# ARI SHOWCASE

## AGRICULTURAL RESEARCH INSTITUTE
## at CAL POLY POMONA
## December 1, 2017

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**The California State University Agricultural Research Institute**

CAL POLY POMONA

# 17th Annual
# Cal Poly Pomona

# Agricultural Research Institute
# Showcase 2017

Featuring oral and poster presentations of research projects from
ARI-sponsored professors and students

1 December 2017
Kellogg West Conference Center at Cal Poly Pomona
Pomona, California

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17th Annual
Cal Poly Pomona
Agricultural Research Institute
SHOWCASE 2017
1 December 2017 1:00pm – 5:00pm

1:00 **Poster Session**

2016-2017 ARI-funded projects. Principal Investigators and students available for questions & discussion.

2:00 **Opening Remarks**

Dr. Soraya Coley, President, Cal Poly Pomona

Dr. Sadiq Shah, Associate Vice President, Research, Innovation & Economic Development, Cal Poly Pomona

Dr. Lisa Kessler, Dean, Don B. Huntley College of Agriculture, Cal Poly Pomona

Dr. Shelton Murinda, ARI Campus Coordinator, Cal Poly Pomona

2:15 **Oral Presentations**

1. **Dr. Gabriel Davidov Pardo**, Human Nutrition & Food Science, Cal Poly Pomona, "Encapsulation of Lutein in Multilayered Nanoemulsions Stabilized by Polyphenolic Extracts and Maillard Conjugates"
2. **Dr. Zhuangjie Li**, Chemistry & Biochemistry, CSU Fullerton, "Cataphotolysis of Propanil in Water Using Nanotechnology"
3. **Dr. Shelton Murinda**, Animal &Veterinary Sciences, Cal Poly Pomona, "Production of Algae Feeds from Dairy Waste Nutrients"
4. **Justin Medina**, Lab of Dr. David Still, Plant Science, Cal Poly Pomona, "Identification of Physiological and Genetic Factors Associated with Higher Nitrogen Use Efficiency in Lettuce Grown Under Limiting Nitrogen"
5. **Dr. Subodh Bhandari**, Aerospace Engineering, Cal Poly Pomona, "Unmanned Aerial Vehicles for Precision Agriculture Using Multispectral Images and Machine Learning"

3:05 **Break/posters**

3:30 **Oral Presentations (continued)**

6. **Dr. Erin Questad,** Biological Sciences, Cal Poly Pomona, "Uses of Southern California Black Walnut (*Juglans californica*) in Landscaping, Restoration, and Control"
7. **Dr. Aaron Fox**, Plant Science, Cal Poly Pomona, "Alternative Pest Control Methods for the Invasive Pest, *Bagrada hilaris*"
8. **Dr. Anna Soper**, Plant Science, Cal Poly Pomona, "Studies to Increase Field Establishment of and Parasitism by *Tamarixia radiata* for Control of Asian Citrus Psyllid"
9. **Dr. Junjun Liu**, Biological Sciences, Cal Poly Pomona, "Development of DNA Aptamers Specifically Targeting Shiga Toxin Type 2"
10. **Dr. Jill Adler-Moore**, Biological Sciences, Cal Poly Pomona, "Protection Against Pulmonary Aspergillosis in Chickens and Mice Following Vaccination with a Liposomal *Aspergillus* Vaccine"

4:20 **Oral Presentation Closing Remarks**

4:25 **Poster Session (continued)**

# Acknowledgments

Welcome to the 17th Annual Cal Poly Pomona Agricultural Research Institute (ARI) Showcase. This event was sponsored by the California State University (CSU) ARI and Don B. Huntley College of Agriculture. This year's showcase will feature projects exclusively conducted by Cal Poly Pomona campus researchers and their collaborators. The event will provide an opportunity to learn about the applied research being conducted by faculty, staff and students to improve agriculture in California.

The CSU ARI exemplifies working for California through university and industry partnerships. The ARI provides diversified multi-campus applied research support that annually matches ~$4.5 million in State General Funds. This funding supports research on high priority issues facing California agriculture in diverse research areas (Agricultural Business, Biodiversity, Biotechnology, Food Science/Safety/Security, Natural Resources, Production and Cultural Practices, Public Policy, and Water & Irrigation Technology).

We thank the ARI Board of Governors who serve as our policy and funding authority, and the Deans from our four Colleges of Agriculture (Cal Poly Pomona, Cal Poly San Luis Obispo, Chico State, and Fresno State), who oversee the respective ARI campus operations, for their support. We extend our appreciation to the support we get from our stakeholders in government, industry and academia.

Special thanks go to Deanna Stewart in the Cal Poly Pomona College of Agriculture Development Office for designing both the evites and the cover for this publication and to Penne Fode for her perennial assistance with the sign-in desk. A debt of gratitude is extended to Dr. Wei Bidlack, our Cal Poly Pomona ARI Administrative Support Coordinator. This showcase would not have been possible without Wei's resourcefulness, foresight, planning, and organizational efforts.

Thanks to all that made this event a resounding success!

