COC Proposals – Project Year 2016

Project Leader	Title	Amount
Jim Stewart	South SJV olive fly monitoring project	$6,334
Ernie Simpson	Sacramento Valley olive fly monitoring project	$6,500
Ron Haff	Real-time removal of insect damaged olives from the processing stream	$35,000
Jim Adaskaveg	Epidemiology and management of olive knot	$42,000
Charlie Pickett	Biological control of olive psyllid (renewal)	$31,680
Carol Lovatt / Elizabeth Fichtner	PGRs and pruning treatments to manage alternate bearing	$16,045

COC Proposals – Project Year 2016
Project Summaries

Stewart – South SJV olive fly monitoring project - $6,334
Olive fly monitoring would be continued at the same nine sites as previous years, with an additional site added for 10 sites total. Fly counts in each of the orchards would be available to aid growers in the treatment decision making processes.

Simpson – Sacramento Valley olive fly monitoring project - $6,500
Olive fly monitoring would be continued at the same 12 sites as previous years. Fly counts in each of the orchards would be available to aid growers in the treatment decision making process.

Haff – Real-time removal of insect damaged olives from the processing stream - $35,000
Olive fly damaged fruit can be identified mechanically because they give off a different waveband [light] pattern under near-infrared. Similar sorting technology from this lab has used these wavebands to identify damaged pistachios in real-time. This project would build and test a bench-top prototype sorter to remove olive fly damaged fruits from a processing stream. If results are positive, a proposal for a full-size model will be submitted next year.

Adaskaveg – Epidemiology and management of olive knot - $42,000
This olive knot project builds on previous years of research. First, Deccosan will be evaluated as an equipment sterilizer for preventing infection of pruning wounds. Second, three new antibiotic treatments will be optimized for treatment timings and additives, and additives to enhance copper efficacy will be tested. Third, growth chamber studies will try to reproduce situations that can cause systemic infection of olive knot.

Pickett – Biological control of olive psyllid - $31,680
The most important parasitoid of olive psyllid in the Mediterranean is currently in colony in California. This project will finish testing to ensure the parasitoid does not affect non-target psyllid species and will begin releases of the parasitoid onto psyllid-infested olives in southern California.

Lovatt/Fichtner – PGRs and pruning treatments to manage alternate bearing - $16,045
$5000 in matched funds have been obtained for this project
This project builds on the previous work looking at mechanisms responsible for alternate bearing and tests a management plan to mitigate alternate bearing. Treatments will test a growth inhibitor (S-ABA) for ON years to reduce fruit set; 6-BA applications during ON years to increase vegetative shoot growth; and AVG applications during OFF years to increase fruit set.

PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project year: 2016 Anticipated Duration of the project: April –November 2016

Project Leader: Jim Stewart Location: Tulare County
Mailing Address: PO Box 1095, Exeter CA 93221
Phone: (559) 730-6243 FAX: (559) 592-4105 E-mail: jsagipmc@verizon.net

Project Title: Southern San Joaquin Valley Olive Fruit Fly Monitoring Project

Cooperating personnel: Bert Quezada, Doug Bigham

Keywords: Olive Fruit Fly, Monitoring, Traps,
Commodity: Olive

PROBLEM AND ITS SIGNIFICANCE:

The monitoring of Olive Fruit Fly (OLFF) in commercial olive groves in the Southern San Joaquin Valley started in 2001. OLFF is potentially the most significant insect pest in commercial Olive.

OBJECTIVES:

The objective of this project would be to continue the monitoring program of adult OLFF in commercial olive groves in the Southern San Joaquin Valley. Detection and seasonal monitoring of OLFF and the accurate timing of control measures, primarily bait sprays, would be the goal of this project. Correlation of fly collections with fruit susceptibility to infestation would indicate to growers when initial bait treatments should be applied. In addition, monitoring would continue to give growers information on the general OLFF population. This information would specific for only the groves being monitored and would be available to growers to aid in making OLFF management decisions in their respective groves in the area being trapped.

PLANS AND PROCEEDURES:

The same nine sites used in the years 2013 to 2015 in commercial olive groves will be set up with traps in April of 2015. The locations will be Ivanhoe, Woodlake, Exeter, South Exeter, Tonyville, West Lindsay, Strathmore, Porterville and Terra Bella. In addition, a site in the city of Visalia would also be monitored. All of these sites are in Tulare County where a high percentage of the commercial olives are located in the Southern San Joaquin Valley. Many of the sites have been monitored starting in 2001. All traps will be in place by the first week of April and the program will end the last week of November. Two yellow panel traps with ammonium carbonate bait and male pheromone will be used per site. Traps will be serviced and OLFF counted weekly. Reports detailing the number of OLFF found at each location will be submitted to the California Olive Committee and interested parties within 24 hours on a weekly basis.

BUDGET REQUEST

Budget year: April 1, 2016-December 1, 2016

Funding Source: California Olive Committee
Leffingwell Ag Sales Co., Inc.
Ag IPM Consultants, Inc.

Salaries and benefits:		$15,400.00
Supplies:		
Traps, bait and pheromone		1200.00
Travel:		
Mileage to trap sites		2,400.00
Equipment:		0.00
	TOTAL	$19,000.00

Funding would be split equally between the above listed funding sources.

Total funding from the California Olive Committee would be: $6,333.33

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Project leader
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Ern's Pest Control

Project Plan/ Research Grant Proposal

Project Year: 2016

Project Leader: Ernie Simpson
Mailing Address: 320 County Road 15 Orland, California 95963
Phone: 530-865-9829 Cell: 530-518-4685
E-mail: ernsimp17@sbcglobal.net

Cooperator: Dani Lightle, Orchards Advisor, UC Cooperative Extension, Orland

Commodity: Olive

Problem and its Significance:

Since the detection of Olive Fruit Fly in California in 1998, it has been a concern to olive growers in commercial orchards; preventative sprays are necessary. Trapping to monitor the Olive Fruit Fly populations in individual orchards is recommended. This will allow growers and PCA's to follow trends to their orchards and help evaluate spray program efficacy. Having an idea of area-wide population trends will help growers and PCA's interpret the results from their orchards.

