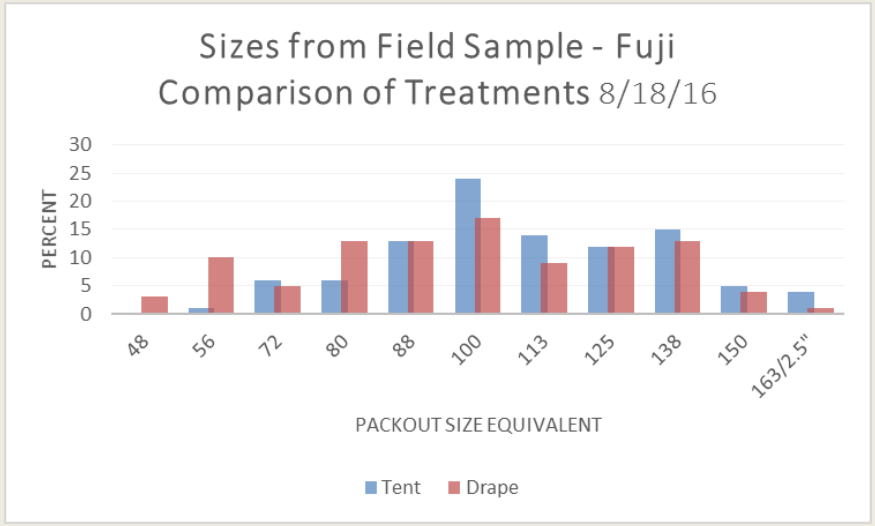
Packout Size Equivalents		
Size	Dia. (in)	Dia. (cm)
48	3.875	9.833
56	3.75	9.5
64	3.625	9.208
72	3.5	8.89
80	3.375	8.573
88	3.25	8.255
100	3.125	7.938
113	3	7.62
125	2.875	7.303
138	2.75	6.985
150	2.625	6.668
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

The graph above (upper left) shows various size distributions, but the following means from the Interior of the tree show that there is no major size difference between treated and control: 7.73 cm (treated) vs 7.84 cm (control).

The means from the Exterior of the rows (size distribution is shown in graph, upper right) reflect possibly a one-size difference between the control and treated: 7.77 cm (treated) vs 8.02 cm (control). The control produced the larger size when comparing the exteriors of the row.

Shadecloth Project Report 1-25-17

Fuji Size
Tent Shadecloth vs Drape Shadecloth



Packout Size Equivalents		
Size	Dia. (in)	Dia. (cm)
48	3.875	9.833
56	3.75	9.5
64	3.625	9.208
72	3.5	8.89
80	3.375	8.573
88	3.25	8.255
100	3.125	7.938
113	3	7.62
125	2.875	7.303
138	2.75	6.985
150	2.625	6.668
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

The graph above shows various size distributions, but the following means from the fruit diameters of the field sample reflect a one-size difference between Tent and Drape treatments when measured in packout size equivalent (left): 7.60 cm (Tent) vs 7.90 cm (Drape).

The Drape treatment resulted in the larger size.

Granny Smith

Tent Treatment (Non-Continuous) vs Control

Shadecloth Project Report 1-25-17

Granny Smith Images – Sampled from Field 8/24/16

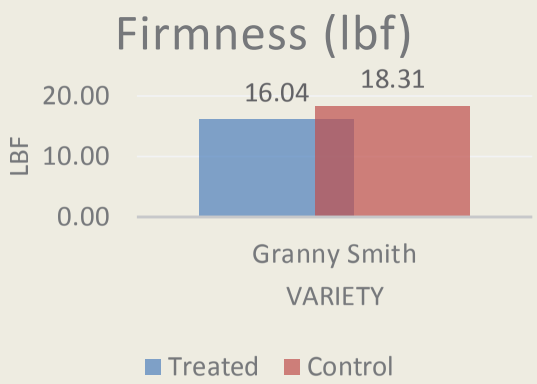
Treated vs Control

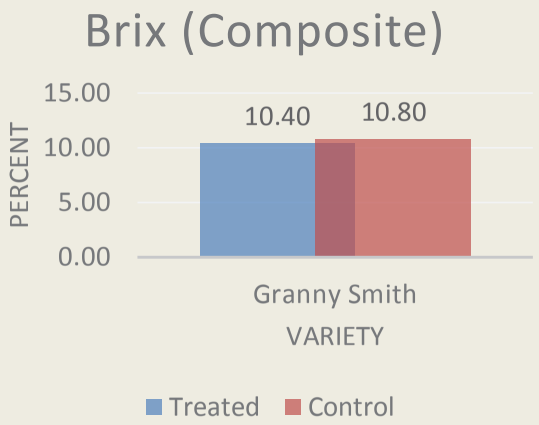
Treated		Control	
Observer comments: - *None available*			Observer comments: - *None available*

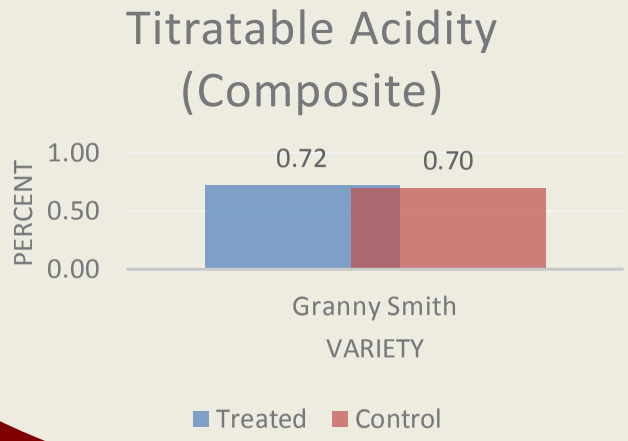
Shadecloth Project Report 1-25-17

Granny Smith – Sampled from Field 8/24/16

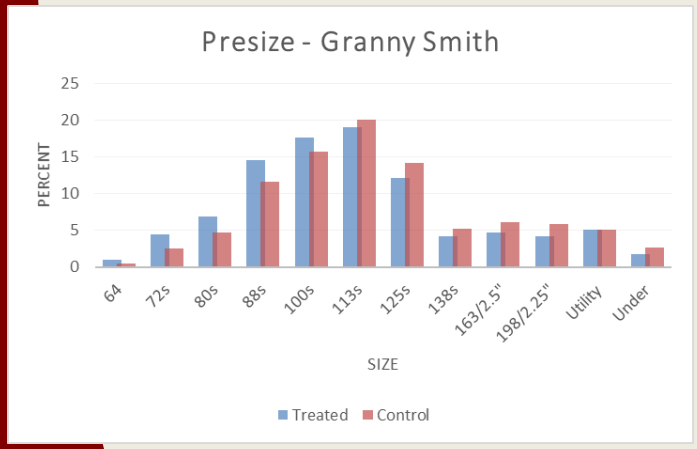
Treated vs Control

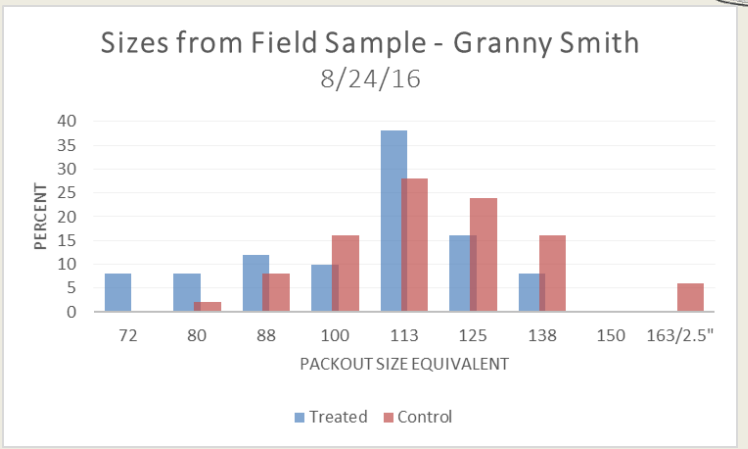


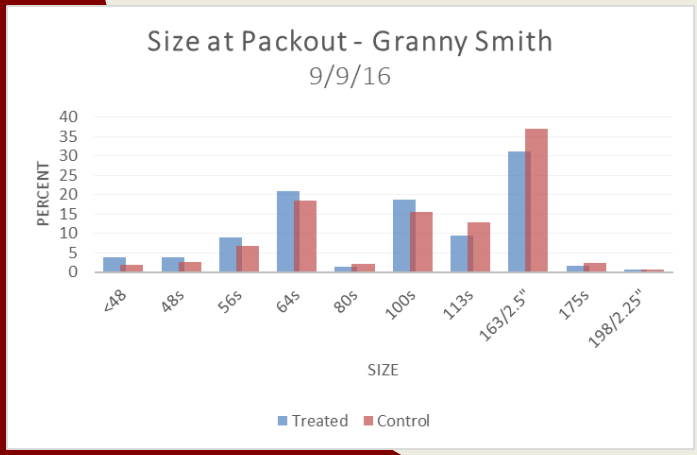




Shadecloth Project Report 1-25-17
Granny Smith Size
Treated vs Control







Mean fruit diameter from field sample: 7.71 cm (treated) vs 7.40 cm (control).

There a one-size difference between control and treated when measured in packout size equivalent (right) from the mean above; the treatment resulted in the larger size.

Packout Size Equivalents

Size	Dia. (in)	Dia. (cm)
48	3.875	9.833
56	3.75	9.5
64	3.625	9.208
72	3.5	8.89
80	3.375	8.573
88	3.25	8.255
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138	2.75	6.985
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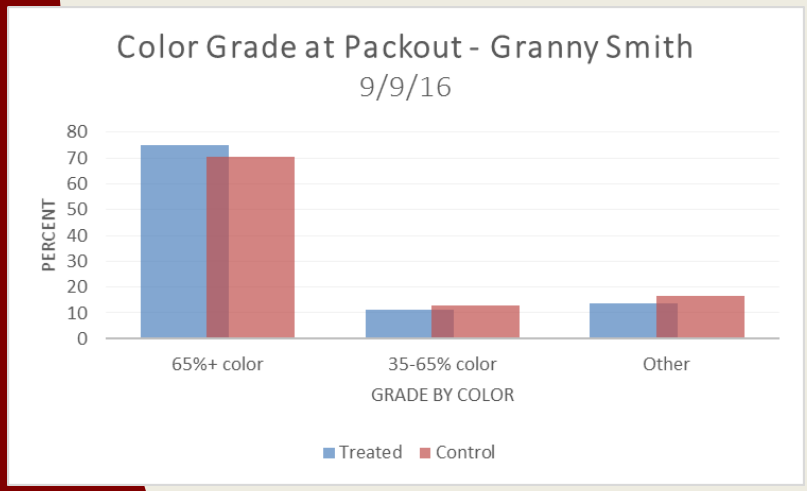
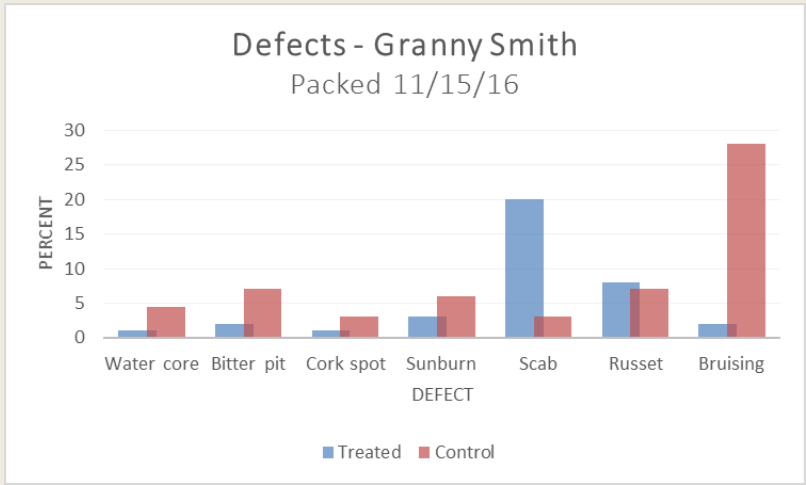
163	2.5	6.35
175	2.375	6.033
198	2.25	5.715

Shadecloth Project Report 1-25-17

Granny Smith Packout – After CA* Storage
Treated vs Control



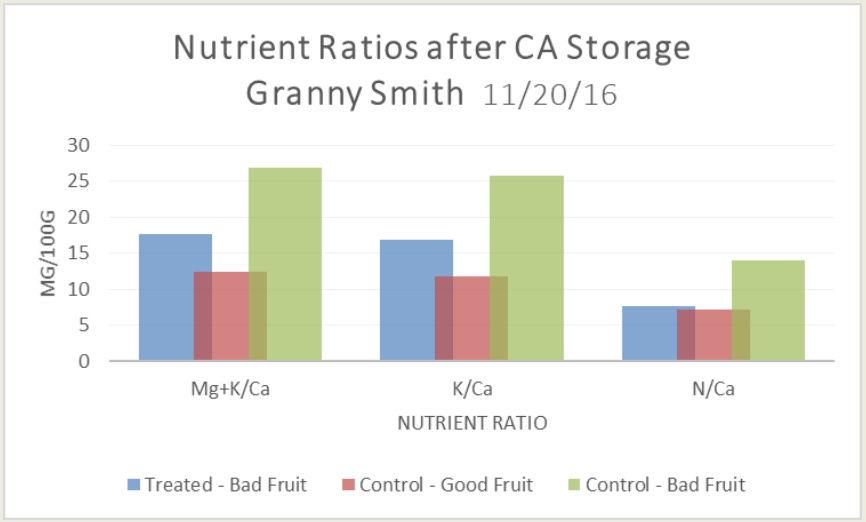


Treated Packout: 86.2%
Control Packout: 83.5%

***CA = Controlled Atmosphere**

Shadecloth Project Report 1-25-17

Granny Smith Packout – After CA Storage, cont'd
Treated vs Control



The bad fruit from the treated and the good fruit from the control had values you would expect given the appearance of the fruit after storage, according to one grower.
("Treated – Good Fruit" data was unavailable.)

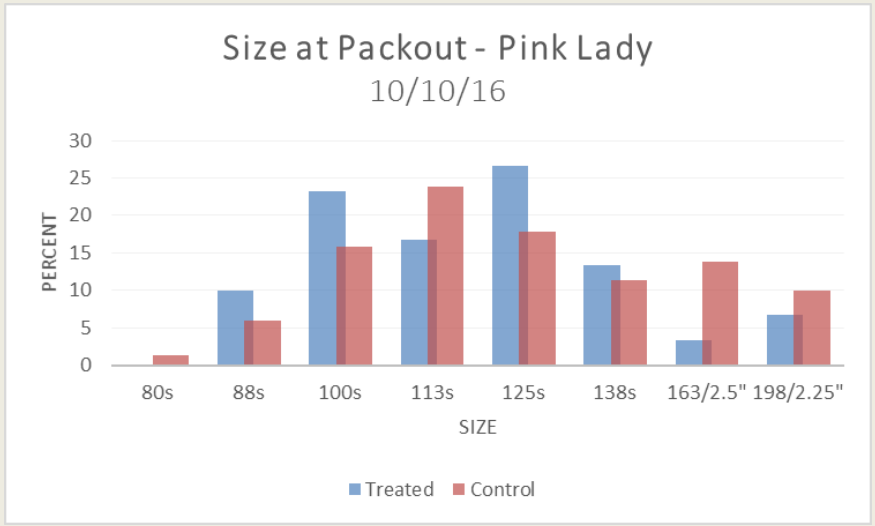
Pink Lady

Enclosed Tarp vs Control

Shadecloth Project Report 1-25-17

Pink Lady Size

Treated vs Control

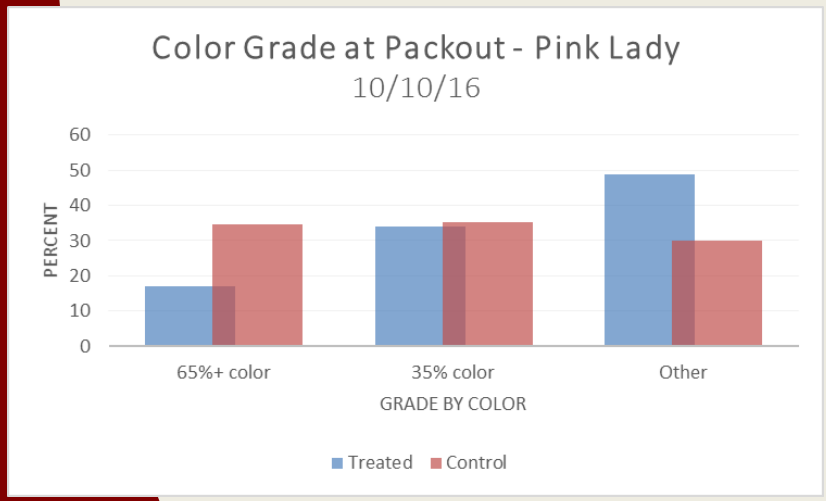


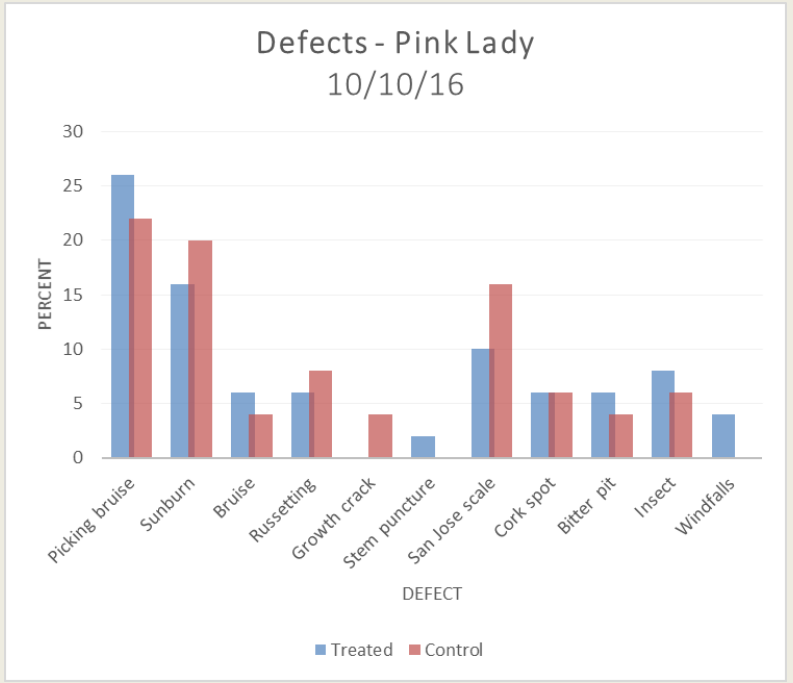
This orchard was not sampled from the field.