Shelton E. Murinda, Ph.D.
ARI Campus Coordinator, Cal Poly Pomona

## Oral Presentation Abstracts

(Listed in order of oral presentations)



(Presenter is bolded; *student researcher)




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# Encapsulation of Lutein in Multilayered Nanoemulsions Stabilized by Polyphenolic Extracts and Maillard Conjugates

Benjamin Steiner*, Viral Shukla*, and Gabriel Davidov-Pardo
Human Nutrition and Food Science Department, Cal Poly Pomona

Impact on California Agriculture: Nanoemulsions enriched with lutein and stabilized with natural antioxidants can be added to beverages made with all natural ingredients where a yellow color is desired. These beverages could be considered functional foods due to the beneficial effects of lutein in human health. Consumers are looking for products made only with natural ingredients, leading to the substitution of artificial colorants for natural ones, such as lutein. Therefore, success in this project could benefit the dairy industry, which is the leading food processing industry in California and the soft beverage sector which is the fifth largest. Moreover, California is the largest wine producer in the US. By finding applications to the pomace extracts including the oil, the wineries will stop paying to remove the pulp and new extractive industries can arise to process and commercialize these extracts.

Rationale/Introduction: Lutein, a colorant, found in yellow corn and marigold flowers can be used as a natural dye in the food industry and as a nutraceutical ingredient due to is beneficial effects on human health. Nevertheless, lutein is not soluble in water and the presence of the conjugated double bonds in its structure, confers lutein with low stability. Nanoemulsions are colloidal dispersions typically formed from emulsifiers, oil, and water, which can be used as a delivery system for lutein. The main differences between nanoemulsions and conventional emulsions are the decrease in the size of the oil droplets, higher optical clarity due to the reduction in light scattering and higher bioavailability of the encapsulated compound due to the increase in surface area. Nanoemulsions can be created using natural emulsifiers like protein but the stability of the systems gets compromised at the isoelectric point of the protein. Therefore, novel techniques such as Maillard conjugation have been explored to improve stability of nanoemulsions made with protein emulsifiers. On the other hand antioxidants can be used to delay the color degradation of lutein and increase the shelf-life of the enriched emulsions.

Experimental Approach: Maillard conjugates of casein and dextran 40 kDa are formed by mixing and drying the protein and the polysaccharide in a 1:1 ratio and subject it to 60ºC and 77.5% relative humidity for 24 h. The Maillard conjugates are characterized by stability of the protein at the isoelectric point and reduction in free amino groups. Multilayered nanoemulsions are formed using the Maillard conjugates as the emulsifier and grape seed oil containing lutein as the dispersed phase. Two different polyphenols found in grapes bound to the Maillard conjugates are used as antioxidants. The emulsions are stored at 45ºC for one month and the physical and chemical stability of the system is assessed every three days.

Major Conclusions: It is feasible to create pH stable Maillard conjugates of casein and dextran 40 kDa. These conjugates proved to be effective in creating nanoemulsions that are stable at different pHs. The next step is to assess the effect of the antioxidants in the stability of the lutein in the enriched nanoemulsions.

# Cataphotolysis of Propanil in Water Using Nanotechnology

Zhen Yu[1], Zhuangjie Li[2], and Victoria Wu[1]*
[1]Electrical & Computer Engineering Department, Cal Poly Pomona, [2]Chemistry and Biochemistry Department, California State University, Fullerton

Impact on California Agriculture: Irrigation of farmland consumes ~80% of total water usage in California. The costs associated with groundwater monitoring and cleansing have cost the state more than $33 million dollars. This research project has significant economic impact to the California agricultural industry and consumers by helping clean up surface and ground water contaminated by pesticides.

Rationale/Introduction: Contamination of California ground and surface water by pesticides, including herbicides and fungicides, due to agricultural application, is an important environmental issue that affects California welfare. It has been reported that a total of 192 million pounds and 186 million pounds of pesticides were used for agricultural practice in California in 2011 and 2012, respectively. Among them Propanil is in the top 100 pesticides used list. Because pesticides are relatively mobile and persistent in soil they can penetrate into ground water following their soil application by farmers. As a result, Propanil has been detected in surface and ground water in many areas of California at various concentrations. Crops including vegetables and fruits could be contaminated if the water containing pesticides is reused for irrigation. It is important to remove pesticides from the irrigated water prior to its reuse.

Experimental Approach: Water samples with Propanil concentrations at part per million (ppm) level were placed into a beaker containing trace amounts of hydrogen peroxide and a glass plate coated with nanoparticles. The samples were exposed to visible light radiation coming from either a regular light bulb or the sun. The change in Propanil concentration was monitored using ultraviolet-visible spectroscopy. Cataphotolysis of Propanil molecules takes place at the surface of nanoparticles, on which the reduction-oxidation reactions occur, leading to oxidative degradation of the Propanil molecules. Propanil degradation was indicated by the absorbance decrease of the ultraviolet-visible spectrum of Propanil at 248 nm. The product of cataphotolysis was probed using liquid chromatography coupled with mass spectrometry (LC-MS), and the acidity of the water sample was measured using a pH meter. Kinetics data was acquired by monitoring the decay of Propanil as a function of time during its cataphotolysis.

Major Conclusions: Propanil molecules were found to undergo decomposition during cataphotolysis when the water samples are radiated by visible light either from a light bulb or the sun. Sunlight was found to increase the degradation rate in comparison to the visible light from the light bulb. The cataphotolytic degradation of Propanil in water follows the first order chemical kinetics, with a rate constant of $k = (4.29 \pm 0.49) \times 10^{-3}\ s^{-1}$. No detectable organic products were found from cataphotolysis of Propanil in the LC-MS examination of the water samples. The acidity of the water sample increased, suggesting that Propanil molecules were oxidized into carbon dioxide, which dissolved in water to form carbonic acid, giving rise to a lower pH value than neutral water.