Objectives:

1: Provide timely information to area growers regarding area-wide olive fruit fly population trends.
2: Continue to develop a historical perspective of olive fruit fly populations for the area.

Plans and Procedures:

Starting in early April plastic McPhail traps using Torula yeast tablets dissolved in water as the bait will be placed in one tree at 12 sites (6 in Glenn County and 6 in Tehama County). The same sites that have been used in previous years will be monitored again to allow for comparison of current years trap catches to previous years. Earlier work in Glenn and Butte Counties has shown that the plastic McPhail traps catch more flies than the commonly used yellow panel trap. Traps will be checked and flies counted weekly. The results and field observations will be posted on the Glenn County UC website (Http://ceglenn.ucdavis.edu) and reported via email to the COC for further distribution. Trapping results will be reported as male and female flies for individual traps and combined and averaged by site for a graphic presentation of the data. Trapping and reporting will be continued through December or until trap catches decline for the year.

Budget Request

Budget Year: 2016

Funding Source: California Olive Committee
Salaries_____$4735
Supplies and Expenses: Trapping Supplies_____$ 300
Travel 2545 mi. @ $.575/mi._____$1465
This may vary due to fuel prices

Total_____$6500

Originator's Signature_____

Ernie Simpson

CALIFORNIA OLIVE COMMITTEE RESEARCH PROPOSAL

Project Year: 2016/17 Anticipated Duration of Project: 2 years

Project Leader: Ron Haff Location: USDA, ARS, WRRC, Albany CA
Mailing Address: 800 Buchanan St, Albany CA 94710
Phone: 510-559-5868 FAX: 510-559-5684 E-mail: ron.haff@ars.usda.gov

Cooperating Personnel: Pei Liang, USDA ARS; Eric Jackson, USDA ARS

Project Title: Real-time removal of insect damaged olives from the processing stream

PROJECT SUMMARY

Problem and its Significance:

The olive fruit fly occurs in all olive growing areas of California and poses a severe economic threat for the state's commercial olive growers. Most research has focused on control strategies, including the breeding of sterile flies, trapping and monitoring, ecological management systems, and importation of natural enemies. However, a rapid non-destructive method for detection and removal of damaged olives would aid with post-harvest management and would benefit the industry, as well as consumers.

Recently published research has indicated that fruit fly damage in olives can be detected based on absorption of light within specific wavebands in the visible/Near-infrared (NIR) region (Tables 1 and 2) (Moscetti et al., 2015). Given such specific wavebands of interest, economical, high speed sorting devices have been previously developed in our lab (Haff and Jackson, 2008). Thus, the development of such a device to removed infested olives would involve the application of already developed procedures and practices over predetermined wavebands, reducing the problem to one of mainly optics, electronics, and material handling. The development of such a device is the logical conclusion to a great deal of previous research in NIR and sorting technologies.

Trial	Dataset				Selected Features (nm)						Error rate (%)			AUC	Wilks' λ	Pr (> *F*)
#	Scatt. C.	Norm.	SG*	Deriv.	1	2	3	4	5	6	fp	fn	total			
01	MSC	Yes	13	-	1178	1226	1246	1566	2150	2246	18.75	0.00	9.38	0.9531	0.3525	< 0.001
02	SNV	Yes	9	1st	1168	1420	1602	1712	-	-	12.50	6.25	9.38	0.9531	0.4590	< 0.001
03	MSC	Yes	13	-	1108	1232	1416	1486	2148	-	6.25	18.75	12.50	0.9570	0.3686	< 0.001
04	MSC	Yes	9	-	1232	1764	2248	-	-	-	12.50	18.75	15.63	0.9141	0.4658	< 0.001
05	SNV	-	5	1st	1420	1710	-	-	-	-	31.25	12.50	21.88	0.8984	0.5328	< 0.001

Table 1. *Results based on pretreatments, GA and LDA performed on the spectra acquired from olive fruit. The selected features corresponded to the wavelengths yielding the lowest error rates of classification per each dataset.*

Trial	Dataset				Selected Features (nm)						Error rate (%)			AUC	Wilks' λ	Pr (> *F*)
#	Scatt. C.	Norm.	SG*	Deriv.	1	2	3	4	5	6	fp	fn	total			
01	MSC	Yes	13	-	1108	1232	1416	1486	2148	-	12.50	0.00	6.25	0.9766	0.3686	< 0.001
02	-	-	13	1st	1108	1168	1418	1466	1710	1984	6.25	12.50	9.38	0.9922	0.3758	< 0.001
03	-	Yes	13	1st	1138	1418	1464	-	-	-	12.50	18.75	15.63	0.9297	0.4588	< 0.001
04	SNV	-	9	1st	1168	1420	1602	1712	-	-	25.00	6.25	15.63	0.9531	0.4590	< 0.001
05	MSC	Yes	5	1st	1422	1712	-	-	-	-	31.25	12.50	21.88	0.8984	0.5874	< 0.001

Table 2. *Results based on pretreatments, GA and QDA performed on the spectra acquired from olive fruit. The selected features corresponded to the wavelengths yielding the lowest error rates of classification per each dataset.*

Objective:

The objective of this project is the development of a real-time, non-destructive sorting device that could detect and remove insect-damaged olives from the processing stream at a speed that would not hinder the normal processing of the fruit and a cost that could reasonably be absorbed by producers.