Shadecloth Project Report 1-25-17

Pink Lady Actual Packout Data

Treated vs Control





The treated section produced fruit with less color than did the control.

The "Other" category may have included fruit with notable color but was sorted out due to defects.

Treated Packout: 51%

Control Packout: 70%

Shadecloth Project Report 1-25-17

Grower Observations
Treated vs Control

Color:

"Tarp had significantly less color [than untreated fruit]. No difference in color with drape net." –Fuji grower

"The untreated area (evaporative cooling only) had better… color… than did the shadecloth area." –Gala 1 grower

Sunburn:

"I don't believe the T-Pee structure was adequate to prevent afternoon facing side of the tree from extreme heat and sun damage." –Gala 1 grower

"We did a partial row with complete coverage of the cloth and noticed much less sunburn in that section." –Gala 1 grower

"Treated (tarp and drape) had significantly less sunburn." –Fuji grower

"The untreated area (evaporative cooling only) had better size… and less sunburn than did the shadecloth area [no evaporative cooling]." –Gala 1 grower

Irrigation:

"More water was applied in the non-treated area through overhead cooling practice. Under-tree irrigation was the same in both sections and based on a % of daily ET." –Gala 1 grower

"Treated area (tarp) required less water…. Tarped area retained more soil moisture." –Fuji grower

"Shade cloth used less [water]." –Gala 2/Pink Lady grower

Shadecloth Project Report 1-25-17

Grower Observations, cont'd
Treated vs Control

Pest/disease pressure and crop protection products:

"No difference [in disease pressure or use of crop protection products]." –Fuji grower

"No noticeable difference. Both areas were treated the same." –Gala 1 grower

"Much higher rate [in treated area] of powdery mildew, we had a bunch of codling moth issues and rodent issues." –Gala 2/Pink Lady grower

Packout:

"No difference in yield [per acre]." –Fuji grower

"Tarp area had less color, so [higher color grade] was about 50% less." –Fuji grower

"Treated area yield was 61 bins/acre. Non-treated was 80 bins/acre. We had a much higher fruit drop in the treated area as well." –Gala 1 grower

"Too soon to tell." –Gala 2/Pink Lady grower

Other:

"Unless we can figure out a way to not have such a decrease in color, the tarped area won't be economically viable." –Fuji grower

"In my opinion we need a better structure [than T-Pee] and for Gala maybe a heavier, more dense cloth (30%?)." –Gala 1 grower

"PCA didn't like going inside tent." –Gala 2/Pink Lady grower

Shadecloth Project Report 1-25-17

Shadecloth Economic Feasibility Assessment

All efforts have been made to provide an accurate and detailed feasibility assessment, however no real conclusions can be made from one season in assessing the economic feasibility of shadecloth in California apple production. Preliminary observations include:

1. Shadecloth did not improve overall apple yield per acre.
2. CPP usage was not measurably impacted.
3. Water usage was anecdotally reduced.
4. In red or bicolored apples, shadecloth detrimentally impacted skin color.
5. With Galas and Pink Ladies, packout per bin decreased in treated fruit (12% and 27.1%, respectively).
6. With Granny Smith, packout per bin increased by (3.2%).
7. Size was improved in Granny Smith.
8. Postharvest disorders were reduced in Granny Smith.

Consensus among the participating growers is that another season is needed before the economic feasibility of using shadecloth in California apple production can be fully assessed. Initial observations indicate that there may be benefits in Granny Smith production but not in Gala, Pink Lady or Fuji production.

Postharvest Quality and Physiology of Apples Subjected to Phytosanitary Irradiation

Anuradha Prakash
Chapman University

Introduction

A major export barrier for US specialty crops is the incidence of pests on agricultural commodities which are endemic to parts of the U.S. and that are not established in potential export destinations. For apples (Malus domestica) exported from California to Mexico, a key pest of concern is the Oriental fruit moth, Grapholita molesta. In 2016, following a request by the California Apple Commission, an addendum to the Operational Work Plan for Import of Articles Intended for Irradiation in Mexico from the United States was signed for CA origin apples intended to be irradiated in Mexico. Irradiation offers an economically beneficial alternative for California apple varieties, especially those targeted to the Mexican market, when Californian producers can take advantage of the earlier harvest compared to Washington State season. It also offers an alternative treatment to methyl bromide (MB) fumigation which can affect quality of certain apple varieties. More importantly, methyl bromide is slated for phase-out under the Montreal Protocol and irradiation offers another alternative for growers to use given that the only other option allowed is a 40/90 day cold treatment and that is not conducive to California's economic marketing plan. Thus, a second pest mitigation option is very important to this industry.

However, irradiation can induce physiological responses in fruits, some beneficial and some harmful to fruit quality. Studies of irradiated apples and many other fruit have shown that the response of fresh fruit respiration to irradiation is highly dependent on cultivar, maturity and irradiation dose levels (Drake and others 1999).

Preliminary work

We conducted a preliminary study to evaluate the response of apples treated with phytosanitary irradiation and subject to temperature conditions during export to Mexico. Freshly harvested apples were irradiated at 250 (target dose for Mexico) and 1,000 Gy with electron beam at Steri-tek (Fremont, CA) and then stored for 7 days at 1 ° C (to simulate transportation from California to Mexico) and 7 days at ambient temperature (to simulate distribution and retail).
Upon treatment, all three varieties exhibited similar responses. Apples treated with 800-1,000 Gy exhibited an increase in ethylene production and respiration rate as compared to the control. During storage, ethylene levels in the irradiated apples dropped and remained low even during ambient temperature storage. Respiration rate, however, remained higher than the control throughout storage. The differences in respiration rate were not manifested in any of the quality parameters tested- color, browning index, malondialdehyde (MDA), sugar content and organic acids. At 250 Gy, firmness was not impacted. Skin and flesh exhibited similar levels of total phenolics in both control and irradiated apples; however, the phenolic content of skin was significantly increased at a dose level of 1000 Gy.

2017-2018 FUTURE RESEARCH

In the coming year, the California Apple Commission will extend three on-going projects.

1) Evaluation of New Postharvest Fungicides for Pome Fruits – Dr. Jim Adaskaveg
2) Shade Cloth Benefits for Apples - Facilitated by CAC staff and research analyzed by Fruit Dynamics
3) Postharvest Quality and Physiology of 'Gala', 'Granny Smith,' and 'Fuji' Apples Subjected to Phytosanitary Irradiation - Dr. Anuradha Prakash

2017/2018	**Amount**
Jim Adaskaveg - Evaluation of New Bactericides for Control of Fire Blight	$19,000[1]
CAC - Shade Cloth Benefits for Apples	$88,648[2]
Anuradha Prakash - Postharvest Quality and Physiology of 'Gala', 'Granny Smith,' and 'Fuji' Apples Subjected to Phytosanitary Irradiation	$1,500[3]
Fiscal Impact for 2017/2018	**$20,500**

1. Research done by Dr. Adaskaveg will be done on both organic and conventional apples
2. This amount was granted to the California Apple Commission by a CDFA Specialy Crops Block Grant and will cover the expenses of the study.
3. This amount was donated by the California Apple Commission for apples that will be used in the study.

AES/CE MAR 84

Workgroup: Apple
Department: Plant Pathology/UCR

University of California
Division of Agricultural Sciences
PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year: 2017-18 Anticipated Duration of Project: 3rd year of 4 years

Principal Investigators: J. E. Adaskaveg
Cooperating: D. Thompson. D. Cary, and H. Forster

Project Title: Evaluation of new biological controls for management of fire blight of apples caused by *Erwinia amylovora* and evaluation of new natural products as organic postharvest fungicides for pome fruits

Keywords: Biological control, natural products, organic treatments

JUSTIFICATION/ BACKGROUND

Epidemiology and management of fire blight. Fire blight, caused by the bacterium *Erwinia amylovora,* is one of the most destructive diseases of pome fruit trees including apples. The disease causes a blackening of twigs, flowers, and foliage and is indigenous to North America but has since spread worldwide. In addition to cankers, the pathogen overwinters in flower buds, diseased fruit, small twigs, and branches. In the spring, blossoms are infected through natural openings in nectaries and pistils. After destroying the blossom, the bacteria spread into the peduncle, spur, and twig. During warm, humid weather, ooze droplets consisting of new inoculum are exuded from the peduncles and other infected tissues. Inoculum is spread by wind, rain, insects, birds, or by man, e.g., by means of contaminated pruning tools. Secondary infections may occur throughout the growing season.

Current chemical control programs for fire blight are based on protective schedules using available registered compounds that are contact treatments. The only registered compound that is locally systemic is the antibiotic streptomycin. Kasugamycin is also locally systemic and the California registration is pending. Control with conventional copper compounds is only satisfactory when disease severity is low to moderate. Historically, these treatments are only used during dormant and bloom periods because russeting commonly occurs on fruit. Subsequently, labeled rates of copper are at low amounts of metallic copper equivalent (MCE) that are at the limit of effectiveness. In 2015-16, low to moderate levels of copper insensitivity in pathogen populations were detected. Spontaneous mutants were also found with high copper resistance (>30 ppm) when the pathogen was continuously exposed to copper in laboratory assays for determining copper sensitivity.

Antibiotics for blight control include streptomycin (FireWall, Agri-Mycin), the less effective oxytetracycline (Mycoshield, FireLine), and the newly registered kasugamycin (Kasumin) that all target different sites in the protein biosynthesis pathway of the pathogen. Others have indicated that oxytetracycline is not persistent and degrades under UV light and rainfall in short periods of time (Christiano et al. 2009, Plant Disease 94:1213-1218). Pathogen resistance against streptomycin has been reported in California. Furthermore, from a regulatory perspective, streptomycin and oxytetracycline have been removed from the approved list of organic treatments of apples and other pome fruits by the National Organic Standards Board (NOSB). Thus, organic growers have very limited choices for disease control.

New re-formulated copper products that can be used at reduced rates of metallic copper equivalent (MCE) and that have less contamination in their formulations that may cause phytotoxicity are available. Some of the coppers are OMRI-approved and these include Badge X2 (Gowan), CS-2005 (Magna Bon, Inc.), and Cueva (Certis). They have been reported to be effective without causing phytotoxicity. Thus, organic research on OMRI-approved coppers needs to be continued especially if antibiotics are no longer approved. Nano-particle copper or zinc products are being tested in Florida against bacterial diseases of citrus. These products will be difficult to register and they are expensive but they possibly can be organically approved as mined compounds. Other concerns are their safety - both to the environment and to workers. Still, we plan to test them against *E. amylovora* in laboratory assays as they become available. If successful, small-scale field trials should then be conducted. Additionally, in 2016-17, we identified copper-enhancing compounds that can be added to registered copper to increase the activity of copper so that the treatment can be more effective at low rates that do not cause phytotoxicity. We plan to continue to evaluate these compounds to improve the performance of copper.

In trials with biocontrols, Blossom Protect *(Aureobasidium pullulans)* was evaluated for the last several years and shown to be very effective and one of the most consistent biologicals that we have evaluated. Actinovate

(Streptomyces lydicus) also showed promise in some trials especially when used at low rates and in combination with a sticker adjuvant. Still, the product was inconsistent. Thus, our recent research on organic alternatives needs to be continued. Other biological controls that have been developed for fire blight in the United States include the registered Blight Ban A506 bio-pesticide (*Pseudomonas fluorescens* strain A506), Serenade (fermentation product of *Bacillus subtilis* strain QST 713), as well as Bloomtime Biological FD Biopesticide (*Pantoea agglomerans* strain E325). Unfortunately, they have been very inconsistent in their performance. They are most effective under low inoculum levels and less favorable micro-environments. Thus, Actinovate, Serenade, Blossom Protect, and the newly registered product Double Nickel 55 (*Bacillus amyloliquefaciens*), will be continued to be evaluated in 2017-2018 in selected mixtures or in rotation with new copper products or other additives.

In general, biocontrols are most effective when they are actively growing on the plant. Several mechanisms have been described for biocontrol agents that lead to the control of the pathogenic agent. (1) Competition for vital resources on the plant surface that limits growth of the pathogen (competition); (2) the biocontrol may produce compounds involved in antibiosis (biochemical inhibition); (3) the biocontrol may increase in biomass and physically block infection sites of the pathogen (site exclusion); (4) the biocontrol agent may directly parasitize the pathogen; and (5) the biocontrol may induce host resistance mechanisms (systemic-acquired resistance). Thus, another aspect of our organic research that we have been working on is to enhance the growth of biologicals by adding enhancers to the tank mixture just prior to application. Growth enhancers tested to date have been inexpensive and have sometimes resulted in improved performance. We recently identified additional compounds that favor growth of three biocontrols as compared to the pathogen. These compounds will be evaluated in the 2017-2018 funding cycle.

Toxicity of some copper and sulfur products has been shown to some of the new biocontrols used in fire blight management. Copper is generally incompatible with against bacterial biocontrols but compatible with yeast-based products. Sulfur is toxic to both fungal and bacterial biocontrols. Testing needs to be extended among the biologicals and other formulations of copper products need to be included. Liquid lime sulfur has activity against fire blight, however, it is phytotoxic to blossoms and results in fruit thinning. We plan to evaluate low rates of copper in mixtures with yeast biocontrols and copper-enhancing compounds that are organically approved or potentially can be approved (e.g., lactic acid, poly-L-lysine, and an experimental called SDH and others). Incompatibilities could prevent the use of biocontrols or limit their use to later-season applications in rotations or tank mixtures.

In research in 2017, use of the OMRI-approved LifeGard (Certis) to complement copper and other control materials as a systemic acquired resistance (SAR) treatment was unsuccessful. The active ingredient of LifeGard is a naturally occurring bacterium *(Bacillus mycoides* isolate J) that was shown to trigger the plant's natural immune response to pathogenic fungi, bacteria, and viruses. The plant's defense system is activated through the production of phytoalexins or certain pathogenicity-related proteins that are non-specific defense chemicals. Possibly, these compounds can be used in combination with other bactericides to enhance efficacy. Thus, SAR research should continue as a supplemental program to a program based on bactericides (copper, sulfur) and biologicals.

Our goal is to develop effective rotational programs for either organic farming practices with the use of copper and biologicals or conventional programs with the use of antibiotics alone or in mixtures with fungicides, copper, biologicals, or potentially SAR compounds during bloom or as cover sprays during early fruit development.

Management of postharvest decays. Apples like other pome fruit can be stored for some period of time using the correct storage environments. Still, postharvest decays caused by fungal organisms can cause losses that are economically detrimental to storing and marketing of fruit. The major postharvest pathogens of apples include *Penicillium expansum, Botrytis cinerea, Alternaria alternata, Mucor piriformis, and Neofabraea* spp. causing blue mold, gray mold, black mold, Mucor decay, and bull's eye rot, respectively. There is a deficiency of postharvest biocontrols and natural products that are available to prevent decays in storage. BioSave 100 is one of the only materials currently available in the United States; whereas other products like Aspire have been discontinued. Still, new biological products have been registered in other countries.

In initial studies in 2013-14, we found that natamycin was similarly effective against a spectrum of postharvest pathogens as the fungicide Scholar in reducing the incidence of gray mold, Rhizopus rot, Mucor rot, and Alternaria decays, but it was not as highly effective against blue mold on apples. Recently, in 2016, natamycin was registered as the biopesticide BioSpectra 100SC. This fungicide has been federally-approved by the US-Food and Drug Administation (FDA) as a food additive to prevent mold growth, including *Penicillium* species, on dairy (e.g., cheese and yogurt) and meat products for many years in the United States. Over all the years in use, resistance in *Penicillium* species against natamycin has not occurred. Working with DSM, the producer, and Pace International, the registrant, we submitted a letter of support to the NOSB for approval of natamycin as an organic postharvest treatment of pome fruits. Currently natamycin is exempt from tolerance by

the US-Environmental Protection Agency (EPA). Therefore, our goal is to continue to evaluate natamycin and other new postharvest fungicides for the management of postharvest decays of apples.

Objectives for 2017-18

Fire blight research

1. Evaluate the efficacy of treatments for managing fire blight.
   A. Laboratory in vitro tests to identify and evaluate growth enhancers of biological control agents.
   B. Laboratory in vitro tests on copper and zinc products (registered copper products and new nano-particles as they become available) with newly identified additives (lactic acid, poly-L-lysine, and experimentals called SBH derivatives) that enhance the activity of these bactericides.
   C. Small-scale hand-sprayer tests using different treatment-inoculation schedules to evaluate coppers (e.g., Badge X2, CS-2005, Cueva, Champ), and biological treatments (e.g., Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55) by themselves or in selected combinations (e.g., copper and Blossom Protect).
   D. Field trials with protective air-blast spray treatments:
      i. New formulations of copper (e.g., Badge X2, CS-2005, Cueva) possibly supplemented with nano-copper oxide (if laboratory assays show activity) with and without newly identified additives (lactic acid, poly-L-lysine, and an experimental called SDH).
      ii. Biological treatments (Blossom Protect, Serenade, Double Nickel 55) with and without the addition of growth enhancers.
      iii. Plant defense activators or SARs alone of in mixtures with other biological control treatments.

Postharvest research

2. Comparative evaluation of new postharvest fungicides
   A. Evaluate natamycin (BioSpectra) and other new postharvest fungicides such as Academy at selected rates against gray mold, blue mold, Alternaria decay, and bull's eye rot and compare to pyrimethanil and fludioxonil.
   B. Evaluate mixtures of these compounds.
   C. Determine baseline sensitivities. Baseline sensitivities for natamycin will be continued to be developed for additional fungal pathogens that are collected.

