-CALIFORNIA APPLE COMMISSION-

ANNUAL REPORT

2014-2015

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CALIFORNIA APPLE COMMISSION

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MESSAGE FROM THE EXECUTIVE DIRECTOR

Alexander J. Ott
Executive Director of the California Apple Commission

The 2014-2015 season was a fast and furious year. The largest issue to hit the apple industry during the year was the listeria outbreak on caramel and candy apples. The food safety outbreak sent ripples throughout the domestic and international markets. Even today, the industry is still having discussions with consumers; state, and international officials; and other members of the apple community, over the isolated incident. Throughout the crisis, the Commission, in conjunction with the U.S. Apple Association, worked tirelessly updating the industry and holding seminars on the foodborne pathogen.

On the international front, Mexico filed anti-dumping charges on U.S. apple producers and shippers that export product to the southern country. Canada continues to have concerns with current country of origin labeling (COOL) and have expressed dumping in their country as well.

2014-2015 also saw some victories for the California apple industry including: a reduction in direct Mexico inspection oversight, a research grant to study the impacts of shade cloth in the production area, and additional Market Access Program (MAP) dollars for international markets including Canada, Mexico and South East Asia (California's top three export markets). Additionally, The Commission continues research for fireblight control alternatives for both organic and conventional growers, and provides the necessary oversight for the Taiwan and Mexico programs for export. Lastly, the Commission continues to serve as a resource for the industry on many issues and continues to strive to "do those things that an individual grower can't."

The California Apple Commission is pleased to present you with its annual report for the 2014 – 2015 year. Again, thank you for your continued support and please do not hesitate to contact us to provide feedback on how we may continue to assist you and the industry.

High Regards,

Alexander J. Ott
Executive Director

THE CHAIRMAN'S CORNER

Dr. Steve Blizzard
Chairman of The California Apple Commission

The California apple industry faced a challenging year in 2014-2015; from drought, to listeria, to anti-dumping lawsuits. Not to mention, the rising costs of doing business in the golden state. Thanks to the Commission's efforts, the industry is able to address these issues by obtaining grants for research and market access dollars, work with government and regulatory officials and consumers, and continue to serve as the representative for the industry when addressing these issues.

The latest crisis, due to the listeria outbreak, showed the value of the California Apple Commission. Thanks to their relationships with national officials and organizations, coupled with their working relationships with other states, a coordinated effort on gathering the facts and addressing questions assisted the industry in getting the facts out on the outbreak. At the beginning of the crisis, several critics wanted to do a full recall on all US apples. After much communication and investigation, it was proven that this outbreak was an isolated incident. However, this should not mean that the industry can do business as usual. In fact, it should be a wake-up call not just for the apple industry but all industries. In short, we are all just one outbreak away from a major crisis.

With the Food Safety Modernization Act (FSMA) just around the corner, the industry will be looking at reviewing its practices and should make sure that mistakes that occurred during the last outbreak will not happen again. The Commission will continue to share with the industry the necessary information needed to review these practices and will continue to assist the industry on this critical issue. In addition, the Commission continues to work on market access issues, pest and disease issues, research, unified voice, and California statistics.

It continues to be a pleasure to serve the industry as your Chairman and continue to look forward in assisting the industry in the months ahead.

Sincerely,

Dr. Steve Blizzard
Chairman

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California Apple Commission
2014 BOARD OF DIRECTORS 2015

DISTRICT 1

Producer Members

David Rider
Bruce Rider & Sons
Term: 7/ 2012 – 6 /2016

Lance Shebelut
Trinity Fruit Sales
Term: 7/ 2016 – 6 /2020

Tad Kozuki
Kozuki Farming, Inc.
Term: 7/ 2013 – 6 /2017

Handler Member

Bill Denevan
Denevan Apple
Term: 7/ 2013 – 6 /2017

Alternate Member

Tim Huebert
Huebert Farms
Term: 7/ 2014 – 6 /2015

DISTRICT 2

Producer Members

Chris Britton
BK Partners
Term: 7/2014 – 6/2018

Virginia Hemly Chhabra
Greene & Hemly
Term: 7/2014 – 6/2018

VACANT

Handler Member

VACANT

Term: 7/2012- 6/2017

Alternate Member

VACANT

Term: 7/ 2014 – 6 /2015

DISTRICT 3

Producer Members

Jeff Colombini
Lodi Farming
Term: 7/2013 – 6/2017

VACANT

Term: 7/2014-6/2018

Steve Chinchiolo
Riverbend Orchards
Term: 7/2014 – 6/2018

Handler Member

Tim Sambado
Prima Frutta
Term: 7/2013 – 6/2017

Alternate Member

VACANT

Term: 7/ 2014 – 6 /2017

PUBLIC MEMBER

Dr. Steve Blizzard
Lagomarsino Group
Term: 7/2013 – 6/2017

Alternate Public Member

VACANT
7/2014-6/2018

DISTRICT MAP

CA APPLE ACREAGE TOTALS

County	Total in Acres
Butte	6.75
Calaveras	14.00
Contra Costa	41.90
Colusa	1.00
El Dorado/Alpine	850.00
Fresno	627.00
Humboldt	27.00
Kern	1,033.00
Kings	3.00
Lake	8.00
Lassen	1.50
Los Angeles	26.01
Madera	123.10
Marin	8.40
Mariposa	64.00
Mendocino	221.00
Merced	3.00
Monterey	76.35
Napa	2.08
Nevada	7.50
Orange	<1.00
Placer	41.00
Riverside	31.00
Sacramento	300.25
San Benito	309.00
San Bernardino	286.00
San Diego	262.00
San Joaquin	3,470.00
San Luis Obispo	169.00
San Mateo	7.90
Santa Barbara	54.47
Santa Clara	120.20
Santa Cruz	2,128.00
Shasta	30.00
Siskiyou	25.00
Solano	140.90
Sonoma	2,155.00
Stanislaus	615.00
Sutter	34.00
Tulare	72.00
Tuolumne	155.00
Yolo	170.00
Yuba	10.70
Total	**13,729.51**

***Total CA Apple Acreage is based on the 2013 County Crop Reports and makes no distinction between fresh, processed, and farmer's markets. The California Apple Commission only represents growers that produce 40,000 pounds or more of fresh apples.**

STATEMENT OF ACTIVITIES

FISCAL YEAR ENDED JUNE 30, 2014

ASSETS

• CASH	$125,547
• ACCOUNTS RECEIVABLE	$25,457
• PREPAID EXPENSES	$13,927
• RESTRICTED CASH DUE TO PENDING LAWSUIT	$1,619,342
• PROPERTY AND EQUIPMENT NET OF ACCUMULATED DEPRECIATION OF $37,234 IN 2013 AND $33,786 IN 2013	$2,822
TOTAL ASSETS	**$1,787,095**

LIABILITIES

• ACCOUNTS PAYABLE	$35,583
• ACCRUED COMPENSATED ABSENCES	$11,656
TOTAL CURRENT LIABILITIES	**$47,239**

NET ASSETS

• RESTRICTED	
- ESCROW ACCOUNT	$1,619,342
• UNRESTRICTED	$120,514
NET ASSETS	**$1,739,856**

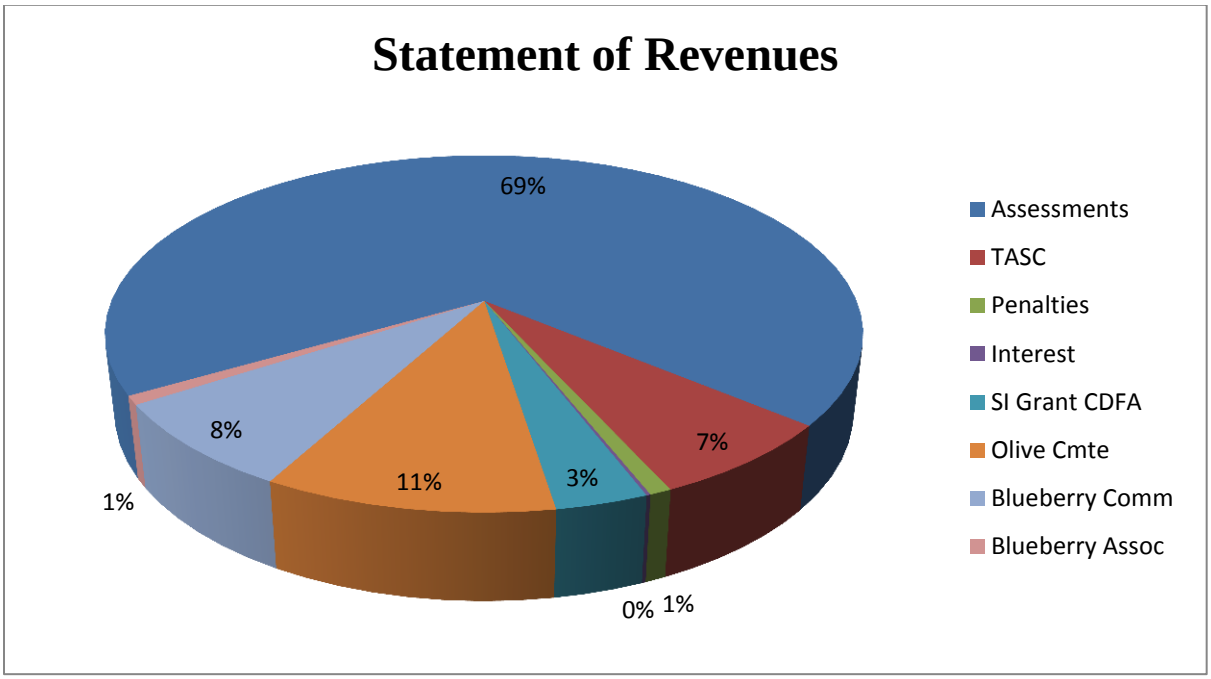
TOTAL LIABILITIES AND NET ASSETS $1,787,095

STATEMENT OF REVENUES

REVENUES

• ASSESSMENTS	$527,657*
• ASSESSMENT INTEREST AND PENALTIES	$6,126
• GRANT INCOME – TASC	$54,354
• OLIVE MANAGEMENT FEES	$80,000
• BLUEBERRY MANAGEMENT FEES	$60,000
• BLUEBERRY ASSOCIATION MANAGEMENT FEES	$6,000
• STARCH IODINE GRANT	$25,481
• INTEREST	$1,139

TOTAL REVENUES **$760,757**



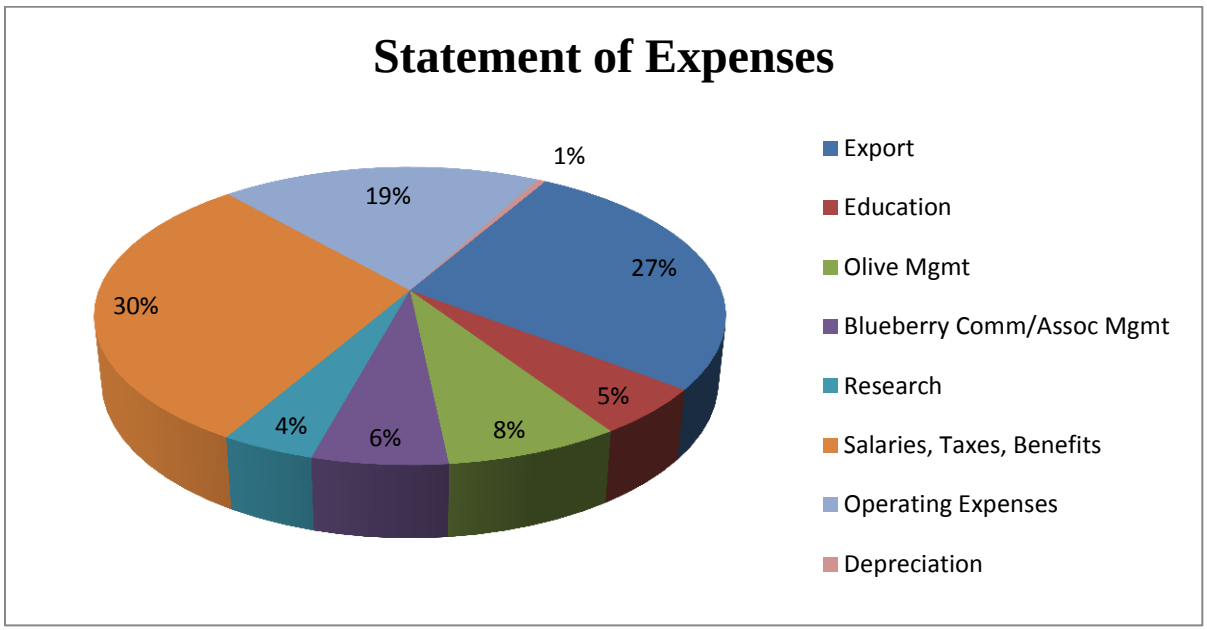
*Includes restricted revenues received pending current lawsuit. Restricted funds shall not be used in operating budget and are stored in a separate escrow account. These funds may not be released until lawsuit is finalized.

STATEMENT OF EXPENSES

EXPENSES

• EXPORT/MARKET DEVELOPMENT	$192,385
• EDUCATION	$36,340
• OLIVE MANAGEMENT	$54,212
• BLUEBERRY MANAGEMENT	$41,868
• RESEARCH	$29,063
• SALARIES, PAYROLL TAXES, BENEFITS	$213,095
• OPERATING EXPENSES	$136,744
• DEPRECIATION	$3,448

TOTAL EXPENSES **$707,155**



CHANGES IN NET ASSETS **$53,602**

NET ASSETS, BEGINNING OF YEAR **$1,686,254**

NET ASSETS, END OF YEAR **$1,739,856**

CA APPLE RESEARCH PROJECTS

In 2014-2015, the California Apple Commission focused on three areas of research. Two were continuations of prior research, while the others began at the end of 2014.

In September 2014, the Commission was granted $313,707 by 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 December 2016. The full report of this study will be available and disseminated to the industry in February 2017.

In December 2014, the Commission became very active on behalf of California apple growers to provide the best information to the industry regarding *Listeria monocytogenes*. Dr. Linda Harris, UCCE specialist in Food Safety and Microbiology, was contacted to present the most current *Listeria* research to the industry.

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) *Shade cloth benefits for apples* – facilitated by CAC staff and research analyzed by Fruit Dynamics[i]

3) Presentation to the apple industry on *Listeria monocytogenes* – Dr. Linda Harris

[i] This study is fully funded by a CDFA Specialty Crops Block Grant.

Annual Report - 2015

Prepared for the California Apple commission

Project Title:	Evaluation of new bactericides for control of fire blight of apples caused by *Erwinia amylovora* and evaluation of new postharvest fungicides for pome fruit
Project Leader:	Dr. J. E. Adaskaveg, Department of Plant Pathology and Microbiology, University of California, Riverside CA 92521.
Cooperators:	L. Wade (Arysta Life Science), Dr. H. Förster, D. Cary, and D. Thompson

SUMMARY

Fire blight management

1. All strains of *E. amylovora* collected in commercial orchards in 2015 were found to be sensitive to the antibiotics oxytetracycline and kasugamycin; whereas some strains were streptomycin-resistant and some moderately-resistant or resistant to copper.
2. In toxicity studies with three biocontrol agent, chemicals used for fire blight control in our field studies, (streptomycin, oxytetracycline, kasugamycin, captan, copper, and mancozeb at 40 ppm) 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. These data indicate that the performance of biocontrols may be dependent on other pesticides used in pome fruit production.
3. In a field trial on the management of fire blight on Granny Smith and Fuji apple, kasugamycin continued to be highly effective. The product performed well by itself, but also in mixtures with copper, Firewall, or Actigard. Registration of Kasumin is expected in California for 2016.
4. Among organic treatments, Blossom Protect (13.5% incidence) and Serenade Optimum (13.9%) were most effective. Copper was least effective (18.7% incidence) as compared to the control (29.7%). The plant defense activator BmJ was ineffective at the rate tested.

Postharvest decay control

1. Postharvest experimental packingline studies focused on new treatments for the management of major decays to provide solutions for conventionally treated and potentially also for organic fruit production. Treatments are being developed based on anti-resistance strategies. Polyoxin-D (Tavano or Oso), and especially EXP-13, performed very well in these studies and showed a relatively wide (Tavano – gray mold, Alternaria rot, Mucor decay) or very wide (EXP-13 – gray mold, blue mold, Mucor rot, Alternaria rot, bull's eye rot) spectrum of activity. These biofungicides are exempt from tolerance by the US-EPA.
2. Applications with the new pre-mixture Academy (difenoconazole and fludioxonil), as well as, Scholar, and Penbotec were all highly effective in reducing blue mold (caused by TBZ-sensitive and -resistant strains of *P. expansum*) and gray mold. The spectrum of activity of Academy includes blue mold, gray mold (TBZ-sensitive and –resistant pathogen populations), bull's eye rot, Alternaria rot, and bitter rot.
3. Most treatments were highly effective when applied in drenches. EXP-13 was very effective using low or high volume systems. Academy is best used as a drench or high volume application system.

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 blackening and death of twigs, flowers, and foliage and is indigenous to North America, but has 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 nectary's 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 control are based on protective schedules, because

available compounds are contact treatments and are not systemic. 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. To date, there is no copper resistance in pathogen populations. Antibiotics for blight control include streptomycin, the less effective oxytetracycline (Mycoshield, Fireline), and the new federally 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 widespread in California. Furthermore, from a regulatory perspective, streptomycin and oxytetracycline are currently being removed from the approved list of organic treatments of apples and other pome fruit by the National Organic Standards Board (NOSB). Thus, organic growers have very limited choices for disease control.

New copper products that are re-formulated with reduced rates of metallic copper equivalent (MCE) and less contamination in their formulation that may cause phytotoxicity have been developed and are now available. These products need to be evaluated and tested for extended usage past the bloom period to determine if an effective mixture or rotational program with other bactericides can be developed without causing fruit russeting. Combinations of kasugamycin with selected copper products were tested in 2012 and 2013 and shown to be effective in some trials. Still only a few products were tested (e.g., Kocide 3000) and newer copper products are now being marketed in the United States. 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.

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. Thus, our recent research on organic alternatives is quite promising. Biological controls that have been developed for fire blight in the United States include 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. These products 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*), should continue to be evaluated in 2015 in selected mixtures or in rotation with new copper products.

In general, biocontrols are most effective when they are growing in high numbers on the plant. Several mechanisms have been described for biocontrol agents that lead to the control of the pathogenic agent. (1) Growth enhances competition for vital resources on the plant surface and limits the growth of the pathogen (competition); (2) the biocontrol may produce compounds involved in antibiosis (biochemical inhibition); (3) the biocontrol may increase in biomass to physically block infection sites of the pathogen (site exclusion); (4) the biocontrol agent may directly parasitize the pathogen; and (5) the biocontrol may induce of resistance in the host tissue (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 resulted in improved performance. We plan to continue this research.

Toxicity of some copper and sulfur products used in fire blight control has been shown for some of the new biocontrols. Incompatibility of copper has been shown with bacterial biocontrols but not against yeast-based products. Sulfur was toxic to both fungal and bacterial biocontrols. Thus, testing needs to be extended among the biologicals and other formulations of copper and sulfur products need to be included. Incompatibilities could prevent the use of biocontrols in rotations or tank mixtures.

In more recent research to complement copper and other control materials, a new strategy is to use the OMRI-approved BmJ (CX-10250, Certis), a new product that presumably functions as a systemic acquired resistance or SAR material. The active ingredient of BmJ WG 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. These types of compounds deserve continued evaluation especially since they are OMRI approved. 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. Furthermore, SAR compounds may have a longer-lasting effect on the plant's defense activation. 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 for 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 crop losses that are economically detrimental to 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. 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 2012-14, we found that polyoxin-D (Ph-D, Oso, Tavano) was similarly effective to the fungicide Penbotec in reducing the incidence of gray mold, but it was not effective against blue mold. In 2013, we showed that this compound and another one called EXP-13 are also highly effective against *Alternaria* species. EXP-13 also shows good efficacy against decays caused by *Penicillium*, *Botrytis*, and *Mucor* spp. Polyoxin-D and EXP-13 have an exempt registration status and thus, both have the potential to be effective organic treatments if they become certified by the NOSB. Our goal is to continue to evaluate these products for the management of postharvest decays of apples. The registrants of these fungicides are supporting the development on fruit crops and are planning to submit for registration. EXP-13 has been used as a federally-approved food additive to prevent mold growth, including *Penicillium* species, on dairy products for many years in the United States. Over all the years in use, resistance in *Penicillium* species against EXP-13 has not occurred. Thus, we plan to evaluate these very exciting new products for the management of postharvest decays of apples.