Plans and Procedures:

The approach to building a sorting device will be based on the design of commercially available NIR/vis modular sorters (Figure 1) which employ bandpass filters and splitting mirrors to isolate wavebands of interest for measurement with photodiode detectors. During the first year, the results presented in Tables 1 and 2 will be analyzed in terms of matching the most effective wavebands in terms of sorting accuracy with commercially available bandpass filters which generally have a width of about 40 nm, more or less. The availability and affordability of splitting mirrors at the required wavelengths will be determined. A "benchtop" scale prototype will be constructed and tested.

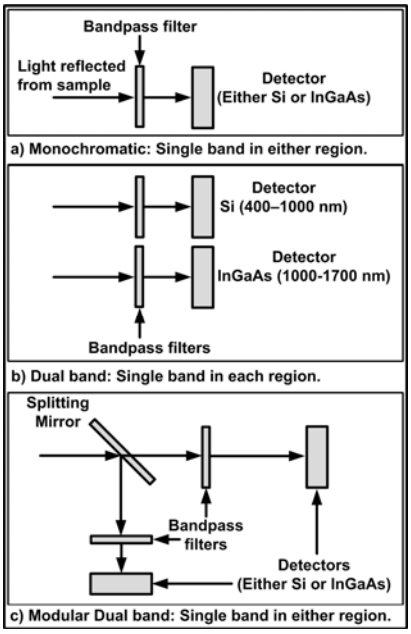


Figure 1. The design of the modular dual band sorter allows easy changing of the mirror, filters, and detectors and is therefore able to detect any bands between 400 nm and 1700 nm at either detector.

If the results of the first year indicate the building of a full scale sorter for commercial use is justified, a proposal will be submitted for the second year.

References

Haff, R.P. and Pearson, T.C. Spectral band selection for optical sorting of pistachio nut defects. *Transactions of the ASABE*. 49(4): 1105-1113. 2006.

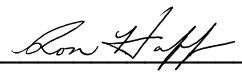
Haff, R.P. and Jackson, E.S. Low cost real-time sorting of in shell pistachio nuts from kernels. *Applied Engineering in Agriculture*. 24(4):487-490. 2008.

Moscetti, R., Haff, R.P., Stella, E., Contini, M., Monarca, D., Cecchini, M., and Massantini, R. Feasibility of NIR Spectroscopy to detect olive fruit infested by Bactrocera oleae. Postharvest Biology and Technology. 99: 58-62. 2015.

BUDGET REQUEST

Budget Year: 2016/17

Indirect Research Costs (IRC)	$3,500
Salaries and Benefits (Peishish Liang, Postdoc, 25%)	$25,000
Equipment	$4,000
Travel	$2,500
Total	$35,000



Originator's Signature

Date 9/23/2015

AES/CE MAR 84

Workgroup: Olive
Department: Plant Pathology/ UCR

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

Project Year: 2016

Anticipated Duration of Project: 3rd year of 3 years

Principal Investigators: J. E. Adaskaveg

Cooperating: D. Thompson, K. Nguyen, H. Förster, D. Lightle (UCCE - Butte Co.), and E. Fichtner (UCCE-Tulare Co.)

Project Title: Epidemiology and management of olive knot caused by *Pseudomonas savastanoi* pv. *savastanoi*

Keywords: Bactericides, biological controls, and systemic acquired resistance (SAR) compounds

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JUSTIFICATION/ BACKGROUND

Olive knot caused by the bacterium *Pseudomonas savastanoi* pv. *savastanoi* (Psv) occurs throughout olive (*Olea europaea*) growing regions of the world including California (Young, 2004). The pathogen enters through wounds causing hyperplastic outgrowths (knots, tumors, galls, etc.) on branches and occasionally on leaves and fruit. Olive knot is one of the most economically important diseases of olives as infection may lead to tree defoliation, dieback, and reduced tree vigor, which ultimately lowers fruit yield and quality (Schroth, 1973). Psv can be found as both an endophyte and epiphyte of the olive phyllosphere, but the main source of inoculum are Psv-induced olive knots. Inoculum production of the pathogen is promoted during wet periods. It is exuded from knots and disseminated by rain, wind, insects, birds, as well as human activity. We demonstrated that inoculum is produced very rapidly after wetting olive knots. The opportunistic pathogen takes advantage of wounds caused by natural leaf abscission, frost, and hail damage, as well as pruning and harvesting practices. These latter orchard practices lead to direct mechanical damage of the knots and exposure of inoculum. After entering its woody host, the pathogen actively induces knot formation by production of indoleacetic acid (IAA) and cytokinins. In California, infections occur mostly during the rainy season (late fall, winter, and spring) but knots do not develop until new growth starts in the spring. Infections can occur at fairly low temperatures (5-10° C) and thus, wetness is the main limiting factor for the disease. Historically, the most susceptible olive cultivars were Manzanillo, Sevillano, Ascolano, and Mission, and none of the newer cultivars is resistant to the pathogen.

Formation of olive knots on wounded, inoculated branches depends on inoculum concentration as well as cultivar. We are focusing our studies on cv. Manzanillo but will include cv. Arbequina in selected trials, both of which are highly susceptible to the disease. Knot induction is usually localized to the initial entry point of the bacterium. Systemic movement of the pathogen has rarely been observed (Wilson and Magie, 1964). In spring 2014 evaluations of our fall 2013 trials in commercial and experimental olive plots we noticed apparent systemic movement of Psv which we never observed in any of our previous trials. Infections caused bark blistering and cracking as well as development of knots in proximity to and away from the initial point of inoculation, even on neighboring branches. In more severe cases, inoculated branches died. Potential causes of systemic movement have not been well characterized. Thus, one of our objectives was to determine environmental or other factors leading to these symptoms and whether the pathogen is migrating internally or externally on the host. These studies were initiated in 2015.