# Production of Algae Feeds from Dairy Waste

Joe McHugh[1]*, Fatimah Ansari[1]*, Amera Kchech[1]*, Shelton E. Murinda[2], Marcia Murry[1], Gregory Schwartz[3], Trygve Lundquist[4], and A. Mark Ibekwe[5]
[1]Biological Sciences & [2]Animal Veterinary Sciences Department, Cal Poly Pomona, [3]BioResource and Agricultural Engineering & [4]Civil and Environmental Engineering Department, Cal Poly San Luis Obispo, [5]USDA-ARS, U.S. Salinity Laboratory, Riverside

Impact on California Agriculture**:** California is the number one dairy producing state in the US, but in recent years many dairies have been forced to close or relocate due to increased costs of feed and manure disposal. The primary means of manure disposal is distributing the manure on fields of high yield crops such as corn. In the San Joaquin Valley, this type of land resource is beyond capacity. The goal of this project is to cultivate microalgae on dairy farm wastewater to produce animal feed from waste (manure) nutrients, while purifying the water.

Rationale/Introduction: A highly productive crop is needed that will convert manure nutrients, nitrogen (N) and phosphate (P), into feed but in smaller land areas than crops such as corn. Microalgae have a high capacity for nutrient removal and have shown great potential as a supplement for animal feed. With annual yields, typically 7-13 times greater than soy or corn, this potential feed would have 40 to 50% of their biomass as protein, and would contain amino acids, high lipid levels and vitamins, that are valuable in animal feeds. Critically, for the biomass to be used as safe livestock feed, it must be free from pathogens, toxins and heavy metals.

Experimental Approach: The algae are cultivated in 30-cm deep, 970-L, paddle-wheeled, raceway ponds. Algal biomass, removal of N and P, and other parameters are monitored. Seasonally dominant algae were determined by microscopy and confirmed by DNA sequencing. Rapidly growing isolates were studied under controlled environmental conditions in the lab to simulate parameters that were present in the model ponds at the time of sampling. Advanced compositional analysis of algal biomass is being determined using a variety of methods, initially targeting protein and lipid content of isolates, and will be determined by amino acid and fatty acid profiles, respectively. Pathogen and algal communities present in feed processed from algal biomass is studied using next generation sequencing (NGS). Samples were tested and quantified for cyanotoxins using GC-MS and ELISA. Heavy metal concentrations were determined using inductively coupled plasma (ICP)-MS.

Major Conclusions: The naturally inoculated raceway ponds achieved significant nutrient uptake, i.e., 75-85% N, and greater removal of P, for units receiving 80-100% dairy lagoon effluent per day. Recommended seasonal hydraulic residence times (HRTs) before harvesting were; 2.5-3 days in summer and fall, 4 days in spring, and 6 days in winter. More than 100 seasonally dominant algae species have been isolated, characterized and preserved for future use. Algae isolates (n=16) were characterized for fatty acid profiles using GC-MS. NGS data suggest that caution must be exercised in choosing DNA extraction methods that yield representative microbial populations (microalgae, bacteria, including pathogens) present in the ponds. All samples with algae biomass were negative for the cyanotoxins: microcystin, nodularin, anatoxin-a, saxitoxin and cylindrospermopsin. Pathogens were not detected in the dairy lagoon effluent (DLE), control or treatment samples. Most major minerals and heavy metals were at insignificant concentrations of <0.05 ppm to <2 ppm. PCR procedures were developed for universal detection of cyanobacteria and their toxins (microcystin and anatoxin-a). These are all good indications for global safety of the algal biomass destined for use as animal feed.

**Identification of Physiological and Genetic Factors Associated with Higher Nitrogen Use Efficiency in Lettuce Grown Under Limiting Nitrogen**

Justin Medina[1]*, Daniel Donate[2]*, Derrick Dizon[1]*, Youngsook You[3], and David W. Still[3,4]
[1]Biological Sciences Department, [2]Agribusiness & Food Industry Management Department, [3]Plant Science Department, Cal Poly Pomona; [4]CSU Agricultural Research Institute

Impact on California Agriculture: Lettuce is the most valuable vegetable crop in California worth over $2.0 billion annually. Lettuce requires a dependable supply of high-quality water and high amounts of nitrogen (N)-based fertilizers to maximize yield and to obtain the size and quality the market demands. However, water is an increasingly unpredictable commodity with climate models predicting less precipitation and available water in California. Greenhouse gases drive global warming, and atmospheric nitrous oxide, a long-lived and potent greenhouse gas, has increased dramatically since 1940; N-based fertilizers are, by far, the major anthropogenic source of this gas.

Rationale/Introduction: Developing cultivars with improved nitrogen and water use efficiency will lower the environmental impact of growing the crop and help ensure its sustainability in California. Nitrogen use efficiency (NUE) is a product of N uptake and N assimilation. Identifying genotypes with superior N uptake under field conditions is difficult due to the large number of genes affecting the trait, and the environmental influence on the expression of these genes.

Experimental Approach**:** A wide variety of germplasm including sexually compatible non-domesticated *Lactuca* species and commercial cultivars were screened for N uptake and root growth. To minimize environmental effects and identify genetic and physiological underpinnings of N uptake, seedlings were germinated and grown under a controlled environment in an agarose-based media supplemented with 0.1X MS salts with $NH_4NO_3$ N added at levels sufficient to limit or not limit growth (limited and non-limiting N levels). Root growth was assessed every 48 h for 15 days by photographing agarose plates containing the seedlings and analyzing the growth of individual roots from the digital image using Root Detection software version 0.2.1. For each genotype, the overall root length and relative growth rate and leaf N concentration (as a proxy for N uptake) was determined. For both the non-limiting and limiting N treatments, the population frequency distribution for the root length and growth rates was determined. The genotypes comprising the top and bottom 5% of the population in terms of leaf N were identified from these distributions. These genotypes will be used for bulk segregate analysis RNA-seq (BS RNA-seq) to identify physiological mechanisms, metabolic pathways, key genes and allelic mutations that can be targeted to improve nitrogen use efficiency in lettuce.