Plans and Procedures

Evaluation the efficacy of treatments for managing fire blight. Laboratory assays and small-scale field trials. In laboratory assays we will evaluate new copper and zinc products as they become available (e.g., nano-copper oxide or nano-zinc oxide), as well as copper-enhancing compounds (e.g., newly identified additives such as lactic acid, poly-L-lysine, and experimental SBH derivatives) will be evaluated for their toxicity to *E. amylovora* in laboratory assays. Growth will be compared between non-amended and amended media, and the most effective additives will be selected for field trials.

In small-scale field tests in an experimental orchard, treatments using the copper products Badge X2, CS-2005, and Cueva, and the biological treatments Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55 will be applied to run-off to open blossoms using a hand sprayer. Treatments with biological control agents will also be mixed with growth enhancers; whereas copper treatments will be mixed with newly identified additives (e.g., lactic acid,po/y-L-lysine, and experimental SBH derivatives) based on laboratory results. If new products and copper-enhancing compounds are toxic or improve the toxicity of copper in the laboratory assays, small scale field tests similar to those described above will be done. Each replication will consist of one branch on

each of four trees. After selected time periods, blossoms will be spray-inoculated with *E. amylovora* (10^6 cfu/ml), inoculated branches will be bagged overnight, and disease will be evaluated based on the number of diseased blossoms per 100 blossoms evaluated per replication. The post-infection activity of treatments will be evaluated by first inoculating blossoms and treating after 24 h.

Field studies on the management of fire blight using protective treatments during the growing season. Air-blast sprayer field studies on the relative efficacy of protective treatments will be conducted in an experimental apple orchard at the Kearney AgCenter where fire blight caused crop losses previously. Two applications will be done (at 10-20% and at 60-80% bloom). The relative efficacy of protective treatments (Badge X2, CS-2005, Cueva, Blossom Protect, Actinovate, Serenade, Taegro, and Double Nickel 55), as well as of selected SAR compounds will be evaluated alone or in selected mixtures to develop integrated programs for resistance management. Incidence of new blight infections on blossoms and leaves in addition to potential phytotoxic effects of the treatments (e.g., fruit russeting) will be evaluated. Application timings will be determined based on temperature, rainfall, and host development. Treatments will be replicated four to six times on different trees. Data for chemical and biological control will be analyzed using analysis of variance and LSD mean separation procedures of SAS 9.4.

Efficacy of new postharvest fungicides for managing apple decays in storage. Fruit (cvs. Granny Smith and Fuji) will be treated similar to commercial practices concerning harvest, handling, packing, and temperature-management of fruit. Fruit will be wound-inoculated with conidial suspensions of several decay fungi *(B. cinerea, P. expansum, N. perennans, Alternaria* sp.) and treated after selected times. Natamycin (BioSpectra 100SC) will be evaluated in experimental packingline trials at Kearney Agricultural Center at selected rates by themselves or in mixtures. Four replications of 20-40 fruit per rep of will be used. For the new fludioxonil-difenoconazole pre-mixture (i.e., Academy), we will compare the efficacy of different application methods (in-line drench, CDA, and T-jet). Treatments will be compared to pyrimethanil and fludioxonil. Data will be analyzed using analysis of variance and averages will be separated using least significant difference mean separation procedures of SAS 9.4.

Determination of baseline sensitivities. Baseline sensitivities for natamycin will be continued to be developed for apple pathogens that are collected with a goal of 70 isolates for each pathogen. We will use the spiral gradient dilution method that allows for efficient, high-throughput evaluation of isolates to determine EC50 concentrations.

Benefits to the industry

Fire blight research. Historically, the overuse of streptomycin led to resistant pathogen populations and the over-reliance of oxytetracycline as a substitute for streptomycin has led to the first detections of oxytetracycline resistance in the pathogen. With the limited number of materials available to pome fruit growers, new active ingredients that are OMRI approved are needed for managing fire blight in an integrated approach. Information from this research project will help to develop integrated programs using rotations or mixtures of organic compounds (e.g., copper), biologicals, and SAR compounds to effectively manage the disease. With removal of antibiotics as treatments for organic production, research on organic alternatives are desperately needed for apple production. Research in this project has already identified biologicals with consistent and inconsistent performance. Newer biologicals (e.g., Actinovate, Blossom Protect) are more consistent with growth enhancers in performance and their usage with newer copper products and compounds that enhance copper activity (e.g., lactic acid, poly-L-lysine, and experimental SBH derivatives) will help the organic apple industry manage fire blight without antibiotics. We are also showing that some products are poor performers and we are providing information through UCIPM and apple industry newsletters. Our concept of enhancing growth of the biologicals and inducing SAR may provide much needed treatments for growers to manage the disease.

Postharvest decay management research. For the packer, the challenge is to develop management programs using new fungicides for control of gray mold, blue mold, Alternaria rot, and other decays of apple. The challenge to the industry is to store fruit and provide decay-free, wholesome fruit to local and distant markets. For this, fungicide management programs need to be developed and continually adapted for control of gray mold, blue mold, and other decays of apple based on new organically certified fungicides that will allow rotations and mixtures to optimize control of postharvest fungal pathogens. The development of several effective postharvest fungicide treatments including materials that are exempt from tolerance and potential certified as organic will improve performance and greatly decrease losses of fruit from various decays during storage in a durable program that will be effective for many years. Baseline sensitivities that we are

establishing in pathogen populations will facilitate the early detection and prevent the spread of resistance. Another critical aspect of this research is improving the efficacy of each material using optimal application methods such as using postharvest re-circulating in-line drenches. Thus, information from this research directly benefits growers and packers by identifying and registering new materials, as well as development of improved application practices for control of postharvest diseases of apples.

References

1. Van Der Zwet, T. and Keil, H.L. 1979. Fire Blight - A Bacterial Disease of Rosaceous Plants. United States Department of Agriculture, Handbook No. 510.200 pp.
2. Vanneste, J. (ed.). 2000. Fire Blight: The Disease and its Causative Agent, *Erwinia amylovora*. CAB International, Oxford. 384 pp.

Budget Request:

Budget Year: 2017-2018.

Funding Source: _____ Apple Commission of California _____

Salaries and Benefits:	Post-Docs/SRA		5,000
	Lab/Field Ass't		500
	Subtotal		5,500
	Employees' Benefits		2,500
		Subtotal	8,000
Supplies and Expenses*			10,000
Equipment			0
Operating Expenses/Equipment Travel (Davis Campus only)			0
Travel			1,000
Department Account No. _____		**Total**	**19,000**

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* - Costs include expenses of $10,000 for maintaining an apple orchard at the Kearney AgCenter.

Originator's Signature: J.E. Adaskaveg _____ Date: 7-11-2017

Department Chair: Katherine Borkovich _____ Date: 7-11-2017

Liaison Office: Date:

Project 49 California Apple Commission $88,648

PROJECT TITLE
Extension of Shade Cloth Benefits for California Apples

PROJECT DURATION
Start Date: March 1, 2017
End Date: February 28, 2018

SUMMARY
In 2014, the California Apple Commission (CAC) received a Specialty Crop Block Grant to investigate the benefits of shade cloth on apples in California. Due to unforeseen challenges such as an extremely early apple harvest, the closing of California shipping ports, and structural design issues, the project lost almost a year of valuable data for the project. The CAC is requesting additional funding to obtain more data which will strengthen the validity of the findings. Since the shade cloth is already purchased and installed, the additional funding will pay for the cost of the extended research and personnel to implement the grant.

PROJECT PURPOSE
Issue, Problem or Need
In 2014, the CAC received a grant to investigate the benefits of shade cloth. Due to unforeseen circumstances, including port closures and harvest timing, valuable data was lost during the first research year. This will be the final year of the project and an extension will increase the validity of the research. The overall goal of the project is to determine the economic viability of applying shade cloths in California. Improving color and specifically limiting sunburn on California apples will dramatically improve their marketability.

Apples should be grown in a 68°F- 86°F environment. Shade cloth can reduce temperatures within the orchard up to 12°F. On average, California apples are grown at 88°F. Utilizing shade cloth could improve apple color as well as protect apples from sunburn/hail damage. The project will monitor the amount of overhead water (OW) that is utilized on the shade cloth orchards and the amount of crop protection products (CPP). The CAC estimates that if the temperature of the orchard is lower, the grower will use less OW to maintain the temperature.

The project objectives are to 1) Determine whether shade cloth can significantly improve the color, quality, and size of California apples; 2) Determine if shade cloth can reduce the use of OW and reduce the amount of CPP use; and 3) Analyze if shade cloth is economically feasible in California. If all of these objectives are proven correct, they will change the way California apples are marketed and sold. The extension request is to replace the research lost during year one of the grant. Much was learned in the first year and the CAC would like to apply it during this extension.

This project intends to increase demand for specialty crops through targeted market efforts. If shade cloth works as it is intended to, California apple producers will produce apples with increased color and improved size. California apple handlers have already suggested that marketing apples using the shade cloth as incentive is the ultimate goal if the shade cloth demonstrates effectiveness. In addition, increased color and size are highly desired by retailers and could extend California's shipping window by several weeks. If the window is expanded, California will assuredly move most if not all of the California apples before other regions enter the market and demand and price is decreased significantly.

Project Objectives

1) Determine whether shade cloth can significantly improve the color, quality, and size of apples in California climate.
2) Determine if shade cloth can reduce the volume of water used during overhead cooling and reduce the amount of CPP used to protect from sunburn.
3) Analyze if shade cloth is economically feasible in California.

Project Beneficiaries

Estimated number of project beneficiaries: 72

Does this project directly benefit socially disadvantaged farmers as defined in the RFA? Yes ☐ No ☑

Does this project directly benefit beginning farmers as defined in the RFA? Yes ☐ No ☑

Statement of Solely Enhancing Specialty Crops

By checking the box to the right, the recipient confirms that this project solely enhances the competitiveness of specialty crops in accordance with and defined by 7 U.S.C. 1621. ☑

Continuation of Project Information

How this project will differ from and build on the previous efforts:

This project will finish the 2014 grant. As stated above, the previous grant did not attain as much information or research as needed during the initial year. This will extend the current grant by one year and cement the validity of the project. Several unforeseen circumstances delayed or prevented the grant from getting the necessary research. Those delays included the closure and massive delays at local ports which prevented the shade cloth from arriving in a timely manner. Eventually, the shade cloth was flown in and the shade cloth manufacturer took the loss on the remaining shade cloth left at the port. Secondly, the harvest timing was exceptionally early. A heat wave and lack of chilling hours accelerated the apple maturing process and they were ready for harvest well before normal. This prevented the growers from having the shade cloth up and ready at the correct time. Compounding this issue, the design of the support structure needed to be revisited due to each grower having different overhead cooling apparatuses.

Summary of the outcomes of the previous efforts:

The CAC is on schedule with the work plan from the approved scope of work. Once the shade cloth was installed, Fruit Dynamics began collecting apples to test, and continued to do so throughout the rest of the season. A report from the first year of the project has been provided, and the California apple industry has benefitted from what has transpired. As a result, the industry has obtained a clearer picture of the practical uses of shade cloth throughout the state.

Lessons learned on potential project improvements:

Several lessons were learned in the initial year. Specifically, the structure for the shade cloth needs to be anchored and designed so that wind does not cause the structure to lean and that the shade cloth does not damage the overhead cooling structure already in place. This design issue has since been fixed for the second year of the project. Additionally, there have been suggestions that some type of rolling mechanism should be used to assist the shade structure in retracting back and forth before and after the season. This suggestion is already being looked at by individual growers outside the scope of the grant. In the initial year, the grant provided valuable information regarding structure requirements, costs of installation, and preliminary data on color and size. The CAC will receive more data on color and size in year two, but a third year is needed to increase the validity of the project.

Likelihood of the project becoming self-sustaining:
Once the grant has concluded the CAC will distribute the findings to the entire California apple industry. If the findings are positive on color enhancement, reduced water usage, reduced product usage, and economically viability, then the California apple industry will have to make the decision to convert regular orchards into orchards that are covered with shade cloth. If the findings are positive, it would be in their best interest to do so as it will increase the marketability and sales of California apples. The conversion of the orchards will be funded entirely by each individual grower. Of course, if the information provided by the grant indicates that shade cloth is not a viable or useful option the industry will not move forward in converting the regular orchards to shade cloth. The overall objective of this grant is to provide accurate, reliable, information to the California apple industry and let them make the decision individually.

Support from Other Federal or State Grant Programs
Was this project submitted to a Federal or State grant program other than the SCBGP for funding and/or is a Federal or State grant program other than the SCBGP funding the project currently? Yes ☐ No ☑

EXTERNAL PROJECT SUPPORT
Project supporters include the Buy California Marketing Agreement/CA GROWN, the California Cherry Board, the California Grape and Tree Fruit League, and the Western Agricultural Processors Association. The California Cherry Board supports this project because the answer to this research will be imperative to the development and maintenance of the California apple market. In addition, the results that are obtained from this research provide the opportunity for other crops, like cherries, to apply this research to further improve California cherry production.

EXPECTED MEASURABLE OUTCOMES
☑ **Outcome 5:** Enhance the competitiveness of specialty crops through more sustainable, diverse, and resilient specialty crop systems.

- **Indicator 1:** One new or improved innovations models (biological, economic, business, management, etc.), technologies, networks, products, processes, etc. developed for specialty crop entities including producers, processors, distributors, etc.
- **Indicator 3:** 72 specialty crop growers/producers (and other members of the specialty crop supply chain) that have increased revenue expressed in dollars.
- **Indicator 8:** 72 growers and 8 handlers that gained knowledge about science-based tools through outreach and education programs.
- **Description:** Beginning in April 2015, the CAC worked alongside several growers comparing and contrasting four 10-acre plots from Northern and Southern California. This provided an effective sample size of close to 400 to 500 tons of apples per year to evaluate. The research included comparing and contrasting growth, color, damage, and profitability of apples from each plot. Two plots from each growing region will utilize shade cloths and the other two plots will be grown traditionally. They will be side by side to achieve valid data. The shade cloth group used different shade cloth colors and exposure percentage levels to decipher which would be most beneficial to California growers. The project team will run this experiment in 2016, and if the extension is approved, another experiment will be conducted in 2017 with actual harvest during the months of July through October. Economic impact and cost effectiveness of the shade cloths will be concluded in December 2016 with final results being disseminated by the end of February 2017, unless the extension is approved. If approved, the final results will be disseminated in February 2018. Throughout the course of the project, the research will also compare and contrast the differences between the shade cloth and control orchards when describing the amount of water and CPP usage. This will provide quantifiable data to the growers on how shade cloth can

reduce costs. Once benefits and results are calculated, this information will be available to the California apple industry in February 2017. Again, if the extension is approved all research will be available in February 2018. All research will be conducted by a third party researcher who will work in conjunction with the participating growers. This third party researcher will be required to provide the CAC with bi-monthly status reports on the progress of the grant with a final report due in December 2017. The CAC will serve as a distribution and coordination center for all the information collected from this grant. In February 2015, 2016, and 2017 the CAC will provide the industry with an update of the grant through the CAC annual report to the industry. Per approval of the extension, in February 2018, a final report with the conclusions of the grant will be provided to the industry within the CAC annual report to the industry.

BUDGET NARRATIVE

Budget Summary	
Expense Category	**Funds Requested**
A. Personnel	$12,797
B. Fringe Benefits	$0
C. Travel	$851
D. Equipment	$0
E. Supplies	$0
F. Contractual	$65,000
G. Other	$10,000
Direct Costs Subtotal	**$88,648**
H. Indirect Costs	$0
Total Budget	**$88,648**

A. Personnel

#	Name/Title	Level of Effort	Funds Requested
1	Carrie Schellenberg, Research Coordinator – Part-Time Employee	960 hours	$12,797.00
		Personnel Subtotal	**$12,797**

Employee 1: The research coordinator will perform the day-to-day operations of the project and act as a liaison to the third party researcher and the growers participating in the project. Specifically, this involves communicating with the researcher and growers on a regular basis to make sure the grant requirements are being met and that the work plan is being followed in a timely manner; keeping the Directors updated on the status of the project; and submitting necessary grant documents. The research coordinator will work on all above activities throughout the duration of the grant, which is anticipated to start in March 2017 and finalize in February 2018.

B. Fringe Benefits

No costs requested.

C. Travel

#	Trip Destination	Type of Expense	Unit of Measure	Number of Units	Cost per Unit	Number Claiming Expense	Funds Requested
1	Linden	Mileage	Miles	300	$0.54	1	$162.00
		Per Diem	Days	1	$34.50	1	$34.50
2	Linden, Lodi, Courtland, and/or Modesto	Mileage	Miles	360	$0.54	2	$389.00
		Per Diem	Days	1	$34.50	2	$69.00
3	Linden	Mileage	Miles	300	$0.54	1	$162.00
		Per Diem	Days	1	$34.50	1	$34.50
						Travel Subtotal	**$851**

Trip 1 (01/2017): This meeting will allow all participants in the project to be on the same page regarding payment of grant costs, data collection details, as well as the project objectives which are outlined in the grant. One day trip.

Trip 2: Visits to the trial blocks by CAC staff allow the CAC to be more connected to the actual state of the shade cloth; to see what is actually going on out there, to take pictures, and to talk with the growers in person regarding their site. Two, one day trips.

Trip 3 (12/2017): This meeting accomplishes the same benefits of trip one and allows for any final input from participants that may be useful for the final report or any other project information dissemination by the CAC. One day trip.

CONFORMING WITH YOUR TRAVEL POLICY ☑
By checking the box to the right, the recipient confirms that the organization's established travel policies will be adhered to when completing the above-mentioned trips in accordance with 2 CFR 200.474 or 48 CFR subpart 31.2 as applicable.

D. Equipment

No costs requested.

E. Supplies

No costs requested.