Objectives for 2015

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. Small-scale hand-sprayer tests using different treatment-inoculation schedules to evaluate coppers (Badge X2, CS-2005, Cueva, Champ) and biological treatments (Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55) used by themselves or in combination.
   C. Field trials with protective air-blast spray treatments:
      i. New formulations of copper (e.g., Badge X2, CS-2005, Cueva).
      ii. Biological treatments (Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55) with and without the addition of growth enhancers.
      iii. Plant defense activators or SARs (e.g., BmJ).
      iv. Selected mixture and rotation programs (e.g., BmJ+Blossom Protect, BmJ+Serenade).

Postharvest research

2. Comparative evaluation of new postharvest fungicides
   A. Evaluate polyoxin-D (Oso) and EXP-13 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. Determination of baseline sensitivities. Baseline sensitivities for EXP-13 and polyoxin-D will be continued to be developed for additional fungal pathogens that are collected.

Plans and Procedures

***Isolation and culturing of* E. amylovora.** Fire blight samples were obtained from pome fruit trees in the spring and early summer of 2015 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 selected antibiotics using the spiral

gradient dilution (SGD) method and to copper using SGD and dilution plates.

Laboratory assays on the sensitivity of* Aureobasidium pullulans *(Blossom Protect) to copper and sulfur. Nutrient agar was amended with copper at selected concentrations up to 400 ppm MCE or with sulfur (wettable sulfur) at 0 ppm (control), 3000 ppm, 4000 ppm, 6000 ppm, and 12,000 ppm. The biocontrol was streaked onto the agar and growth was evaluated after four days of incubation.

Laboratory evaluation of enhanced growth of biological controls. In laboratory assays we identified enhancers of growth of the biological control agents in Actinovate and Blossom Protect. For this, the biocontrol organisms were grown on a basic, low-nutrient agar medium that were amended with selected carbohydrates (e.g., sucrose) and other nutrients such as different nitrogen sources. Growth was compared between non-amended and amended media and the most effective additives were selected to be used in field trials.

***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 an experimental apple orchard at the Kearney Agricultural Research and Extension Center (KARE). Two applications were done at 30% and at 80% bloom. Selected treatments were evaluated as shown in Tables 1 and 2. Incidence of new blight infections on flower clusters in addition to potential phytotoxic effects of the treatments (e.g., fruit russeting caused by copper) were evaluated. Application timings were determined based on temperature, rainfall, and host development. Treatments were replicated four times on two trees per replication. Data for chemical and biological control 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. Fruit of cv. Granny Smith 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, N. perennans*, *Alternaria* sp. and *Mucor piriformis*) and treated after 16 to 18 h with test fungicides. EXP-13 and polyoxin-D (Tavano) were evaluated in experimental packingline trials at KARE at selected rates by themselves or in mixtures using difference application methods. Twenty to forty fruit for each of four replications were used. For the new fludioxonil-difenoconazole pre-mixture, we compared the efficacy of different application methods (in-line drench, CDA). Treatments were compared to pyrimethanil and fludioxonil. Data were analyzed using analysis of variance and averages were separated using least significant difference mean separation procedures of SAS 9.4.

RESULTS AND DISCUSSION

***Antibiotic and copper sensitivity among* E. amylovora *strains collected in California*.** In our survey work, all strains of the pathogen were found to be sensitive against the antibiotics oxytetracycline and kasugamycin; but some strains were streptomycin-resistant. Although streptomycin-resistance is present in some commercial orchards, streptomycin may be effectively used in a rotation program. Resistant populations remain low in orchards where streptomycin was not used for several years. Resistant strains are less fit and not as competitive as wild-type sensitive strains. Strains were also found to be less sensitive to copper. Laboratory studies are ongoing. We also confirmed that the pathogen has the ability to quickly adapt to low residual levels of copper (a process previously described as spontaneous mutation). Thus, similar to streptomycin usage, copper should be used as a rotational treatment and should not be used repeatedly in the same season. The labels of registered copper products use low rates (e.g., Kocide 3000 - 0.18 to 0.22 MCE lb/A) and thus, repeated use will select for less sensitive strains.

Laboratory assays on the sensitivity of* Aureobasidium pullulans *(Blossom Protect) to copper and sulfur. Copper (up to 400 ppm MCE tested) did not inhibit growth of the biocontrol organism as compared to the control. Sulfur was inhibitory at concentrations of $\geq$4000 ppm and growth was completely inhibited by 12,000 ppm sulfur. Sulfur rates used in the field at 10-20 lb/A/100 gal are equivalent to 12,000 - 24,000 ppm. Thus, field rates of wettable sulfur would be inhibitory to the biocontrol agent and should not be applied in mixtures with Blossom Protect.

Laboratory studies to enhance growth of biological controls. Growth of *Streptomyces lydicus* (Actinovate) was enhanced with the addition of some growth enhancers. Growth increased by one log unit in the best treatment, but most enhancers tested had a positive effect on the biocontrol population (visual) or

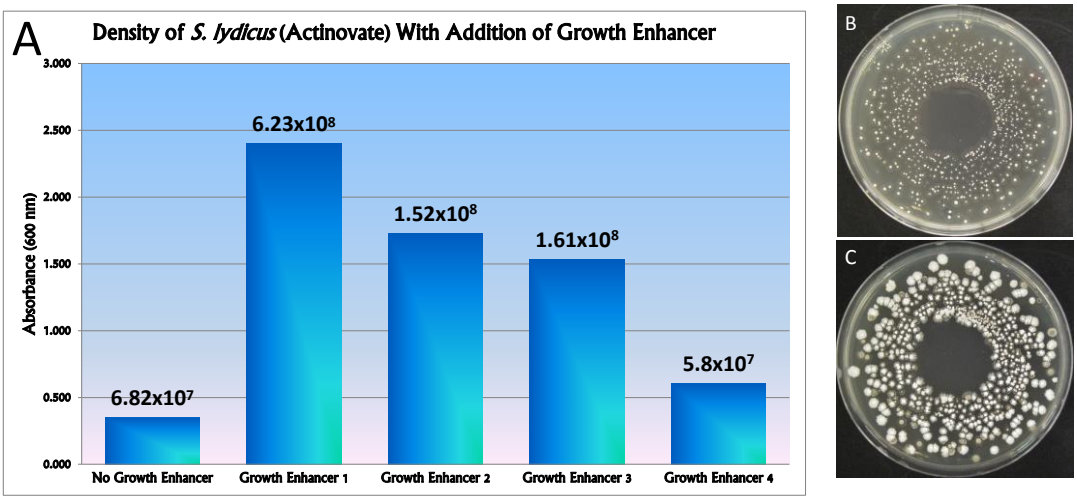


Fig. 1. Growth comparisons of the biological control agent *Streptomyces lydicus.* A) Absorbance of the biocontrol using a standard liquid medium (A) or a visual comparison of growth on a petri dish without (B) or with (C) growth enhancers after 6 days of incubation at 25°C. Higher absorbance indicates higher populations. Growth enhancer 1 increased growth by 1 log (i.e., ten-fold).

density in the medium as measured by absorbance (Fig. 1A-C). The increased amount of growth was evaluated as a way to potentially increase performance and consistency of biocontrols in out-competing the fire blight pathogen.

Field studies on fire blight using protective treatments during the growing season. In the spring of 2015, field trials using conventional and organic treatments starting at bloom were conducted on the management of fire blight of cvs. Granny Smith and Fuji apple. Approximately one month after the second application, disease incidence on Granny Smith was 29.7% in the control.

Table 1. Efficacy of bactericides and biocontrols for the management of fire blight of cv. Granny Smith apples at KARE 2015

No.	Treatment*	Rate/A	Incidence of blight**	LSD^
1	Control	---	29.7	a
2	K-Phite	96 fl oz	20.0	b
3	Serenade Optimum + growth enhancer	16 oz + 32 oz	19.4	b
4	Blossom Protect + growth enhancer	20 oz + 32 oz	19.4	b
5	Actinovate + NuFilm P	8 oz + 8 fl oz	19.0	b
6	Badge X2	8 oz	18.7	b
7	Mycoshield + AgriMycin 17	12 oz + 4 oz	18.6	bc
8	Actinovate + NuFilm P + growth enhancer	8 oz + 8 fl oz + 32 oz	17.8	bcd
9	Fireline	16 oz	16.8	bcd
10	Kasumin 2L + ChampION^{++}	51 fl oz + 8 oz	15.8	bcde
11	Kasumin 2L + Fireline	51 fl oz + 12 oz	15.0	bcde
12	Kasumin 2L + Manzate ProStik	64 fl oz + 5 lb	14.6	bcde
13	ChampION^{++} + Mycoshield	8 oz + 16 oz	14.4	bcde
14	Mycoshield + AgriMycin 17	16 oz + 8 oz	14.2	bcde
15	Serenade Optimum	16 oz	13.9	bcde
16	Kasumin 2L	64 fl oz	13.8	bcde
17	Blossom Protect + Buffer	20 oz + 8 lbs	13.5	bcde
18	AgriMycin 17	8 oz	11.9	cde
19	Kasumin 2L + Actigard	64 fl oz + 2 oz	11.8	de
20	Mycoshield	16 oz	10.2	e

* - Applications were done on 3-16-15 (33% bloom) and 3-25-15 (80% bloom) using an air-blast sprayer at a rate of 100 gal/A.

**- 100 to 200 flower clusters per each of 4 replications (consisting of 2 trees each) for each treatment were evaluated for the presence of blight on 4-23-15.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation (P > 0.05) procedures.

Table 2. Efficacy of bactericide treatments for the management of fire blight of cv. Fuji apples at KARE 2015

No.	Treatment*	Rate/A	Incidence of blight**	LSD^
1	Control	---	30.9	a
2	Blossom Protect + growth enhancer	20 oz + 32 oz	21.3	ab
3	BmJ (CX-10250)	4 oz	19.5	ab
4	Magna Bon	27 fl oz	19.1	b
5	Companion	192 fl oz	16.5	b
6	Cueva	128 fl oz	16.3	b
7	Actinovate + NuFilm P + growth enhancer	8 oz + 8 fl oz + 32 oz	15.9	b
8	Actinovate + NuFilm P	8 oz + 8 fl oz	15.7	b
9	Serenade Optimum + growth enhancer	16 oz + 32 oz	13.7	b
10	Kasumin 2L + Fireline	51 fl oz + 12 oz	11.9	b

* -Applications were done on 3-20-15 (30% bloom) and 3-26-15 (80% bloom) using an air-blast sprayer at a rate of 100 gal/A.

**- 100 to 200 flower clusters per each of 4 replications (consisting of 2 trees each) for each treatment were evaluated for the presence of blight on 4-24-15.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation (P > 0.05) procedures.

Among conventional treatments, Mycoshield (10.2% incidence), Kasumin + Actigard (11.8%), and Agrimycin (11.9%) were most effective (Table 1). Among organic treatments, Blossom Protect (13.5% incidence) and Serenade Optimum (13.9%) were most effective. Copper was least effective (18.7% incidence). This is not unexpected because copper is a contact material and there are less sensitive strains of the pathogen to copper (*See* comments under toxicity of copper).

On Fuji apple, disease incidence was 30.9% in the control. Kasumin + Fireline showed the lowest disease (11.9% incidence). Serenade Optimum + Growth enhancer was numerically the best organic treatment (13.7% incidence). Overall, most of the organic treatments resulted in some reduction of fire blight from the control. Most of the biological controls need to grow on the leaves and flowers in order to prevent the pathogen from infecting. Unfortunately, only one of the growth enhancement treatments added to the tank improved performance of a biocontrol treatment. In most cases, however, improvement was not observed.

Conventional and organic treatments were also evaluated in two trials on the highly susceptible Bartlett pear. Disease incidence was 38.5% in the control 6 days after the second application and 82.5% 2 weeks after the third application. Kasumin + Agrimycin was most effective among conventional treatments with >90% and 70% disease reduction at the two evaluation dates, respectively. In the trial with organic treatments, disease incidence was 45.3% and 88.9% in the control at the two evaluation dates. In the first evaluation, Serenade Optimum was the best treatment (21.5% incidence), but Blossom Protect + MagnaBon, Blossom Protect + Growth enhancer, and Actinovate + K-Phite also resulted in significant reductions in disease from the control. At the second evaluation, however, none of the treatments was effective and disease incidence was similar to the control.

These studies indicate that organic treatments may have promise as alternative treatments for fire blight management on apple, but not on the more susceptible pear. Laboratory studies are ongoing to determine the temperature optimum for growth of selected biocontrols as compared to *Erwinia amylovora*. Studies are ongoing to determine how to improve growth of the biocontrols on pome fruit trees.

Evaluation of postharvest treatments using single-fungicides, mixtures, and pre-mixtures. In comparative studies using Tavano (polyoxin-D), Tavano-Scholar, and Tavano-EXP-13, all were highly effective against Alternaria rot and very effective against gray mold (Table 3). Interestingly, Tavano showed some efficacy against bull's eye rot and was quite effective against Mucor decay. The Tavano-EXP-13 mixture was the most effective against bull's eye rot and the Tavano-Scholar mixture was most effective against Mucor decay. The efficacy against blue mold was not tested in this trial because polyoxin-D is not effective against this decay based on previous studies.

Table 3. Evaluation of in-line drench applications with polyoxin-D, EXP-13, and Scholar for management of postharvest decays of Granny Smith apples in an experimental packingline study - 2014

			Alternaria alternata		*Neofabraea perennans*		*Botrytis cinerea*		*Mucor piriformis*	
No.	Treatment	Rate	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD
1	Control (water)		50.2	a	95.9	a	91.4	a	94.4	a
2	Tavano	8 fl oz	4.5	b	69.8	c	26.5	b	21.5	c
3	Tavano	16 fl oz	4.5	b	42.3	d	16.7	b	17.0	cd
4	Scholar	8 fl oz	0.0	c	82.7	b	29.0	b	38.7	b
5	Tavano + Scholar	8 fl oz + 8 fl oz	0.7	bc	19.5	e	6.3	c	9.8	d
6	Tavano + EXP-13	8 fl oz + 1000 ppm	0.7	bc	3.5	f	16.3	b	14.7	cd

Fruit were inoculated with *A. alternata* (100,000 spores/ml), *N. perennans* (1,000,000 spores/ml), *B. cinerea* (50,000 spores/ml), or *M. piriformis* (100,000 spores/ml) and incubated at 20C for 16-18 h. Aqueous fungicide treatments were applied using an in-line recirculating drench system that were followed by a CDA application with carnauba fruit coating. Fruit were then incubated at 20C for 12 days.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation ($P > 0.05$) procedures.

EXP-13 applied as T-Jet sprays using two formulations or as in-line drenches was very effective against bull's eye rot in another study (Table 4). Very good to high efficacy was also demonstrated against gray mold, blue mold, Alternaria rot, and Mucor decay. Unlike with other fungicides in previous studies (and in studies with Academy, *see below*), T-Jet and drench applications with EXP-13 were similarly effective. In studies on other crops we found that efficacy of EXP-13 sometimes did not vary significantly when using rates between 500 and 1000 ppm. Thus, it appears that this molecule, in contrast to other fungicides we have evaluated, performs well at a threshold concentration, but higher concentrations (or more effective application methods) do not consistently improve efficacy.

Table 4. Evaluation of EXP-13 and Scholar for management of postharvest decays of Granny Smith apples in an experimental packingline study using different application methods - 2014

				Botrytis cinerea		*Penicillium expansum*		*Mucor piriformis*		*Alternaria alternata*		*Neofabraea perennans*	
No.	Treatment	Rate/100 gal	Appli-cation	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD
1	Control (water)	---	Drench	87.2	a	70.7	a	60.4	a	96.8	a	90.3	a
2	EXP-13 WP	1000 ppm	T-Jet	11.5	b	5.4	b	26.4	b	23.5	b	10.6	b
3	EXP-13 SC	1000 ppm	T-Jet	18.1	b	10.7	b	20.1	bc	20.0	b	11.6	b
5	EXP-13 WP	1000 ppm	Drench	16.9	b	7.4	b	26.4	b	18.7	b	11.5	b
6	EXP-13 WP + Scholar	1000 ppm + 150 ppm	Drench	5.2	b	0.0	c	16.0	c	1.0	c	4.2	b

Fruit were wound-inoculated with *B. cinerea* (50,000 spores/ml), *P. expansum* (500,000 spores/ml), *M. piriformis* (100,000 spores/ml), *A. alternata* (100,000 spores/ml), or *N. perennans* (1,000,000 spores/ml) and incubated at 20C for 16-18 h. Aqueous fungicide treatments were applied using an in-line recirculating drench or a T-Jet system and were followed by a CDA application with carnauba fruit coating. Fruit were then incubated at 20C for 12 days.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation ($P > 0.05$) procedures.

Overall, polyoxin-D, and especially EXP-13, performed very well in these studies and showed a relatively wide (Tavano – gray mold, Alternaria rot, Mucor decay) or very wide (EXP-13 – gray mold, blue mold, Mucor rot, Alternaria rot, bull's eye rot) spectrum of activity. Both formulations of EXP-13 were similar in efficacy. The WDG formulation of polyoxin-D that was evaluated previously, however, was not as effective as the liquid Tavano formulation that we used in 2014 and that was applied at very low rates (32 to 64 ppm active ingredient). Both treatments are fermentation products and potentially could be classified as postharvest biopesticides.

The new pre-mixture Academy that was developed to prevent resistance development against fludioxonil was evaluated in two studies on Granny Smith apple. The 16-fl-oz rate (containing 176 ppm fludioxonil and 300 ppm difenoconazole/100 gal) performed mostly similar to the 8-fl-oz rate. The pre-mixture was highly effective against blue mold, gray mold, and Mucor decay when applied as an in-line drench (Tables 5, 6). It also performed well against Alternaria rot, but was not very effective against bull's eye rot (probably because of a limiting low rate

of difenoconazole in the pre-mixture). Thus, Academy has a fairly wide spectrum of activity with blue mold, gray mold, Alternaria rot, Mucor rot, bitter rot (this was demonstrated in previous studies), and some efficacy against bull's eye rot. Although difenoconazole is not effective against gray mold, and generally did not provide an additive effect in blue mold control when used in mixtures with Scholar as compared to using Scholar alone, registration of the pre-mixture will be an 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 (but not Mucor decay or bitter rot) are also controlled by Penbotec. Resistance against pyrimethanil has developed in populations of *Penicillium*, *Botrytis*, and *Neofabraea* spp. at some locations and thus, this fungicide has to be rotated with different modes of action.

Table 5. Evaluation of fludioxonil-difenoconazole (Academy) for management of postharvest decays of Granny Smith apples in an experimental packingline study using different application methods - 2014

				Penicillium expansum		*Mucor piriformis*		*Alternaria alternata*		*Neofabraea perennans*	
No.	Treatment	Rate/100 gal	Appli-cation	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD	Incid. (%)	LSD
1	Control (water)	---	Drench	81.1	a	54.2	a	41.3	a	90.7	b
2	Academy 394SC	8 fl oz = 236 ppm	Drench	2.2	d	13.2	c	16.8	b	75.2	c
3	Academy 394SC	16 fl oz = 470 ppm	Drench	2.1	d	9.1	c	11.3	bc	52.5	d
4	Scala	32 fl oz = 960 ppm	Drench	0.0	d	33.7	b	11.1	bc	9.6	e
5	Academy 394SC	8 fl oz	CDA	56.9	b	54.5	a	51.9	a	99.3	a
6	Academy 394SC	16 fl oz	CDA	51.1	b	51.4	ab	54.7	a	98.5	a
7	Scala	32 fl oz	CDA	6.9	c	54.4	a	7.1	c	11.2	e

Fruit were wound-inoculated with, *P. expansum* (500,000 spores/ml), *M. piriformis* (100,000 spores/ml), *A. alternata* (100,000 spores/ml), or *N. perennans* (1,000,000 spores/ml) and incubated at 20C for 16-18 h. Aqueous fungicide treatments were applied using an in-line recirculating drench or a T-Jet system and were followed by a CDA application with carnauba fruit coating. For Academy, the A20682B formulation was used. Fruit were then incubated at 20C for 12 days.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation ($P > 0.05$) procedures.