Major Conclusions: With respect to N uptake, three of the top six genotypes under limited N were commercial cultivars. Since lettuce breeders made selections on materials that were grown under optimal water and nutritional conditions, this result was not unexpected. Under limited N, no commercial cultivars were ranked in the top 15% of the population in N uptake. Instead, five of the top six genotypes were *L. serriola* accessions and the sixth genotype was a *L. saligna* accession. Conversely, under limited N, the bottom 15% of the population in terms of N uptake was comprised mostly of commercial cultivars. These data indicate the N uptake of a given genotype grown under high N does not predict its performance under low N. However, progress in improving NUE can be made. A single genotype ranked in the top 5% under limited and non-limited N, and, the best performing genotypes under limiting N had values of about 90% of the best performing genotypes grown under non-limiting N. These encouraging results indicate that lettuce cultivars can be developed that will require less N fertilizers to be applied, thereby reducing the environmental impact and ensuring that lettuce can sustain itself as a viable crop well into the future.

# Unmanned Aerial Vehicles for Precision Agriculture Using Multispectral Images and Machine Learning

Subodh Bhandari[1], Amar Raheja[2], Mohammad Chaichi[3], Robert Green[3], Dat Do[2]*, Mehdi Ansari[3]*, Katrina Nordyke[4]*, Joseph Wolf[3]*, Tristan Sherman[1]*, Frank Pham[2]*, and Kevin Gongalez[3]*
[1]Aerospace Engineering Department; [2]Computer Science Department; [3]Plant Sciences Department, [4]Mechanical Engineering Department, Cal Poly Pomona

Impact on California Agriculture: California is one of the world's largest agricultural producers and exporters. California's agriculture is also one of the largest users of chemicals and water resources. Any savings in chemicals and water will reduce the cost of production and environmental impact, and help conserve water. Near infrared (NIR) images obtained using remote sensing techniques help determine the crop performances and stresses of a large area in a short amount of time for precision agriculture, which aims to optimize the amount of water, fertilizers, and pesticides by using site-specific management of crops.

Rationale/Introduction: The overall goal of the project is to use unmanned aerial vehicle (UAV)-based remote sensing technology and machine learning for precision agriculture. The main advantage of UAV-based remote sensing is the reduced cost and immediate availability of high resolution data. This helps detect crop stresses throughout the crop season. Conventional methods of remote sensing use satellites and manned aircraft. However, the images have low resolutions, and have large revisit periods. Also, these methods cost $8,000 to $10,000 per data capture for high resolution data of a 200 hectare farm. For remote sensing to play an important role for precision agriculture, the associated cost must be reduced. However, though the UAV-based remote sensing technology has made significant progress in recent years, much less has been done on validating the accuracy of the data. To be useful for the real-world applications, the accuracy of remote sensing data must be validated using proven ground-based methods.

Experimental Approach: We have been using lettuce and citrus crops in our study. A test plot for growing lettuce at Cal Poly Pomona's Spadra farm has been designed. Nitrogen and moisture content of the soil was determined prior to beginning the study. The plot is being subjected to different levels of nitrogen and water treatments. UAVs equipped with multispectral/hyperspectral sensors and digital cameras are being flown over the lettuce and existing citrus trees for remote sensing data. The ground truth sensors include chlorophyll meter, water potential meter, and handheld spectroradiometer. The spectral data from the UAV and spectroradiometer are used in the determination of normalized differential vegetation index (NDVI) that is used to assess plant health. The red-green-blue (RGB) images are used for developing the machine learning classifiers.

Major Conclusions: With the data collected so far, the NDVI obtained using the spectroradiometer has shown good correlation with the chlorophyll meter and water potential meter data. Accuracy of the machine learning algorithm in predicting the plant health is satisfactory. The remote sensing data have shown slightly lower correlation with the ground truth data. Changes in the remote sensing data collection method are expected to improve the correlation.

# Uses of Southern California Black Walnut (*Juglans californica*) in Landscaping and Restoration

Erin J. Questad, Edward Bobich, Kristin Bozak, Eliza Hernández, Joshua Paolini, Sierra Lauman*, and Jose Marfori*
Biological Sciences Department, Cal Poly Pomona

Impact on California Agriculture: The economic effects of the prolonged drought in California extend to industries such as agriculture, water supply, and ornamental horticulture, with estimated economic losses up to $1.8 billion in 2015 alone.

Rationale/Introduction: Because water supplies are at record lows, water conservation has never been more important in California's recent history. Currently, most landscaping plants in Southern California require substantial irrigation. Hence, the use of arid-adapted plants in landscaping is essential for regional water conservation and is already a popular approach to reducing water needed for irrigation. The best candidates for low water-use landscapes are native plants that are adapted to Southern California's long-term variability in its rainfall regime. A native tree that shows promise for landscaping is the rare, deciduous *Juglans californica* (Southern California black walnut). In addition to being drought-tolerant and deciduous, *J. californica* is allelopathic and produces a compound known as juglone that chemically inhibits other species. Determining which species can co-occur with *J. californica* and be used as companion plantings can increase the use of this drought-tolerant tree in landscaping and aid in its restoration.