F. Contractual

#	Name/Organization	Hourly Rate / Flat Rate	Funds Requested
1	Fruit Dynamics	Flat Rate	$35,000
2	Prima Frutta	Flat Rate	$12,000
3	Lodi Farming	Flat Rate	$7,500
4	BK Partners	Flat Rate	$7,500
5	Greene & Hemly	Flat Rate	$3,000
		Contractual Subtotal	**$65,000**

Contractor 1: Fruit Dynamics
Fruit Dynamics is the third party researcher that was hired for the 2014 Specialty Crop Block Grant received for the shade cloth project. The contract will be extended for an additional year so that the researcher may continue the data collection and analysis they have already begun for the current project.

Contractor 2: Prima Frutta
Prima Frutta is a grower that the CAC will work with throughout the duration of this project. Prima Frutta will conduct all shade cloth trials and research listed within this grant. They will also be responsible for communication with the CAC and Fruit Dynamics regarding status reports and coordination efforts. They have allotted eight acres for the purposes of shade cloth research.

Contractor 3: Lodi Farming
Lodi Farming is a grower that the CAC will work with throughout the duration of this project. Lodi Farming will conduct all shade cloth trials and research listed within this grant. They will also be responsible for communication with the CAC and Fruit Dynamics regarding status reports and coordination efforts. They have allotted five acres for the purposes of shade cloth research**.**

Contractor 4: BK Partners
BK Partners is a grower that the CAC will work with throughout the duration of this project. BK Partners will conduct all shade cloth trials and research listed within this grant. They will also be responsible for communication with the CAC and Fruit Dynamics regarding status reports and coordination efforts. They have allotted five acres for the purposes of shade cloth research.

Contractor 5: Greene & Hemly
Greene & Hemly is a grower that the CAC will work with throughout the duration of this project. Greene & Hemly will conduct all shade cloth trials and research listed within this grant. They will also be responsible for communication with the CAC and Fruit Dynamics regarding status reports and coordination efforts. They have allotted two acres for the purposes of shade cloth research.

CONFORMING WITH YOUR PROCUREMENT STANDARDS ☑
By checking the box to the right, the recipient confirms that the organization followed the same policies and procedures used for procurements from non-federal sources, which reflect applicable State and local laws and regulations and conform to the Federal laws and standards identified in 2 CFR Part 200.317 through.326, as applicable. If the contractor(s)/consultant(s) are not already selected, the organization will follow the same requirements.

G. Other

#	Item Description	Cost Per Unit	Number of Units	Acquire When?	Funds Requested
1	Shade Cloth Maintenance	$500	20	As needed	$10,000.00
				Other Subtotal	**$10,000**

Expense 1: Throughout the season and possibly during installation/takedown, the shade cloth can tear or become dislodged from the anchoring systems. These braces, clips, rings, and wirings will need to be repaired or replaced. This cost is an annual requirement for a shade cloth orchard.

H. Indirect Costs
No costs requested.

Anuradha Prakash
Chapman University

Next Steps

We propose to conduct a comprehensive study on the effect of phytosanitary irradiation on two major export varieties of apples from California, 'Gala' and 'Granny Smith,' with the ultimate goal of developing quality standards for fruit that may be irradiated. The specific objectives are to:

a) Evaluate how the stage of maturity at harvest impacts irradiated fruit physiology.
b) Evaluate whether diphenylamine (DPA) treatment is necessary to prevent superficial scald in irradiated 'Granny Smith' apples.
c) Conduct a comparative evaluation of irradiated fruit with fumigated fruit.
d) Determine how year-to-year variability in fruit quality affects irradiated fruit quality.
e) Understand the changes in postharvest physiology as a result of irradiation so quality impacts can be minimized by factors such as management of temperature, maturity at harvest and at treatment, and storage conditions.
f) Provide industry groups with critical knowledge about the effects of irradiation on the quality of specialty crops. Because irradiation can have significant positive or negative effects on fruit quality, knowledge of how this affects these specific California varieties of greatest export value to Mexico is critical for making decisions about whether to use irradiation.

The results of this project will help develop quality standards that growers and shippers can implement to ensure that the fruit is harvested and treated at the optimum maturity stage for irradiation, assure high post-treatment quality and shelf-life during commercial distribution and to integrate irradiation as a viable phytosanitary option into commodity export systems.

PEST, DISEASE & STANDARDIZATION

PEST, DISEASE, & STANDARDIZATION SUMMARY

The California apple industry continues to strive to produce a healthy and safe product. Through its work in pests, disease, and standardization, the Commission continues to partner with other entities to represent the industry on critical issues.

The Food Safety Modernization Act (FSMA) was signed into law on January 4th, 2011 by President Barack Obama. The purpose of the law mandates the U.S. Food and Drug Administration (FDA) to implement a "comprehensive, science-based, preventative control across the food supply." For several years, the Administration drafted several new rules including: Preventative Controls For Food Facilities, Produce Safety Rule, Authority To Prevent Intentional Contamination, Inspection Frequency, Records Access, and Testing By Accredited Laboratories. Although these rules have been drafted, guidance documents are still being formulated. The FDA has made it clear that the Administration plans to do an education roll out to assist growers, packers, and handlers on the implementation of the new Act.

The Commission will continue to update the industry as these new guidance documents are released. For more information, please visit the following link to view the most recent publication of the rules for the Food Safety Modernization Act : www.fda.gov/Food/GuidanceRegulation/FSMA/default.htm.

CALIFORNIA APPLE EXPORT MARKETS

WORLD APPLE REVIEW

The publication of the World Apple Review was launched two decades ago by Dr. Desmond O'Rourke to provide the apple industry with an insight into issues happening across the global market. The report includes summaries of both current and future issues within the industry. The 2017 edition of The World Apple Review called *Solving the Variety Puzzle*, has one dominant theme which identifies the key changes that are affecting our industry. Specifically, the review outlines changes that may affect areas such as production, trade, processing, consumption, marketing, pricing, and profitability in old and new apple varieties.

Other topics that this year's World Apple Review covers include the following and more:

- Can the period of recent prosperity be sustained?
- Demand for non-traditional fruits surging;
- More apples becoming available for export;
- Challenges penetrating markets in Middle East, Southeast Asia, South America;
- Apple demand responds slowly to income increases, strongly to price increases;
- How inflation and exchange rates are affecting global competition;
- Organics still winning the public relations battle over conventional fruit;
- Technology now an integral part of competition in fresh apples; and
- Labor anxiety is still pervasive. How close is automation as a solution?

These annual reviews have been beneficial in providing readers with an early insight and the knowledge to proactively address these issues as they arise in their businesses. Read more about the World Apple Review at www.e-belrose.com.

CA GROWN PARTNERSHIP

California Grown, also known as the Buy California Marketing Agreement (BCMA), is a joint effort of agricultural industry groups representing the products of California's farms, ranches, forests, and fisheries. Working as an advisory board to the California Department of Food and Agriculture, BCMA brings together industry and government resources to increase the awareness, consumption, and value of California agricultural products, helping the state's consumers enjoy the best of the California lifestyle.

California Grown is funded through public and private contributions by the U.S. Department of Agriculture, the California Department of Food and Agriculture, and California agricultural organizations.

The CAC participates as an active member of the California Grown partnership by attending regular board meetings and joining internal committees. Through this partnership, the CAC is able to promote California apples at various events including, California Agriculture Day at the Capitol, the Produce Marketing Association's Fresh Summit Exposition, and many more.

CALIFORNIA APPLE EXPORT AND DOMESTIC MARKET OVERVIEW

The California Apple Commission has culminated the final export numbers for the 2016/2017 season. California exported a total of 86,464 boxes. Exports were extremely down throughout the U.S. and California was not an exception. Access to markets that the U.S. and California have normally enjoyed were curtailed by anti-dumping disputes, phytosanitary restrictions, and other logistical problems. Combined with the strengthening of the U.S. dollar, which caused U.S. products to be more expensive than their competitors, export volumes were going to decrease. California is still one of the largest exporters in the United States and actively recieves Market Access Program dollars to help maintain these necessary export markets.

Last season, the Commission and the US Apple Export Council received $998,749 for the 2016-2017 program year and will receive roughly $1,000,000 for the 2017/2018 program year.

California receives many benefits from the overall funding as we are one of the largest exporters on the Council and participate in almost every export program. Below is a list of the top five countries and U.S. states that California shipped to this season. Enclosed is an overview of each market that receives MAP, TASC, or EMP funding and all statistical shipping and destination information.

Top Countries		**Top U.S. States**	
1) Canada	(70,196)	1) California	(622,088)
2) Mexico	(10,716)	2) Texas	(132,264)
3) Taiwan	(5,552)	3) Florida	(80,270)

FOREIGN AGRICULTURAL SERVICE

The Foreign Agricultural Service (FAS) helps expand and maintain foreign markets for U.S. agricultural products by removing trade barriers and enforcing U.S. rights under existing trade agreements. The FAS works with foreign governments, international organizations, and the Office of the U.S. Trade Representative to establish international standards and rules to improve accountability and predictability for agricultural trade. Additionally, FAS partners with cooperators, such as the U.S. Apple Export Council, to help U.S. exporters develop and maintain agricultural export markets. FAS distributes funding to these cooperators via the Farm Bill under programs such as the Market Access Program (MAP), Technical Assistance for Specialty Crops (TASC), and Emerging Market Programs (EMP). Each of these programs keep U.S. products more competitive and counter the subsidized foreign competition in the international market.

Currently, the California Apple Commission, through partnering with the US Apple Export Council, received a share of the $998,749 for the 2016-2017 season. This funding allocation covered 9 export markets, in which California participated in four of the markets. These dollars funded programs such as the Mexico inspection program, import and retail trade servicing within the export markets, consumer communication, trade missions, education, and market research. The overall allocation to the U.S. Apple Export Council for the 2017-2018 program year will be roughly $1,000,000.

CANADA

Canada continues to be the largest and most important export market, hovering at about 60% of total California apple exports. Competition from early variety Washington state apples, holdover from the southern hemisphere, and the influx of Chinese apples has severely squeezed California's shipping window. This is not just an apple specific problem, other commodities are experiencing the same difficulties.

Additionally, the exchange rate fluctuations between the Canadian dollar (CAD) and the U.S. dollar (USD) have slowed trade for most commodities between the two countries. In January 2016, the CAD was worth $.68 per $1 USD, a decade low, and is currently hovering around $.77 CAD per $1 USD. The lower value has forced U.S. goods to be relatively more expensive, thus leading Canadians to buy more foreign imports such as Chinese apples. On a positive note, the exchange rate for the Canadian dollar has steadily risen since May 2017 and looks to be stabilizing which should help with the purchasing of the traditionally more expensive U.S. products.

As for local apple production, Canada has notoriously seen production decline consistently over the last decade. New varieties are beginning to stem the decline as apples that are more conducive to the Canadian weather conditions are being planted. Fortunately, it will be several years before the HoneyCrisp, Ambrosia, and Artic apple varieties hit full production. The local varieties should not directly compete with California varieties, but it will increase competition in an already saturated market.

In 2016, the USAEC began a new strategy in Canada. This strategy includes coordinating with California shippers and targeting specific retailers at particular times based on the shipments that were going to Canada. This strategy was referred to as "Following the fruit," and the USAEC is going to continue this method in 2017-2018 with the hopes of partnering with other commodities to stretch resources. Additionally, the USAEC is now running the tasteUS marketing Global Based Initiative (GBI) which should provide additional resources and funding to pair with the USAEC assets.

The Foreign Agriculture Service and the U.S. Apple Export Council will contribute $90,935 in 2017-2018 on behalf of the California Apple Commission to help maintain this market.

MEXICO

Due to Mexico's close proximity to California and ability to purchase specific sizes and varieties, Mexico continues to be a strong export market for California apples. Difficulties such as competition from holdover in the southern hemisphere, earlier varieties from Washington State, and antidumping litigation have slowed exports to Mexico. As a whole, the U.S. apple industry relies on the Mexico market greatly. When it comes to apples, Mexico is the United State's largest trading partner. When the Mexico market has fluctuated or has been stymied, the U.S. apple industry has staggered. The goal of the Commission and the USAEC is to keep the border open and limit any interruptions. Marketing efforts have been eliminated and all efforts and funding goes towards market access issues.

With that in mind, as the new administration ramps up efforts to modernize the North American Free Trade Agreement (NAFTA), apples could quickly become a political pawn. Since U.S. agriculture, specifically apples, has benefited greatly from NAFTA, any restructuring to the original agreement will most likely include a "tit for tat" scenario. Mexico and Canada could use agriculture as push back when the U.S. begins to demand changes to the manufacturing sectors. Additionally, old problems such as anti-dumping litigation and country of origin labeling (COOL) issues could be revisited. Revisiting these issues would be incredibly harmful and detrimental to the apple industry. The Commission will be working with the US Apple Association to try and prevent this.

For the 2016-2017 season, the Mexico inspection program continued the phase-out process of the newly negotiated workplan. In the new workplan, the inspector arrived in California in July and certified all participants in the export program. Once fumigation chambers and cold treatment rooms were certified by the Mexico inspector, he returned to Mexico and USDA-APHIS took over. The Mexico inspector returned to California two additional times in 2016. These additional visits were to inspect USDA-APHIS inspections and to ensure the program was in compliance. A total of 19,908 boxes were inspected and subsequently approved by USDA-APHIS with no apparent pests. The 2016 export season marked the 2nd year of the 4 year phase-out process. In 2017, the third year of the phase-out program, the Mexico inspector came to California for 3 days in early July to initiate the program. USDA-APHIS will maintain the program throughout the duration of the export season with the Mexico inspector returning to California in mid-September for a final compliance review. This phase-out process has significantly reduced the overall cost to the program which at its peak was close to $80,000 and is now roughly $5,000 annually.

Additionally, the Commission, in conjunction with USDA-APHIS and Chapman University, was successful in adding irradiation as an additional treatment protocol to Mexico export program. California apples are now allowed to be irradiated in the U.S. or Mexico (if tarped) as a treatment protocol. California apples are being used as a trial run for other commodities. With the help of Chapman University, research on irradiation and apples will continue throughout the 2017 season.

The Foreign Agriculture Service and the U.S. Apple Export Council will contribute $12,000 in 2017-2018 on behalf of the California Apple Commission to help maintain this market.

SOUTHEAST ASIA

The South East Asia (SEA) region, which includes Malaysia, Thailand, Indonesia, Singapore, Vietnam, and the Philippines, was once one of California's largest trading partners. Unfortunately, the market has not fully recovered from the Listeria crisis in 2014.

At one point, South East Asia (SEA) was one of the most important export markets, not only to California, but to all of the United States. Exports to SEA have decreased due to several reasons. Specifically, the region has been engulfed with cheap Chinese apples which flooded the region once news of the Listeria outbreak spread. When the Russian ban on Western goods began, it was thought that China would fill the void being left by Poland and the SEA region would return to "normal." Unfortunately, this has not happened. Citing concerns regarding the quality and safety of U.S. apples, retailers in SEA are wanting prices comparable to their Chinese counterparts. In 2016, 87% of Chinese apple exports were directed to the SEA region.

To attempt to combat this trend, the US Apple Export Council (USAEC) has increased the focus on SEA. The USAEC, in conjunction with Washington State, began addressing the food safety concerns by contacting the retailers directly and providing educational materials. Additionally, the USAEC began marketing other varieties, such as the Empire apple out of New York. This apple has gained some traction which has encouraged other USAEC members to become involved. The apple variety with the most success is the Granny Smith. With the departure of one of California's largest Granny Smith suppliers, a void has been created which has yet to be filled.

In 2017, the USAEC will conduct a trade mission to SEA. This mission will have two main objectives. First, to meet with fruit buyers and educate them on the varieties and availability of apples outside of Washington State. Second, to inform the buyers and government officials about the steps that were taken to correct and prevent any future food safety problems. Although the listeria outbreak was a very rare and isolated incident, reassuring the SEA community should help the rejuvenation process.

The Foreign Agriculture Service and the U.S. Apple Export Council will contribute $257,000 in 2017-2018 on behalf of the California Apple Commission to help maintain this market.

INDIA

India is rapidly becoming one of the largest importers of apples in the world. According to the World Apple Review, India has grown from importing roughly 99,000 metric tons of fresh apples in 2009 to around 247,000 metric tons in 2016. Red Delicious apples from Washington State and Fuji apples from China make up the majority of the imports. Since India has an enormous middle and upper class, demand for other varieties of high quality apples is also increasing. As the Indian government has eased restrictions that prevented large retail chains from entering the market, more locations and avenues for the consumer to buy high quality produce is increasing.

After several research and exploratory years, the USAEC made the decision to begin committing more resources into India. These funds have been used for retail promotions, trade shows, representation, and trade missions. Although California supports the USAEC efforts to expand and build a market in India, the CAC does not view India as a priority market for California. If the Indian market is developed and expanded, more apples from Washington State and the Eastern U.S. will be exported there which should ease pressure on more localized and California specific export markets, such as Canada and Mexico.

THE RUSSIAN EFFECT ON EXPORTS

Since 2014, Russia has enforced an embargo against most western products. Unfortunately, apples continue to be one of the top products on that banned list. At one point, Russia was the largest importer of apples in the world. Once the embargo took effect, it was thought that other non-western countries, mainly China, would fill the void. Unfortunately, due to the world economic sanctions, the Russian economy began to slow and the ruble's value dropped dramatically. This drop in value decreased the purchasing power of Russia and sent the non-western apples elsewhere.

The embargo has severely affected exports by the European Union, mainly Poland who produces over 40 million boxes annually. To combat this influx of apples within the EU, the EU member countries provided emergency funds to promote the domestic consumption of apples. Additionally, the EU has become much more aggressive in the promotion and expansion of EU apples in other markets such as South America, Asia, and Africa. Poland, the country most hurt by the Russian embargo, has tried to decrease their exposure by bypassing the embargo through using less reputable trade routes into Russia. Russian authorities have gradually clamped down on the smuggling of western products into Russia which has left Poland and other EU members quickly looking for other markets. Furthermore, Poland is attempting to fast track their access for entry into the United States by piggy-backing on the current EU protocols. In June 2017, Congress asked USDA-APHIS to conduct a full pest and disease risk analysis to ensure Poland is able to meet the requirements. If Poland cannot meet the current EU requirements, they will be forced to follow a more stringent and comprehensive workplan.