In 2016, we plan to continue these low-temperature studies in addition to implementing chemical treatments during periods of frost to determine if treatments are able to control Psv movement and knot development under these conditions. After repeated applications, the antibiotic oxytetracycline has been reported to move systemically to young citrus tissue. This strategy may also provide improved control of

olive knot in these situations and therefore will be evaluated along with other treatments. Additionally, soil applications of kasugamycin will be evaluated to determine if systemic uptake can be achieved.

Sanitation and prevention are the most successful strategies for management of olive knot. Any horticultural practice that promotes tree health, minimizes tree stress, and results in less leaf drop will reduce infections. Removal of knots during dry periods (i.e., summer to early fall) reduces inoculum and re-infection at pruning sites. Because the bacteria may be carried on pruning shears, frequent disinfection of equipment is necessary. Painting galls with Gallex is an effective therapeutic treatment but is very labor intensive and impractical. Spray applications of copper-containing bactericides have been very effective in minimizing the disease, but they often may need to be repeated to protect new wounds. A minimum of two applications is usually necessary: one in the fall before the rainy season starts and one in the spring when most leaves have been shed. Additional applications may be needed during winter rains or spring/summer hail storms. New copper formulations have been developed to reduce the metallic copper equivalent while maintaining the efficacy of the treatment. Our evaluations of copper sensitivity in populations of the olive knot pathogen indicated a reduced sensitivity of all strains with several strains showing an increased tolerance to copper. These results demonstrate a potential risk towards resistance development of Psv to copper with its continual and often exclusive use. Although the combination of copper and mancozeb is highly toxic to strains of Psv that are less sensitive to copper, the EPA will not allow additional crops to be added to the mancozeb label. In 2015 trials, we tested several copper hydroxide formulations at the highest labeled rates which resulted in exceptional disease control. High rates of copper were effective even when challenged with a copper-tolerant Psv strain. In order to maintain copper efficacy and reduce resistance development, we are planning to evaluate high rates of copper in mixed treatments with antibiotics and other chemicals. Trials performed in 2015 with selected copper enhancing compounds did improve copper performance as compared to copper alone (using low rates of copper) and will be further evaluated. We will no longer pursue systemic acquired resistance (SAR) compounds for the control of olive knot as past trials have resulted in highly inconsistent disease control. Additionally, in more recent trials where we inoculated SAR-treated plants with reduced Psv concentrations showed very poor to no control when compared to copper treatments.

We have been instrumental in the development of the new agricultural antibiotic kasugamycin (commercial name Kasumin) for several bacterial diseases of agronomic crops in the United States. Kasugamycin has high activity against *Erwinia* and *Pseudomonas* species and moderate activity against *Xanthomonas* species and other plant pathogenic bacteria. We found it to be the most promising new treatment for preventing olive knot in our field studies, including in a commercial application to inoculated branches. We plan to continue its evaluation, especially in mixtures with copper. Kasugamycin is currently federally registered on pome fruit crops (e.g., apples and pears), whereas use on olives was approved as an "A" priority by IR-4 in Sept. 2014. In Sept. 2015, we proposed and IR-4 accepted an "A" priority for oxytetracycline based on the need to develop several active ingredient that along with copper can used in rotation or in mixtures. These antibiotics proposed uses were considered low risk because they were requested as after harvest, dormant and leaf drop treatments prior to the development of the crop in the current season. Thus, we will continue to evaluate kasugamycin, oxytetracycline, and other antibiotics as well as adjuvants that may optimize performance. Having several years of data will provide the best use strategies for growers.

In our research on sanitation treatments as part of an integrated olive knot management program, we demonstrated that quaternary ammonia compounds, guanidine, and chlorhexidine were highly toxic against the olive knot pathogen in laboratory studies. The quaternary ammonia sanitizers are volatile compounds that leave near zero residues and are not corrosive to equipment. We extensively tested Deccosan 321 (Maquat) for its effectiveness against Psv and obtained federal registration of it as a sanitizer of field equipment for use on olives in 2015. We initiated several small field trials in the spring of 2015 and plan to continue these trials in 2016.

RESEARCH OBJECTIVES

1) **Continuation of quaternary ammonium compound (QAC) trials.**
   a. Evaluate the performance of the quaternary ammonium compound Deccosan 321 as an equipment sanitizer under field conditions in comparison to chlorine by itself and in conjunction with additional foliar treatments (copper and kasugamycin).

b. Test the effect of pH on Deccosan 321 activity against Psv in direct contact assays.

2) **Efficacy of new bactericides.**
   a. Optimize the efficacy of antibiotic treatments (kasugamycin, oxytetracycline, streptomycin) against Psv in greenhouse and field trials using various formulations (technical and commercial grades), application timings, and additives (UV blockers, buffering agents, etc.)
   b. Develop copper activity-enhancing (CAE) materials such as Terrazole, Tanos, and amino-thiadiazole (ATD) when using maximum rates of copper.
   c. Field trials on the persistence of copper-antibiotic mixtures after a rain event using stickers and oils vs. hydrated lime.
   d. Field trials using high rates of copper mixed with antibiotics in tank mixtures as a resistance management strategy using copper-resistant strains of Psv.
3) **Epidemiology and management under different environmental conditions with copper-resistant strains of the pathogen.**
   a. Continue to conduct growth chamber studies to reproduce systemic infections of Psv.
   b. Determine if protective treatments can reduce infection of olives under low-temperature conditions using different rates and application timings
   c. Greenhouse studies on soil drench application of antibiotics (e.g., Kasumin) against olive knot systemic infections using potted olive plants.