Experimental Approach: In order to determine companion plantings for *J. californica*, we established a field experiment by planting six native shrubs, a native bunchgrass, four native annual species, and four common non-native, invasive species underneath the canopy, along the dripline, and outside of the canopy of eight different *J. californica* trees at Cal Poly Pomona's Lyle Center for Regenerative Studies. We carried out complementary laboratory and greenhouse experiments to test the effect of the chemical juglone on seed germination and seedling growth.

Results: Most species had inhibited seed germination in the presence of low concentrations of juglone; however, seeds germinated readily under field conditions. Species such as *Heteromeles arbutifolia, Prunus ilicifolia,* and *Phacelia distans* had the greatest growth under canopy or dripline conditions, compared to open areas; whereas, other species did not.

Major Conclusions: Potential allelopathy due to juglone did not appear to be a barrier to seed germination or plant growth in contrast to studies of other *Juglans* species. This finding may occur because of the drier soil conditions in Southern California compared to more temperate climates. While all species tolerated conditions under trees, *Heteromeles arbutifolia, Prunus ilicifolia,* and *Phacelia distans* are the top candidates for companion plantings with *J. californica* trees and should be considered for use in landscaping and the restoration of the understory of this ecosystem.

## Alternative Pest Control Methods for the Invasive Pest, *Bagrada hilaris*

Aaron F. Fox[1], Shayan Ettehadieh[2]*, Diego Palomino-Ibarra[1]*, Lani Yamasaki[3]*, Jose Aguilera[2]*, Joseph Wolf[1]*, and AnnMarie Niemeyer[3]*
[1]Plant Science Department, [2]Agribusiness & Food Industry Management/Agricultural Science Department, [3]Biological Sciences Department, Cal Poly Pomona

Impact on California Agriculture: Bagrada bug, *Bagrada hilaris*, is an invasive insect pest originally from Africa that is now found throughout Southern California, the Southwest U.S., and as far north as Yolo County. Bagrada bug causes significant damage to Cole crops (e.g., broccoli, cabbage, kale) and has been seen feeding on a host of other crop families, from papaya to potatoes. Bagrada bugs have produced 10% crop loss in broccoli, 20% crop loss in cauliflower, and 35% yield loss in cabbage. Yearly production of broccoli, cauliflower and cabbage in California are worth $806.6 million, $309 million, and $177.7 million, respectively.

Rationale/Introduction: Despite Bagrada bug's significant impact on California agriculture, only preliminary research on the insect's biology has been conducted and very few effective control measures have been developed. Due to a lack of alternative control methods, organic growers and urban farmers have been especially impacted by the Bagrada bug. Vacuuming is one pest management methods that has proven successful in other crops, and may be an option for organic Bagrada bug control.

Experimental Approach: The original approach of this research project, to investigate vacuuming on Bagrada bug populations during the spring, summer, and fall of 2017, was hampered by the fact that Bagrada bugs were not present in farm fields throughout California for the first nine months of the year. Bagrada bug did finally appear in October, and a vacuuming experiment was conducted in turnips, *Brassica rapa* var. *rapa*, at Cal Poly Pomona's campus farm. Bagrada bugs were collected via vacuum sampling from Treatment and Control plots for five days. All treatment plots were vacuumed with a modified leaf blower on the first day of the experiment, and on the subsequent four days three Treatment plots were randomly selected and insects were collected with a the vacuum. Each day three Control plots that had never been previously vacuumed were sampled with the vacuum. All insect samples were brought back to the lab and kept in the laboratory freezer until they were inspected for Bagrada bug and other key insect groups.

Major Conclusions: Vacuuming may reduce Bagrada bug populations in the field, but it cannot stop Bagrada bug outbreaks after they happen. New research will need to see if vacuuming can prevent outbreaks from happening. Furthermore, vacuuming can be destructive to the crop and this needs to be factored into the feasibility of this pest control method. Finally, Bagrada bug's absence from California crop fields during most of the year raises many questions about the biology of this invasive insect.

## Studies to Increase Field Establishment of and Parasitism by *Tamarixia radiata* for Control of Asian Citrus Psyllid

Anna L. Soper, Danielle Ruais*, Kat Nunez*, Benjamin J. Lehan, and Valerie Mellano
Plant Sciences Department, Cal Poly Pomona

Impact on California Agriculture: The United States is the second largest producer of citrus, with a 34% market share. The citrus industry is under a massive threat from a bacterial disease called Huanglongbing (HLB), which is vectored by the invasive Asian Citrus Psyllid (ACP). HLB is the most devastating disease of citrus in the world. Symptoms of HLB include yellow shoots, leaf mottle, small upright leaves and lopsided fruit with a bitter flavor. Infected trees decline in health, produce inedible fruit and eventually die. There is no cure for the disease and infected trees must be removed and destroyed to prevent further spread of HLB. Recent studies in Florida have shown that the presence of HLB increases citrus production costs by up to 40 percent and has resulted in a loss of over $7 billion and 6,600 jobs over the last five years. To date, over 200 finds of HLB has been detected in Southern California in Orange, Los Angeles, and Riverside counties. Of greatest concern to growers is limiting the spread to the urban areas and not to commercial groves. California's citrus industry ranks first in the U.S. in terms of value and second (after Florida) in terms of production. Establishment of HLB in California in commercial orchards would cause economic losses via direct damage to citrus plants and quarantine restrictions designed to mitigate the spread of the two. The present control strategy in the urban area is the use of a parasitic wasp known as *Tamarixia radiata.*

Rationale/Introduction: Citrus in Southern California is especially common in the urban ecosystem. With the introduction of ACP and HLB to the area, it is especially critical to find an effective solution in the urban area, to prevent spread to commercial orchards. A wasp native to Pakistan, *Tamarixia radiata*, has been proven to be useful as a classical biological control agent against ACP. Through a combination of parasitization and host feeding, a single female wasp can successfully kill over 500 ACP. Additionally, she can kill up to 80% of ACP from nymphal parasitism alone. The purpose of our experiment was to increase *Tamarixia* egg load prior to release in the urban environment as it has been found that more eggs lead to higher percent parasitism among the wasps which would lead to greater mortality of ACP.