This dramatic increase of EU apples into the world market has caused a slight decrease in the demand for U.S. apples. The U.S. apple industry is aware of the new competition and have adjusted promotional and educational funds to combat the issue. For now, most importers are still choosing the United States' consistency and quality over the cheaper Polish apples.

CALIFORNIA APPLE DOMESTIC AND EXPORT STATISTICS

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2016-2017

STATE	GALA	GRANNY SMITH	FUJI	PINK LADY	BRAEBURN	OTHER	TOTAL
ALABAMA	6,429	588	5,640				12,657
ARIZONA	36,216	28,494	765	4,837	400		77,312
ARKANSAS	13,800		3,840				17,640
CALIFORNIA	208,719	169,507	146,279	66,989	3,611	26,982	622,087
COLORADO	10,465	882	588		559	547	13,041
CONNECTICUT		686	98				784
FLORIDA	58,350	8,882	10,836		98	2,104	80,270
GEORGIA	31,989	13,808	6,062	88	98		52,045
HAWAII	405		1,614				2,019
ILLINOIS	50,886	5,546	5,140				61,573
INDIANA	19,781	1	4,367		363	1,324	25,836
IOWA	3,905	2,086	175	147	7		6,320
KANSAS	560		176				736
KENTUCKY	10,359	419	3,584		441	1,882	16,685
LOUISIANA	10,197	784	720				11,701
MAINE	8,880	3,000	1,380	1,003			14,263
MARYLAND	436	1,302	49			1,470	3,257
MASSACHUSETTS	1,918	702	294				2,914
MICHIGAN	30,174	2,922	4,507				37,603
MINNESOTA	24,279	42,951	6,099	1,212	294	1,987	76,823
MISSISSIPPI	10,143	98	2,640				12,881
MISSOURI	28,121	1,958	4,679				34,758
MONTANA							
NEBRASKA	10,620		180				10,800
NEVADA	12,019	21,686	14,809	5,065			53,579
NEW HAMPSHIRE		70					70
NEW JERSEY	1,653	1,504			47		3,204
NEW MEXICO	16,100	10,329	2,820	240			29,489
NEW YORK	10,811	16,276	3,525	1,564			32,176
NORTH CAROLINA	16,502	247	4,285		49	1,407	22,490
OHIO	34,717	836	5,943			686	42,182
OKLAHOMA	16,406	12,214	4,020	4,100			36,740
OREGON	70	46	98		49	70	333
PENNSYLVANIA	26,187	24,401	7,969	2,311		364	61,232
SOUTH CAROLINA	11,620	441	2,040				14,101
TENNESSEE	15,066	2,352	3,479				20,897
TEXAS	83,273	20,873	16,661	8,012	23	3,422	132,264
UTAH	30,975	3,120	9,747	4,350			48,192
VERMONT			98		484		582
VIRGINIA	13,200	196	2,141				15,537
WASHINGTON	6,144	3,430	3,128		98	191	12,991
WISCONSIN	19,219	2,688	3,157		343		25,407
WYOMING	5,180		200				5,380
TOTAL	**895,776**	**405,326**	**300,434**	**99,919**	**6,964**	**42,436**	**1,750,856**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2015-2016

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	21,302	455	1,552				23,309
ALASKA	217						217
ARIZONA	28,834	15,001	735	2,596			47,166
ARKANSAS	10,214	160	325				10,699
CALIFORNIA	240,232	163,692	120,450	49,540	8,910	29,721	612,547
COLORADO	6,853	441	540		196	119	8,149
CONNECTICUT	196	49					245
FLORIDA	57,843	10,004	5,635	25	266	119	73,892
GEORGIA	25,217	12,066	4,220				41,503
HAWAII	392		645				1,037
ILLINOIS	42,631	21,879	7,268	490	441	322	73,031
INDIANA	25,827	4,375	2,394		357	47	33,000
IOWA	3,159	2,266	49	56	21		5,551
KANSAS	1,880	147		595			2,622
KENTUCKY	15,272	848	1,313		390	190	18,013
LOUISIANA	14,208	4,599	2,991				21,798
MAINE	8,515	3,398					11,913
MARYLAND	588	2,122	49				2,759
MASSACHUSETTS	4,760	2,425	309	877	27	98	8,496
MICHIGAN	23,078	3,692	7,090	98	98		34,056
MINNESOTA	8,128	32,437	147	1,922	1,058	539	44,231
MISSISSIPPI	12,558	195	969				13,722
MISSOURI	31,929	7,839	5,605				45,373
NEBRASKA	11,887	260					12,147
NEVADA	14,280	9,782	9,045	4,144			37,251
NEW HAMPSHIRE	98	196				21	315
NEW JERSEY	2,800	2,366	35		391	98	5,690
NEW MEXICO	18,311	14,588	2,176	2,278	301		37,654
NEW YORK	15,790	18,715	2,161	294			36,960
NORTH CAROLINA	18,743	4,611	3,825		112		27,291
OHIO	34,639	5,433	4,923		145	98	45,238
OKLAHOMA	18,967	7,795	4,005				30,767
OREGON	539	882	98		82	31	1,632
PENNSYLVANIA	24,206	21,171	5,475	1,029			51,881
RHODE ISLAND	1						1
SOUTH CAROLINA	11,775	260	520				12,555
TENNESSEE	8,586	2,906	946				12,438
TEXAS	101,285	37,828	13,882	11,278	178	49	164,500
UTAH	26,866	3,499	2,786				33,151
VIRGINIA	6,611	130					6,741
WASHINGTON	4,601	244					4,845
WISCONSIN	22,636	4,365	4,330				31,331
WYOMING	4,110	2,836	1,365				8,311
Total	**930,566**	**425,958**	**217,859**	**75,222**	**12,973**	**31,452**	**1,694,032**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2014-2015

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	19,241	3,962	1,369	1,950			26,522
ARIZONA	14,444	24,323	4,745	582	49		44,143
ARKANSAS	8,005	455	65	975			9,500
CALIFORNIA	189,811	275,407	124,793	12,261	3,236	55,912	661,422
COLORADO	1,666	8,363	2,932		525	1,846	15,332
CONNECTICUT	203	49					252
FLORIDA	41,915	15,708	9,603	2,517	49	308	70,100
GEORGIA	17,531	16,499	4,928	975	147	49	40,129
HAWAII	121						121
ILLINOIS	23,628	16,548	8,195	2,296	443	1,078	52,188
INDIANA	21,419	5,479	2,674	2,656	273	1,596	34,097
IOWA	2,805	6,327	166		93		9,391
KANSAS	759	3,001	25		98		3,883
KENTUCKY	8,443	1,450	294	975		392	11,554
LOUISIANA	5,855	2,685	2,579	1,460			12,579
MAINE	5,155	1,011		975			7,141
MARYLAND	774	8,267	98			929	10,068
MASSACHUSETTS	6,523	21,987	735	1,521	98	772	31,636
MICHIGAN	11,469	5,176	6,129		97		22,871
MINNESOTA	3,224	32,643	182	294	977	250	37,570
MISSISSIPPI	3,642	650	780	843			5,915
MISSOURI	20,588	8,420	5,560	2,360			36,928
NEBRASKA	10,673	520	650	1,235			13,078
NEVADA	11,446	11,657	1,225	975			25,303
NEW HAMPSHIRE						143	143
NEW JERSEY	539	17,332	1,176			224	19,271
NEW MEXICO	7,595	11,026	1,865	650			21,136
NEW YORK	7,274	46,356	2,164	1,612	28	14	57,448
NORTH CAROLINA	13,728	5,187	3,479	975	30	87	23,486
OHIO	27,916	8,354	4,554	1,967		954	43,745
OKLAHOMA	14,000	2,930	3,161	1,820			21,911
OREGON	2,450	98	49		98	216	2,911
PENNSYLVANIA	22,817	34,032	3,859	2,275	355	1,005	64,343
SOUTH CAROLINA	10,182	1,531	455	649			12,817
TENNESSEE	7,364	5,156	1,040	975			14,535
TEXAS	93,389	66,219	19,958	12,899	98	3,117	195,680
UTAH	5,819	3,138	1,820	650			11,427
VIRGINIA	14,345	4,890	1,550	1,170			21,955
VERMONT			14			35	49
WASHINGTON	6,798	11,134		650		145	18,727
WISCONSIN	9,782	2,810	3,306	975			16,873
WYOMING	15,203	2,025	1,340	650			19,218
TOTAL	688,547	692,806	227,517	62,767	6,694	69,072	1,747,405

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2013-2014

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	17,359	940		98	294		18,692
ARIZONA	21,303	10,779	1,618	4,035	427		38,162
ARKANSAS	11,709						11,709
CALIFORNIA	223,144	426,553	173,135	102,500	8,041	36,557	969,932
COLORADO	3,396	1,979	359	70	196	1,48	7,481
CONNECTICUT	851						851
DIST. OF COLUMBIA	931						931
FLORIDA	31,727	6,234	3,909	70	583	469	42,993
GEORGIA	12,703	9,871	3,587		441	49	26,651
HAWAII	405	98	1,785				2,288
ILLINOIS	41,011	5,532	3,968	2,695		442	53,648
INDIANA	16,402	18,087	1,632	533		728	37,382
IOWA	2,403	3,925	1,715	903	1,078		10,024
KANSAS				430			430
KENTUCKY	10,043	5,902	245	80	490	523	17,283
LOUISIANA	4,822	83	1,785	15			6,705
MAINE	1,950	1,666					3,616
MARYLAND	1,798	196	128	441	14	642	3,219
MASSACHUSETTS	5,612	14,423	2,372	2,691	343	1,116	26,557
MICHIGAN	8,770	8,987	5,375		224		23,356
MINNESOTA	1,920	23,794	441	828	1,597	405	28,985
MISSISSIPPI	7,152						7,152
MISSOURI	26,910	3,136	2,190	490			32,726
NEVADA	9,787	13,275	49				23,111
NEW HAMPSHIRE	77	294	98		371	147	987
NEW JERSEY	1,225	7,109	296	889	752	1,246	11,517
NEW MEXICO	13,368	93	142		28		13,631
NEW YORK	5,804	18,127	1,050	2,564	1,225		28,770
NORTH CAROLINA	9,202	3,418	3,129		21	70	15,840
OHIO	18,018	5,054	6,986	2,366		852	33,276
OKLAHOMA	20,949						20,949
OREGON	147	1,591			49	314	2,101
PENNSYLVANIA	13,292	21,603	4,659	885	337	1,420	42,196
SOUTH CAROLINA	3,345	352		49			3,746
TENNESSEE	5,690	5,647		2,532			13,869
TEXAS	99,327	126,276	3,950	16,169	920	1,463	248,105
UTAH	16,700	2,614		1,195			20,509
VIRGINIA	1,847	2,221			784		4,852
WASHINGTON	10,019	49,734				98	59,851
WISCONSIN	2,430	28	2,249		49		4,756
WYOMING	2,976						2,976
TOTAL	**686,538**	**799,625**	**226,852**	**142,530**	**18,264**	**48,022**	**1,921,832**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2012-2013

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	7,357	9,864	186				17,407
ARIZONA	17,341	16,655	4,374	1,294	21		39,685
ARKANSAS	3,998						3,998
CALIFORNIA	216,877	297,090	94,785	45,606	5,645	15,727	678,730
COLORADO	12,799	8,610	2,401	266	125	1,674	25,875
CONNECTICUT	343	539					882
FLORIDA	32,641	16,582	4,880	29		98	54,230
GEORGIA	19,698	16,398	8,218	2,940	147		47,401
HAWAII	1,079	1,027	1,244				3,347
IDAHO	490						490
ILLINOIS	27,676	14,968	1,581	9,124	411	1,238	54,998
INDIANA	10,106	6,154	3,357		98	671	20,386
IOWA	952	3,846	98	294	1,019		6,209
KANSAS	2,500	819		294			3,613
KENTUCKY	7,181	24,046	260		196	98	31,781
LOUISIANA	2,413	1,664	4,164				8,241
MAINE	854	6,514					7,368
MARYLAND	3,528	12,831	2,037	1,390	14	532	20,332
MASSACHUSETTS	13,181	20,379	3,087	1,420	392	21	38,480
MICHIGAN	20,278	21,915	18,758		21		60,972
MINNESOTA	2,010	43,745	693	581	695	2,049	49,773
MISSISSIPPI	6,829						6,829
MISSOURI	23,265	19,175	3,049				45,489
MONTANA	196			182			378
NEBRASKA	1,708						1,708
NEVADA	3,450	10,680	296				14,426
NEW HAMPSHIRE	147	245	52			1,459	1,903
NEW JERSEY	603	10,569	472			1,299	12,943
NEW MEXICO	3,899	147					4,046
NEW YORK	10,400	28,939	1,205	1,716	56	42	42,358
NORTH CAROLINA	2,399	4,811	1,313				8,523
NORTH DAKOTA		209					209
OHIO	22,938	10,808	2,874	1,743	49	980	39,392
OKLAHOMA	9,288	49	455				9,792
OREGON	3,309	2,891		686		137	7,023
PENNSYLVANIA	14,849	27,839	1,889	4,471	35	1,310	50,393
SOUTH CAROLINA	2,764	3,136					5,900
TENNESSEE	9,751	7,925		490			18,166
TEXAS	81,150	84,894	9,104	19,239	978	2,551	197,916
UTAH	11,847	777	399	1,540	35		14,598
VERMONT	49						49
VIRGINIA	1,894	2,296	377				4,567
WASHINGTON	9,238	14,858	134	1,070	147		5,447
WISCONSIN	7,845	294	287	91	444		8,961
WYOMING	5,178		175				5,353
TOTAL	639,296	754,189	172,204	94,466	10,528	29,886	1,700,568

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2011-2012

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	14,602	14,319		147			29,068
ARIZONA	33,583	27,018	3,405	5,160		1,653	70,819
ARKANSAS	9,425						9,425
CALIFORNIA	187,132	251,077	102,186	48,385	2,600	60,198	651,580
COLORADO	18,294	15,684	3,009	1,596	303	1,429	4,0316
CONNECTICUT	3,388	1,568	98				5,054
DIST. OF COLUMBIA	196	196				686	1,078
FLORIDA	35,384	30,768	2,588		21	3,174	71,935
GEORGIA	31,182	17,718	7,505	2,450		3,058	61,913
HAWAII	294	98	343				735
IDAHO	133	539					672
ILLINOIS	41,511	35,830	4,893	3,920	245	5,609	92,009
INDIANA	34,460	31,970	3,103		210	2,925	72,668
IOWA	483	5,497	32		234		6,246
KANSAS	2,604	4,440	198	588		1,675	9,506
KENTUCKY	14,240	23,990	882		147	1,397	40,656
LOUISIANA	13,133	5,045	3,220				21,398
MAINE	1,631	11,870					13,501
MARYLAND	6,451	17,761	21,655	7,028		3,155	56,050
MASSACHUSETTS	4,949	37,752	4,655	6,909	156	8,272	62,693
MICHIGAN	26,632	21,455	7,670	196	420	4,953	61,326
MINNESOTA	11,598	54,720	49	2,429	1,742	19,808	90,347
MISSISSIPPI	3,705	3,045					6,750
MISSOURI	2,7841	16,293	5,754	1,637		3,466	54,992
MONTANA	245	1,077					1,322
NEBRASKA	7,605	7,163		168			14,936
NEVADA	7,319	7,323	245			1,134	16,021
NEW HAMPSHIRE	350	420			21	290	1,081
NEW JERSEY	6,344	18,777	196		14	812	26,143
NEW MEXICO	11,473	5,948	49				17,470
NEW YORK	8,182	36,120	2,128	3,393		5,186	55,009
NORTH CAROLINA	8,000	24,677	2,974	416	63	273	36,404
NORTH DAKOTA		28		40		147	215
OHIO	42,361	24,357	7,017	539	98	1,428	75,800
OKLAHOMA	13,444	12,475	1,533		145	49	27,646
OREGON	2,685	4,004	196			962	7,848
PENNSYLVANIA	19,164	33,233	2,856	7,894	258	3,615	67,020
RHODE ISLAND		147					147
SOUTH CAROLINA	1,160	10,472				294	11,926
TENNESSEE	15,619	12,703		1,746		2,058	32,127
TEXAS	91,224	93,039	6,795	19,445	441	7,071	21,8016
UTAH	27,451	13,053	4,420	735		98	45,757
VERMONT	196	49					245
VIRGINIA	8,295	11,546	686			1,134	21,661
WASHINGTON	18,581	28,204	6,569		49	7,093	60,496
WISCONSIN	8,934	10,636	665	196	33	637	21,101
WYOMING	18,420	5,235	1,820				25,475
TOTAL	**839,913**	**989,347**	**209,396**	**115,018**	**7,201**	**153,739**	**2,314,612**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2010-2011

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	14,342	49					14,391
ARIZONA	59,031	42,189	714	490	1,593	269	104,286
ARKANSAS	3,960	3,700					7,660
CALIFORNIA	336,880	360,229	258,476	84,676	16,105	27,485	1,083,854
COLORADO	10,817	6,159	2,093	1,909	49	1,225	22,252
CONNECTICUT		2940					2,940
DIST. OF COLUMBIA	854	784	98				1,736
FLORIDA	25,780	13,003	4,368	240	128	499	44,018
GEORGIA	20,929	15,512	4,246	1,078		927.1	42,692
HAWAII	987	123	441				1,551
ILLINOIS	40,796	25,316	4,796			538	71,447
INDIANA	16,546	9,054	4,375		98	1,939	32,012
IOWA	2,072	2,058			49		4,179
KANSAS	98	98		1,073			1,269
KENTUCKY	14,323	1,074	147	5,880	514		21,938
LOUISIANA	4,234	5,499	1,995				11,728
MAINE	1,738	17,983					19,721
MARYLAND	3,647	23,335	1,239	2,177		1,470	31,868
MASSACHUSETTS	4,879	56,419	2,205	5,376	245		69,124
MICHIGAN	5,150	14,247	6,037	652	245		26331
MINNESOTA	9,996	49,460	245	2,695	326	441	63,163
MISSISSIPPI	6,039						6,039
MISSOURI	15,068	10,924	2,660	1,470	98		30,221
MONTANA				49			49
NEBRASKA	4,175						4,175
NEVADA	18,566	24,762	49				43,377
NEW HAMPSHIRE	441	147			147	288	1,023
NEW JERSEY	7,135	23,917	985	273		1,331	33,641
NEW MEXICO	11,296	2,798	244		98		14,436
NEW YORK	7,020	68,482	1,905	1,118	98		78,624
NORTH CAROLINA	12,746	6,768	4,011	50	529	1	24,105
NORTH DAKOTA	98						98
OHIO	13,440	5,911	5,295	5,864		190	30,700
OKLAHOMA	12,915	8,098	1,934	196			23,143
OREGON	7,470	947	2,176	486	87	273	11,439
PENNSYLVANIA	24,328	27,605	4,684	1,078	539	378	58,612
SOUTH CAROLINA	6,650	7,806					14,456
TENNESSEE	13,569	6,692	1,862	1,862			23,985
TEXAS	102,382	74,606	10,105	24,338	1,835	1,883	215,150
UTAH	22,768	147	116	490	28		23,549
VIRGINIA	6,860	4,508		637			12,005
WASHINGTON	9,543	13,650	4,620			196	28,009
WEST VIRGINIA				3			28,009
WISCONSIN	9,943	5,528	1,610	539			17,620
WYOMING	8,590	5,637	2,240				16,467
TOTAL	898,106	948,167	335,972	144,701	22,812	39,334	2,389,092