PLANS AND PROCEDURES

1) Continuation of quaternary ammonium compound (QAC) trials.

a. We initiated several small field trials with Deccosan 321 in 2015 and are planning to expand these trials in 2016. Trials will be performed in olive orchards at UC Riverside (cv. Arbequina), UC Davis (cvs. Arbequina and Manzanillo), and at a commercial orchard in Yuba county (cv. Arbequina). Trials will involve the contamination of field pruning equipment with a suspension of Psv, sanitation with Deccosan 321, and then making pruning cuts and injuries to disease-free olive branches and twigs. Specifically, a handheld gas-powered hedger will be used to simulate larger commercial pruning equipment. The hedger pruning teeth will be contaminated by spraying with a suspension of Psv, sanitized using Deccosan 321 at labeled rates and exposure durations, and the hedger will then be used to make pruning wounds that will include lateral cuts along larger limbs (i. e., scraping against branches) and terminal stub cuts of smaller branches. Pruning of olive branches with a disinfected hedger will be used as a negative control, and pruning with a contaminated non-sanitized hedger as a positive control. Wounds created by a Psv-contaminated and QAC-sanitized hedger will also be spray-treated with copper hydroxide or a copper hydroxide-kasugamycin mixture in additional treatments. The experiment will be laid out using a randomized complete block design.

b. Deccosan 321 efficacy under different pH conditions will be investigated using an in vitro direct contact assay. For this, a biological buffer solution will be chosen that can accommodate a pH range of 5 to 9. Psv will be mixed with a fixed concentration of Deccosan 321 prepared in buffer at pH 5, 6, 7, 8, or 9. After selected time periods, suspensions will be diluted 1000-fold with sterile water, and then spiral-plated onto culture media for enumeration of viable bacteria to determine Deccosan 321 efficacy. For controls, Psv suspensions at the various pH values will be diluted and plated without exposure to Deccosan 321. This information will be useful to find out of efficacy of Deccosan 321 can be improved by changing the acidity of the solution.

2) Efficacy of new bactericides.

a. Optimize the efficacy of antibiotic treatments (kasugamycin, oxytetracycline, streptomycin) against Psv in greenhouse and field trials using various formulations (technical and commercial grades), application timings, and additives (UV blockers, buffering agents, etc.). We will be exploring strategies that can potentially optimize the effectiveness of the antibiotics kasugamycin, oxytetracycline, and streptomycin. In greenhouse trials, we will compare technical and commercial formulations of the antibiotics using cvs. Manzanillo and Arbequina. In the field, application timings will be adjusted so that the antibiotics are applied during the period in the day when there is reduced sunlight to protect treatments from heat and UV degradation (our past treatments have typically been applied midday with intense sunlight). Addition of

adjuvants such as UV blockers and buffering agents to antibiotics will also be evaluated for improved disease control.

b. We will continue to evaluate copper-activity enhancing materials in field trials as a strategy to reduce copper resistance development. Previous trials have resulted in improved control when mixing these compounds with copper, especially against a copper-tolerant strain. Modifying rates of copper or CAE compounds in combination may increase control.

c. Persistence of copper-antibiotic mixed treatment after a period of simulated rain using overhead irrigation. Plants will be wounded and treated followed by a period of rain before wounds are Psv inoculated. We will evaluate selected agricultural stickers and oils compared to hydrated lime mixed with antibiotics and copper.

d. Field trials using high rates of copper formulations (7 lbs/acre) mixed with streptomycin (Firewall), oxytetracycline (Fireline), and kasugamycin (Kasumin).

For the above trials, we will design the trials with 4 or more replications of each treatment and evaluate the data using analysis of variance and mean separation procedures using SAS version 9.4.

3) Efficacy of bactericides under different environmental conditions.

a. Continue to conduct growth chamber studies to reproduce systemic infections of Psv. Plants will be subjected to low temperatures (-5°C) for selected periods of time (4 to 12 h) after wounding and inoculation. Plants will then be transferred to the greenhouse and observed for disease development. Scanning electron microscopy (SEM) of frost-damaged olive twig sections will be performed to visualize bark injuries.
To track the movement of Psv and to determine if migration is systemically inside plant tissues or epiphytically, we will use selective re-isolation techniques and electron microscopy. Secondary wounds will be made at different distances from the initial inoculated wound. Development of knots and re-isolation of Psv from these wounds and from inside tissues distal to the original inoculation site will suggest systemic movement. Tissue samples will be taken after different incubation periods at different distances from the initial wound and examined using SEM. Inoculations may also be done with a copper-resistant strain to allow for discrimination of the inoculated isolate from potentially naturally present Psv strains (the majority of field strains are copper-sensitive).

b. Determine if protective treatments can reduce infection of olives under low-temperature conditions using different rates and application timings. Greenhouse grown cv. Manzanillo olives will be subjected to low temperature conditions (-5°C) in growth chambers. We will focus on several combinations of conditions to evaluate the best time to apply treatments (high copper rates and antibiotics) when freezing events are predicted to occur which will include:

1. Wounding healthy olive twigs and treating wounds with select compounds. Inoculating wounds with a Psv suspension. Placing trees in growth chambers for a duration of 12 hours at -5°C. Removing trees to greenhouse for growth until evaluations are made.
2. Wounding healthy olive twigs and treating wounds with select compounds. Placing trees in growth chambers for a duration of 12 hours at -5°C. Removing trees and inoculating wounds before moving trees to greenhouse until evaluations.
3. Wounding healthy olive twigs and placing plants in growth chamber. Removing plants, treating with compounds and inoculating with a Psv suspension before placing trees in greenhouse until evaluations.

c. Greenhouse trials using antibiotics applied as a soil drench will be conducted on potted olive plants. Different rates, application intervals, and number of applications will be evaluated to determine greatest disease control. Plants will be wounded and inoculated in between applications intervals or after the final application is made.

For the above trials, we will design the trials with 4 replications of each treatment and evaluate the data using analysis of variance and mean separation procedures using SAS version 9.4.