Experimental Approach: In the Winter and Spring quarters from 2014 to 2017 a total of 91 undergraduate and graduate students undertook research projects to examine methodologies to increase the production and field establishment of *Tamarixia radiata* and to better understand the citrus psyllid. As many projects were conducted, only one project will be highlighted here. *Tamarixia radiata* wasps were obtained from the CDFA greenhouse located on the campus of Cal Poly Pomona. To evaluate the effects of diet on egg load, female wasps ages 6 and 12 days were fed crushed ACP, Honey, CoQ10, and Royal Jelly. These wasps were dissected after 24 hours and egg development was counted and recorded.

Major Conclusions: The results of all research projects were presented at an annual symposium in June from 2014-2017. In the project of *Tamarixia* egg load, it was found that wasps fed ACP nymphs (their preferred host) had the highest number of eggs in the 12 day old wasps but in 6 day old wasps, those fed CoQ10 and Royal Jelly had the highest average egg load per wasp. This research shows that through artificial diet, we can positively affect adult egg load, thereby increasing parasitism rates once released.

## Development of DNA Aptamers Specifically Targeting Shiga Toxin

Andrew Chen*, Michael Garrett*, Shawnee Angeloni*, and Junjun Liu
Biological Sciences Department, Cal Poly Pomona

Impact on California Agriculture: Shiga toxins (Stx) are primarily associated with Shiga toxin–producing *Escherichia coli* (STEC). STEC infections often cause diarrhea, but some patients develop life threatening hemolytic uremic syndrome. The impact of STEC outbreaks is not limited to human health. Agricultural products contaminated with STEC must be recalled, which often results in significant loss to producers. California (CA) is a major beef and dairy producing state and a recent survey detected STEC in about 40% of farms and ranches. Therefore, to protect CA agriculture and human health, it is important to have an efficient way to detect any Stx-producing bacteria.

Rationale/Introduction: Stx are usually produced by O157:H7 STEC and many other non-O157 STEC serotypes. However, infections with *Shigella dysenteriae* and *S. sonnei* that also produce Stx were recently reported in CA. Most contamination management focuses on the detection of bacteria. However, this approach is inefficient as it needs to detect each individual serotype. A more effective approach would be to detect the toxins themselves. Antibody-based tests are widely used due to their rapidity and simplicity, but these methods encounter drawbacks including the cost and difficulty associated with antibody production from animals, instability and lack of quality consistency from batch to batch. These properties limit the application of antibodies in food safety tests. Recently, aptamers have emerged as very promising target recognition agents. DNA aptamers are short single-stranded DNA fragments that fold into distinct three-dimensional conformations capable of binding strongly and selectively to target molecules. In comparison to antibodies, aptamers have many advantages including lower overall costs, avoidance of animal use, consistent quality from batch to batch, long shelf life at ambient temperature, and ability to detect small molecules such as heavy metal ions and toxins. These unique characteristics make aptamers an ideal alternative to antibodies.

Experimental Approach: There are two main types of Stx, Stx1 and Stx2, and the latter is usually more virulent. By using a process called Systematic Evolution of Ligands by EXponential enrichment (SELEX), we screened for DNA aptamers specifically targeting both Stx1 and Stx2. The aptamers selected by the process were verified for their binding affinity and specificity.

Major Conclusions: By using asymmetric PCR SELEX, we have successfully selected a DNA aptamer that binds to Stx1 with high specificity and can detect Stx1 at the level of 125 ng in an aptamer-based direct enzyme-linked immunosorbent assay (ELISA). This aptamer is highly specific, as it did not detect Stx2 at a similar level. Work is underway to identify a second Stx1 aptamer to be used in a Sandwich ELISA which would improve the detection sensitivity. The screening for Stx2 aptamers is in progress. Once the rest of the aptamers have been selected, we will be able to develop a fully aptamer-based assay for the detection of Stx1 and Stx2 either separately or combined in a single assay.

# Decreased Fungal Burden and Production of Anti-*Aspergillus* Antibodies Following Vaccination of Chickens with a Liposomal *Aspergillus* Vaccine

Matthew Slarve[1]*, Hernan Reza[1]*, Lisa Griggs[2], Tracey McNamara[2], Ellen Collisson[2], Sam Ho[3], Suming Chiang[3], Gary Fujii[3], and Jill Adler-Moore[1]
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Impact on California Agriculture: The economic impact of poultry respiratory diseases in California is estimated to reach $75 million a year. One of these diseases is pulmonary aspergillosis caused by the ubiquitous saprophytic fungus *Aspergillus fumigatus.* Aspergillosis in chickens and turkeys results in impaired growth, difficulty breathing, loss of appetite, respiratory failure and even death. It can cause acute symptoms in young birds with a potential mortality rate of up to 90%, leading to carcass condemnation, and loss of entire flocks.