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2009-2010

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	22,663						22,663
ARIZONA	26,552	1,9541	3,420	2,798		91	52,402
ARKANSAS	13,630	3,885					17,515
CALIFORNIA	149,145	369,232	102,671	56,641	9,459	7,272	694,421
COLORADO	8,166	4,477	6,486	1,253	955	625	21,962
CONNECTICUT	588	1,813					2,401
DIST. OF COLUMBIA	196	98					294
FLORIDA	41,921	7,412	4,711		98	798	54,940
GEORGIA	15,769	6,911	4,354		490	196	27,720
HAWAII	963	196	1,470				2,629
IDAHO							0
ILLINOIS	30,488	13,201	7,799	392	294	1,478	53,652
INDIANA	32,647	12,166	5,726	238	245	392	51,414
IOWA		3,318	141	980	14		4,453
KANSAS	132		679	294			1,105
KENTUCKY	12,877	5,831	98		147	175	19,128
LOUISIANA	6,530	2,140	2,625				11,295
MAINE	4,140	22,842					26,982
MARYLAND	2,598	27,267	3,758	98	147	536	34,404
MASSACHUSETTS	3,773	38,984	2,914	3,073	2,082	21	50,847
MICHIGAN	20,237	27,456	882	4,265			52,840
MINNESOTA	5,537	33,074	35	490	147	1,055	40,338
MISSISSIPPI	6,480	769	49				7,298
MISSOURI	24,122	3,360	3,555	2,591			33,628
MONTANA	441	294	98		49		882
NEBRASKA	10,755	2,040					12,795
NEVADA	9,400	4,428					13,828
NEW HAMPSHIRE	196	949	147			226	1,518
NEW JERSEY	9,596	18,128				484	28,208
NEW MEXICO	10,685	196	147	98	49		11,175
NEW YORK	12,789	61,930	4,221	2,606	2,576	327	84,449
NORTH CAROLINA	12,041	2,212	2,115			21	16,389
NORTH DAKOTA	98						98
OHIO	31,194	12,076	2,655	3,670		439	50,034
OKLAHOMA	16,354	1,505	2,520				20,379
OREGON	2,298	5,037	1,666		98	189	9,288
PENNSYLVANIA	21,725	30,759	4,277		667	963	58,391
SOUTH CAROLINA	8,970	1,054					10,024
SOUTH DAKOTA							0
TENNESSEE	23,015	8,267	98				31,381
TEXAS	90,441	61,265	7,539	22,239	245	1421	183,150
UTAH	24,394	6,667	3,724	224			35,009
VIRGINIA	9,983	4,465	398				14,846
WASHINGTON	14,969	6,605	5,334			105	27,013
WISCONSIN	9,708	3,820	2,800	147	182		16,657
WYOMING	15,253	3,504					18,757
TOTAL	**763,463**	**839,175**	**189,114**	**102,097**	**17,945**	**16,814**	**1,928,608**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2008-2009

STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	17,805	10,038	3,914				31,757
ALASKA	98						98
ARIZONA	24,454	30,298	4,107	1,078		24	59,961
ARKANSAS	6,475	525					7,000
CALIFORNIA	274,786	673,536	177,101	93,594	4,384	25,446	1,248,847
COLORADO	12,467	17,015	3,761	3,111	844	1,260	38,458
CONNECTICUT	196	2,707					2,903
DIST. OF COLUMBIA	98						98
FLORIDA	47,269	21,400	1,081	98	234	3,263	73,345
GEORGIA	15,113	23,352	4,315		147	735	43,662
HAWAII	1,116	677	2,709				4,502
IDAHO	5,261	539	294				6,094
ILLINOIS	21,029	34,519	3,986	343	98	2,298	62,273
INDIANA	15,385	18,390	2,816	1,260	84	1,957	39,892
IOWA	588	3,094					3,682
KANSAS	1,793	1,029	147	245			3,214
KENTUCKY	11,478	12,793	1,274	666		310	26,521
LOUISIANA	5,026	4,782	875				10,683
MAINE		13,174					13,174
MARYLAND	9,307	44,072	735	1,323	196	49	55,682
MASSACHUSETTS	13,838	74,234	1,568	2,030		247	91,917
MICHIGAN	35,521	67,219	8,872	9,342			120,954
MINNESOTA	7,742	30,086	787	1,666	28	2,464	42,773
MISSISSIPPI	7,868	4,646	98				12612
MISSOURI	27,449	16,864	3,066	774	98		48,251
MONTANA		91				49	140
NEBRASKA	5,605	3,525					9,130
NEVADA	49	3772	196				4,017
NEW HAMPSHIRE	196	735			221	285	1,437
NEW JERSEY	11,738	46,759	441		441	372	59,751
NEW MEXICO	7,450	2,742			186		10,378
NEW YORK	11,631	84,835	2,033	2,295	285	758	101,837
NORTH CAROLINA	21,744	8,981	2,905				33,630
NORTH DAKOTA		49					49
OHIO	33,557	34,912	4914	6057	147	349	79,936
OKLAHOMA	10,081	3,379	935				14,395
OREGON	8,598	9,562	2170	735	294	4,403	25,762
PENNSYLVANIA	18,972	32,776	977	294	441	859	54,319
SOUTH CAROLINA	4,345	4,896					9,241
SOUTH DAKOTA	98						98
TENNESSEE	18,900	21,901		1,022			41,823
TEXAS	98,687	130,521	11,938	27,833	245	2,759	27,1983
UTAH	14,046	11,734	3,798	2,205			31,783
VIRGINIA	13,701	10,329	882	147			25,059
WASHINGTON	20,675	26,060	2,597			471	49,803
WISCONSIN	11,926	5,619					17,545
WYOMING	8,355	3,960					12,315
TOTAL	**882,516**	**1,552,127**	**255,292**	**156,118**	**8,373**	**48,358**	**2,902,784**

CALIFORNIA APPLE COMMISSION-UNITED STATES
DOMESTIC SHIPMENTS 2007-2008

STATE	GALA	GRANNY SMITH	FUJI	PINK LADY	BRAEBURN	OTHER	TOTAL
ALABAMA	7,007	1,877	320				9,204
ARIZONA	34,869	21,659	8,327	658		57	65,560
ARKANSAS	2,749	1,552					4,301
CALIFORNIA	164,591	401,910	211,817	73,568	13,359	16,357	881,602
COLORADO	14,522	18,184	2,796	2,744	172	371	38,789
CONNECTICUT		637				637	1,274
DIST. OF COLUMBIA		196					196
FLORIDA	27,818	11,543	796	1,139	245	683	42,224
GEORGIA	11,209	17,193	3,325			731	32,458
HAWAII	1,352	36	2,094	419	14	181	4,096
IDAHO	1,380	518					1,898
ILLINOIS	6,389	22,202	2,411	3,648	2,450	2,286	39,386
INDIANA	23,194	19,032	370	392	444	1,176	44,608
IOWA		8,701	3,517	980	2,576		15,774
KANSAS	1,959		98	3,185			5,242
KENTUCKY	7,624	9,313					16,937
LOUISIANA	4,312	3,129					7,441
MAINE	2,111	23,199	770				26,080
MARYLAND	9,861	13,381	541	2,100	637	280	26,800
MASSACHUSETTS	10,845	29,823	147	2,401			43,216
MICHIGAN	20,274	15,431	5,718	196		588	42,207
MINNESOTA	3,509	28,185	21	441	2,458	619	35,233
MISSISSIPPI	3,045	6,026	245				9316
MISSOURI	30,558	11,485	3,708	4,984			50,735
MONTANA	0	0	0	0	0	0	0
NEBRASKA	4,015	2,126	63		63		6,267
NEVADA	2,824	5,802	1,705		230		10,561
NEW HAMPSHIRE	103	221				424	748
NEW JERSEY	3,829	15,642	2,520	294		396	22,681
NEW MEXICO	1,323	3,170	640				5,133
NEW YORK	6,096	59,925	2,675	2450	49	478	71,673
NORTH CAROLINA	8,894	4,251	1,095				13,145
OHIO	28,481	25,165	4,282	294		293	58,515
OKLAHOMA	6,035		2,400				8,435
OREGON	2,569	629	372		97	963	4,630
PENNSYLVANIA	8,453	15,585	476			227	24,741
RHODE ISLAND	49	490					539
SOUTH CAROLINA	3,221	670	140				4,031
TENNESSEE	8,584	16,207		49			24,840
TEXAS	61,877	107,510	12,190	32,238	1,655	980	216,450
UTAH	10,760	4,261	1,215	147	137		16,520
VERMONT	0	0	0	0	0	0	0
VIRGINIA	6,371	3,574	1,365	539			11,849
WASHINGTON	5,414	6,932			98	189	12,633
WEST VIRGINIA	0	0	0	0	0	0	0
WISCONSIN	2,909	4,760		959			8,628
WYOMING	4,220	2,640	570				7,430
TOTAL	565,205	944,772	278,729	133,825	24,684	27,916	1,974,026

CALIFORNIA'S TOP 5 STATES

2001 - 2002		
1	California	1,146,587
2	New York	473,316
3	Texas	212,378
4	Massachusetts	105,896
5	Florida	96,877

2002 - 2003		
1	California	1,348,951
2	Texas	279,028
3	Massachusetts	126,021
4	New York	191,624
5	Illinois	141,671

2003 - 2004		
1		
2	California	1,409,491
3	Texas	328,190
4	New York	212,095
5	Florida	153,483
	Illinois	130,305

2004 - 2005		
1	California	1,385,719
2	Texas	289,084
3	New York	172,145
4	Michigan	113,914
5	Florida	104,664

2005 - 2006		
1	California	1,281,242
2	Texas	269,165
3	Massachusetts	127,127
4	New York	125,481
5	Michigan	103,177

2006 - 2007		
1	California	1,067,289
2	Texas	277,094
3	Missouri	181,318
4	Florida	106,220
5	Ohio	94,765

2007 - 2008		
1	California	881,602
2	Texas	216,450
3	New York	71,673
4	Arizona	65,570
5	Ohio	58,515

2008 - 2009		
1	California	1,071,112
2	Texas	253,561
3	Michigan	109,280
4	New York	87,951
5	Massachusetts	75,794

2009 - 2010		
1	California	694,422
2	Texas	183,150
3	New York	84,449
4	Pennsylvania	58,392
5	Florida	54,940

2010 - 2011		
1	California	1,083,854
2	Texas	215,150
3	Arizona	104,286
4	New York	78,624
5	Illinois	71,447

2011 - 2012		
1	California	651,580
2	Texas	218,016
3	Illinois	92,009
4	Minnesota	90,347
5	Ohio	75,800

2012 - 2013		
1	California	678,730
2	Texas	197,916
3	Michigan	60,972
4	Illinois	54,998
5	Florida	54,230

2013 - 2014		
1	California	969,932
2	Texas	248,105
3	Washington	59,851
4	Illinois	53,648
5	Florida	42,993

2014 - 2015		
1	California	661,422
2	Texas	195,680
3	Florida	70,100
4	Pennsylvania	64,343
5	New York	57,448

2015 - 2016		
1	California	612,547
2	Texas	164,500
3	Florida	73,892
4	Illinois	73,031
5	Pennsylvania	51,881

2016 - 2017		
1	California	622,088
2	Texas	132,264
3	Florida	80,270
4	Arizona	77,312
5	Minnesota	76,823

EXPORT TOTALS
2016-2017

COUNTRY	GALA	GRANNY SMITH	FUJI	BRAEBURN	CRIPPS PINK	OTHER	TOTAL
CANADA	53,736	15,360	245	225	147	483	70,196
MEXICO	1,896	8,820					10,716
TAIWAN			5,552				5,552
TOTAL	55,632	24,180	5,797	225	147	483	86,464

EXPORT TOTALS
2015-2016

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	34,166	9,394	549	133	546	196	44,984
HONG KONG							
INDIA							
INDONESIA							
MALAYSIA							
MEXICO	11,760	6,853					19,908
PANAMA	514	6,853	6,853				661
PUERTO RICO		6,853					49
SRI LANKA							
TAIWAN			6,853				13,682
THAILAND							
VIETNAM							
TOTAL	46,440	17,689	14,280	133	546	196	79,284

EXPORT TOTALS
2014-2015

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	TOTAL
CANADA	62,546	21,849	9,420	441	343	94,599
HONG KONG	882					882
INDIA		950				950
INDONESIA		4,831				4,831
MALAYSIA		17,933				17,933
MEXICO	6,762	4,389				11,151
PHILLIPPINES		3,910				3,910
PUERTO RICO		686				686
SRI LANKA		2,885				2,885
TAIWAN		2,940	25,912			28,852
THAILAND		9,690				9,690
VIETNAM		980				980
TOTAL	70,190	71,043	35,332	441	343	177,349

EXPORT TOTALS
2013-2014

COUNTRY	GALA	GRANNY SMITH	FUJI	BRAEBURN	OTHER	TOTAL
CANADA	74,805	43,226	13,388	196	490	132,105
ECUADOR		2,696				2,696
FRENCH POLYNESIA	294					294
INDONESIA		980				980
MALAYSIA		46,509				46,509
MEXICO	199	30,985				31,184
PERU		931				931
PHILLIPPINES		6,860				6,860
PUERTO RICO	49					49
SINGAPORE		4,662				4,662
SRI LANKA		11,680				11,680
TAIWAN	19	4,786	5,504			10,309
THAILAND		7,825				7,825
UNITED ARAB EMIRATES		4,655				4,655
VIETNAM		3,900				3,900
TOTAL	75,366	169,695	18,892	196	490	256,084

EXPORT TOTALS
2012-2013

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	147,268	57,066	9,635	980	147	931	216,027
COLOMBIA		2,875					2,875
COSTA RICA	911						911
EL SALVADOR	931						931
HONG KONG		1,029					1,029
INDONESIA		2,940					2,940
MALAYSIA		31,713					31,713
MEXICO	13,425	26,278					39,703
PANAMA		1,617					1,617
PERU		3,087					3,087
PHILLIPPINES		2,903					2,903
PUERTO RICO		42					42
SINGAPORE		5,419					5,419
SRI LANKA		900					900
TAIWAN		5,152	31,384				36,536
THAILAND		9,775					9,775
VIETNAM		980					980
TOTAL	162,535	151,776	41,019	980	931	309,197	309,197

EXPORT TOTALS
2011-2012

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	161,846	49,674	2,450	2,143		16,675	232,788
COLOMBIA		980					980
ECUADOR		5,965					5,965
HONG KONG		965					965
INDONESIA		1,940					1,940
MALAYSIA		30,818					30,818
MEXICO	9,968	8,799		2,058			20,825
PANAMA		7,791					7,791
PERU		2,940					2,940
PHILLIPINES		2,910					2,910
SRI LANKA		5,880					5,880
TAIWAN		0	15,629				15,629
THAILAND		5,769					5,769
TOTAL	171,814	124,431	18,079	4,201	0	16,675	335,200

EXPORT TOTALS
2010-2011

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	51,241	63,779	98	1,617		147	116,882
COLOMBIA		980					980
ECUADOR		294					294
HONG KONG		3,038					3,038
INDIA		245					245
INDONESIA		14,592					14,592
MALAYSIA		13,643					13,643
MEXICO	17,339	17,297					34,636
NEW ZEALAND		980					980
PERU		2,900					2,900
PHILLIPINES		3,871					3,871
SINGAPORE		4,580					4,580
TAIWAN	2,664	2,590	31,700				36,954
THAILAND		3,890					3,890
VIETNAM		4,900					4,900
TOTAL	71,244	137,579	31,798	1,617	0	147	242,385

EXPORT TOTALS
2009-2010

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	73,846	54,643	1,127	392		119	130,127
COLOMBIA		1,960					1,960
COSTA RICA	900	98					998
ECUADOR		1,680					1,680
EL SALVADOR	2,700						2,700
INDIA		1,078					1,078
INDONESIA		13,173					13,173
JAMAICA	45						45
MALAYSIA		38,509					38,509
MEXICO	13,197	2,058					15,255
PANAMA	490	1,078	267				1,835
PERU		2,254					2,254
PHILLIPINES		1,917					1,917
SAUDI ARABIA		2,156					2,156
SINGAPORE	840	17,234					18,074
TAIWAN	5,840	6,589	59,033				71,462
THAILAND	900	4,760					5,660
UNITED ARAB EMIRATES		14,065					14,065
UNITED KINGDOM	1,820						
VIETNAM		980					
TOTAL	100,578	164,232	60,427	392	0	119	324,768