Table 6. Evaluation of in-line drench applications with Scholar, Academy, and EXP-13 for management of postharvest gray mold of Granny Smith apples in an experimental packingline study - 2014

			Botrytis cinerea	
No.	Treatment	Rate/100 gal	Incid. (%)	LSD
1	Control (water)	---	94.7	a
2	Scholar	8 fl oz	10.7	c
3	Scholar	16 fl oz	0.0	c
4	Academy	8 fl oz	6.1	c
5	Academy	16 fl oz	6.0	c
6	EXP-13 WP	500 ppm	27.0	b

Fruit were wound-inoculated with *B. cinerea* (50,000 spores/ml) and incubated at 20C for 16-18 h. Aqueous fungicide treatments were applied using an in-line recirculating drench system and were followed by a CDA application with carnauba fruit coating. For Academy, the A20682B formulation was used. Fruit were then incubated at 20C for 12 days.

^ - Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation ($P > 0.05$) procedures.

Shade Cloth Benefits for Apples

Annual Report – 2014 to 2015

In September of 2014, the California Apple Commission (CAC) was awarded a CDFA Specialty Crops Block Grant (SCBG) to study the effects of shade cloth on apple orchards in California. The study officially began in October 2014. This project was designed to determine if the use of shade cloth in apple orchards would have a significant and cost-efficient effect for our apple growers in California; paying particular attention to fruit quality, hail protection, and reduced amount of crop protective product and water usage.

The CAC began by hiring a part-time employee for the duration of the grant to perform the day to day operations of the grant and act as a liaison to the third party researcher. Carrie Schellenberg, a past intern and Communications Administrator for the CAC, was hired for the position. She began work on the project in the beginning of October 2014.

According to the design of the grant, four California apple growers were selected to participate in the study in order to replicate the experiment in different places and on different apple varieties that are a representation of all apple growing in California. This was accomplished in October 2014.

After sending out requests for proposals (RFPs), the CAC decided to hire Fruit Dynamics to conduct the third-party research for the project. This was done in November 2014. The CAC has hired Fruit Dynamics in the past; they were involved in the CAC's successful Starch Iodine study.

The Commission then began sending out RFPs to shade cloth companies to find a good source of materials for the project. CAC staff and the participating growers met with several companies and ultimately decided to purchase the shade cloth from Extenday due to the variety of materials they offered and their advanced technology. This contract was awarded to them in December 2014.

Talks began in December between CAC staff and the participating growers to determine the amount of shade cloth needed and what types to use. In the course of this discussion, it became evident that the current structure of the existing orchards that were to be used for the study was not sufficient to support any shade cloth. The CAC then began discussing what would need to be done to mediate this problem. It was determined that more structure would need to be added in each test block. A contractor for such work, Dan Drake Enterprises, was selected by the growers based on having worked with him in the past. The CAC was able to request and have approved a line-item shift within the grant budget to cover expenses.

Dr. Linda Harris, Ph. D

Listeria monocytogenes

Summary

2014-2015

Dr. Linda J. Harris is a specialist in the Cooperative Extension for Food Science and Technology at the University of California, Davis. She has gathered and prepared extensive amounts of research concerning the lethal pathogen *Listeria monocytogenes* along with various practices that may be utilized to prevent future outbreaks. The following report features methods of identification for high risk areas of listeria as well as sanitation programs and environmental monitoring practices that are designed to limit the risk of contamination.

Her studies on the recent caramel apple outbreak focus on several main factors. She has discovered the effects that variables such as temperature and fruit skin damage have on the risk of contamination. What was found when studying caramel apples in particular was that when the skin of the apple was punctured by the stick, it allowed Listeria to spread to the inner flesh of the fruit. She found that when apples without sticks were stored at 77 degrees Fahrenheit, the Listeria strain took approximately 11 days to show any sign of increase. However, the fruit containing a stick (stored at the same temperature) took only 2-3 days. Her research also shows that an increase in water activity and pH under the layer of caramel will contribute to Listeria growth at the interface.

Dr. Harris's work provides essential guidelines for environmental monitoring in any type of packing house or fruit storage facility. This monitoring is of utmost importance in reducing the possibility of a Listeria contamination. Establishing zones, sanitation controls, and employee hygiene training are a few of the essential preventative steps mentioned in the report. In addition, it is highly important to establish long-term preventative maintenance throughout the facility. This can be achieved through regular cleaning as well as continuous testing of potentially contaminated areas. If any form of contamination is found, it is extremely important to take the correct steps to ensure that the bacteria does not spread to further areas of the facility. Pathogens have the likelihood of forming in many areas of a facility and it is important to note that although a surface may appear to be clean, there is still a very good possibility that it may be contaminated.

The zone method that Dr. Harris refers to is an organization structure of areas in the packing house, numbered one through four, in order of their proximity to the actual fruit. For example, Zone One areas are nearest to the fruit and include anything that makes direct contact with the produce including slicers, conveyor belts, brushes, etc. Zone Four areas are those that are not near the fruit, rather, these are places that employees have daily access to including locker rooms, loading docks, cafeterias, etc. It is highly important to familiarize yourself, along with your employees, with these zones to help create and maintain a cleaner, contaminate free working environment.

Identification of High-Risk Areas for *Listeria monocytogenes* and Verification of Sanitation Programs – Environmental Monitoring



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Food Science and Technology
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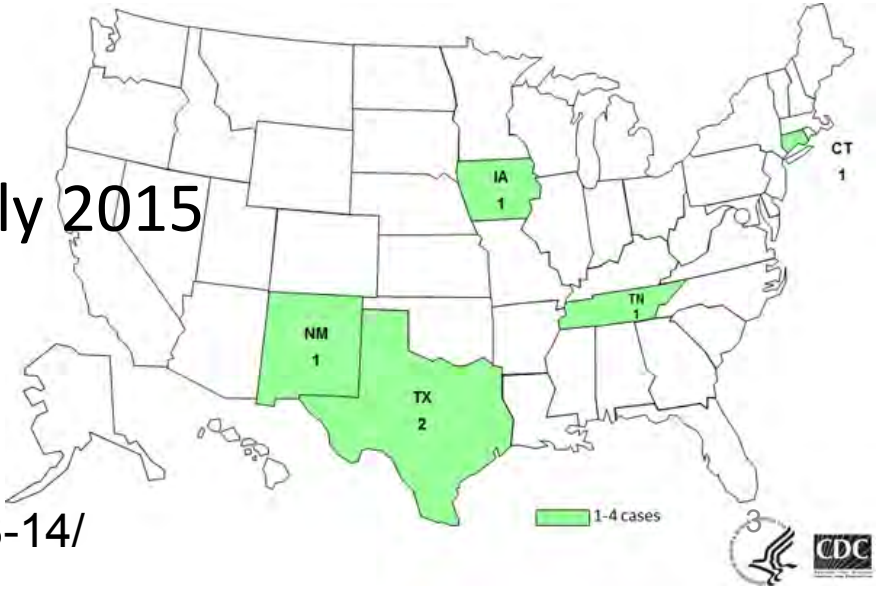
Yakima, WA April 21, 2015

Outline

- Outbreaks/illnesses
  - New methodologies, new approaches
    - Peanut butter, 2014
    - Stone fruits, 2014
    - Caramel apples, 2014
- Environmental monitoring - approach
  - Zone concept
  - Environmental pathogens
    - *Salmonella*
    - *Listeria monocytogenes*

2014 Nut Butter Outbreak - Identification in Reverse

- Routine inspection of facility
  - January 2014
  - Isolates *Salmonella* Braenderup
    - PFGE fingerprinting
    - Whole genome sequencing
- Search PulseNet for cases
  - January (2), February, March, April, May
- Epidemiology
- Re-inspection, re-isolation July 2015
  - *Salmonella* Braenderup
- 6 months product recall



http://www.cdc.gov/salmonella/braenderup-08-14/

Morbidity and Mortality Weekly Report (*MMWR*)

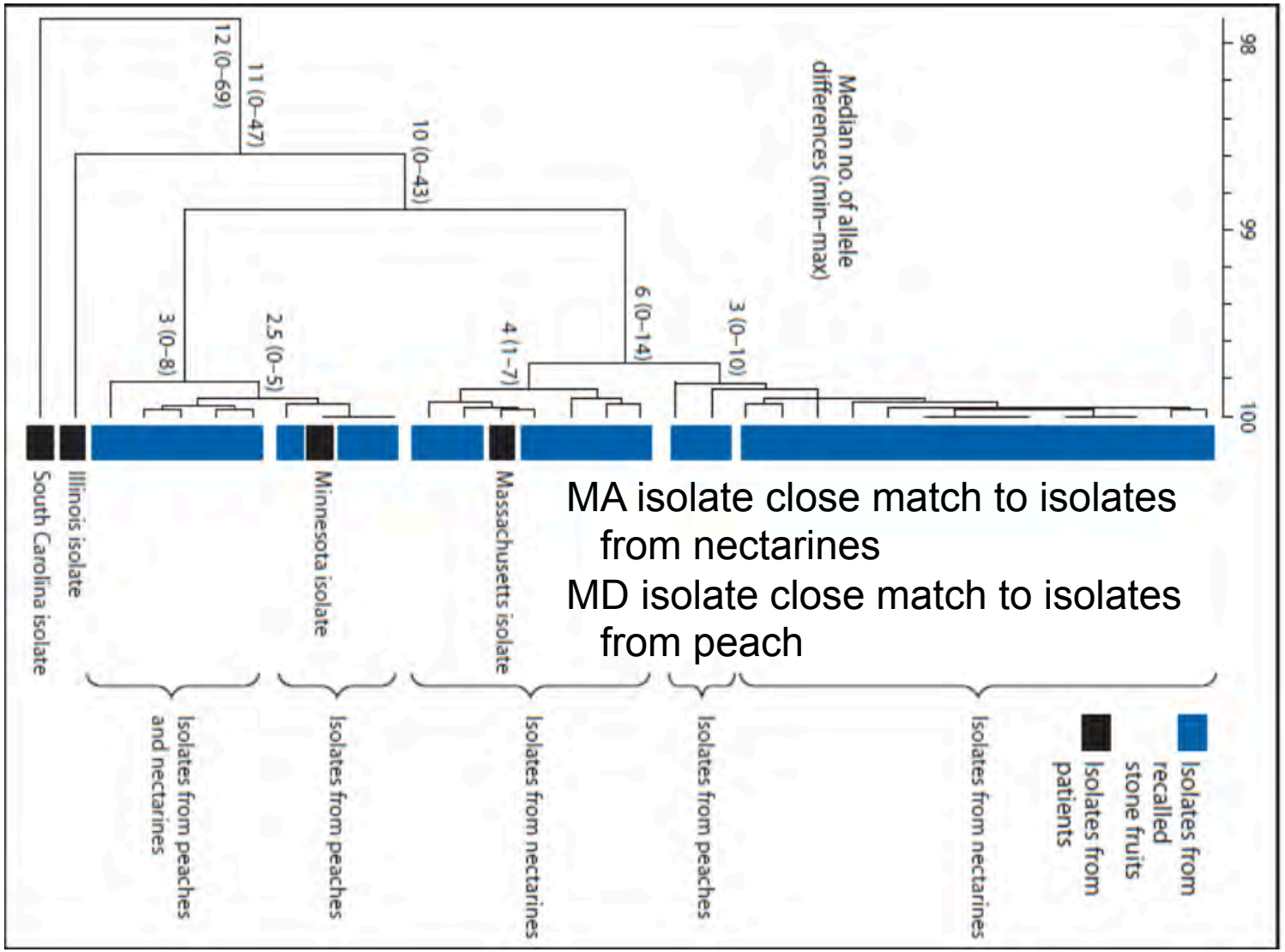
MMWR

Recommend Tweet Share

Notes from the Field: Listeriosis Associated with Stone Fruit — United States, 2014

Weekly
March 20, 2015 / 64(10);282-283

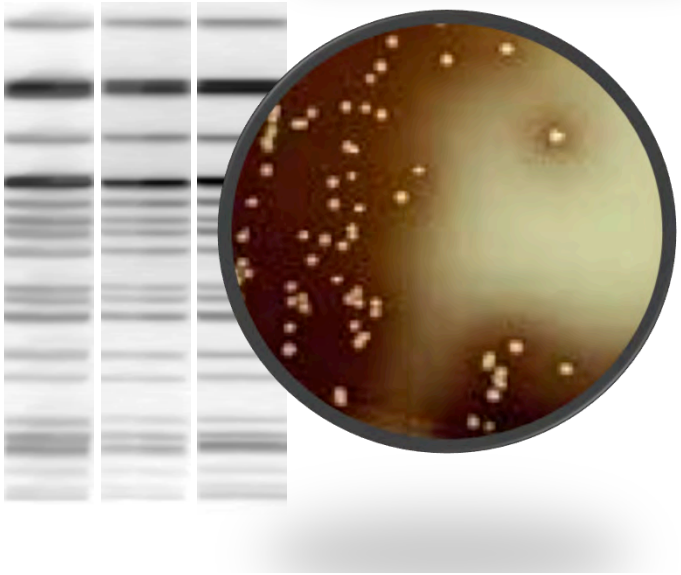
Listeriosis associated with stone fruit 2014



2014 Listeriosis – Caramel Apples

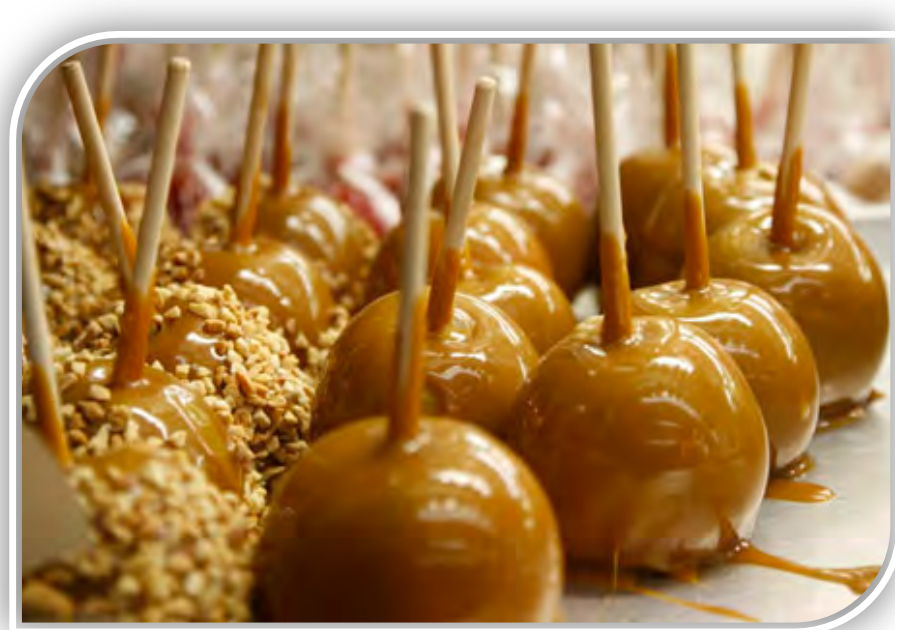
- Commercially produced, prepackaged caramel apples
- Linked to single California packing facility
- PFGE link outbreak and environmental strains
- 35 illnesses/7 deaths; 12 states; Manitoba
  - Three cases of meningitis in otherwise healthy children
    - aged 5–15 years

- Unlikely food attribution – ho history
  - Whole apple surface dry
  - pH apple flesh: 3.6 to 4.0
  - Aw caramel: <0.80
  - Limits of growth for *L. monocytogenes*
    - pH 4.4
    - Aw of 0.92



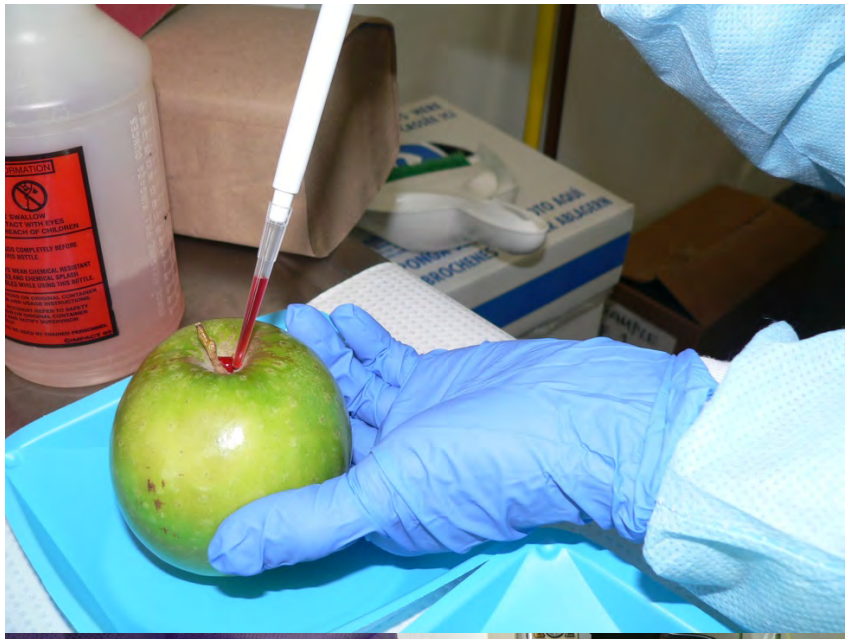
Questions:

- Can outbreaks strains grow at lower pH and/or A_w limits?
- Were conditions present that could support growth of *Listeria monocytogenes*?
  - E.g., caramel/apple interface
- Could damage to the apple (insertion of stick) contribute to ability to support growth?