Rationale/Introduction: Drug treatments for aspergillosis in poultry have had limited success because the regimens involve a combination of topical and inhalation drug treatments which are logistically challenging. A vaccine conveying protection against *A. fumigatus* spores could effectively prevent the establishment of the infection, and avoid the heavy economic losses associated with this infection. There is clearly a need to develop a safe and effective *Aspergillus* vaccine for poultry which is not presently available.

Experimental Approach: To execute the vaccine studies, we first standardized a pulmonary aspergillosis model in specific-pathogen-free (SPF), 4 and 7 week old chickens (n=8/group). Variables investigated included fungal spore challenge dose, age of chickens, and immunosuppressive regimen since immunosuppression is a major risk factor for aspergillosis. We determined that mucosal infection of chickens with 2-4 x$10^8$ *A. fumigatus* spores in 200 µl, following intramuscular dexamethasone administration at 4.5 mg/kg on day -1, 0, +1 and +2 relative to challenge day 0, would produce morbidity and high fungal burden in the lungs and tracheas [colony forming units (cfu)/g tissue]. We used this *Aspergillus* infection model to test a VesiVax® liposomal vaccine (Molecular Express Inc.) containing the immunogenic recombinantly-made *Aspergillus* proteins, Aspf3 (7.5 µg/dose) and Aspf9 (7.5 µg/dose), and the adjuvant tucaresol. SPF chickens (males and females, n=8/group) were vaccinated subcutaneously at 7 days old, and mucosally at 14 and 21 days of age with either the liposomal Aspergillus protein vaccine, the liposomes with tucaresol and no proteins, or phosphate buffered saline (PBS). At 27, 28, 29 and 30 days of age, the chickens received 4.5 mg/kg of dexamethasone immunosuppressant via intramuscular injection. At 28 days of age, birds were challenged with *A. fumigatus* spores (2.25 x $10^8$), monitored for morbidity and 5 days later blood, lungs and tracheas collected, homogenized and plated on Sabouraud's agar to determine cfu/g fungus. Serum was separated from blood for determination of anti-*Aspergillus* antibody agglutination titers. The two control groups lost significantly more weight ($p \leq 0.01$) than the *Aspergillus* vaccine group with significantly higher fungal burden in their lungs ($p \leq 0.003$) and tracheas ($p = 0.0002$ vs. PBS, $p = 0.09$ vs. liposomes alone). Anti-spore agglutination antibody titers were significantly elevated for the *Aspergillus* vaccine group vs. control groups ($p=0.0006$).

Major Conclusions: The results of these experiments indicate a strong potential for this *Aspergillus* liposomal vaccine to be an effective method of protecting poultry from pulmonary aspergillosis and needs to be further investigated to optimize its efficacy by testing different vaccine doses, timing of the vaccine doses and routes of vaccine administration.

Poster Presentations (*student researcher)

1. **Algae for Conversion of Manure Nutrients to Animal Feed: Evaluation of Advanced Nutritional Value, Toxicity, and Zoonotic Pathogens**
   Joseph McHugh[1]*, Alyssa Sancio[1]*, Natalie Eugenio[1]*, Amera Kmech[1]*, Shelton E. Murinda[2], Gregory Schwartz[5], Marcia Murry[1], A. Mark Ibekwe[4] and Trygve Lundquist[5]
   [1]Department of Biological Sciences and [2]Department of Animal & Veterinary Sciences, Cal Poly Pomona, [3]Department of BioResource & Agricultural Engineering and [5]Department of Civil & Environmental Engineering, Cal Poly San Luis Obispo, and [4]USDA-ARS, U.S. Salinity Laboratory, Riverside

2. **Alternative Pest Control Methods for the Invasive Pest, *Bagrada hilaris***
   Aaron F. Fox[1], Shayan Ettehadieh[2]*, Diego Palomino-Ibarra[1]*, Lani Yamasaki[3]*, Jose Aguilera[2]*, Joseph Wolf[1]* and AnnMarie Niemeyer[3]*
   [1]Department of Plant Sciences; **[2]Department of Agribusiness & Food Industry Management/Agricultural Science** and [3]Department of Biological Sciences, Cal Poly Pomona

3. **Breeding Lettuce for Increase Water and Nitrogen Use Efficiency**
   Youngsook You[1], Fabian Perez[1]*, Deborah Lopez[1]*, Blake Stark[1]*, Lucia Sellati[1]*, Ivan Aguirre[1]*, Simone Ferguson[1]*, Jenna Ramirez[1]*, Emilio Ortiz[1]*, Nancy Sun[1], Daniele Ellis[1] and David W. Still[1,2]
   [1]Department of Pant Sciences, Cal Poly Pomona, and [2]California State University Agricultural Research Institute

4. **Cataphotolysis of Propanil in Water Using Nanotechnology**
   Zhen Yu[1], Zhuangjie Li[2] and Victoria Wu[2]*
   [1]Department of Electrical & Computer Engineering, Cal Poly Pomona, and [2]Department of Chemistry and Biochemistry California State University, Fullerton

5. **Development of DNA Aptamers Specifically Targeting Shiga Toxin**
   Andrew Chen[1]*, Michael Garrett[1]*, Shawnee Angeloni[1]* and Junjun Liu[1]
   [1]Department of Biological Sciences, Cal Poly Pomona

6. **Development of Slow-bolting Iceberg and Romaine Cultivars for Desert Production Areas**
   Youngsook You[1], Leah Zucker[2], Ivan Simko[2], Ryan Hayes[2] and David W. Still[1,3]
   [1]Department of Plant Sciences, Cal Poly Pomona; [2]USDA-ARS, Salinas, CA and [3]California State University Agricultural Research Institute