References

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Budget Request:

Budget Year: 2016 Funding Source: Olive Board of California

Salaries and Benefits:	Post-Docs/RAs		22,000
	Lab/Field Ass't		2,000
	Subtotal		24,000
	Employee's Benefits*		14,000
		Subtotal	38,000
Supplies and Expenses			0
Equipment and University Land and Orchard charges			1,000
Operating Expenses/Equipment Travel (Davis Campus only)			0
Travel			3,000
Department Account No. _____		**Total**	**$42,000**

*-Note: Benefits for UCR employees have increased dramatically over last years.

J.E. Adaskaveg Date: Sept. 30, 2015

Originator's Signature (PI)

Katherine Borkovich

Dept. Chair _____ Date: Oct. 2, 2015
(Riverside Campus)

Liaison Officer _____ Date: _____

University of California
Division of Agricultural Sciences

PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year: 2016 Anticipated Duration of Project: one year

Project Leader: C. H. Pickett Location: UC Berkeley quarantine
Mailing Address: CDFA, 3288 Meadowview Rd., Sacramento, CA 95832
Phone: 916.262-2053 FAX:916.262-2059 E-mail:cpickett@cdfa.ca.gov

Project Title: Renewal: Biological Control of Olive Psyllid Parasitoid, *Psyllaephagus euphyllurae* (Hymenoptera: Encyrtidae)

Cooperating Personnel: Dr. Kent Daane

Keywords: olive psyllid, biological control
Commodity(s): olive fruit Relevant AES/CE Project No.:

Problem and its Significance:

The olive psyllid, *Euphyllura olivina* (Hemiptera: Psyllidae), was first reported in California in 2007 infesting olive trees in San Diego and Orange counties. It has now spread to Riverside and Los Angeles counties and has been found on olive trees at one private residence in Monterey County. So although we don't know for certain that it will become a serious pest in commercial production regions of central and northern California, we do know that it is spreading. This pest naturally occurs throughout the Mediterranean Basin, both coastally and inland, and exclusively attacks the flower blossoms and growing tissue of olive (Tzanakakis 2006, unpubl. data). The olive psyllid is reproductively active during spring months when nymphal populations can cause significant reductions to the olive fruit set. Spring infestations have been reported reducing fruit yields by up to 60% in some parts of the Mediterranean (Jardak, T, 1984, Tzanakakis, M. E. 2006).

The principal parasitoid attacking this pest in the western Mediterranean Basin, *Psyllaephagus euphyllurae* (Garcia-Mercet 1921, Aversenq 2005) was initially discovered and collected from Spain as part of other foreign exploration activities. Through funding from the Olive Commission in 2011 and funding from the Federal Specialty Crops Block Grant Program, 2012-2015, we have made a great deal of progress in demonstrating, under quarantine conditions, the host specificity of this parasitoid: that it attacks only olive psyllid (Table 1). This information is required to obtain a field release permit in California. It also shows that *P. euphyllurae* is highly host specific, a trait shared with other parasitoids released over past decades in California and that have successfully suppressed agricultural pests. However, it is possible we may be asked for additional testing, delaying release for another season. Also our Block Grant ended in June 2015 and may not be renewed. If the Block grant is not funded, we will solicit the COC for another year of funding beyond 2015.

Table 1. Non-target psyllid species, selection criteria, and preliminary results in host specificity testing.

Psyllid species	Selection criteria	Non-target attacks
Asian citrus psyllid, *Diaphorina citri*	Relatedness	none
Ceanothia ceanothi	Natural habitat near olive production	none
Fremontia psyllid, *Dichlidophlebia fremontiae*	Relatedness, and habitat proximity	Not completed
Potato psyllid, *Bactericera cockerelli*	Native pest psyllid	none
French broom psyllid, *Arytinnis*	Beneficial insect attacking a	none

Our long term goal is to establish permanent populations of this parasitoid in southern California, before the olive psyllid spreads farther north into commercial production areas. By doing so, it may be possible to greatly delay, or even prevent its spread north and contain the population within southern California. Establishment of *P. euphyllurae* will also permanently reduce olive psyllid populations throughout its current and future distribution in California. Two hyperparasitoids (parasitoids that kill other parasitoids) have been found while collecting in Spain; these do not occur in California allowing the candidate parasitoid to exert far more impact on olive psyllid in its new home. A second parasitoid was discovered attacking olive psyllid in southeastern Spain during a recent collecting trip in support of the above project in a region that matches climatically with the central valley of California. Both *Psyllaephagus euphyllurae* and *Psyllaephagus pulchellus* co-occur in the more inland, and southern regions of Spain. With continued funding, we can insure permitting and release of the one parasitoid recently tested and most commonly associated with olive psyllid in Spain, *P. euphyllurae*.

Now is the time to be pro-active with this pest. Without an effective parasitoid in California, populations of olive psyllid will be more costly to control. We have in culture what is likely the most important natural enemy attacking the olive psyllid in the western Mediterranean Basin, the native home for both of these insects. We also have in place trained personnel who can rapidly complete studies and move on to field releases, hopefully before this pest establishes permanent populations in key olive growing regions.

Objectives:

1. Complete host specificity testing of *P. euphyllurae*, if required.
2. Release for permanent establishment *P. euphyllurae* into olive psyllid infested trees.

Plans and Procedures:

The goal of host range testing is to show that the candidate parasitoid for introduction attacks only the target pest insect, e.g. the olive psyllid, or has only a very narrow range of species that it can develop on. At this time, testing has been done on four species of psyllids. These represent native and non-native species, of which one is being considered for release as a biocontrol agent for an invasive weed. However, additional replication is needed for some species, and we hope to complete testing on a fifth non-target psyllid.