EXPORT TOTALS
2008-2009

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	93,120	130,021	8,858	147		906	233,052
COLOMBIA		931					931
COSTA RICA		441					441
ECUADOR		4,200					4,200
HONG KONG		1,928					1,928
INDIA		3,920					3,920
INDONESIA		11,260					11,260
JAMAICA	392						392
MALAYSIA		129,263	196				129,459
MEXICO	58,409	38,038	3,773				100,220
NEW ZEALAND		5,128					5,128
PANAMA	994	6,603	784				8,381
SINGAPORE		44,532					44,532
SRI LANKA		6,878					6,878
TAHITI	30						30
TAIWAN		1,927	68,341				70,268
THAILAND		2,860					2,860
UNITED ARAB EMIRATES		3,528					3,528
UNITED KINGDOM				16,443			16,443
TOTAL	152,945	391,458	81,952	16,590	0	906	643,851

EXPORT TOTALS
2007-2008

COUNTRY	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
CANADA	121,382	115,132	199	343	312	804	238,172
COLOMBIA		1,911					1,911
ECUADOR		1,848					1,848
GUATEMALA	533	846					1,379
HONG KONG		6,420					6,420
INDIA		5,823	980				6,803
INDONESIA		1,800					1,800
JAMAICA	490						490
KUWAIT		1,911					1,911
MALAYSA		56,378	1,555			84	58,017
MEXICO	16,737	1,494					18,231
PANAMA	2,131	3,969					6,100
PERU		980					980
PUERTO RICO	49						49
SAUDI ARABIA	4,742						4,742
SINGAPORE		21,367	524				21,891
SRI LANKA		1,911					1,911
TAIWAN			30,786				30,786
THAILAND	1,462	1,154	756				3,372
UNITED KINGDOM				31,298			31,298
TOTAL	147,526	222,944	34,800	31,641	312	888	438,111

HISTORICAL PACK OUT REPORT

VARIETY	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015-2016	2016-2017
FUJI	375,371 375,371	295,886 295,886	337,244 337,244	249,541 249,541	367,770.3 367,770.3	227,475 227,475	213,223 213,223	245,745	262,849.80	232,140.00	306,231.00
GALA	755,617 755,617	714,879 714,879	1,035,461 1,035,461	864,044 864,044	969,350.2 969,350.2	1,011,727 1,011,727	801,831 801,831	761,904	758,736.90	977,006.40	951,408.40
GRANNY SMITH	2,029,851 2,029,851	1,244,291 1,244,291	1,943,585 1,943,585	805,345 805,345	1,085,746 1,085,746	1,113,778 1,113,778	905,965 905,965	969,320	763,849.30	443,648.00	429,506.20
CRIPPS PINK	191,764 191,764	165,477 165,477	172,708 172,708	102,489 102,489	146,317.5 146,317.5	119,219 119,219	95,446 95,446	142,530	63,208.60	75,355.30	100,066.00
BRAEBURN	23,160 23,160	24,831 24,831	8,373 8,373	17,945 17,945	22,297.9 22,297.9	7,201 7,201	10,675 10,675	18,460	6,694.10	13,519.60	7,189.40
ARKANSAS BLACK					6,796.4 6,796.4						
GOLDEN DELICIOUS				739 739	1,452 1,452					5.00	
GRAVESTEIN	4 4				8 8						
HONEYCRISP					9,010.6 9,010.6			8,998	6,192.00		
JONAGOLD		492 492									
LADY APPLE					293.13 293.13						
PIPPIN					274 274						
RED DELICIOUS	400 400	780 780		678 678	512 512	639 639	671 671	2,015	2,778.00	1,366.00	2,547.00
SPITZENBERG					180 180						
SUNDOWNER	2,244 2,244	1,177 1,177									
SWEETIE									2,766.00		
OTHER	20,110 20,110	26,355 26,355	49,264 49,264	15,516 15,516	21,469 21,469	169,775 169,775	30,146 30,146	37,499	57,679.00	30,277.00	40,372.00
Total Packed	**3,398,521**	**2,474,168**	**3,546,635**	**2,056,297**	**2,631,477**	**2,649,814**	**2,057,957**	**2,186,471**	**1,924,753.70**	**1,773,317.30**	**1,837,320.00**
Total Shipped	**3,398,521**	**2,474,168**	**3,546,635**	**2,056,297**	**2,631,477**	**2,649,814**	**2,057,957**	**2,186,471**	**1,924,753.70**	**1,769,710.30**	**1,837,320.00**

INDUSTRY COMMUNICATIONS

APPLE COMMUNICATIONS

The California Apple Commission takes pride in ensuring our audience is kept up to date with issues concerning the apple industry. The CAC is on social media. Please follow us on the following social media outlets and let us know what you think. We would love to know what you want to hear more about.

Facebook.com/CaliforniaAppleCommission

Pinterest.com/calapple

The Commission has published a series of newsletters throughout the season, and they are included in this year's annual report. The Commission encourages you to sign up for our newsletters that are available both online and in hard copy. To sign up for the California Apple Commission's online newsletter, visit Calapple.org under the "About Us" tab. You can subscribe in the newsletter section. To subscribe to our hard copy newsletter please contact the Commission office. The Commission sends out newsletters on a bi-monthly basis.

CALIFORNIA APPLE COMMISSION

NEWSLETTER

Issue No. 122 May/June 2017

COMMISSION PARTNERS WITH CA GROWN

The California Apple Commission has partnered with the Buy California Marketing Agreement, or CA Grown, to help connect consumers and California apple growers. CA Grown is an organization that works to connect Californians with the farmers and ranchers that grow and produce their food. The motto or mission statement of CA Grown is as follows; "That is why California Grown was created: to emphasize our strong ties to the land and to our neighbors; to take pride in our homegrown products and our work; and to support our economy and our Californian way of life." To find out more about CA Grown and how you can support locally grown products, please visit californiagrown.org.

COMMISSION ATTENDS UNITED FRESH

On June 13-15, 2017, the California Apple Commission visited Chicago, IL to attend the annual United Fresh Produce Conference. The purpose of this visit was to create and maintain relationships and connections within the industry. From family businesses to global corporations, United Fresh brings together members across every segment of the supply chain to build relationships that are as solid with a handshake as they are with a contract. This organization helps empower industry leaders to join forces and shape sound government policy. United Fresh delivers the resources and expertise companies need to succeed in managing complex business and technical issues. They also provide the training and development individuals need to advance their careers in produce. Through these endeavors, United Fresh unites our industry with a common purpose – to build long-term success for our members, and to increase produce consumption.

IRRADIATION RESEARCH

Dr. Anuradha Prakash has begun her research on irradiation treatment for apples. California apples destined to Mexico are subjected to one of two phytosanitary treatments- cold treatment that requires a minimum of 40 days at 0°C or less, or fumigation with methyl bromide which causes damage to the fruit. An alternative treatment, recently approved by USDA-APHIS is irradiation. The objectives of this study are to determine the postharvest quality of 'Gala,' 'Granny Smith,' and 'Fuji' apples treated by irradiation. If you would like to know more about irradiation and this research project, please contact Todd Sanders at the Commission office.

NAFTA UPDATE

Changes to the North American Free Trade Agreement (NAFTA) are anticipated after the Trump administration gave official notice to Congress in May. Only modest details were provided about the possible changes Trump would seek to an agreement that he called "the worst trade deal ever." A renegotiation resolution is planned for September but could come sooner. Since Canada and Mexico are two of the top three export markets for CA apples, this "new deal" may have an impact on the CA industry. The Commission will give an update as soon as more information is available. To read more about the NAFTA renegotiations, please visit nytimes.com.

MEXICO INSPECTOR

In late July, the Mexico inspector will arrive in California to start the California/Mexico apple export program. In ordinance with the California/Mexico work plan, the Mexico inspector must certify all packing sheds and fumigation chambers

intending on exporting apples to Mexico. Thanks to the Commissions efforts, there is a reduction in oversight from Mexico, and the Mexico Inspector will be in California at the beginning of the season and then periodically thereafter. If you would like to be added to the list of acceptable packing sheds, please contact the Commission office. If you have any questions regarding the Mexico Export Program, please contact Todd Sanders at the Commission office.

TAIWAN TRAINING SEMINAR

Executive Director, Alex Ott at Taiwan Training Seminar.

On June 28, 2017, the California Apple Commission hosted the Taiwan training seminar. The seminar is organized in conjunction with USDA-APHIS with the intent on training the necessary personnel from different packing sheds in the process of detecting Codling Moth as outlined by the Taiwan work plan. If you would like to participate in the next seminar or want more general information about the Taiwan training seminar, please contact the Commission office.

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CALENDAR OF EVENTS

- **USAEDC**
  -Date: July, 11-13, 2017
  -Location: Arlington, VA
- **Mexico Inspector Visit**
  -Date: July, TBD, 2017
  -Location: Clovis, CA
- **US Apple Outlook and Marketing Conference**
  -Date: August 24-25, 2017
  -Location: Chicago, IL
- **Asia Fruit Logistica**
  -Date: September 6-8, 2017
  -Location: Hong Kong, China
- **United Fresh Public Policy Conference**
  -Date: September 18-20, 2017
  -Location: Washington, D.C.
- **Produce Marketing Association Expo**
  -Date: October 20-21, 2017
  -Location: New Orleans, LA

California Apple Commission
2565 Alluvial Ave, Ste. 182
Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
www.calapple.org

CALIFORNIA APPLE COMMISSION

NEWSLETTER

Issue No. 121 March/April 2017

COMMISSION ATTENDS CAPITOL HILL DAY

Mark Seetin (USApple), Jeff Colombini (Board Member), Tabitha Francis (Intern), Congressman Jim Costa, Executive Director, Alex Ott, Director of Trade and Technical Affairs, Todd Sanders on USApple's Capitol Hill Day.

On March 23-24, 2017, the California Apple Commission visited Washington D.C. The purpose of this visit was to attend the USAEC strategic planning meeting, the US Apple Association, Board meeting, and to meet with members of Congress to provide information on some of the current successes and problems that face the California apple industry. For example, issues concerning labor, crop insurance, and the security of MAP and TASC funds in the upcoming 2018 Farm Bill were discussed. All of these issues are vital to the U.S. apple industry and could have dramatic effects on the industry in the future.

CAC MEETS WITH USAEC

On March 23, 2017, the California Apple Commission met with the US Apple Export Council to discuss current markets and USAEC funding. The USAEC is expected to receive roughly 1 million dollars in funding which will be utilized in 6-8 markets. The USAEC assists the Commission and other U.S. Apple producing states obtaining Market Access Program (MAP) and Technical Assistance for Specialty Crop (TASC) dollars for foreign markets. The priority markets which include: Canada, Mexico, and Southeast Asia, receive MAP dollars for inspectors and in-country representatives. Currently, USAEC markets include: Canada, Central America, India, Mexico, Southeast Asia, and United Kingdom. For further information, please do not hesitate to contact the Commission office.

SHADE CLOTH MEETING

On March 7, 2017, members of the California apple industry met to discuss the shade cloth research project. The primary purpose of the shade cloth research project is to investigate the benefits of applying shade cloth to California apples. These benefits could include decreased water usage, increase in apple color, and decrease in overall orchard temperature. The shade cloth project is funded through the California Department of Food and Agriculture Specialty Crop Block Grant, and is currently in its final year. If you would like more information, please contact the Commission office.

USDA FCIC BOARD GIVES GREEN LIGHT TO DEVELOP APPLE TREE CROP INSURANCE

For the last year, US Apple's Risk Management Task Force and a number of apple growers have been working with Agrilogic Consulting, LLC, a consulting company with a vast knowledge and experience in developing crop insurance programs. At the recent quarterly meeting, the Federal Crop Insurance Commission (FCIC) gave final approval to move forward with the development of the apple tree policy. Apple growers will be given the choice to sign up for one or both apple tree policies that will provide protection on both the fruit produced and on the trees themselves. The FCIC board approval means that FCIC will provide funding support to develop the apple tree policy. With the board's approval of the framework proposal, AgriLogic will continue to work with the Risk Management Task Force and the apple industry to complete the apple tree insurance program.

BILLS AIM FOR LONGTERM DROUGHT SOLUTIONS

As California begins to move away from a drought emergency, state legislators feel the need to start moving toward long term solutions that will help safeguard the state against future droughts. The following are a few bills that have been proposed:

AB 1667: Introduced by Assemblywoman Laura Friedman, this bill would require the installation of landscape water meters on commercial, institutional, industrial, and multifamily service connections. These implications would help water managers measure the use of outdoor water use and plan for better conservation and efficiency measures.

SB 740: Introduced by Senator Scott Wiener, this bill would require the State Water Resources Control Board, in consultation with other state agencies, to adopt regulations for developing oversight and management programs for the onsite treatment of water for non-potable use, providing an alternative supply of water.

SB 252: Introduced by Senator Bill Dodd, this bill emphasizes the need for more transparency in new well construction resulting in better

management of groundwater sustainability. The bill would require any area overlying a critically overdrafted basin to make certain information about new wells available to the public and easily accessible before any new well permit can be issued. If the new plan is approved, a well completion report will be required which includes information on well capacity (such as the estimated pumping rate) and will also have to be made accessible by the public. To read more about this article, please visit californiadrought.org.

APRIL 2017 EDITION OF *MARKET NEWS*

This is the fifth report on the 2016 apple crop. According to the survey, fresh apple holdings on April 1, 2017, totaled 53.1 million bushels, 13% more than the inventories reported for April 1st of last year. Processing holdings totaled 21.7 million bushels, a 9% increase from last year on April 1st. The total number of apples in storage on April 1, 2017, was 74.8 million bushels, 12% more than last February's total of 66.9 million bushels and 7% above the 5 year average for that date.

TAIWAN TRAINING SEMINAR IN JUNE

The California Apple Commission will be hosting the Taiwan training seminar in June. The seminar is organized in conjunction with USDA-APHIS. The purpose of the seminar is to train the necessary personnel from different packing sheds in the process of detecting Codling Moth as outlined by the Taiwan work plan. If you would like to participate, please contact the commission staff.

INTERN SELECTED FOR PMA CAREER PATHWAYS

The California Apple Commission's intern has been selected to participate in the Produce Marketing Association (PMA) Career Pathways program. The program was designed to attract university students to the produce and floral industries. The intern will be paired with a career professional for three days, and will attend numerous educational workshops, engage in networking opportunities, and participate in a group project before the event that will enhance the entire learning experience. The PMA Career Pathways program is an all-expense paid trip paid by PMA and its sponsors.

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CALENDAR OF EVENTS

- **SIAL Exhibit**
  - -Date: May 2-4, 2017
  - -Location: Toronto, Canada
- **CPMA (Canadian Produce Marketing Association)**
  - -Date: May 9-11, 2017
  - -Location: Toronto, Canada
- **Taiwan Training Seminar**
  - -Date: June, TBD
  - -Location: Clovis, CA
- **United Fresh Summit**
  - -Date: June 13-15th, 2017
  - -Location: Chicago, IL

CALIFORNIA APPLE COMMISSION
California Apple Commission
2565 Alluvial Ave, Ste. 182
Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
www.calapple.org

CALIFORNIA APPLE COMMISSION

NEWSLETTER

Issue No. 120 January/February 2017

COMMISSION ATTENDS FRUIT LOGISTICA

Executive Director, Alex Ott (back left), Director of Trade and Technical Affairs, Todd Sanders (back center) and Chargé d'Affaires, Kent Logsdon (front center), of U.S. Embassy at Fruit Logistica in Berlin.

On February 8-10, 2017, the California Apple Commission participated in Fruit Logistica, Berlin through the U.S. Apple Export Council. Fruit Logistica is the largest fresh fruit trade show in the world. This trade show provides the Commission the unique opportunity to reach a vast audience of retailers and importers from around the world. If you would like more information or plan on attending next year, please contact the Commission office.

USAEC DEVELOPS STRATEGIC PLAN FOR UNIFIED EXPORT STRATEGY

On January 24, 2017, the US Apple Export Council (USAEC) held a strategic planning meeting. The USAEC is an organization that is made up of several apple producing states including: California, Michigan, New York, Pennsylvania, and Virginia. Additionally, the USAEC is the vehicle that provides Market Access Program (MAP), Technical Assistance for Specialty Crop (TASC), Emerging Market Program (EMP) dollars to its member states. California receives dollars for its Canada, Mexico, South East Asia and Central America markets. In 2015/2016, California, and other Council states, received over $514,000 in assistance for these markets. That is over a $12 return for every one dollar California puts into the program.

During the strategic planning meeting, states prioritized markets and continue to look to open and maintain market access. In addition, the Council looked at ways to streamline its expenses and look at ways to reduce the costs of the Council. The draft document is currently being reviewed by the Council and will be finalized in March, providing a direction for staff to carry out the important MAP and TASC programs for the member states.

CALIFORNIA DROUGHT UPDATE

The wet weather in recent weeks has been topping the news for many reasons. Governor Jerry Brown has issued state of emergency in 50 counties across California in response to the severe storms that have been occurring. These winter storms have made it possible for California to lift the designation of "exceptional drought". Half of the state is still experiencing moderate to severe drought conditions of which Ventura, Santa Barbara, Kern, and Los Angeles counties are the worst. Despite the improvements in snow pack and reservoir levels, groundwater aquifers, forests, and endangered fish species may require several years to recover from the drought impact. Additionally, the storms of late have Californians questioning the integrity of the Oroville Dam in Northern California, the nation's tallest. Counties and cities in the surrounding areas of Lake Oroville have issued emergency evacuation orders due to eroded primary and emergency spillways which could result in the release of uncontrolled water. To learn more about the California drought, please visit californiadrought.org.

FOOD SAFETY MODERNIZATION ACT IS HERE… ARE YOU READY?

The Food Safety Modernization Act (FSMA) is moving forward at full speed. Under the FSMA law, the Food and Drug Administration (FDA) is focused on prevention and risk based food safety standards. Some key components in the mandate include: mandatory preventative controls for food facilities, mandatory produce safety standards, authority to prevent intentional contamination, mandated inspection frequency, record access, testing by accredited laboratories, greater response and enforcement, importer accountability – including third party certification, and enhanced partnerships through state, local and foreign capacity building. Currently, the Preventative Control Rule is for handlers, packers, and shippers. It is expected that the industry have these mandates in place by January 1, 2018. For additional information, please contact the Commission office.