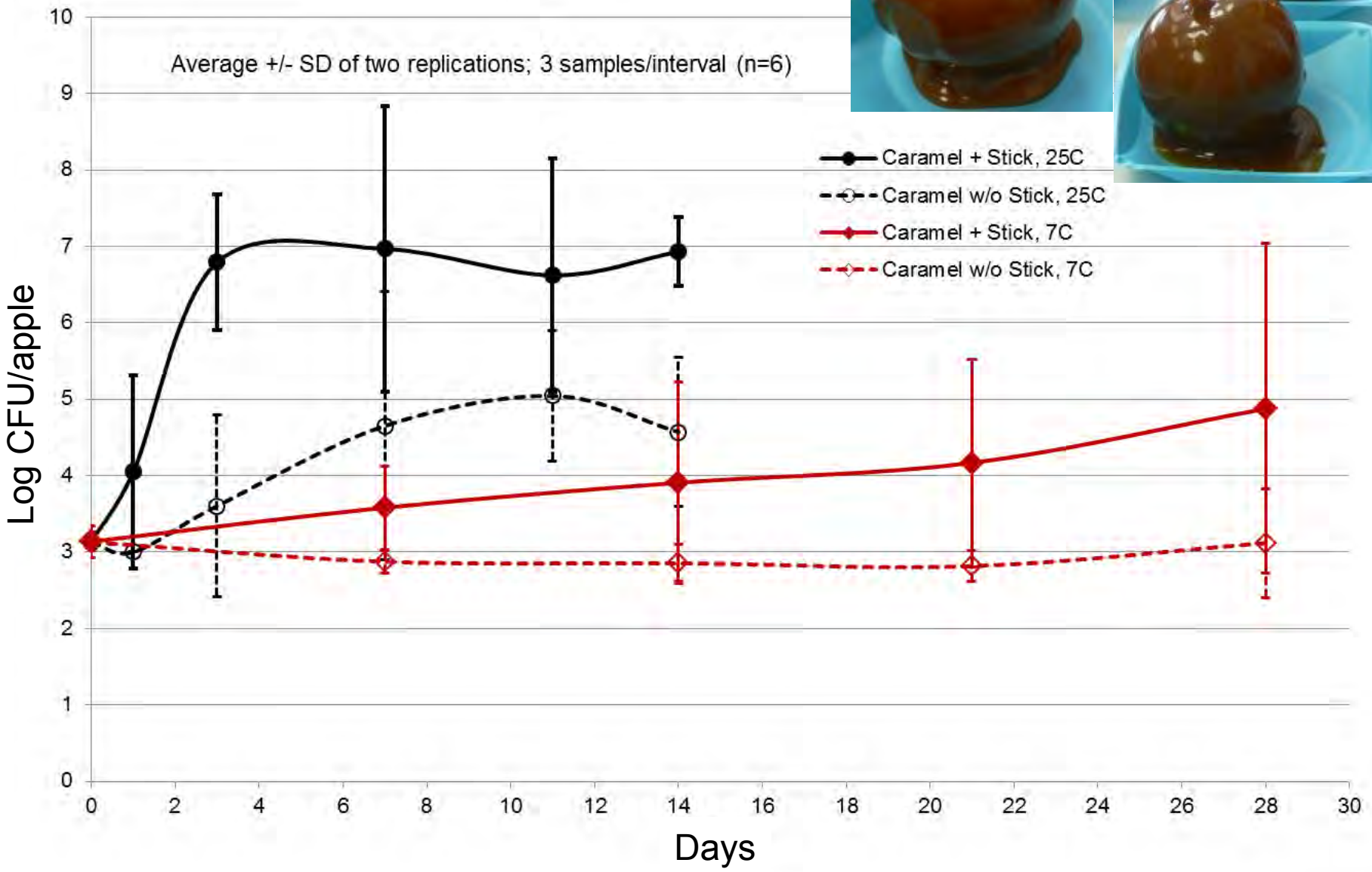
FRI Lab studies

- Outbreak strains obtained from WI Lab of Hygiene
- Preliminary work
  - *damaging* apple allowed growth
  - Obviously damaged apples not used by processors
- Follow up studies
  - Inoculated
    - apple surface, stem, calyx
  - Measure populations
    - before and after hot caramel dip
    - Enumeration from surface rinse
  - Food grade dye used to track inoculum



- Apples
- Stick/No stick
- Caramel 195°F
  - Dip (stick or tongs)

- Storage
  - 77 and 45°F


Average +/- SD of two replications; 3 samples/interval (n=6)
Caramel + Stick, 25C
Caramel w/o Stick, 25C
Caramel + Stick, 7C
Caramel w/o Stick, 7C
Log CFU/apple
Days
0
1
2
3
4
5
6
7
8
9
10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30

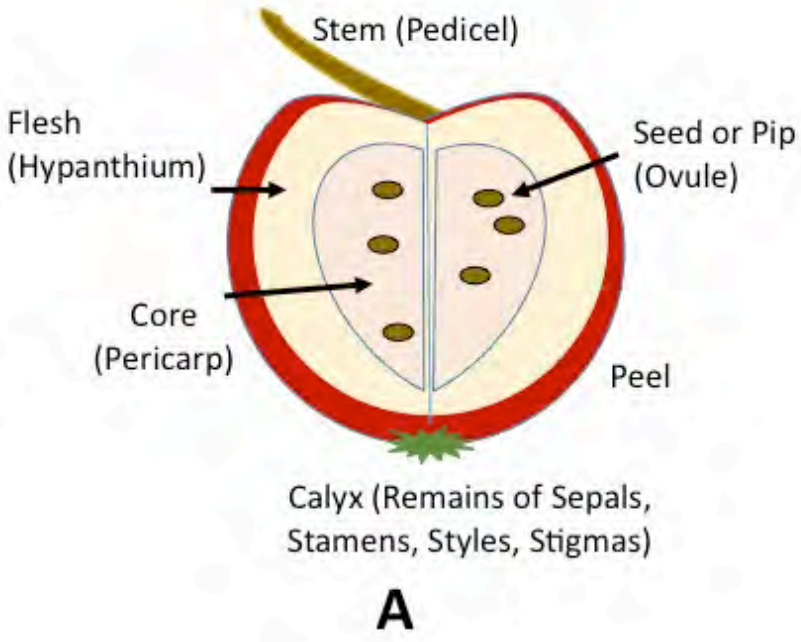
Apple + Caramel + 77°F/25°C
2 log increase in *Listeria monocytogenes* in 11 days

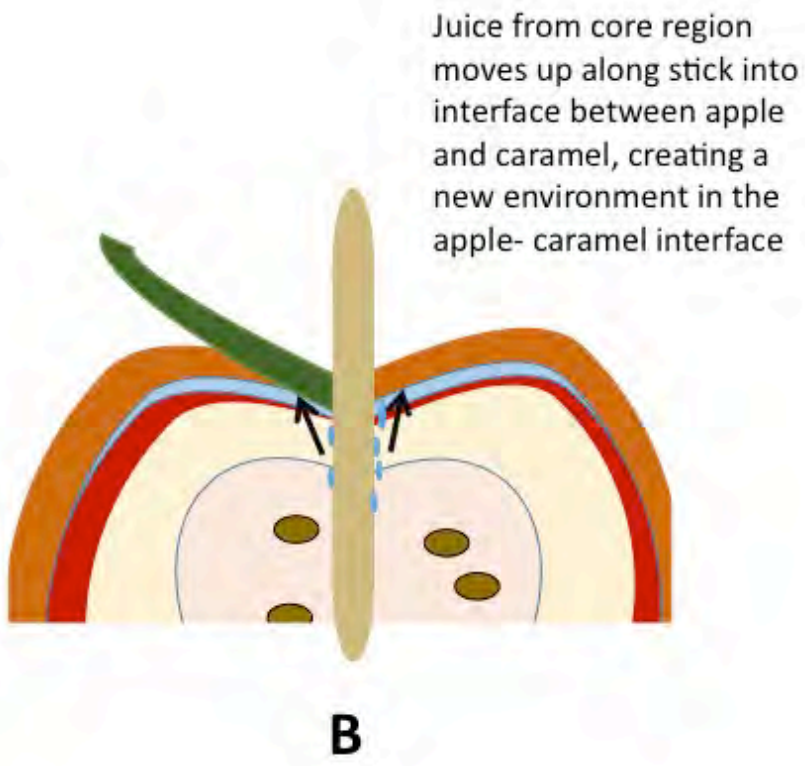
Apple + Stick + Caramel + 77°F/25°C
4 log increase in *Listeria monocytogenes* in 2 to 3 days

Hypothesis:
Pathogen protected from sanitizer or heat from caramel

Photo: Incursion of dye (surrogate for microbe) during washing of warm apples in cold water

Deep depressions may protect microbes from contact with hot caramel





Hypothesis:

- Increased water activity and pH under caramel layer
- Growth in microenvironment at interface

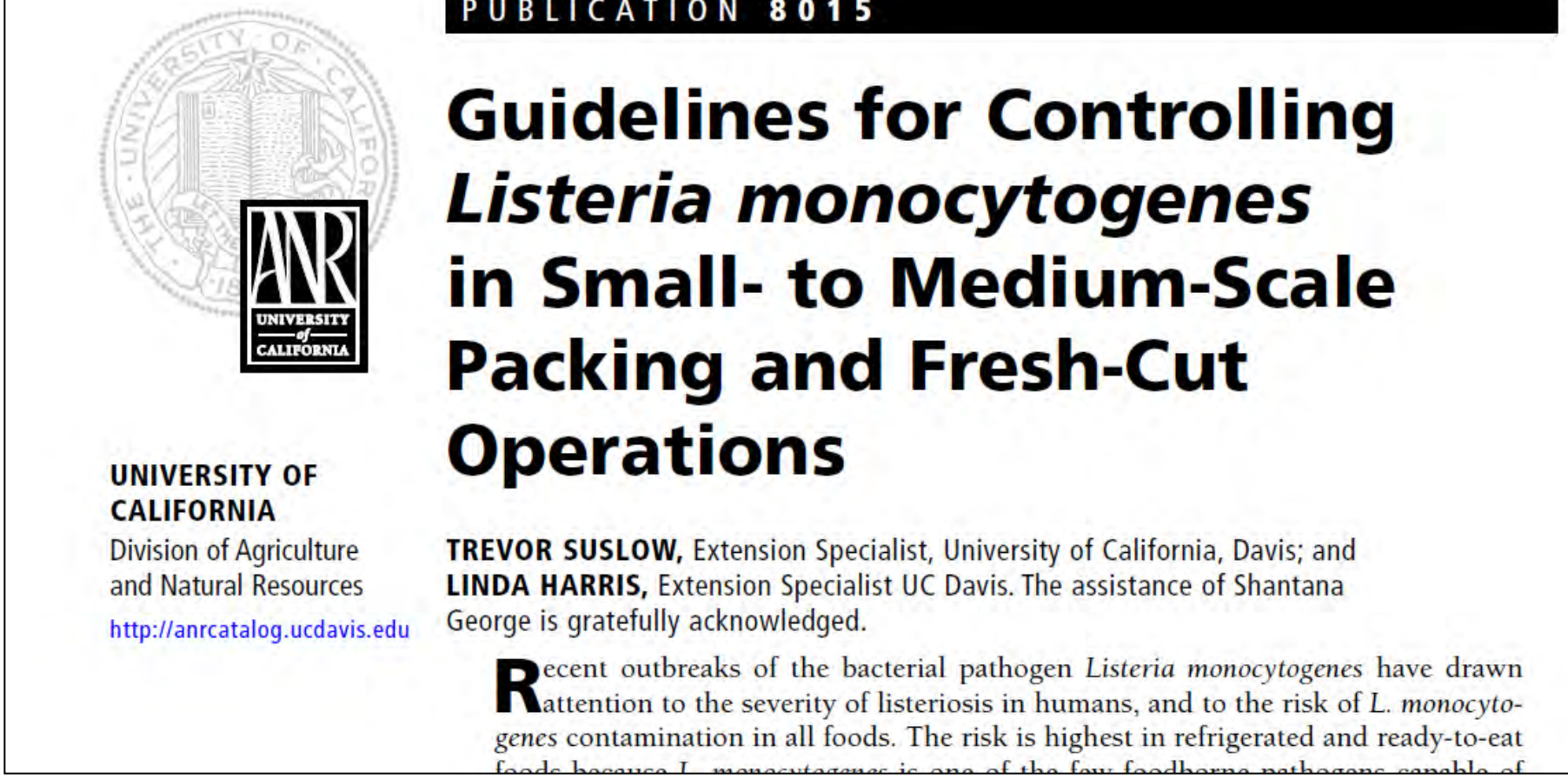
Improving the safety of caramel apples

- Short term fix:
  - Limited out of refrigeration storage
    - E.g. <24 h display
  - Consumer labeling to refrigerate
  - Validated disinfection step for apples
    - E.g. 5-log kill
  - Environmental controls
- Future research
  - Additional of growth inhibitors
    - Caramel dip
    - Apple wax
  - Understand basic science between colonization in/on apple

Environmental Monitoring

Listeria is not a new issue for packinghouses.

Published 2000



PUBLICATION 8015

Guidelines for Controlling *Listeria monocytogenes* in Small- to Medium-Scale Packing and Fresh-Cut Operations

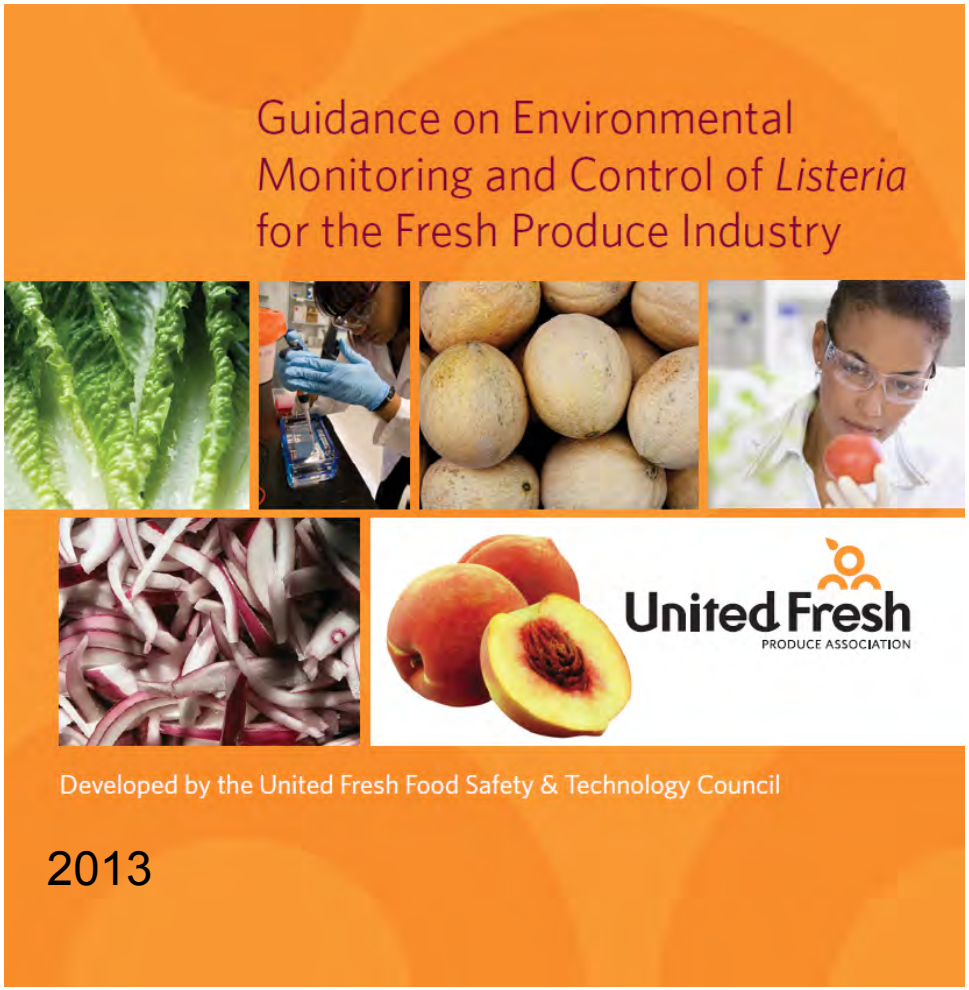
UNIVERSITY OF CALIFORNIA
Division of Agriculture and Natural Resources
http://anrcatalog.ucdavis.edu

TREVOR SUSLOW, Extension Specialist, University of California, Davis; and **LINDA HARRIS,** Extension Specialist UC Davis. The assistance of Shantana George is gratefully acknowledged.

Recent outbreaks of the bacterial pathogen *Listeria monocytogenes* have drawn attention to the severity of listeriosis in humans, and to the risk of *L. monocytogenes* contamination in all foods. The risk is highest in refrigerated and ready-to-eat foods because *L. monocytogenes* is one of the few foodborne pathogens capable of

http://anrcatalog.ucdavis.edu/pdf/8015.pdf

Guidance Resources:
RAC's, Fresh-cut, Dry Facilities



http://www2.unitedfresh.org/forms/store/ProductFormPublic/

http://www.almonds.com/processors/processing-safe-product#pem

Environmental monitoring

Builds on Existing GMP and Sanitation Programs

Environmental Monitoring

- **A verification step**
  - **Verify** that you are following the procedures you developed (‘**compliance**’)
  - **Verify** that the plan is working in practice.

Verification activities include

- Review of
  - written policies and procedures
  - quality systems audits, GMP self-audits, etc.
  - records that support the GMP programs
    - E.g., sanitation and training records
- Observation of
  - cleaning and sanitation, sanitary conditions,
  - GMP compliance, etc.

Pathogen Accumulation

- Microbes may survive, especially on surfaces that remain wet (brush/sponge rolls; floors)
- Use of dump tanks
  - Pathogens can accumulate during packing

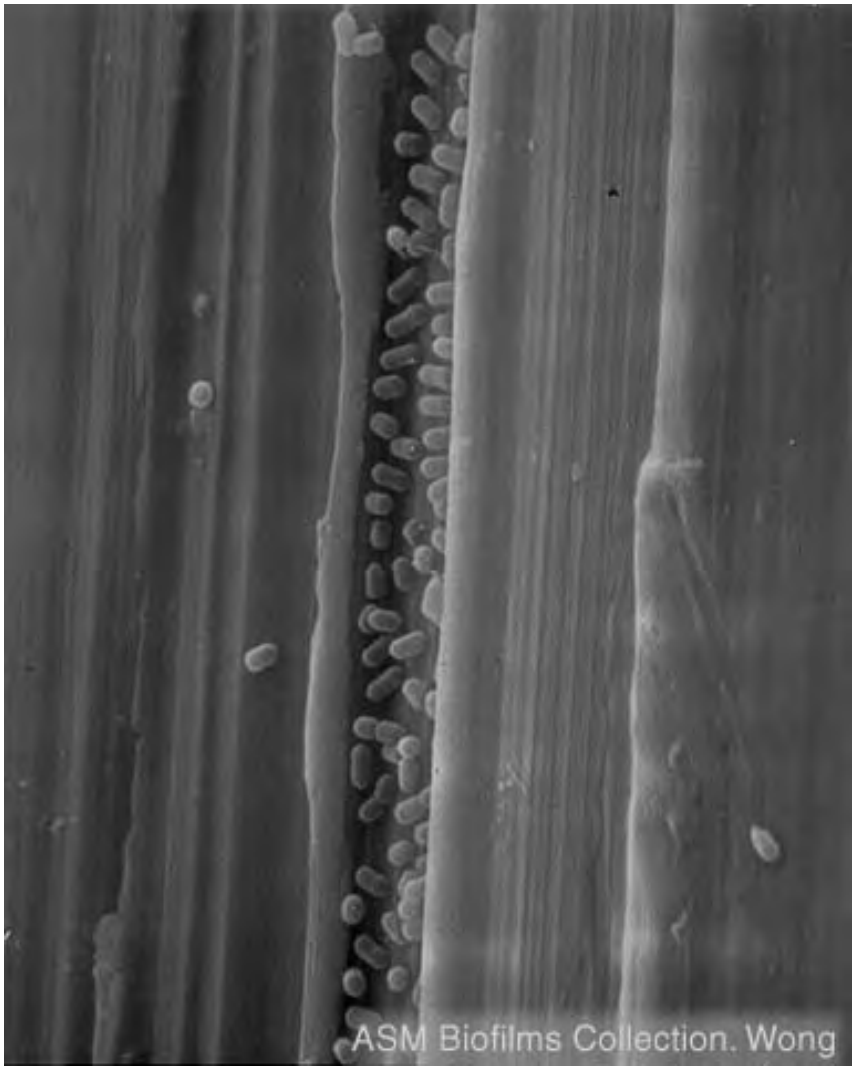
Surface that remain wet = harborage
Organic matter = growth potential

Pathogen accumulation

- Contact of plant material with surfaces:
  - waxes and plant sap accumulate
  - Partially decayed plant material
    - sticks to surfaces
    - is loaded with microbes

Bacteria Can Hide

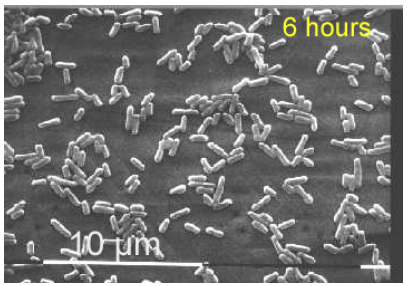
- Even though a surface may appear smooth, there are many places for bacteria to hide!
- This is polished stainless steel.