Non-Target Psyllids for host testing. Several native and exotic psyllids are in culture at quarantine laboratories located at UC Riverside, UC Berkeley, and CDFA in Sacramento, and USDA ARS in Albany. These psyllids were selected and tested for several reasons, including relatedness to the olive psyllid, occurrence in habitat similar to and near where commercial olives are grown, and their availability. California has a rich diversity of native psyllids associated with its native vegetation (Percey et al. 2011). However, only a small subset can be chosen for testing since there are over 165 representative species. We have also tested against the Asian citrus psyllid, which is related to the

olive psyllid. If *P. euphyllurae* is unable to attack and develop on a related psyllid, then it is unlikely to develop on the native, more distantly related psyllids. Several native psyllids are associated with native plants common to foothill regions of southern and central California, i.e. *Ceanothus* spp., *Fremontodendron californicum*, and *Rhus ovata* (Table 1). Associated psyllids are *Ceanothia* sp., *Diclidophlebia fremontiae,* and *Calophya triozomima*. The biological control agent, *Arytinnis hakani*, imported for control of French broom *Cytisus scoparius*, has also undergone testing.

Host plants. Insects will be reared on respective host plants (Table 2). Psyllids require new plant growth for feeding and reproduction, therefore plants will routinely be clipped to maintain a constant supply of new flush growth. Most of these psyllids are host specific and require rearing on a single species of plant. Host plants will be purchased from nearby nurseries. Plants lacking availability will be grown from cuttings at the CDFA in Sacramento, California.

Table 2. List of host plants and non-target psyllids.

Psyllid species	Host plant	Botanical name
Asian citrus psyllid, *Diaphorina citri*	Citrus	*Citrus spp.*
Ceanothia ceanothi	Ceanothus	*Ceanothus integerrimus*
Fremontia psyllid, *Dichlidophlebia fremontiae*	Flannel bush	*Fremontodendron californicum*
Potato psyllid, *Bactericera cockerelli*	Egg plant	*Solanum melongena*
French broom psyllid, *Arytinnis hakani*	French broom	*Genista monospessulana*

Rearing olive psyllid, its parasitoid, and non-target psyllids. The olive psyllid, olive tree saplings, and non-target host plants are currently in culture at CDFA's quarantine and greenhouse in Sacramento. Psyllids and plants are periodically shipped or hand-carried to Riverside for host specificity testing on an as-needed basis. Additional olive psyllids are collected in the field in southern California as well. Prior to testing, saplings are transferred to Ray Leach 'Cone-tainers' which have done well in host range tests for the Asian citrus psyllid parasitoid, *Tamarixia radiata* (Hoddle and Pandey 2014). Host plants will be placed in Bugdorms (Megaview Science, Taiwan) and maintained in a laboratory until needed for testing in Quarantine.

Host Testing.

The remaining choice and no-choice tests will be conducted in a laboratory inside of the UC Berkeley Quarantine facility using sequential no-choice, and choice exposure testing procedures. Rooted seedlings with 10 to 20 nymph test insects will be caged with the candidate parasitoid, *P. euphyllurae* alone or together with the olive psyllid, also placed on rooted seedlings. The three experimental treatments will be as follows:

Sequential no-choice tests: *P. euphyllura* is exposed to olive psyllid first, then to a non-target psyllid; or *P. euphyllura* is explosed to the non-target then to olive psyllid. Exposure times will be ca. 4 hrs, and temperatures will be set at 25 to 27 °C, with a 40% RH and 14:10 L:D photophase, following Hoddle and Pandey (2014).

Choice tests: *P. euphyllura* is exposed to olive psyllid and a second non-target host simultaneously, with each foraging on respective host plants, for 4 hrs. under the same environmental conditions as above.

Data will be recorded on the number of psyllids successfully developing to adults, psyllid nymph mortality, and number of parasitoids emerging from host psyllids. Observations will also be recorded once each hour, on the number of attempts at parasitism, and number of contacts between hosts and parasitoids.

Releases.

Once a field release permit is obtained, parasitoids will be released during spring months onto trees infested with olive psyllid in southern California. Past surveys of infested trees in southern California have found no native parasitoids or predators feeding on these psyllids. Release trees will be monitored for establishment and impact of released parasitoids for as long as funding is available. Travel to Spain to field collect additional parasitoids may be required if we are unable to mass rear adequate numbers. This trip would be made during May when olive psyllids are at their highest numbers both in Spain and southern California. Collections would be made at locations known to harbor high numbers of parasitoids.

References

Aversenq, S., C. Gratraud, and C. Pinatel. 2005. Ravageurs et auxiliaires des oliviers, synthèse de trois ans d'observations dans le Sud-Est de la France. Phytoma 586: 32-36.

Garcia-Mercet, R. 1921. Fauna Iberica. Himenópteros: Fam. Encirtidos. Junta para la ampliación de estudios e investigaciones cientificas. Instituto Nacional de Ciencias. Madrid, Spain.

Hoddle, M. S. and R. Pandey. 2014. Host range testing of *Tamarixia radiata* (Hymenoptera: Eulophidae) sourced from the Punjab of Pakistan for classical biological control of *Diaphorina citri* (Hemiptera: Liviidae: Euphyllurinae: Diaphorini) in California. Journal Economic Entomology 107: 125-136.

Jardak, T., H. Smiri, M. Moalla, and H. Khalfallah. 1984. Tests to assess the damage caused by the olive psyllid *Euphyllura olivina* Costa (Homoptera, Psyllidae): preliminary data on the harmfulness threshold. *In* R. Cavallora A. Crovetti (eds.) Integrated Pest Control in Olive –Groves. Proceedings of the CEC /FAO/IOBC International Joint Meeting/Pisa/3-6 April 1984. Published for the Commission of the European Communities by A. A. Balkema/Rotterdam/Boston/1985.

Percy, D. M., A. Rung, and M.S. Hoddle. 2012. An annotated checklist of the psyllids of California (Hemiptera: Psylloidea). Zootaxa 3193: 1-27.

Tzanakakis, M. E. 2006. Insects and Mites Feeding on Olive, Distribution, Importance, Habits, Seasonal Development and Dormancy. Koninklijke Brill NV, Leiden, The Netherlands. 182 pp.