7. **Encapsulation of Lutein in Multilayered Nanoemulsions Stabilized by Polyphenolic Extracts and Maillard Conjugates**
   Benjamin Steiner[1]*, Viral Shukla[1]* and Gabriel Davidov-Pardo[1]
   [1]Department of Human Nutrition and Food Science, Cal Poly Pomona

8. **Gas Exchange of Plants and Soil in Relation to Canopy Coverage by Southern California Black Walnut Trees**
   Edward G. Bobich[1] and Erin J. Questad[1]
   [1]Department of Biological Sciences, Cal Poly Pomona

**9. Green Abalone Aquaculture Method Development and Technology Transfer**
Benjamin Grime[1,2,3]*, Austin Pyles[1], Ariadne Reynolds[2], Tom Ford[2] and Jeremy T. Claisse[1]
[1]Department of Biological Sciences, Cal Poly Pomona; [2]The Bay Foundation, Los Angeles, CA and [3]Southern California Marine Institute, San Pedro, CA

**10. HPLC and Antioxidant Analysis of Crude Natural Food Color Extracts Purified by Micro- and Nano-filtration Systems**
Harmit Singh[1], Carol Pow Sang[1]*, Evelyn Sanchez[1]* and Leslie Perez[1]*
[1]Department of Human Nutrition and Food Science, Cal Poly Pomona

**11. Identification of Physiological and Genetic Factors Associated with Higher Nitrogen Use Efficiency in Lettuce Grown Under Limiting Nitrogen**
Justin Medina[1]*, Daniel Donate[2]*, Derrick Dizon[1]*, Youngsook You[3] and David W. Still[3,4]
[1]Department of Biological Sciences; [2]Department of Agribusiness & Food Industry Management; [3]Department of Plant Sciences, Cal Poly Pomona and [4]California State University Agricultural Research Institute

**12. Impact of Kaolin Clay Particle Films Imidacloprid on Silverleaf Whitefly, Natural Enemy Assemblages and Bee Pollination**
Joan M. Leong[1], Vonny M. Barlow[2], Carmel (Pearson) Tabush[1]*, Jon Sacro[1]*, Seth Kapp[1]* and Andy Tung[1]*
[1]Department of Biological Sciences, Cal Poly Pomona; [2]Division of Agricultural and Natural Resources, University of California, Blythe, CA and Department of Entomology & Nematology, University of California Davis

**13. Protection Against Pulmonary Aspergillosis in Chickens and Mice Following Vaccination with a Liposomal *Aspergillus* Vaccine**
Matthew Slarve[1]*, Hernan Reza[1]*, Lisa Griggs[2], Tracey McNamara[2], Ellen Collisson[2], Sam Ho[3], Suming Chiang[3], Gary Fujii[3] and Jill Adler-Moore[1]
[1]Department of Biological Sciences, Cal Poly Pomona; [2]Western University of Health Sciences College of Veterinary Medicine and [3]Molecular Express Inc., Dominguez Hills, CA

**14. Separation, Analysis and Antioxidant Potential of Food Colors and Phenolic Compounds from Peach Processing Wastewater**
Harmit Singh[1], Shirin Mal Ganji[1]*, Emily Harris[1]* and Shannen N. Hilse[1]*,
[1]Department of Human Nutrition and Food Science, Cal Poly Pomona

**15. Student Research Projects Focused on Maximizing the Production and Establishment of *Tamarixa radiata,* the Biological Control Agent of the Asian Citrus Psyllid**
Anna Soper[1], Benjamin Lehan[1], and Valerie Mellano[1]
[1]Department of Plant Sciences, Cal Poly Pomona

**16. The Use of Pruning, Cytokinin Application, and Fertilizer Application to Increase Flush in *Murraya koenigii* (L.) (Rutaceae) and Subsequent Egg Laying by ACP (*Diaphorina citri*, Kuwayama) (Hemiptera: Psyllidae)**
Kat Nunez[1]*, Anna Soper[1], Benjamin Lehan[1] and Valerie Mellano[1]
[1]Department of Plant Sciences, Cal Poly Pomona

**17. Unmanned Aerial Vehicles for Precision Agriculture Using Multispectral Images and Machine Learning**

Subodh Bhandari[1], Amar Raheja[2], Mohammad Chaichi[3], Robert Green[3], Antonio Espinas[4], Dat Do[2]*, Mehdi Ansari[3]*, Katrina Nordyke[5]*, Joseph Wolf[3]*, Tristan Sherman[1]*, Frank Pham[2]* and Kevin Gongalez[3]*

[1]Department of Aerospace Engineering; [2]Department of Computer Science; [3]Department of Plant Sciences; [4]Department of Apparel Merchandising and Management and [5]Department of Mechanical Engineering, Cal Poly Pomona

**18. Uses of Southern California Black Walnut (*Juglans californica*) in Landscaping and Restoration**

Erin J. Questad[1], Edward Bobich[1], Kristin Bozak[1], Eliza Hernández[1], Joshua Paolini[1], Sierra Lauman[1]* and Jose Marfori[1]*

[1]Department of Biological Sciences, Cal Poly Pomona

**19. Utilization of Orange Pomace for Food and Packaging Applications**

Jonathan Guo[1]*, Helene Mecate[1]*, Jamie Lam[1]*, Carolina K. Maksudi[1]*, Huiying Hu[1]*, Xia Chen[2], Wei-Jen Lin[3], Yan Liu[4] and Yao Olive Li[1]

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