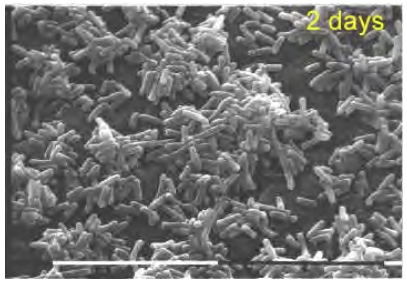


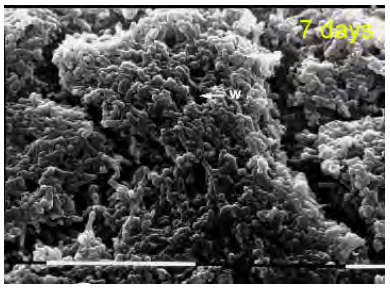
http://www.asmusa.org/edusrc/biofilms/hires/044h.jpg

Microbes (including *Listeria)* form biofilms

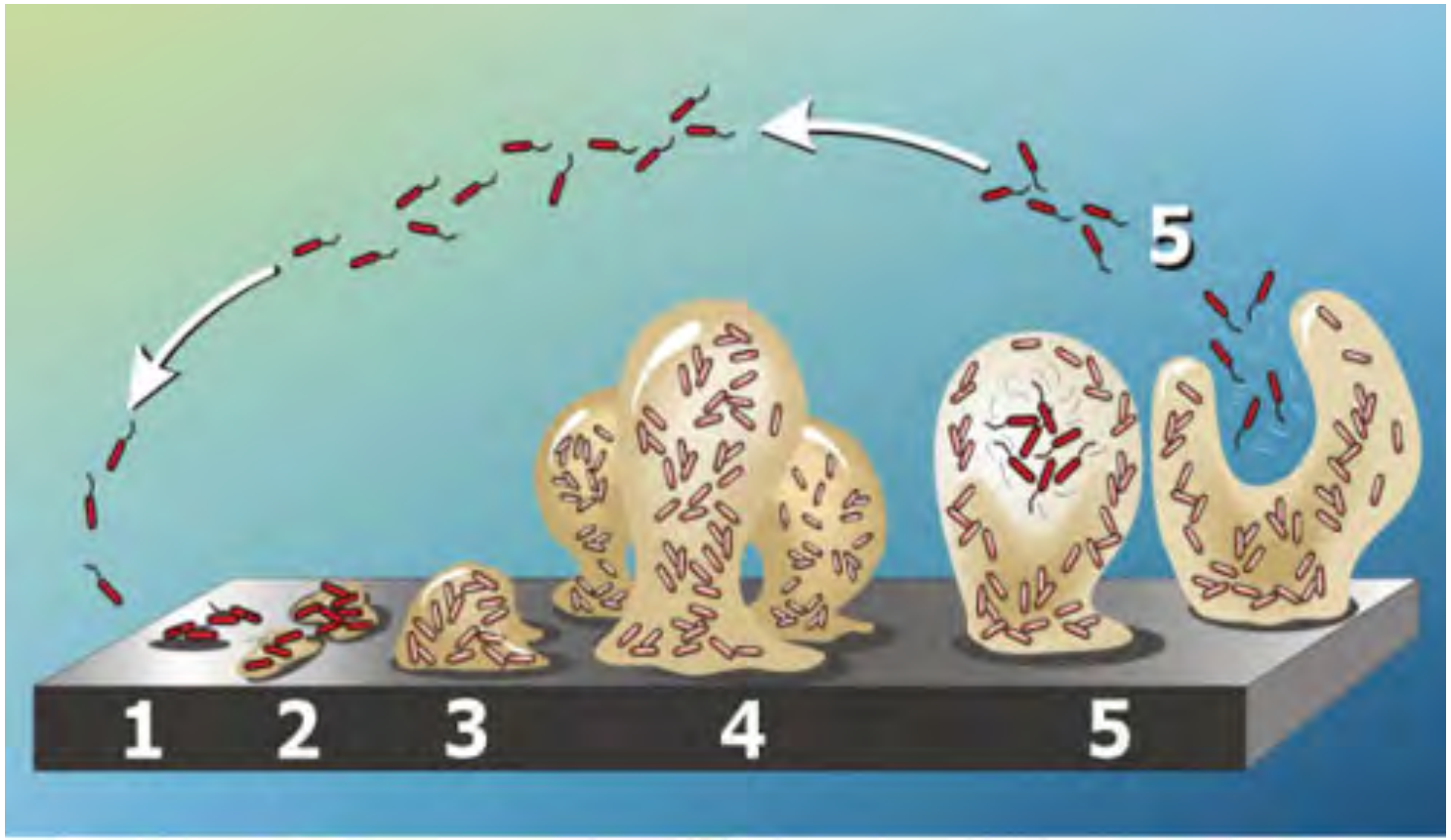
- Biofilms can be found everywhere
- Collections of microscopic organisms which have attached themselves to a surface (and each other) in the interests of survival.
- Characterized by a sticky adhesive substance.
  - Provides protection
  - Serves as attractant

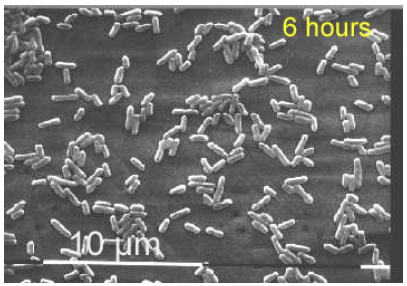


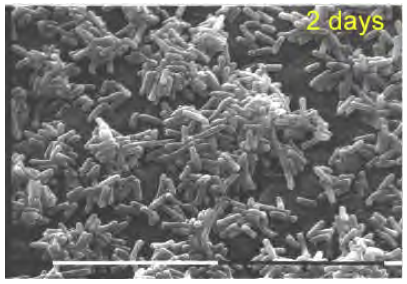


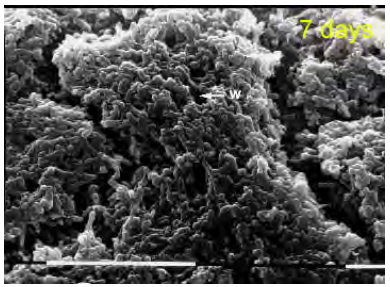


The Making of A Biofilm

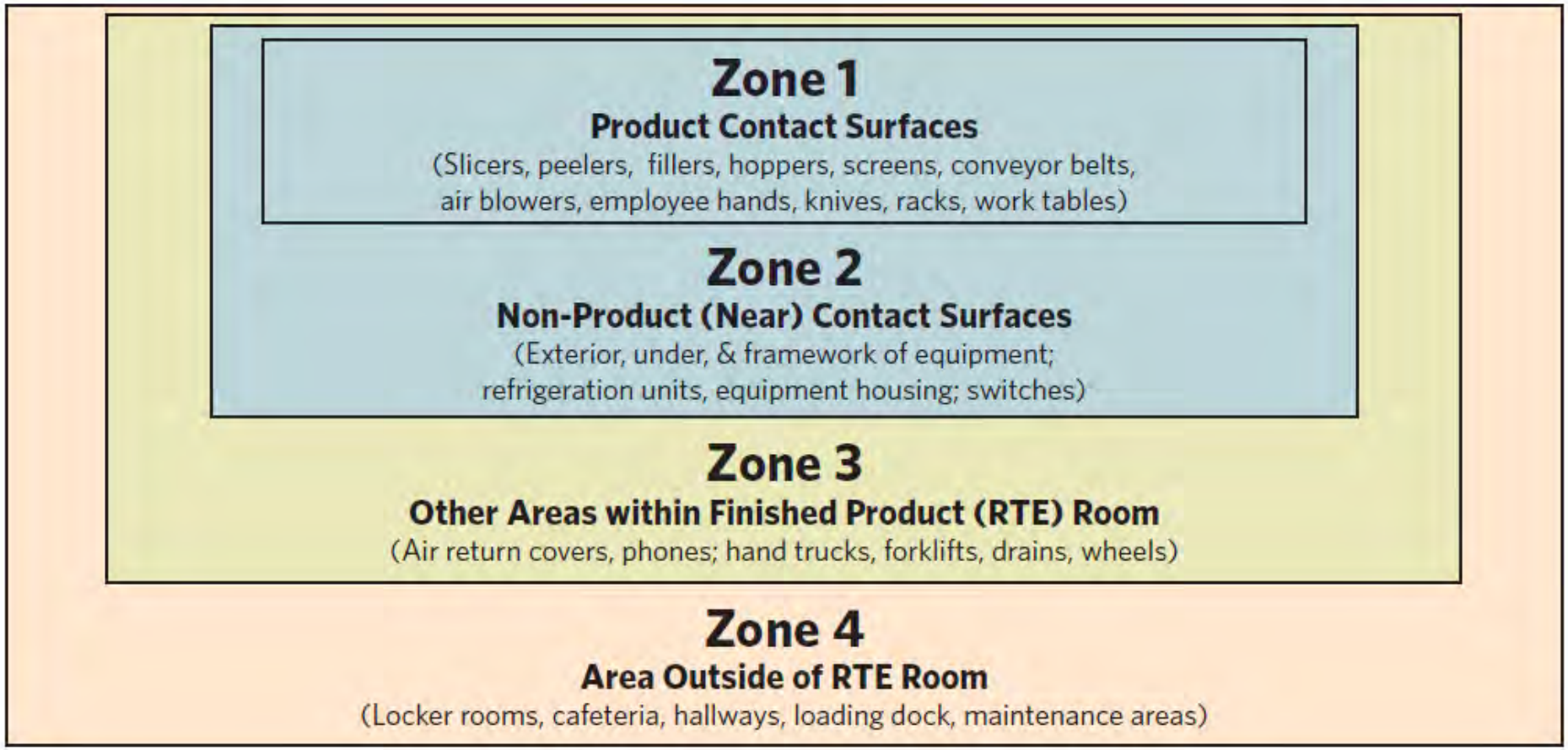








Zone Concept for Setting Master Schedule Cleaning and Sanitation & Environmental Monitoring Programs



Zone 1

- *Direct* or *indirect* product contact surfaces
- Direct
  - surfaces exposed to product during equipment operation
    - conveyor belts, brushes, rollers
    - ladders, hoses, tools, etc. used by workers who also handle product or touch product contact surfaces

Photo credit: Almond Board of California, M. D. Danyluk

Zone 1

- Indirect
  - surfaces from which liquids or dust or other material may drain, drop, diffuse, or be drawn into the product or into the container, and surfaces that touch product contact surfaces or the product container (ABC PEM manual)
  - Not universal agreement on which surfaces classify as indirect
  - A sanitation survey can be used to identify and reduce the number of indirect contact points in a facility

Zone 1

- Routine Tests
  - Visual Inspection – is it visibly clean?
  - Organic matter indicator
    - Adenosine triphosphate (ATP) testing
    - Pass/fail levels determined
  - Is it microbiologically clean?
    - Indicator organisms
      - aerobic plate count
      - coliform count
    - Results assessed against established metrics

Environmental Testing

- How often to swab food contact surfaces for APC…once week…once a month?

<u>Develop a Master Swab Plan</u>

Frequency of testing: Routine sampling may be performed weekly, monthly or quarterly depending on the amount of product produced, risk and facility history. There is no "right" answer as to frequency and number of swabs.

Zone 1

- Special circumstances only
  - Environmental Pathogens
    - *Listeria* spp.*, Listeria monocytogenes*, *Salmonella*

Environmental pathogen

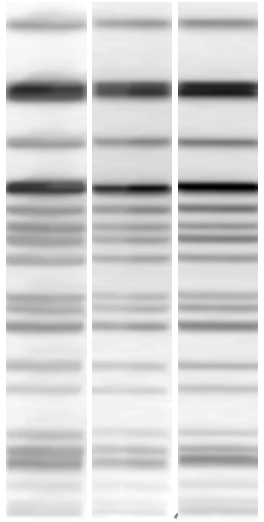
- means a pathogen capable of surviving and persisting within the manufacturing, processing, packing, or holding environment such that food may be contaminated and may result in foodborne illness if that food is consumed without treatment to significantly minimize the environmental pathogen.

Proposed preventive controls rule, 2014

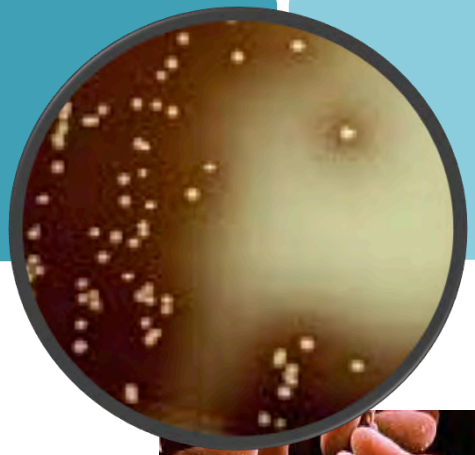
Dry processes

- Pathogen:
  - *Salmonella*
- Example indicator organism
  - *Enterobacteriaceae*

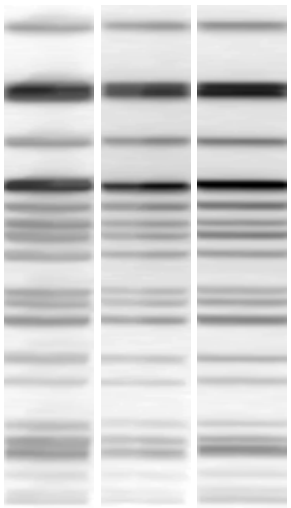
- Infant formula
  - Pathogen: *Cronobacter sakazakii* (formerly *Enterobacter sakazakii*)



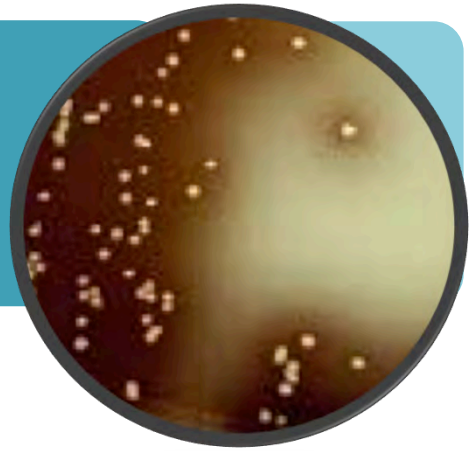
Wet processes



- Pathogen
  - *Listeria monocytogenes*
- Example indicator organism
  - *Listeria* spp.
  - NOTE: Positive for *Listeria* spp. on food contact surface may be considered equivalent to finding *L. monocytogenes*



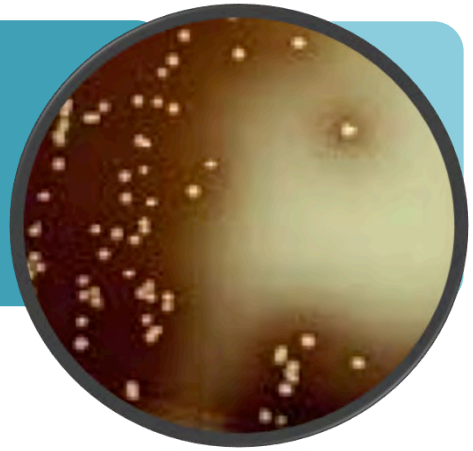
Testing for *Listeria* spp.



- Zone 4
  - Removed from processing
    - Warehouses, bathrooms, maintenance areas, loading docks, offices, entrance

- Why?
  - Confirmation that tests for *Listeria* spp. are working
  - May reveal ingress points

Testing for *Listeria* spp.



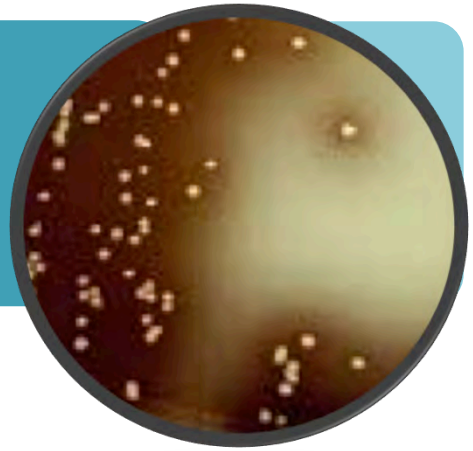
- Zone 3
  - Surfaces further removed from product contact
    - Walls, walkways, phones, carts, air handling units, drains
- Why?
  - These areas provide niches and harborages
  - Can accumulate moisture and nutrients
  - Zone 3 contamination can move to Zones 2 and 1
    - Workers, air, water (often during cleaning)

Testing for *Listeria* spp.

- What is the recommended frequency for swabbing drains for *Listeria* spp. in a fruit packing house?

See United Fresh guidance document for discussion

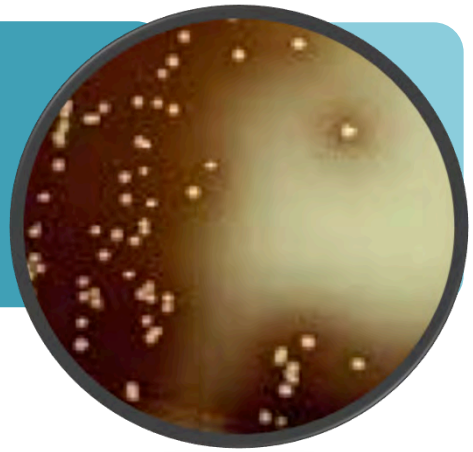
Testing for *Listeria* spp.



- Zone 2
  - *Immediately next to* food contact surfaces
    - Outside and under food contact surfaces
      - Exterior, under, & framework of equipment; refrigeration units, equipment housing; switches

- Why?
  - More likely than Zone 3 to collect moisture and nutrients, shorter distance to transfer bacteria to food contact surfaces.

Testing for *Listeria* spp.



- Zone 1
  - Food contact surfaces
    - Hoppers, conveyor belts, brushes, employee hands, racks, work tables
- Listeria spp. testing NOT USUALLY DONE
  - A positive on this surface may be considered indicative of product contamination
- If/When?
  - Between production lots, when affected product can be held until results are known.
  - End of season, before start of season
  - During in depth investigations

Where to look? “Be the *Listeria*”

What about a positive finding?

- You MUST have a written corrective action.
- Transient
  - Not found in repeated testing
- Resident
  - Repeatedly found
- Examine the site, implement appropriate cleaning/sanitation
  - Retest the site and surrounding area
  - Increase routine testing in and around area until several negative results
- If resident *Listeria* spp. is suspected
  - Form a team
    - Investigate potential cause, implement corrective action, retest
- Document all activities

Special Events

- Enhanced environmental monitoring should be considered when:
  - Construction
  - New equipment installation
  - Major repairs
  - Breaks in operation

Indicator and Pathogen Testing

- Results
  - Understand the limitations.
  - Define Critical Limits **in Writing**
    - What is unacceptable?
  - Define Corrective Action **in Writing**
    - Action for unacceptable result?
  - **Written** data disposition **policy.**

Indicator and Pathogen Testing

- Data processing
  - Keep good records
  - Evaluation of trends
  - Recognizing site-specific deviations
  - Recognizing equipment or practice-specific risks
- Further characterization of isolates
  - *Listeria* spp. to *L. monocytogenes* to fingerprints
  - Genome sequencing
- Whole community analysis

Summary

- Environmental monitoring
  - Is a verification activity that can be used to assess the efficacy of GMPs and a sanitation program
  - For zone 1 surfaces assessing for indicators of reduced organic or microbial load (e.g., ATP, APC) is common
  - For zone 2 to 4 surfaces assessing for a pathogen or pathogen indicator (e.g., *Listeria* spp.) may be appropriate
- Written
  - Environmental monitoring plan and corrective actions
  - Documentation is critical

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

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) *Shade cloth benefits for apples* – facilitated by CAC staff and research analyzed by Fruit Dynamics

2015/2016	**Amount**
Jim Adaskaveg – Evaluation of new bactericides for control of fireblight…	$16,000
CAC – Shadecloth benefits for apples	$303,707[i]
Fiscal Impact for 2015/2016	**$16,000**

[i] This amount was granted to the California Apple Commission by a CDFA Specialty Crops Block Grant and will cover the expenses of 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: 2016 Anticipated Duration of Project: 2nd year of 4 years

Principal Investigators: J. E. Adaskaveg

Cooperating: D. Thompson, D. Cary, and H. Förster

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, 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. In 2015, low to moderate levels of copper insensitivity in pathogen populations was detected. Antibiotics for blight control include streptomycin, 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 fruit 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 need to be evaluated for other bacterial pathogens such as *E. amylovora*. These products are organically approved as mined compounds. We plan to test them by themselves and in combination with kasugamycin or other products (registered copper products) in laboratory assays. If successful, small-scale field trials should then be conducted.

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. Thus, our recent research on organic alternatives is quite promising. 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*), should continue to be evaluated in 2016 in selected mixtures or in rotation with new copper products.