USDA'S CROP INSURANCE BOARD APPROVES DEVELOPMENT OF APPLE TREE PROGRAM

USApple's Risk Management Task Force has been diligently working with a consulting company to determine the feasibility of developing a crop insurance program that would cover apple trees. The apple tree

policy will also give growers the additional choice of signing up for one or both programs that would provide protection on both the fruit produced and the trees themselves. The Federal Crop Insurance Commission (FCIC) has granted final approval for the development phase of the apple tree policy. The FCIC board approval means that they will provide funding in the development of the apple tree policy. To find out more about this, please visit usapple.org

FORM 700's

As outlined by CDFA and the Fair Political Practices Commission (FPPC) all Board of Directors filers must complete the necessary Form 700. Board members are now eligible to submit your Form 700 electronically through eDisclosure. To access eDisclosure system and complete your Form 700, please log on to https://form700.fppc.ca.gov/. Upon login, you will see a list of positions that you are required to file Form 700's for. Once you have completed your form, the system will prompt you to electronically submit your completed Form 700. After completion, your form will be saved in your online-filing cabinet under "Previous Filings" menu.

As a reminder~Form 700's are due April 3, 2017.

Should you have any problems accessing or completing your eDisclosure Form 700, please contact Rene Robertson at (916) 324-3722 or via email at Form700@fppc.ca.gov or the Commission office.

NEW SECRETARY OF AGRICULTURE ANNOUNCED

The new Trump Administration has selected Sonny Perdue for U.S. Agriculture Secretary. Mr. Perdue is the former Governor of Georgia. Governor Perdue, who served at the highest office for Georgia for two terms, earned his doctorate in veterinary medicine. Once approved by the Senate, Perdue will oversee the creation of the very important 2018 Farm Bill. Several programs that the Commission utilizes in the Farm Bill include: Market Access Program (MAP), Technical Assistance for Specialty Crop (TASC), Emerging Market Program (EMP), and Specialty Crop Block Grant dollars. The Commission will continue to work with the new administration to ensure that these programs continue.

The Commission staff will update the industry as the Farm Bill makes its way through the legislative process.

INTERN SELECTED FOR 2017 YALs

The CAC's intern, Tabitha Francis, has been selected to participate in the 2017 USApple Young Apple Leaders (YALs) program. Tabitha will be spending March 22nd-March 25th in D.C. meeting with apple industry leaders and attending Congressional meetings on USApple's Capitol Hill Day. The mission of YALs is to equip the next generation with an understanding of federal regulatory and legislative apple issues, and provides an opportunity to learn from peers and apple leaders from around the country. *The YAL Program sponsors cover all costs associated with participation*.

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CALENDAR OF EVENTS

- **U.S. Apple Capitol Hill Day**
  -Date: March 23rd, 2017
  -Location: Washington, D.C.
- **USAEC Meetings**
  -Date: March 23rd-24th, 2017
  -Location: Washington, D.C.
- **United Fresh Summit**
  -Date: June 13-15th, 2017
  -Location: Chicago, IL

California Apple Commission
2565 Alluvial Ave, Ste. 182
Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
www.calapple.org

CALIFORNIA APPLE COMMISSION

Wishing you a Merry Christmas, and Happy New Year from the CAC!

NEWSLETTER

Issue No. 119 November/December 2016

DRAFT BEST MANAGEMENT PRACTICES & GUIDANCE DOCS NOW AVAILABLE

The Department of Water Resources has released its first publication of Best Management Practices as required by the Sustainable Groundwater Management Act. DWR has elected to publish two categories of information that can be beneficial to Groundwater Sustainability Agencies with developing Groundwater Sustainability Plans. DWR has created a draft of Best Management Practices and Guidance Documents addressing sustainability management of ground water. BMPs are intended to provide clarification, guidance, and examples to help GSAs develop the essential elements of a Groundwater Sustainability Plan. Draft Best Management Practice topics include the following:

1: Monitoring Protocols, Standards, and Sites, 2: Monitoring Networks and Identification of Data Gaps, 3: Hydrogeologic Conceptual Model, 4: Water Budget, and 5: Modeling. Guidance Documents provide suggestions, with supporting graphics, for developing certain GSP components where no established practices in the water management industry exist. Draft Guidance Documents include the following: 1.Preparation Checklist for GSP Submittal, 2.GSP Annotated Outline, 3.Establishing Sustainable Management Criteria, 4.Engagement with Tribal Governments, and 5.Stakeholder Engagement and Communications. To read more about this information, please visit: water.ca.gov/groundwater/sgm/bmps.cfm.

REGISTRATION FOR PHYTOSANITARY IRRADIATION WORKSHOP NOW OPEN

Registration for the 7th annual Chapman University Phytosanitary Irradiation Forum is now open. The forum is organized in cooperation with the USDA and the Joint program of the FAO/IAEA. The objective of the forum is to increase use and knowledge on irradiation as a means of phytosanitary treatment, which in turn will increase global trade and prevent invasive pests. The forum will be held March 21st-22nd, 2017 at Chapman University. Topics for the forum include efficacy, technology and consumer acceptance, global use, logistical challenges, regulatory agency perspectives, export certification and import regulations, and market access and trade. There is a registration fee of $100 per guest. For information on how to register for this forum, please visit chapman.edu or contact the Commission office.

CHINA: FRESH DECIDUOUS FRUIT ANNUAL

China's apple production post season is at 43.5 MMT in marketing year 2016/17, up two percent from last year. Pear production is expected to increase by three percent, to 19.3 MMT, and grape production is forecasted to increase by six percent to 10.2 MMT. China's imports of deciduous fruit will continue to increase on strong demand for high quality fruit and off-season supplies. Fruit exports will continue to rebound if we continue to have increasing, but low-priced foreign supply.

MEXICO: FRESH DECIDUOUS FRUIT ANNUAL

Apple production in Mexico for marketing year 2016/17 (August/July) is forecast at 730,000 metric tons, which is a smaller crop compared to 2015/16 due to weather issues. Total pear imports for 2016/17 (July/June) are estimated to be lower compared to 2015/16 due to an expected lower demand. Total Mexican table grape production for 2016/17 (May/April) is estimated at 280,000 metric tons. Grape exports are expected to decrease to about 156,000 metric tons for 2016/17. The United States remains the major supplier of deciduous fruits to Mexico.

MEXICO INSPECTOR

In early August, the Mexico inspector arrived in California to start the California/Mexico apple export program. Juan Jose

Lopez was this year's inspector. In accordance with the California/Mexico work plan, the Mexico inspector visited California again November 28th- December 2nd to certify all packing sheds and fumigation chambers intending on exporting apples to Mexico. This year's work plan has concluded and will resume next year. If you have any questions regarding the Mexico Export Program, please contact Todd Sanders at the Commission office.

SEN. FEINSTEIN AND REP. MCCARTHY STRIKE WATER DEAL

A bipartisan agreement between Senator Dianne Feinstein and House Majority Leader Kevin McCarthy, dealing with short as well as long term goals for the California drought, has been included in the FY17 Water Resources Development Act (WRDA). The agreement between Feinstein, McCarthy, and other House republicans entailed creating a 90 page bill to link with a broader measure created by Senator Barbara Boxer. The House approved the legislation, S. 612, on Thursday December 8, 2016. In the 728 page bill, there is something to help many parts of the nation. The bill includes $558 million for water-storage, recycling and desalination projects in California, including funding for a possible reservoir project north of Sacramento. To read more about this article and WRDA, please visit sacbee.com.

CAC ANNUAL REPORT

The Annual Reports are complete and have been shipped out. The Annual Report includes information on the current and future research, education projects, market reports, and other pertinent industry information. If you would like a hard copy, please contact the Commission office.

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APPLE BITES

Apple-Loaded Shortbread Cookies

- 1 lb unsalted butter, room temp
- 1 1/4 cups granulated sugar
- 1 1/4 tsp vanilla extract
- 4 1/4 cups all-purpose flour, sifted
- 2 tsp kosher salt
- 1 1/3 cups fresh California apples, skin on, small dice

1. In stand mixer, add butter and sugar. Blend until mixture is light yellow.
2. Add vanilla. Sift in flour and salt. Add small pieces of apple and continue blending, using hands, until incorporated.
3. Remove dough, use a little flour (if needed), and work into a long roll (dough log). Wrap dough in plastic and chill for 45-60 minutes until butter sets.
4. Pre-heat oven to 350 degrees. Remove dough from fridge. Slice into ½ inch circles and place onto ungreased baking sheet. Bake for 20 minutes, or until golden. 5. Top with Apple Cider & Mascarpone Frosting.

Recipe courtesy of U.S. Apple Association; http://www.usapple.org

CALENDAR OF EVENTS

- **Public Policy Meeting**
  -Date: January 23-26, 2017
  -Washington, DC
- **Fruit Logistica**
  -Date: February 8-10 , 2017
  -Berlin, Germany

California Apple Commission
2565 Alluvial Ave, Ste. 182
Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
www.calapple.org

CALIFORNIA APPLE COMMISSION

NEWSLETTER

Issue No. 118 September/October 2016

CAC RECIEVES GRANT EXTENSION

The CAC was approved for a Specialty Crop Block Grant (SCBG) on October 1, 2014 to study and evaluate the effects of shade cloth on apples and to determine the economic viability of using the shade apparatus. The Commission is optimistic that the shade cloth could improve color, possibly reduce water use, and protect the apples from sun damage. This past year, the CAC applied for an extension of the current shade cloth research due to the delays experienced during the initial year. The Specialty Crop Block Grant Program approved the extension for the 2017 program year. The scope of the grant research has not changed and should be similar to the previous year. If you would like a copy of the grant or would like more information on how to participate, please contact the Commission office.

COMMISSION ATTENDS PMA

General Session at the Produce Marketing Fresh Summit Conference.

On October 14-16, 2016, the California Apple Commission attended the Produce Marketing Association's (PMA) international convention and exposition in Orlando, FL. The convention allowed the Commission the ideal opportunity to meet with and maintain relationships with other industry leaders while being updated on several current industry topics and workshops. The Commission also participated in a breakfast that was hosted by the US Apple Export Council (USAEC). This breakfast was designed to bring all major importers from Mexico, Central America, Asia, India, and other important trading partners into one room and educate them about the USAEC and its membership. This particular breakfast had around 150 guests with most of them demonstrating large interest in importing apples from California. If you have any questions or would like more information about certain countries that participated, contact the Commission office.

ASIA FRUIT LOGISTICA

Todd Sanders with the CAC at the USAEC booth.

On September 7-9, 2016, the California Apple Commission joined the U.S. Apple Export Council (USAEC) in Hong Kong for Asia Fruit Logistica. This is the largest fresh fruit trade show in Asia and provides the Commission the unique opportunity to reach a vast audience of consumers and buyers. The Commission was able to partner with the USAEC, and provide information about the availability of California apples. Southeast Asia continues to be a top 3 export market for California and buyers continue to request granny smith varieties. For further information, please contact Todd Sanders at the Commission office.

ARCTIC FUJI APPLE APPROVED

The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) has announced their decision to approve a line of genetically engineered (GE) apples

known as the Arctic® Fuji. This GE apple, developed by Okanagan Specialty Fruits, Inc. (OSF), is engineered for enzymatic browning resistance. APHIS previously reviewed and deregulated this GE trait in other apples such as the Arctic Golden and Arctic Granny. APHIS has prepared a plant pest risk similarity assessment (PPRSA) and a preliminary Finding of No Significant Impact (FONSI). To read more about this article please visit aphis.usda.gov.

UNITED FRESH HOLDS FSMA TRAINING

After the FDA's publication of the final Preventative Controls Rule under Food Safety Modernization Act (FSMA), United Fresh will hold training on this topic for packinghouses, cooling operations, and others who pack or hold raw produce. The training will be held from Monday, November 7th 2016, through Wednesday, November 9th, 2016 from 8:30am to 12pm in Fresno, CA. The training will be held at The Center for Irrigation Technology on the CSU Fresno campus. The training will provide a multi-faceted program to assist produce industry members to comply with the new regulation as required under the new law. The Preventative Controls for Human Food final rule requires companies that are subject to the rule, to have a "preventative controls qualified individual" on staff that is trained and approved on the FDA curriculum. This training will be specific to cooling operations as a United Fresh working group has developed specific example plans for these types of companies. The registration includes training materials and certificate along with a light breakfast. For more information about the training and how to register please visit unitedfresh.com or contact the commission office.

CAC ANNUAL REPORT

The Annual Reports are complete and have been shipped out. The Annual Report includes information on the current and future research, education projects, market reports, and other pertinent industry information. If you would like a hard copy, please contact the Commission office.

***Did you know you can receive an e-newsletter instead of the snail mail version? If you would like to sign up, please email intern@calapple.org*

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CALENDAR OF EVENTS

- **U.S. Ag. Export Development Council**
  -Date: November 14-17, 2016
  - Baltimore, MD
- **Public Policy Meeting**
  -Date: January TBD, 2016
  -Washington, DC
- **Fruit Logistica**
  -Date: February 8-10 , 2017
  -Berlin, Germany

California Apple Commission
2565 Alluvial Ave, Ste. 182
Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
www.calapple.org

CALIFORNIA APPLE COMMISSION

NEWSLETTER

Issue No. 117 July/August 2016

GMO BILL PASSED THROUGH SENATE

On July 8th, 2016 the U.S. Senate passed S.764. This bipartisan GMO labeling bill was introduced by Senate Agriculture Committee Chairman, Pat Roberts, and Ranking Minority Member, Debbie Stabenow. This compromise legislation was designed to counteract the law that took effect in Vermont on July 1st. Also, this bill will prevent confusion and cost for the industry and consumers alike due to a plethora of state regulations that would have gone with the law passed last year. USApple is applauding the passage of this legislation and is hoping the House of Representatives will follow. The Senate Bill 764 calls for mandatory disclosure of present GMO's which may be done by text, symbol, or a link to a website. The important distinction between this legislation and the bill that passed last year is, last year's bill allowed for "non GMO" labeling but had no requirement for labeling the presence of GMOs. When the legislation was announced in late June, USApple joined hundreds of food and agriculture organizations in a letter urging immediate action. To read more about this article please visit usapple.org.

Executive Director, Alex Ott at the Taiwan training seminar.

TAIWAN TRAINING SEMINAR

On July 10th, 2016, the California Apple Commission hosted the Taiwan training seminar. The seminar is organized in conjunction with USDA-APHIS. The purpose of the seminar was to train the necessary personnel from different packing sheds in the process of detecting Codling Moth as outlined by the Taiwan work plan. If you would like to participate in a future seminar, please contact the commission office.

ARCTIC APPLES

The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) is announcing a preliminary hearing to extend deregulation to a line of genetically engineered (GE) Apples known as Arctic® Fuji. This GE apple, developed by Okanagan Specialty Fruits, Inc. (OSF), is engineered for enzymatic browning resistance. APHIS previously reviewed and deregulated this GE trait in other apples. APHIS has prepared a preliminary hearing with an accompanying plant pest risk similarity assessment (PPRSA) and a preliminary Finding of No Significant Impact (FONSI). To read more about this article please visit aphis.usda.gov.

U.S. APPLE HARVEST FALLS BY 12%

Apple harvest for the U.S. fell 12% from last season. Approximately 238 million bushels of apples were grown in the U.S. during the 2015 season. The U.S. Department of Agriculture's National Agricultural Statistics Services' estimate for July was 1% lower than the 5 year average and 2% lower than the pre-season estimate, according to an analysis of data done by the USApple Association. The approximation of 238 million bushels was higher than the 235 million that were forecasted at the U.S. Apple's 2015 annual conference. To read more about this article please visit thepacker.com.

USAPPLE EFFORTS SAVE APPLE RESEARCH LABORATORY

USApple's efforts to save the Apple Postharvest Research Laboratory in Beltsville were successful and the USDA has reversed its decision to close the lab. The research program is the only USDA apple postharvest research in the United States. The research program had operated for more than 100 years, but was under scrutiny by the USDA for elimination in the FY2017 budget. While defending the possibly closing lab,

USApple told USDA officials that apples are the third most valuable fruit crop in the U.S., with an annual value of roughly $4 billion. Also mentioning the fact that apples are the most valuable fruit export, with annual exports valued at over $1 billion in revenue and are an important contributor to the U.S. balance of trade. In a message to the President of USApple, the Principal Researcher on the project, Jim Bair, Dr. Wayne Jurick, expressed his gratitude for USApple's support of the program. To read more about this article please visit usapple.org

CA APPLE MEXICO INSPECTOR

In early August, the Mexico inspector arrived in California to start the California/Mexico apple export program. Juan Jose Lopez was this year's inspector. In accordance with the California/Mexico work plan, the Mexico inspector must certify all packing sheds and fumigation chambers intending on exporting apples to Mexico. If you have any questions regarding the Mexico Export Program, please contact Todd Sanders at the Commission office.

U.S. APPLE ASSOCIATION CONFERENCE

Staff from the California Apple Commission attended the recent U.S. Apple Association Conference. The conference was held Thursday August 25th through Friday August 26th 2016, In Chicago.

CAC ANNUAL REPORT

In the near future please be on the lookout for the California Apple Commission Annual Report. The Annual Report includes information on the current and future research, education projects, market reports, and other pertinent industry information. If you would like a hard copy, please contact the Commission office.

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APPLE BITES

APPLE CHIPS

Ingredients:

- 3 California apples (I use Granny Smith or Pink Lady)
- ground cinnamon
- granulated sugar

Directions:

- Preheat oven to 200F degrees. Line two large baking sheets. Set aside.
- Wash and thinly slice the apples. Spread the apple slices onto the baking pans making 1 single layer. Sprinkle with cinnamon and sugar.
- Bake 1 hour, flip apples over, bake for another 1-1.5 hours. Turn oven off. Keep the apples inside as the oven cools down for 1 hour. This will help them get crunchy. Some apples may just be chewy and only slightly crunchy after 3 hours in the oven. Store apple chips at room temp in an airtight container for up to 1 week.

Recipe courtesy of SALLYSBAKINGADDICTION.COM

CALENDAR OF EVENTS

- **Asia Fruit Logistica**
  -Date: September 7-9, 2016
  -Location: Hong Kong, China

California Apple Commission
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Clovis, CA 93611
PH: (559) 225-3000
FAX: (559) 456-9099

calapple@calapple.org
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