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 should be evaluated in field trials in 2016.

Toxicity of some copper and sulfur products used in fire blight control has been shown for some of the new biocontrols. 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 and sulfur 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 liquid lime sulfur. Incompatibilities could prevent the use of biocontrols or limit their use to later-season applications in rotations or tank mixtures.

In research in 2015, use of OMRI-approved BmJ (CX-10250, Certis) to complement copper and other control materials as a systemic acquired resistance (SAR) treatment was unsuccessful. The active ingredient of BmJ WG 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. These types of compounds deserve continued evaluation especially if they are OMRI approved. 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. Furthermore, SAR compounds may have a longer-lasting effect on the plant's defense activation. 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 2012-14, we found that polyoxin-D (Ph-D, Oso) was similarly effective to the fungicide Penbotec in reducing the incidence of gray mold, but it was not effective against blue mold. In 2013, we showed that this compound and another one called EXP-13 is also highly effective against *Alternaria* species.EXP-13 also shows good efficacy against decays caused by *Penicillium*, *Botrytis*, and *Mucor* spp. Polyoxin-Dand EXP-13 have an exempt registration status and thus, both have the potential to be effective organic treatments if they become certified by the NOSB. Our goal is to continue to evaluate these products for the management of postharvest decays of apples. The registrants of these fungicides are supporting the developmenton fruit crops and are planning to submit for registration. EXP-13 has been used as a federally-approved food additive to prevent

mold growth, including *Penicillium* species, on dairy products for many years in the United States. Over all the years in use, resistance in *Penicillium* species against EXP-13 has not occurred. Thus, we plan to evaluate these very exciting new products for the management of postharvest decays of apples.

Objectives for 2016

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 nano-particle copper and zinc products
   C. Small-scale hand-sprayer tests using different treatment-inoculation schedules to evaluate coppers (Badge X2, CS-2005, Cueva, Champ), nano-copper and –zinc products, and biological treatments (Blossom Protect, Actinovate, Serenade, Taegro, Double Nickel 55) by themselves or in combination.
   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 or nano-zinc oxide (if laboratory assays show activity).
      ii. Biological treatments (Blossom Protect, Serenade, Double Nickel 55) with and without the addition of growth enhancers.
      iii. Plant defense activators or SARs (e.g., BmJ) alone of in mixtures with other biological control treatments (e.g., BmJ+Blossom Protect, BmJ+Serenade).

Postharvest research

2. Comparative evaluation of new postharvest fungicides
   A. Evaluate polyoxin-D (Oso) and EXP-13 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 EXP-13 and polyoxin-D 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 identify enhancers of growth of the biological control agents in Actinovate, Blossom Protect, and possibly others. For this, the biocontrol organisms will be grown on a basic, low-nutrient agar medium that will be amended with selected carbohydrates (e.g., sucrose, molasses) and other nutrients such as different nitrogen sources. Additionally nano-particle products (e.g., nano-copper oxide or nano-zinc oxide) will be evaluated for their toxicity to *E. amylovora* in in vitro 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. If nano-particle products are toxic in in vitro 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 (BmJ) 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. EXP-13 and polyoxin-D will be evaluated in experimental packingline trials at Kearney Agricultural Center at selected rates by themselves or in mixtures. 20-40 fruit for each of four replications will be used. For the new fludioxonil-difenoconazole pre-mixture, 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 polyoxin-D and EXP-13 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 EC_{50} 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 will help the organic apple industry manage fire blight without antibiotics. Are 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 have 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 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: 2016.
Funding Source: Apple Commission of California

Salaries and Benefits:	Post-Docs/RAs		7,000
	Lab/Field Ass't		2,500
	Subtotal		9,500
	Employees' Benefits		3,500
		Subtotal	13,000
Supplies and Expenses*			3,000
Equipment			0
Operating Expenses/Equipment Travel (Davis Campus only)			0
Travel			3,000
Department Account No. _____		**Total**	**19,000**

***** - Costs include expenses of $2000 for maintaining an apple orchard at the Kearney AgCenter.

Originator's Signature J.E. Hasbrouck Date: 8-24-2015

Department Chair Katherine Borkovich Date: 8-24-2015

Liaison Officer _____ Date: _____

PESTS, DISEASE, & STANDARDIZATION

PESTS, DISEASE, AND STANDARDIZATION SUMMARY

The number one story for apples in the 2014-2015 was listeria. The listeria outbreak on caramel and candy apples had ramifications not just in the golden state and the U.S., but globally. On December 19, 2014, the Centers for Disease Control and Prevention (CDC) announced that it was collaborating with several states and the U.S. Food and Drug Administration (FDA) in an investigation of the outbreak of *Listeria monocytogenes* infection (listeriosis) in commercially produced, and prepackaged caramel apples. The Commission worked with other apple producing states and the U.S. Apple Association on this issue.

After the investigation, a single company was identified with the outbreak, and all apples associated with this company were recalled and removed from the market place. Despite this recall, the U.S. apple market still experienced a negative impact on several of its export markets. Even though the apples came from only one company, several South East Asian countries banned U.S. apples in general. In fact, representatives from the Animal Plant Health Inspection Service (APHIS), the FDA, and officials from Indonesia visited California with questions on this issue. Additionally, the Commission held a listeria meeting with the industry to discuss what was found during the investigation and what type of practices the industry should review.

With the Food Safety Modernization Act (FSMA) preparing for implementation, future emphasis on Food Safety is here. The Commission continues to work with necessary officials and scientists to relay the latest information on this issue and will continue to be actively engaged in this issue as this law is fully implemented. Please see Dr. Harris's research and summary within the research section of this Annual Report (Pg. 26).

In addition, please note the included article regarding Dr. Kathleen Glass's hypothesis and findings regarding the recent Listeria outbreak. She discusses the possible effects that puncturing an apple with a stick and sealing it with caramel may have had on the presence of Listeria in the recently infected apples. Please find this article within the following pages.

Crisis Communication- US Apple Association & California Apple Commission Respond to Listeria monocytogenes

During the Listeria monocytogenes outbreak of 2014-2015, the California Apple Commission worked in conjunction with the US Apple Association to address the crisis. The Commission, along with other apple producing states, believed that a unified voice provided through the US Apple Association would result in the clearest and strongest message to the public. Members of US Apple's staff were relentless in providing updates to the Commission and other states from the Food and Drug Administration, talking points for the industry, and correcting misinformation nationally. Meanwhile, the Commission handled state and local media on behalf of the California apple industry. This national and state dynamic showed great cooperation and coordination during the crisis. Without a crisis communication plan in place, the industry would have suffered an incredible setback. However, thanks to the working relationship between all organizations, the public; buyers: state, national, and international officials; and the industry were well informed about the situation. This is a great lesson of what to do when a crisis hits an industry.

Food Safety News
Breaking news for everyone's consumption

IAFP 2015: Experts May Have Determined How Caramel Apples Caused That *Listeria* Outbreak

By James Andrews -- July 26, 2015

In November 2014, health officials began investigating two concerning clusters of *Listeria* infections that seemed to be related. The two strains of bacteria had already killed at least five people and hospitalized a few dozen others by the time they got to the case, and they wanted to find the source and stop it as quickly as possible.

Ultimately, the investigation led back to a very unexpected source. It was caramel apples, sold under various brand names but with all used apples traced to one [apple distributor.]

Perhaps even more unexpected was the next observation: The [apple distributor] apples that were coated in caramel sickened people, and yet others had eaten the non-caramel apples from [the apple distributor] and did not become ill.

For most people, the first assumption would be that the caramel, or the coating process, was somehow causing the contamination. But that didn't make sense to investigators, since so many different companies were responsible for the caramel coating.

Testing at the [apple distributor] facility showed that the contamination was clearly occurring there. That's when experts began hypothesizing that the caramel coating process was somehow exacerbating the contamination.

To get to the bottom of the matter, Dr. Kathleen Glass from the University of Wisconsin-Madison led a study that replicated the procedures and conditions that the caramel apples had likely undergone. Glass, associate director of the Food Research Institute at the university, presented her preliminary findings on Tuesday at the 2015 International Association for Food Protection annual meeting in Portland, Or.

On their own, neither apples nor caramel struck Glass as foods that would typically foster *Listeria* growth. Something about the caramel coating process had allowed for bacterial growth.

Her hypothesis: When the sticks (used for holding the caramel apple) punctured the contaminated

apples, they spread small amounts of apple juice over surface of the otherwise dry outer skin. Then, once the caramel coating was applied, it locked in the juice and created a micro-environment in which the Listeria on the surface of the apple could grow undisturbed.

To test the hypothesis, Glass' team inoculated a number of apples with Listeria. They then punctured the apples with a stick and applied caramel coating to half of them, while coating the other half in caramel but leaving out the sticks, so that there was no puncture to allow for juice to escape from the inside of the apples.

Then, half of stick-punctured caramel apples went into a refrigerator, and the other half were left at room temperature. The same was done with stick-free apples: half in the fridge, half at room temperature.

Both sets of stick-punctured caramel apples—the room-temperature and the refrigerated – grew *Listeria* at a significantly faster rate than the stick-free caramel apples.

Within days, the amount of *Listeria* present on the stick-punctured, room-temperature apples more than doubles, which the stick-free room-temperature caramel apples saw mild, steady growth of the bacteria over a much longer period of time. The stick-punctured apples in the fridge still grew a significant amount of bacteria, while the growth of bacteria on the stick-free refrigerated apples was relatively minimal.

Glass said the data were still under peer review, but she believes this is a plausible explanation for how the first known caramel apple *Listeria* outbreak could have happened.

Earlier in the same presentation, Robert Tauxe from the U.S. Centers for Disease Control and Prevention (CDC) shared statistics with the audience on the historic numbers of *Listeria* outbreaks detected in the U.S. each year, dating back to 1983.

For the 14-year period from 1983-1997, the U.S. detected only five *Listeria* outbreaks, said Tauxe, who is CDC's deputy director for the Division of Foodborne, Waterborne and Environmental Diseases.

In 1998, CDC introduced PulseNet, a network and pathogen database shared by health departments around the country. With increased outbreak surveillance, the agency began detecting 2.3 *Listeria* outbreaks each year between 1998-2003.

In 2004, the agency introduced its "*Listeria* initiative," an enhanced surveillance system for *Listeria* infections, and the average number of outbreaks detected each year rose to 2.9.

Finally, in 2014, many health departments around the country had begun to adopt whole-genome sequencing, a method of identifying pathogens much more accurately than previous methods. That year, the agency counted nine *Listeria* outbreaks – by far the most it has ever detected in a year.

It's not that we're experiencing more *Listeria* outbreaks today than in the 1980s, Tauxe explained. We're simply getting much better at finding them.

Correction: This article has been updated to correct an error. The caramel apple study was erroneously said to split the apples into two separate groups: Apples that were punctured with a stick and then coated with caramel, and apples that were punctured with a stick, but left caramel free. That was incorrect. The two groups were divided between apples that were punctured with a stick and then coated with caramel, and apples that were coated with caramel, but nor punctured with a stick.

CA APPLE EXPORT MARKETS

CA EXPORT AND DOMESTIC MARKET OVERVIEW

The California Apple Commission has culminated the final export numbers for the 2014/2015 season. California exported a total of 177,574 boxes. Due to a much smaller than average crop, exports were down in volume but on par proportionally. California is still the third largest exporter of apples in the United States and actively receives Market Access Program dollars to help maintain these necessary export markets. Adiitionally, California is a member of the U.S. Apple Export Council and works with other states to obtain Market Access Program (MAP), TASC, and EMP dollars.

Last season, the Commission and the US Apple Export Council received $1,104,764 for the 2014/2015 program year and is looking to receive roughly $998,650 for the 2015/2016 program year.

California receives a lot of 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 Five Countries (boxes)	
1) Canada	(94,795)
2) Taiwan	(28,852)
3) Malaysia	(17,933)
4) Mexico	(11,151)
5) Thailand	(9,690)

Top Five in the U.S. (boxes)	
1) California	(637,778)
2) Texas	(195,681)
3) Florida	(70,100)
4) Pennsylvania	(64,343)
5) New York	(57,448)

FOREIGN AGRICULTURAL SERVICE

The Foreign Agricultural Service (FAS) helps expand and maintain foreign markets for U.S. agricultural products by helping remove 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 up with cooperators like the U.S. Apple Export Council to help US 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 Crop (TASC), and Emerging Market Programs (EMP). Each of these programs keep US products more competitive and counter subsidized foreign competition in the international market.

Currently, the California Apple Commission, through partnering with the US Apple Export Council, received $1,104,764 for the 2014-2015 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 2015-2016 program year will be roughly $998,650.

CANADA

Canada is California's most important and largest export market. Roughly 60 percent of California's exports are designated for Canada split evenly between the Gala and Granny Smith varieties. The U.S., mainly Washington State, is the chief supplier of apples to Canada enjoying approximately an 80% market share. Due to increased production/holdover in the Pacific Northwest, tough competition from locally grown fruit, and later varieties from the southern hemisphere, the marketing window is getting tighter for California. In addition, Chinese apples are gaining traction in the market with more retailers carrying the Fuji variety.

The U.S. Apple Export Council's marketing strategy is to build and focus on California's specific marketing window and the promotion of apples that are fresh and of high quality. The goal is to keep Canadian retailers for as long as possible as Washington State begins their harvest 3-4 weeks later. In past seasons, the Council has tried to provide the retailers with incentives to stay with California for several weeks longer than normal which would provide enough time for California to finalize its season. Additionally, if the Granny Smith variety can enter the Canadian market earlier, California can capitalize on the fact that there is virtually zero domestic production in Canada at that time. The Council also wants to encourage retailers to make the switch out of southern hemisphere fruit as early as possible. Granny Smiths on the market at the time of California's harvest tend to be holdover from the southern hemisphere. Coinciding with the large volumes coming out of Washington State makes it more difficult for California to ship out.

In 2014-2015, California Gala's began arriving in Canada during the 1st week of August and remained until mid-September. Gala promotions were kept at a minimum as the majority of the promotional activities were focused towards the start of Granny Smiths. The Council began promotional activities of the Granny Smith variety in September and October to coincide with the Canadian Thanksgiving. In Canada, the Thanksgiving holiday is traditionally linked to European harvest festivals with fruits and vegetables playing a major role. The Granny Smith variety is almost always included in most cornucopias. Exports to Canada were lower than usual in 2014-2015 due to a combination of a small California crop, a very large and early crop in Washington State, and the strong US/Canadian dollar ratio. In 2014-2015, California exported a total of 94,795 boxes to Canada.

In regards to Canada, several major concerns are on the horizon. First, the World Trade Organization (WTO) ruled in favor of Canada and Mexico in a complaint against the U.S. mandatory country of origin labeling (COOL) law, which took effect in 2008. In this complaint, Canada and Mexico argued that the U.S. was unjustly requiring meat from Mexico and Canada to be labeled and separated during processing within the U.S. In response, the WTO is allowing both Canada and Mexico to levy retaliatory tariffs against other commodities totaling $3 billion. Regrettably, on the list of commodities that can be affected by the tariffs are apples. Congress is expected to address the issue in the very near future but until that happens, the shipments during the 2015-2016 season could be affected.

Secondly, the Ontario Apple Growers Association is attempting to gather evidence to file an anti-dumping claim against the U.S. Although a majority of the apples from the U.S. are shipped from Washington State, if a complaint is filed it will encompass the entire U.S. and most likely include all varieties. Canada has filed anti-dumping complaints in the past with the most recent grievance occurring in the 1990's. These past grievances have specifically focused on the Red and Gold delicious varieties. The Commission is aware of these issues and will update the industry as needed.

The Foreign Agricultural Service and the U.S. Apple Export Council will contribute $126,935 in 2015-2016 on behalf of the California Apple Commission to help maintain this market.

MEXICO

Apples are the second most consumed fruit in Mexico with Mexico remaining one of the top markets for the U.S. apple industry. Washington State alone exports over 10 million boxes annually to Mexico. On November 3, 2014, the California/Mexico Apple Export program officially ended, completing the 2014-2015 season. California's volume was significantly down when exporting to Mexico. During the 2014 season, California exported only 11,151 boxes to Mexico. This decrease can be attributed largely to California's much smaller crop, elevated domestic prices, and large holdover from both Washington State and the southern hemisphere.

Wholesale markets continue to drive most of produce sales, representing roughly 65% of the market. Retail giants such as Walmart and Soriana are investing in the smaller markets by opening express stores that can move more volume of produce but leave an overall smaller footprint. This, included with the Mexican government's increased focus on childhood obesity and demand for fresh produce, should continue to rise.

The Commission's and the U.S. Apple Export Council's strategy in Mexico is fairly simple: Keep the border open. In the past, the Council was able to spend promotional dollars in Mexico. Unfortunately, with the increase in the oversight programs for California and the Eastern U.S. all marketing programs were suspended. In California alone, the inspection program totaled approximately 70,000 in 2014-2015. On a positive note, thanks to the Commissions efforts, in January 2015, negotiations between Mexico-SAGARPA and USDA-APHIS reached a tentative agreement on the reduction of the Mexico/California Apple Oversight Program. In this agreement, Mexico would introduce a new pilot program where the inspectors would perform audits on a monthly basis for the first year. In year two of the pilot program, the inspector's duration in California would be reduced by 50% if no pest detections occurred. In the final and third year of the pilot program, the inspector would make only two auditing trips. This pilot program is a significant advancement.

With Mexico, several other major concerns are imminent. First, the World Trade Organization (WTO) ruled in favor of Canada and Mexico in a complaint against the U.S. mandatory country of origin labeling (COOL) law, which took effect in 2008. In this complaint, Canada and Mexico argued that the U.S. was unjustly requiring meat from Mexico and Canada to be labeled and separated during processing within the U.S. In response, the WTO is allowing both Canada and Mexico to levy retaliatory tariffs against other commodities totaling $3 billion. Regrettably, on the list of commodities that can be affected by the tariffs are apples. Congress is expected to address the issue in the very near future but until that happens, the shipments during the 2015-2016 season could be affected.

Secondly, in December 2014, the Mexican Government filed a dumping lawsuit on behalf of the Chihuahua growers. This lawsuit named all U.S. companies that exported apples to Mexico during the 2013 season. Although California exported a limited volume to Mexico and all data suggests California was not dumping, California exporters must defend themselves in court to avoid a substantial tariff. The anti-dumping case and any penalties granted should be finalized in October of 2015.

The Foreign Agricultural Service and the U.S. Apple Export Council will contribute $67,000 in 2015-2016 on behalf of the California Apple Commission to help maintain this market.

SOUTHEAST ASIA

In 2014-2015, South East Asia (SEA), a region which includes Malaysia, Thailand, Indonesia, Singapore, Vietnam, and the Philippines, went through a fairly turbulent season. California exported only 37,344 boxes to SEA which was a decrease from the previous year. Like most of California's export markets, SEA was affected by high domestic prices, large holdover from Washington State and the southern hemisphere, and a smaller than usual California crop. SEA has also begun to import large volumes of apples from China which has also minimized California's market window.

Traditional channels account for the bulk of US apple shipments in SEA, but modern retail outlets are expanding aggressively. Retail chains are looking to capitalize on the growing middle class and the developed upper class. Areas such as Singapore, and other developed areas within Malaysia, are experiencing a trend of consumers expecting upgraded facilities with all of the amenities of modern retailers. The Council is looking to exploit this trend by marketing and promoting California Granny Smiths as a great flavor, high-end fruit. Distinguished by its great color and fresh appeal, the Council considers this to be California's best angle to increase Granny Smith sales in the upper to middle class retail banners. Historically, the SEA region has been a Red Delicious, Golden Delicious, Fuji, and Granny Smith market with limited space for other varieties. Recently, the Council has been concentrating on introducing other varieties. Varieties such as the Empire, Rome, and Gala have demonstrated a growing demand when consumers were given the chance to sample in store.

As for competition, Washington State and China dominate the SEA region. China's market share has grown in the past couple of years; most likely due to China's ability to provide year around availability, low prices, and close proximity. Fortunately, China main export has been large volumes of the Fuji variety which is not in direct competition with California's number one variety: Granny Smith.

The SEA region was dramatically affected by the Listeria outbreak from California. In December 2014, the Food and Drug Administration (FDA) notified the Commission of an outbreak of Listeria on Granny Smith apples originating from California. A recall was issued but unfortunately a large quantity of the recalled apples had been exported to the SEA region. Even though a majority of the apples in question were consumed and out of the market, Indonesia and Malaysia closed their borders to all shipments from the U.S. Since California had finalized its season, the affects were minor. As for Washington State, it obviously affected them immensely. Months passed before the borders reopened and U.S. apples were allowed to enter. The USDA, the Council, Washington State, and the Commission are working hard to repair the damage done by the Listeria outbreak.

In 2015-2016, the Foreign Agricultural Service and the U.S. Apple Export Council will contribute $240,000 on behalf of the California Apple Commission to help maintain this market.

INDIA

In the very near future, India is set to become one of the largest importers of U.S. apples in the world. The demand for high quality, delicious, and, most importantly, safe fruit has risen sharply due to the enormous middle class of over 250 million people. Following Washington State's initial success in India, the U.S. Apple Export Council looked to capitalize by promoting specific apple varieties to fill a niche market. In 2008-2009, with zero promotional activities, only 3,920 boxes were shipped from the US Apple Export Council participating states. By the end of 2010, with only a few promotional programs operating, that number grew to 31,074 boxes. There is enormous market potential in India; however, there are some limitations with the distribution channels and retail sectors. In 2011, the Indian government recommended easing restrictions on allowing the entry of major multi-brand retail chains. Since the majority (85-90%) of fresh produce is sold at roadside stands, retail giants such as Walmart are sensing an enormous opportunity and are beginning to look for investment opportunities.

Due to California's specific varieties and limited crop size, at this time, the CAC considers India to be a very low potential market. Demand and price for California apples is too high domestically therefore limiting what could be exported to India. Nevertheless, the CAC does see a value in the market for other states. If large volumes of apples from Washington State and the Eastern US are exported to India, it would greatly decrease the pressure domestically and could ease the pressure on more local export markets such as Mexico and Canada.

The US Apple Export Council plans on having a very focused and targeted marketing effort in India. Using MAP and EMP program dollars, the Council will educate and promote specific Eastern US varieties to the upper and middle class population.

The Foreign Agricultural Service and the U.S. Apple Export Council will contribute $137,667 on behalf of the California Apple Commission to help maintain this market.

BRAZIL

Several years ago, the U.S. Apple Export Council began applying for Market Access Programs and Technical Assistance for Specialty Crop funding through the Foreign Agricultural Service. The U.S. Apple Export Council also began requesting USDA-APHIS to begin applying pressure on the Brazilian government to ease market restrictions concerning certain varieties of apples from the U.S. Currently, the main pest of concern is the Apple Maggot. A 55 day cold treatment protocol is required in order to export to Brazil. In 2013-2014, the US Apple Export Council had planned on capitalizing on the 2014 World Cup and the 2016 Summer Olympic Games being held in Brazil. Due to a decline in production from the East Coast, most activities that were scheduled to take place in 2014 were suspended until the 2016 season in order to coincide with the Summer Olympics.

The US Apple Export Council hired a representative in Brazil to manage, plan, and execute all promotional activities but again due to the shorten crop all promotions were suspended until 2016. During the 2013-2014 season, the representative formulated trade leads, addressed any challenges that appeared, and met with the Brazilian government officials to facilitate trade during the US apple season.

Competition for the Brazilian market continues to be Southern Hemisphere holdover crop and Europe. Since Russia has been closed to imports, Poland has become a much larger opponent on the world stage. Polish apples exported to Brazil have risen sharply during the Russian embargo. This has not affected California directly but with more volume and cheaper varieties from Poland going into Brazil other US states have been affected which can cause leaching into California's domestic and export markets.

With the exception of Washington State, the California Apple Commission considers Brazil strictly an Eastern U.S. market. With Brazil's desire for red varieties and the simplicity of shipping routes, most of the demand will be filled by the Eastern States. For California, there is little opportunity in Brazil due to the cold treatment requirements, shipping expenses, and the limited seasonal window between the Southern Hemisphere and Washington State. Although the U.S. Apple Export Council will consider Brazil an option, California does not consider it a priority.

The Foreign Agricultural Service and the U.S. Apple Export Council will contribute $5,000 during the 2015 season to help set up and explore this market.

RUSSIA

In August 2014, due to political unrest between Russia and the West, Russia prohibited all imports from Europe and the U.S. for one year, but has continued into the 2015-2016 season. This will have a tremendous effect on the world apple market considering Washington State alone exported close to twelve million boxes to Russia. Consequently, all apples from the West and Europe that would normally go to Russia will now be in other markets. Poland, for example, normally exports large apple quantities to Russia. Since that market has been temporarily frozen, Polish apples are being exported elsewhere. In turn, this is causing a detriment to California and U.S. Apple exports as our markets are now in direct competition.

The USAEC will maintain an in-country representative, but all promotion and marketing activities will be terminated until the constraints have been lifted. The Commission anticipates that the export restrictions will be lifted by the 2016-2017 California apple season.

CENTRAL AMERICA

The Central America region which consists of Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, and Panama has been quickly gaining attention from the US Apple Export Council over the last several years. Unfortunately, the 2014 season had a smaller than usual crop from the Eastern US which forced higher domestic prices and therefore slowed demand within Central America. Due to the smaller crop, the promotional programs in Central America were adjusted with some of the activities being cancelled or reduced in scope.

The specific marketing campaign for the US Apple Export Council relies on differentiating itself from Washington State. By focusing on marketing and sampling different, new, fresh varieties from the U.S., importers within Central America have begun to branch out from the traditional Red's and Golden apple varieties. This has provided the U.S. Apple Export Council a unique niche in Central America as a small percentage of importers represent the majority of apple imports. Each of them are looking for the newest variety to distinguish themselves from their competitors. In addition to the in country representative, the US Apple Export Council will host a trade mission to most of Central America. This trade mission will take place during the 2015-2016 season and will look to introduce new varieties and shippers to the region.

In 2014-2015, California did not export to Central America. Though the demand for California apples is relatively high in this region, the prices needed to purchase the apples have discouraged Central American buyers. The focus of the US Apple Export Council in Central America is to promote and introduce new varieties from the Eastern US. The US Apple Export Council and its Eastern partners believe that the Eastern US has a distinct advantage over Washington State with specific varieties available and shipping logistics.

The Foreign Agricultural Service and the U.S. Apple Export Council contributed $123,625 during the 2014-2015 season and will fund $148,625 in 2015-2015 on behalf of the US Apple Export Council to help maintain this market.

CA APPLE DOMESTIC & EXPORT STATISTICS

CALIFORNIA APPLE COMMISSION

DOMESTIC AND EXPORT REPORTS

2014-2015 SEASON

CALIFORNIA DOMESTIC APPLE STATISTICS
CALIFORNIA TOP 5 STATES
EXPORT TOTALS
PACK OUT REPORT

CALIFORNIA APPLE COMMISSION - UNITED STATES 2014 - 2015							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**CRIPPS PINK**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	19,241.60	3,962.00	1,369.00	1,950.00			**26,522.60**
ARIZONA	14,444.10	24,323.00	4,745.00	582.00	49.00		**44,143.10**
ARKANSAS	8,005.00	455.00	65.00	975.00			**9,500.00**
CALIFORNIA	189,811.50	275,407.50	124,793.30	12,261.60	3,236.10	55,912.00	**661,422.00**
COLORADO	1,666.20	8,363.00	2,932.00		525.00	1,846.00	**15,332.20**
CONNECTICUT	203.00	49.00					**252.00**
FLORIDA	41,915.00	15,708.00	9,603.00	2,517.00	49.00	308.00	**70,100.00**
GEORGIA	17,531.80	16,499.00	4,928.00	975.00	147.00	49.00	**40,129.80**
HAWAII	121.00						**121.00**
ILLINOIS	23,628.20	16,548.20	8,195.00	2,296.00	443.00	1,078.00	**52,188.40**
INDIANA	21,419.40	5,479.00	2,674.00	2,656.00	273.00	1,596.00	**34,097.40**
IOWA	2,805.00	6,327.00	166.00		93.00		**9,391.00**
KANSAS	759.50	3,001.00	25.20		98.00		**3,883.70**
KENTUCKY	8,443.00	1,450.00	294.00	975.00		392.00	**11,554.00**
LOUISIANA	5,855.00	2,685.00	2,579.00	1,460.00			**12,579.00**
MAINE	5,155.00	1,011.00		975.00			**7,141.00**
MARYLAND	774.20	8,267.00	98.00			929.00	**10,068.20**
MASSACHUSETTS	6,523.00	21,987.00	735.00	1,521.00	98.00	772.00	**31,636.00**
MICHIGAN	11,469.00	5,176.00	6,129.00		97.00		**22,871.00**
MINNESOTA	3,224.90	32,643.00	182.00	294.00	977.00	250.00	**37,570.90**
MISSISSIPPI	3,642.00	650.00	780.00	843.00			**5,915.00**
MISSOURI	20,588.50	8,420.00	5,560.00	2,360.00			**36,928.50**
NEBRASKA	10,673.00	520.00	650.00	1,235.00			**13,078.00**
NEVADA	11,446.00	11,657.00	1,225.00	975.00			**25,303.00**
NEW HAMPSHIRE						143.00	**143.00**
NEW JERSEY	539.00	17,332.00	1,176.00			224.00	**19,271.00**
NEW MEXICO	7,595.00	11,026.00	1,865.00	650.00			**21,136.00**
NEW YORK	7,274.00	46,356.00	2,164.00	1,612.00	28.00	14.00	**57,448.00**
NORTH CAROLINA	13,728.10	5,187.00	3,479.00	975.00	30.00	87.00	**23,486.10**
OHIO	27,916.40	8,354.00	4,554.00	1,967.00		954.00	**43,745.40**
OKLAHOMA	14,000.20	2,930.00	3,161.00	1,820.00			**21,911.20**
OREGON	2,450.00	98.00	49.00		98.00	216.00	**2,911.00**
PENNSYLVANIA	22,817.00	34,032.00	3,859.00	2,275.00	355.00	1,005.00	**64,343.00**
SOUTH CAROLINA	10,182.00	1,531.00	455.00	649.00			**12,817.00**
TENNESSEE	7,364.00	5,156.00	1,040.00	975.00			**14,535.00**
TEXAS	93,389.10	66,219.60	19,958.00	12,899.00	98.00	3,117.00	**195,680.70**
UTAH	5,819.00	3,138.00	1,820.00	650.00			**11,427.00**
VERMONT			14.00			35.00	**49.00**
VIRGINIA	14,345.30	4,890.00	1,550.30	1,170.00			**21,955.60**
WASHINGTON	6,798.20	11,134.00		650.00		145.00	**18,727.20**
WISCONSIN	9,782.00	2,810.00	3,306.00	975.00			**16,873.00**
WYOMING	15,203.00	2,025.00	1,340.00	650.00			**19,218.00**
TOTAL	**688,547.20**	**692,806.30**	**227,517.80**	**62,767.60**	**6,694.10**	**69,072.00**	**1,747,405.00**

CALIFORNIA APPLE COMMISSION - UNITED STATES 2013 - 2014							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**CRIPPS PINK**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	17,359.61	940.80		98.00	294.00		**18,692.41**
ARIZONA	21,303.86	10,779.00	1,618.00	4,035.00	427.00		**38,162.86**
ARKANSAS	11,709.75						**11,709.75**
CALIFORNIA	223,144.99	426,553.70	173,135.10	102,500.80	8,041.10	36,557.00	**969,932.69**
COLORADO	3,396.75	1,979.00	359.00	70.00	196.00	1,481.00	**7,481.75**
CONNECTICUT	851.38						**851.38**
DIST. OF COLUMBIA	931.00						**931.00**
FLORIDA	31,727.50	6,234.80	3,909.00	70.00	583.00	469.00	**42,993.30**
GEORGIA	12,703.50	9,871.10	3,587.00		441.00	49.00	**26,651.60**
HAWAII	405.85	98.00	1,785.00				**2,288.85**
ILLINOIS	41,011.76	5,532.10	3,968.10	2,695.00		442.00	**53,648.96**
INDIANA	16,402.02	18,087.00	1,632.00	533.00		728.00	**37,382.02**
IOWA	2,403.45	3,925.00	1,715.00	903.00	1,078.00		**10,024.45**
KANSAS				430.00			**430.00**
KENTUCKY	10,043.78	5,902.00	245.00	80.00	490.00	523.00	**17,283.78**
LOUISIANA	4,822.00	83.00	1,785.00	15.00			**6,705.00**
MAINE	1,950.00	1,666.00					**3,616.00**
MARYLAND	1,798.30	196.00	128.00	441.00	14.00	642.00	**3,219.30**
MASSACHUSETTS	5,612.60	14,423.00	2,372.00	2,691.00	343.00	1,116.00	**26,557.60**
MICHIGAN	8,770.53	8,987.00	5,375.00		224.00		**23,356.53**
MINNESOTA	1,920.00	23,794.00	441.00	828.00	1,597.20	405.00	**28,985.20**
MISSISSIPPI	7,152.31						**7,152.31**
MISSOURI	26,910.19	3,136.00	2,190.00	490.00			**32,726.19**
NEVADA	9,787.11	13,275.00	49.00				**23,111.11**
NEW HAMPSHIRE	77.00	294.00	98.00		371.00	147.00	**987.00**
NEW JERSEY	1,225.00	7,109.00	296.00	889.00	752.00	1,246.00	**11,517.00**
NEW MEXICO	13,368.16	93.10	142.10		28.00		**13,631.36**
NEW YORK	5,804.50	18,127.00	1,050.00	2,564.00	1,225.00		**28,770.50**
NORTH CAROLINA	9,202.00	3,418.00	3,129.00		21.00	70.00	**15,840.00**
OHIO	18,018.92	5,054.00	6,986.00	2,366.00		852.00	**33,276.92**
OKLAHOMA	20,949.73						**20,949.73**
OREGON	147.00	1,591.50			49.00	314.00	**2,101.50**
PENNSYLVANIA	13,292.00	21,603.00	4,659.20	885.40	337.00	1,420.00	**42,196.60**
SOUTH CAROLINA	3,345.00	352.80		49.00			**3,746.80**
TENNESSEE	5,690.05	5,647.00		2,532.80			**13,869.85**
TEXAS	99,327.74	126,276.00	3,950.00	16,169.00	920.00	1,463.00	**248,105.74**
UTAH	16,700.13	2,614.00		1,195.00			**20,509.13**
VIRGINIA	1,847.00	2,221.20			784.00		**4,852.20**
WASHINGTON	10,019.80	49,734.00				98.00	**59,851.80**
WISCONSIN	2,430.00	28.00	2,249.00		49.00		**4,756.00**
WYOMING	2,976.00						**2,976.00**
TOTAL	**686,538.27**	**799,625.10**	**226,852.50**	**142,530.00**	**18,264.30**	**48,022.00**	**1,921,832.17**

CALIFORNIA APPLE COMMISSION - UNITED STATES 2012 - 2013							
STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	7357	9864	186				**17407**
ARIZONA	17341	16655	4374	1294	21		**39685**
ARKANSAS	3998						**3998**
CALIFORNIA	219877	297090	94785	45606	5645	15727	**678730**
COLORADO	12799	8610	2401	266	125	1674	**25875**
CONNECTICUT	343	539					**882**
FLORIDA	32641	16582	4880	29		98	**54230**
GEORGIA	19698	16398	8218	2940	147		**47401**
HAWAII	1076	1027	1244				**3347**
IDAHO	490						**490**
ILLINOIS	27676	14968	1581	9124	411	1238	**54998**
INDIANA	10106	6154	3357		98	671	**20386**
IOWA	952	3846	98	294	1019		**6209**
KANSAS	2500	819		294			**3613**
KENTUCKY	7181	24046	260		196	98	**31781**
LOUISIANA	2413	1664	4164				**8241**
MAINE	854	6514					**7368**
MARYLAND	3528	12831	2037	1390	14	532	**20332**
MASSACHUSETTS	13181	20379	3087	1420	392	21	**38480**
MICHIGAN	20278	21915	18758		21		**60972**
MINNESOTA	2010	43745	693	581	695	2049	**49773**
MISSISSIPPI	6829						**6829**
MISSOURI	23265	19175	3049				**45489**
MONTANA	196			182			**378**
NEBRASKA	1708						**1708**
NEVADA	3450	10680	296				**14426**
NEW HAMPSHIRE	147	245	52			1459	**1903**
NEW JERSEY	603	10569	472			1299	**12943**
NEW MEXICO	3899	147					**4046**
NEW YORK	10400	28939	1205	1716	56	42	**42358**
NORTH CAROLINA	2399	4811	1313				**8523**
NORTH DAKOTA		209					**209**
OHIO	22938	10808	2874	1743	49	980	**39392**
OKLAHOMA	9288	49	455				**9792**
OREGON	3309	2891		686		137	**7023**
PENNSYLVANIA	14849	27839	1889	4471	35	1310	**50393**
SOUTH CAROLINA	2764	3136					**5900**
TENNESSEE	9751	7925		490			**18166**
TEXAS	81150	84894	9104	19239	978	2551	**197916**
UTAH	11847	777	399	1540	35		**14598**
VERMONT	49						**49**
VIRGINIA	1894	2296	377				**4567**
WASHINGTON	9238	14858	134	1070	147		**25447**
WISCONSIN	7845	294	287	91	444		**8961**
WYOMING	5178		175				**5353**
TOTAL	**639,296**	**754,189**	**172,204**	**94,466**	**10,528**	**29,886**	**1,700,568**

CALIFORNIA APPLE COMMISSION - UNITED STATES 2011 - 2012							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**CRIPPS PINK**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	14602.2	14319		147			**29068.2**
ARIZONA	33583.3	27018	3405	5160		1653	**70819.3**
ARKANSAS	9425						**9425**
CALIFORNIA	187132.7	251077.4	102186.3	48385.15	2600.5	60198	**651580.05**
COLORADO	18294.3	15684.9	3009	1596	303	1429	**40316.2**
CONNECTICUT	3388	1568	98				**5054**
DIST. OF COLUMBIA	196	196				686	**1078**
FLORIDA	35384.2	30768.4	2588		21	3174	**71935.6**
GEORGIA	31182.5	17718	7505	2450		3058	**61913.5**
HAWAII	294	98	343				**735**
IDAHO	133	539					**672**
ILLINOIS	41511.1	35830.9	4893.1	3920	245	5609	**92009.1**
INDIANA	34460.6	31970	3103		210	2925	**72668.6**
IOWA	483.1	5497	32		234		**6246.1**
KANSAS	2604.6	4440	198.7	588		1675	**9506.3**
KENTUCKY	14240	23990	882		147	1397	**40656**
LOUISIANA	13133	5045	3220				**21398**
MAINE	1631	11870					**13501**
MARYLAND	6451	17761.3	21655	7028		3155	**56050.3**
MASSACHUSETTS	4949	37752.4	4655	6909	156	8272	**62693.4**
MICHIGAN	26632.6	21455.3	7670	196	420	4953	**61326.9**
MINNESOTA	11598.3	54720.5	49	2429	1742.3	19808	**90347.1**
MISSISSIPPI	3705	3045					**6750**
MISSOURI	27841.7	16293.3	5754	1637		3466	**54992**
MONTANA	245	1077					**1322**
NEBRASKA	7605	7163.1		168			**14936.1**
NEVADA	7319	7323	245			1134	**16021**
NEW HAMPSHIRE	350	420			21	290	**1081**
NEW JERSEY	6344	18777	196		14	812	**26143**
NEW MEXICO	11473	5948	49				**17470**
NEW YORK	8182.2	36120.1	2128	3393		5186	**55009.3**
NORTH CAROLINA	8000	24677.2	2974	416.8	63	273	**36404**
NORTH DAKOTA		28		40		147	**215**
OHIO	42361.3	24357.1	7017	539	98	1428	**75800.4**
OKLAHOMA	13444.7	12475.2	1533		145	49	**27646.9**
OREGON	2685.7	4004.9	196			962	**7848.6**
PENNSYLVANIA	19164.7	33233	2856	7894	258	3615	**67020.7**
RHODE ISLAND		147					**147**
SOUTH CAROLINA	1160	10472				294	**11926**
TENNESSEE	15619.7	12703.5		1746		2058	**32127.2**
TEXAS	91224.8	93039.95	6795	19445	441	7071	**218016.75**
UTAH	27451.7	13053	4420	735		98	**45757.7**
VERMONT	196	49					**245**
VIRGINIA	8295	11546	686			1134	**21661**
WASHINGTON	18581	28204	6569		49	7093	**60496**
WISCONSIN	8934	10636	665	196	33	637	**21101**
WYOMING	18420	5235	1820				**25475**
TOTAL	**839,913**	**989,347**	**209,396**	**115,018**	**7,201**	**153,739**	**2,314,612.30**

CALIFORNIA APPLE COMMISSION - UNITED STATES 2010 - 2011							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**CRIPPS PINK**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	14342	49					**14391**
ARIZONA	59031	42189	714	490	1593	269	**104286**
ARKANSAS	3960	3700					**7660**
CALIFORNIA	336880.4	360229.7	258476.4	84676.7	16105.2	27485.53	**1083854**
COLORADO	10817.8	6159	2093	1909	49	1225	**22252.8**
CONNECTICUT		2940					**2940**
DIST. OF COLUMBIA	854	784	98				**1736**
FLORIDA	25780.6	13003.1	4368	240.1	128.1	499	**44018.9**
GEORGIA	20929.8	15512	4246	1078		927.1	**42692.9**
HAWAII	987	123	441				**1551**
ILLINOIS	40796.3	25316.8	4796			538.5	**71447.6**
INDIANA	16546	9054	4375		98	1939	**32012**
IOWA	2072	2058			49		**4179**
KANSAS	98	98		1073			**1269**
KENTUCKY	14323	1074	147	5880	514		**21938**
LOUISIANA	4234	5499	1995				**11728**
MAINE	1738	17983					**19721**
MARYLAND	3647	23335	1239	2177		1470	**31868**
MASSACHUSETTS	4879	56419	2205	5376	245		**69124**
MICHIGAN	5150	14247	6037	652	245		**26331**
MINNESOTA	9996.3	49460	245	2695	326	441	**63163.3**
MISSISSIPPI	6039						**6039**
MISSOURI	15068.5	10924.5	2660	1470	98		**30221**
MONTANA				49			**49**
NEBRASKA	4175						**4175**
NEVADA	18566	24762	49				**43377**
NEW HAMPSHIRE	441	147			147	288	**1023**
NEW JERSEY	7135	23917	985	273.7		1331	**33641.7**
NEW MEXICO	11296	2798	244		98		**14436**
NEW YORK	7020.15	68482.8	1905.15	1118	98		**78624.1**
NORTH CAROLINA	12746	6768	4011	50	529.2	1	**24105.2**
NORTH DAKOTA	98						**98**
OHIO	13440	5911	5295	5864		190	**30700**
OKLAHOMA	12915.2	8098	1934.2	196			**23143.4**
OREGON	7470	947	2176	486	87	273	**11439**
PENNSYLVANIA	24328.2	27605	4684	1078	539	378	**58612.2**
SOUTH CAROLINA	6650	7806					**14456**
TENNESSEE	13569.3	6692.2	1862	1862			**23985.5**
TEXAS	102382.7	74606.2	10105.5	24338	1835.4	1883	**215150.8**
UTAH	22768	147	116	490	28		**23549**
VIRGINIA	6860	4508		637			**12005**
WASHINGTON	9543	13650	4620			196	**28009**
WEST VIRGINIA				3			**3**
WISCONSIN	9943	5528	1610	539			**17620**
WYOMING	8590	5637	2240				**16467**
TOTAL	**898,106**	**948,167**	**335,972**	**144,701**	**22,812**	**39,334**	**2,389,092**

CALIFORNIA APPLE COMMISSION 2009 - 2010							
STATE	GALA	GRANNY SMITH	FUJI	CRIPPS PINK	BRAEBURN	OTHER	TOTAL
ALABAMA	22663						**22663**
ARIZONA	26552.6	19541	3420.2	2798		91	**52402.8**
ARKANSAS	13630	3885					**17515**
CALIFORNIA	149145.5	369232	102671.4	56641	9459.9	7272	**694421.8**
COLORADO	8166	4477	6486	1253	955	625	**21962**
CONNECTICUT	588	1813					**2401**
DIST. OF COLUMBIA	196	98					**294**
FLORIDA	41921.5	7412	4711		98	798	**54940.5**
GEORGIA	15769.2	6911	4354		490	196	**27720.2**
HAWAII	963	196	1470				**2629**
IDAHO							**0**
ILLINOIS	30488.3	13201	7799	392	294	1478	**53652.3**
INDIANA	32647	12166	5726	238	245	392	**51414**
IOWA		3318	141	980	14		**4453**
KANSAS	132.3		679	294			**1105.3**
KENTUCKY	12877	5831	98		147	175	**19128**
LOUISIANA	6530	2140	2625				**11295**
MAINE	4140	22842					**26982**
MARYLAND	2598	27267	3758	98	147	536	**34404**
MASSACHUSETTS	3773	38984	2914	3073	2082	21	**50847**
MICHIGAN	20237.2	27456	882	4265			**52840.2**
MINNESOTA	5537	33074	35	490	147	1055	**40338**
MISSISSIPPI	6480	769	49				**7298**
MISSOURI	24122	3360	3555	2591			**33628**
MONTANA	441	294	98		49		**882**
NEBRASKA	10755	2040					**12795**
NEVADA	9400	4428					**13828**
NEW HAMPSHIRE	196	949	147			226	**1518**
NEW JERSEY	9596.3	18128				484	**28208.3**
NEW MEXICO	10685	196	147	98	49		**11175**
NEW YORK	12789.3	61930	4221	2606	2576	327	**84449.3**
NORTH CAROLINA	12041	2212	2115			21	**16389**
NORTH DAKOTA	98						**98**
OHIO	31194	12076	2655	3670		439	**50034**
OKLAHOMA	16354	1505	2520				**20379**
OREGON	2298	5037	1666		98	189	**9288**
PENNSYLVANIA	21725.05	30759	4277.7		667.1	963	**58391.85**
SOUTH CAROLINA	8970	1054					**10024**
SOUTH DAKOTA							**0**
TENNESSEE	23015.4	8267.9	98				**31381.3**
TEXAS	90441.18	61265	7539	22239	245	1421	**183150.18**
UTAH	24394	6667	3724	224			**35009**
VIRGINIA	9983.5	4465	398.3				**14846.8**
WASHINGTON	14969	6605	5334			105	**27013**
WISCONSIN	9708	3820	2800	147	182		**16657**
WYOMING	15253	3504					**18757**
TOTAL	**763,463**	**839,175**	**189,114**	**102,097**	**17,945**	**16,814**	**1,928,608**

CALIFORNIA APPLE COMMISSION 2008 - 2009							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**CRIPPS PINK**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	17805	10038	3914				**31757**
ALASKA	98						**98**
ARIZONA	24454	30298	4107	1078		24	**59961**
ARKANSAS	6475	525					**7000**
CALIFORNIA	274786	673536	177101	93594	4384	25446	**1248847**
COLORADO	12467	17015	3761	3111	844	1260	**38458**
CONNECTICUT	196	2707					**2903**
DIST. OF COLUMBIA	98						**98**
FLORIDA	47269	21400	1081	98	234	3263	**73345**
GEORGIA	15113	23352	4315		147	735	**43662**
HAWAII	1116	677	2709				**4502**
IDAHO	5261	539	294				**6094**
ILLINOIS	21029	34519	3986	343	98	2298	**62273**
INDIANA	15385	18390	2816	1260	84	1957	**39892**
IOWA	588	3094					**3682**
KANSAS	1793	1029	147	245			**3214**
KENTUCKY	11478	12793	1274	666		310	**26521**
LOUISIANA	5026	4782	875				**10683**
MAINE		13174					**13174**
MARYLAND	9307	44072	735	1323	196	49	**55682**
MASSACHUSETTS	13838	74234	1568	2030		247	**91917**
MICHIGAN	35521	67219	8872	9342			**120954**
MINNESOTA	7742	30086	787	1666	28	2464	**42773**
MISSISSIPPI	7868	4646	98				**12612**
MISSOURI	27449	16864	3066	774	98		**48251**
MONTANA		91				49	**140**
NEBRASKA	5605	3525					**9130**
NEVADA	49	3772	196				**4017**
NEW HAMPSHIRE	196	735			221	285	**1437**
NEW JERSEY	11738	46759	441		441	372	**59751**
NEW MEXICO	7450	2742			186		**10378**
NEW YORK	11631	84835	2033	2295	285	758	**101837**
NORTH CAROLINA	21744	8981	2905				**33630**
NORTH DAKOTA		49					**49**
OHIO	33557	34912	4914	6057	147	349	**79936**
OKLAHOMA	10081	3379	935				**14395**
OREGON	8598	9562	2170	735	294	4403	**25762**
PENNSYLVANIA	18972	32776	977	294	441	859	**54319**
SOUTH CAROLINA	4345	4896					**9241**
SOUTH DAKOTA	98						**98**
TENNESSEE	18900	21901		1022			**41823**
TEXAS	98687	130521	11938	27833	245	2759	**271983**
UTAH	14046	11734	3798	2205			**31783**
VIRGINIA	13701	10329	882	147			**25059**
WASHINGTON	20675	26060	2597			471	**49803**
WISCONSIN	11926	5619					**17545**
WYOMING	8355	3960					**12315**
TOTAL	**882,516**	**1,552,127**	**255,292**	**156,118**	**8,373**	**48,358**	**2,902,784**

CALIFORNIA APPLE COMMISSION 2007 - 2008							
STATE	**GALA**	**GRANNY SMITH**	**FUJI**	**PINK LADY**	**BRAEBURN**	**OTHER**	**TOTAL**
ALABAMA	7007	1877	320				**9204**
ARIZONA	34869	21659	8327	658		57	**65560**
ARKANSAS	2749	1552					**4301**
CALIFORNIA	164591	401910	211817	73568	13359	16357	**881602**
COLORADO	14522	18184	2796	2744	172	371	**38789**
CONNECTICUT		637				637	**1274**
DIST. OF COLUMBIA		196					**196**
FLORIDA	27818	11543	796	1139	245	683	**42224**
GEORGIA	11209	17193	3325			731	**32458**
HAWAII	1352	36	2094	419	14	181	**4096**
IDAHO	1380	518					**1898**
ILLINOIS	6389	22202	2411	3648	2450	2286	**39386**
INDIANA	23194	19032	370	392	444	1176	**44608**
IOWA		8701	3517	980	2576		**15774**
KANSAS	1959		98	3185			**5242**
KENTUCKY	7624	9313					**16937**
LOUISIANA	4312	3129					**7441**
MAINE	2111	23199	770				**26080**
MARYLAND	9861	13381	541	2100	637	280	**26800**
MASSACHUSETTS	10845	29823	147	2401			**43216**
MICHIGAN	20274	15431	5718	196		588	**42207**
MINNESOTA	3509	28185	21	441	2458	619	**35233**
MISSISSIPPI	3045	6026	245				**9316**
MISSOURI	30558	11485	3708	4984			**50735**
MONTANA	0	0	0	0	0	0	**0**
NEBRASKA	4015	2126	63		63		**6267**
NEVADA	2824	5802	1705		230		**10561**
NEW HAMPSHIRE	103	221				424	**748**
NEW JERSEY	3829	15642	2520	294		396	**22681**
NEW MEXICO	1323	3170	640				**5133**
NEW YORK	6096	59925	2675	2450	49	478	**71673**
NORTH CAROLINA	8894	4251	1095				**13145**
OHIO	28481	25165	4282	294		293	**58515**
OKLAHOMA	6035		2400				**8435**
OREGON	2569	629	372		97	963	**4630**
PENNSYLVANIA	8453	15585	476			227	**24741**
RHODE ISLAND	49	490					**539**
SOUTH CAROLINA	3221	670	140				**4031**
TENNESSEE	8584	16207		49			**24840**
TEXAS	61877	107510	12190	32238	1655	980	**216450**
UTAH	10760	4261	1215	147	137		**16520**
VERMONT	0	0	0	0	0	0	**0**
VIRGINIA	6371	3574	1365	539			**11849**
WASHINGTON	5414	6932			98	189	**12633**
WEST VIRGINIA	0	0	0	0	0	0	**0**
WISCONSIN	2909	4760		959			**8628**
WYOMING	4220	2640	570				**7430**
TOTAL	**565,205**	**944,772**	**278,729**	**133,825**	**24,684**	**27,916**	**1,974,026**

CALIFORNIA APPLE COMMISSION 2006 - 2007

STATE	GALA	GRANNY SMITH	FUJI	PINK LADY	BRAEBURN	OTHER	TOTAL
ALABAMA	2656	4399					**7055**
ARIZONA	30400	29025	5028	147	1899		**66499**
ARKANSAS		585					**585**
CALIFORNIA	204262	586417	200049	56273	6810	13478	**1067289**
COLORADO	9403	36244	3913	5946	1938	781	**58225**
CONNECTICUT	336	5425					**5761**
DIST. OF COLUMBIA		1071					**1071**
FLORIDA	26197	69204	10275			544	**106220**
GEORGIA	12266	36035	3730	2580		756	**55367**
HAWAII	777	320	2784	49			**3930**
IDAHO	98		49				**147**
ILLINOIS	10096	29889	2889	196	2413	855	**46338**
INDIANA	17419	33295	2286	1617	173	844	**55634**
IOWA	4935	15631	490	1515	3234	10	**25815**
KANSAS	1281	4333	2548	341	735		**9238**
KENTUCKY	11193	16981	126	686		162	**29148**
LOUISIANA	3267	2255	665				**6187**
MAINE	2646	20952		1182			**24780**
MARYLAND	7987	21705	2199	3276		238	**35405**
MASSACHUSETTS	10051	48224	5488	196			**63959**
MICHIGAN	30560	41796	12812	8174			**93342**
MINNESOTA	3475	27835				232	**31542**
MISSISSIPPI	1115	2963	1015				**5093**
MISSOURI	20077	151876	2827	6538			**181318**
NEBRASKA	880	1554	420				**2854**
NEVADA	271	3152	1691	147			**5261**
NEW HAMPSHIRE		21				98	**119**
NEW JERSEY	6124	22393	1029			215	**29761**
NEW MEXICO			740				**740**
NEW YORK	5586	82820	2731	2031			**93168**
NORTH CAROLINA	2622		3871				**6493**
OHIO	22764	60542	5932	5444		83	**94765**
OKLAHOMA	5966	2118					**8084**
OREGON	2513	4398		1735	49	245	**8940**
PENNSYLVANIA	6206	23398	6392		160	394	**36550**
RHODE ISLAND		196					**196**
SOUTH CAROLINA	360	343					**703**
TENNESSEE	6012	24801					**30813**
TEXAS	68366	161211	14463	27939	3645	1470	**277094**
UTAH	6978	6519		1326	294		**15117**
VIRGINIA	5529	5052	730				**11311**
WASHINGTON	37198	27844					**65042**
WEST VIRGINIA		98					**98**
WISCONSIN	4291	4459	147	511			**9408**
TOTAL	**592,163**	**1,617,379**	**297,319**	**127,849**	**21,350**	**20,405**	**2,676,465**

CALIFORNIA APPLE COMMISSION 2005 - 2006

STATE	GALA	GRANNY SMITH	FUJI	PINK LADY	BRAEBURN	OTHER	TOTAL
ALABAMA	8590	12614		98			**21302**
ARIZONA	35616	46533	5976	6925	3224	966	**99240**
CALIFORNIA	345553	586557	233198	86394	10523	19017	**1281242**
COLORADO	12876	15412		2628	1720	685	**33321**
CONNECTICUT	5818	9423	73				**15314**
DIST. OF COLUMBIA		1029					**1029**
FLORIDA	19077	62217	13679	1456	27	367	**96823**
GEORGIA	11679	42381	5771	1253	182	413	**61679**
HAWAII	1849	2159	6992	98			**11098**
IDAHO	241	3366	98	349			**4054**
ILLINOIS	12446	36630	5370	4345	877	1794	**61462**
INDIANA	7627	27558	1147	3323	196	1872	**41723**
IOWA	980	13392	980	980	980		**17312**
KANSAS	3048	3587	774	1099	372		**8880**
KENTUCKY	3059	13237	3297	535		197	**20325**
LOUISIANA	3618	5136	1078				**9832**
MAINE		19860					**19860**
MARYLAND	15104	35433	4399	7694	244	196	**63070**
MASSACHUSETTS	9139	116721		1267			**127127**
MIAMI	88						**88**
MICHIGAN	20632	61084	14578	6246	343	294	**103177**
MINNESOTA	9486	42536	1609	1351	507	331	**55820**
MISSISSIPPI	4910	8428	2142				**15480**
MISSOURI	10864	24705	6809	2058	392		**44828**
NEBRASKA	751	1499					**2250**
NEVADA	2310	2573	1488	421	490		**7282**
NEW JERSEY	24084	43424	5293	6618	231	691	**80341**
NEW MEXICO	196	98					**294**
NEW YORK	10493	101993	9141	3670	98	86	**125481**
NORTH CAROLINA	5773	6646	4535	819	451		**18224**
OHIO	17958	28239	8797	2090	147	49	**57280**
OKLAHOMA	1313	441	343	735			**2832**
OREGON	4419	7434	58	84	794	5387	**18176**
PENNSYLVANIA	13036	35101	624	98	392	504	**49755**
SOUTH CAROLINA	4410	8491	833				**13734**
TENNESSEE	16744	32722	3875	5398	49		**58788**
TEXAS	75792	131056	22161	36854	1109	2193	**269165**
UTAH	3713	1946	1049	1139	98		**7945**
VERMONT	1232	2146	35		28	42	**3483**
VIRGINIA	5674	4518	882		1225		**12299**
WASHINGTON	23680	44760	2531	2166	1193	441	**74771**
WEST VIRGINIA		49					**49**
WISCONSIN	5534	11914	1211	3528	1027		**23214**
TOTAL	**759,412**	**1,655,048**	**370,826**	**191,719**	**26,919**	**35,525**	**3,039,449**

CALIFORNIA'S TOP 5 STATES

	2000-2001	
1	California	1,282,349
2	New York	239,647
3	Texas	193,518
4	Arizona	98,490
5	Florida	94,463

	2001-2001	
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	New York	191,624
4	Illinois	141,671
5	Massachusetts	126,021

	2003-2004	
1	California	1,409,491
2	Texas	328,190
3	New York	212,095
4	Florida	153,483
5	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	195,681
3	Florida	70,100
4	Pennsylvania	64,343
5	New York	57,448

Export Totals 2014-2015 Season

COUNTRY	GALA	GRANNY SMITH	FUJI	BRAEBURN	OTHER	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 Season

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 Season

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**	**147**	**931**	**309,197**

Export Totals 2011-2012 Season

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 Season

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 Season							
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						**1,820**
VIETNAM		980					
TOTAL	**100,578**	**164,232**	**60,427**	**392**	**0**	**119**	**324,768**

Export Totals 2008-2009 Season

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 Season							
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**

2003 - 2015 End of Season Pack Out Report

VARIETY	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
FUJI	897,665 583,122	469,146 451,294	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
GALA	1,151,528 1,126,900	942,987 798,008	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
GRANNY SMITH	1,696,470 1,597,885	1,947,108 1,501,192	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
CRIPPS PINK	300,418 269,393	214,894 214,894	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
BRAEBURN	13,570 13,570	26,504 13,360	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
ARKANSAS BLACK							6,796.4 6,796.4				
GOLDEN DELICIOUS		3 2				739 739	1,452 1,452				
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		908 908	400 400	780 780		678 678	512 512	639 639	671 671	2,015	2,778.00
SPITZENBERG							180 180				
SUNDOWNER	8,870 8,870	12,954 12,954	2,244 2,244	1,177 1,177							
SWEETIE											2,766.00
OTHER		22,134 22,134	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
Total Packed	**4,068,521**	**3,636,638**	**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**
Total Shipped	**3,599,740**	**3,014,746**	**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**

2014-2015 ANNUAL REPORT

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