BUDGET REQUEST

Budget Year: 2016

Funding Source:

Salaries and Benefits:		_____
Postdocs/RA's		_____
SRA's		
Lab/Field Assistance (9 months @$2400/mo., 75%)		$16,200
Subtotal	Sub2	$16,200
Employee benefits @40%)	Sub6	$6,480
	TOTAL	**$22,680**
Supplies and Expenses	Sub3	0
Equipment	Sub4	0
Travel		
In state, releases and monitoring		$2,000
Overseas, collecting		$7,000
	Sub5	**$9,000**
Grand Total		**$31,680**

Department account number:

_____ Date_____

Originator's Signature

Olive Workgroup / Department of Botany and Plant Sciences, UCR

University of California
Division of Agricultural Sciences

PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year: 2016

Anticipated Duration of Project: New 2-year proposal to determine the efficacy of the PGR and pruning treatments to manage alternate bearing; this requires yield data for 2 consecutive years.

Project Leaders: Carol Lovatt and Elizabeth Fichtner

Project Leaders' Contact Information:
CL-Professor of Plant Physiology, Botany and Plant Sciences-072, UC-Riverside, CA 92521-0124 Phone: 951-827-4663; Fax: 951-827-4437; Email: carol.lovatt@ucr.edu

EF-Farm Advisor, Orchard Systems, Cooperative Extension, 4437 S. Laspina St., Tulare, CA 93274, Phone: 559-684-3310; Fax: 559-685-3319; Email: ejfichtner@ucdavis.edu

Location: Lindcove Research and Education Center, Exeter

Project Title: Managing Alternate Bearing in Olive with PGRs and Pruning

Cooperating Personnel:
Lindcove Research and Education Center, Exeter

Keywords: Alternate bearing, ON-crop trees/year, OFF-crop trees/year, vegetative shoot growth, spring bud break, bud abscission, inhibition of floral development, plant growth regulators, flower and fruit thinning/removal

Commodity(s): Table Olive **Relevant AES/CE Project No.:** 4556H

Problem and its Significance: Alternate bearing (AB), production of a heavy "on-crop" (high yield, ON trees) followed by a light "off-crop" (low yield, OFF trees), occurs in perennial fruit and nut crops and in forest species (where it is called "masting"). AB is a serious problem of significant economic consequence to table olive growers, and probably oil olive growers (Sibbett 2000). Industry-wide, yield can vary from 46,300 tons one year to 195,000 tons the next (USDA NASS 2011 CA Olive Probability Survey Report). In ON years, trees produce a large number of small size fruit with reduced commercial value. In OFF years, trees produce large fruit but too few to provide a good income to the grower. For olive, the ON-crop takes longer to mature, attain size and accumulate oil. The delayed harvest further exacerbates AB.

In tree crops and forest species, there are four known mechanisms by which the ON-crop of fruit reduces floral intensity and yield in the year following the ON-crop. Unfortunately, for California olive growers, all four mechanisms are operating in the 'Manzanillo' olive. Our results provided clear evidence that the ON-crop of fruit (i) reduces summer vegetative shoot growth, starting in July and thus, the number of node pairs that can bear inflorescences the next spring (olive has the potential to produce 2-4 inflorescences per node pair), (ii) causes the abscission of floral buds, with greatest period of floral bud abscission between September and October [consistent with the report of Dag et al., (2010) that olive fruit must be removed before

September to increase return bloom], (iii) inhibits the expression of a key gene required for normal floral development, and (iv) inhibits spring bud break.

There is a recurring need to mitigate the problem of alternate bearing. Alternate bearing is initiated by external factors (freeze; lack of chilling; low or high temperatures at bloom affecting not only the crop trees, but also the pollenizer trees) that cause poor flowering or pollination or excessive flower and fruit drop, resulting in an OFF-crop that is typically followed by an ON-crop, depending on how long it takes the trees to recover from the stress causing the loss of yield. Conversely, optimal conditions during bloom and fruit set such that normal crop thinning fails to take place result in an ON-crop, which is followed by an OFF-crop. Since climate is a factor initiating AB, the need for a corrective strategy reoccurs. The best solution is a flexible management strategy that is easily adapted to ON- or OFF-crop trees and utilized annually.

Results of our attempt to mitigate alternate bearing in 'Manzanillo' olive with foliar-applied PGRs. The best PGRs identified in our branch injection research for increasing summer vegetative shoot growth and spring bud break of ON-crop 'Manzanillo' olive trees and the PGR + urea treatment successful in preventing floral bud abscission in pistachio (the only other crop in which the abscission of floral buds during the ON-crop year is known to perpetuate alternate bearing) were applied to ON-crop trees to test their capacity to increase yield the following year. The experiment included 15 individual tree replications per treatment: (1) ON-crop control trees; (2) ON-crop trees receiving foliar-applied 6-BA + low-biuret urea in June and July and 6-BA only the following spring; (3) ON-crop trees receiving foliar-applied cytokinin X (a proprietary natural product) + low-buiret urea in June and July and cytokinin X only the following spring; (4) OFF-crop trees receiving foliar-applied cytokinin X in June and July; and (5) OFF-crop control trees. The PGRs were applied at 0.9 g/tree and low-biuret urea at 0.18 kg N per tree with a 400-psi handgun sprayer at 4 gallons per tree for good coverage. No applications were made after the spring applications for Year 2.

For Year 1, ON-crop trees treated with 6-BA plus low-biuret urea in June and July produced significantly more fruit per tree than trees in any other treatment, resulting in a net increase in yield of 15 kg/tree compared to the ON-crop control trees and 126 kg/tree compared to the OFF-crop control trees ($P < 0.0001$) (Table 1). The June and/or July application times clearly increased fruit set. Increasing yield with 6-BA and urea in the ON-crop year followed with a spring application of 6-BA resulted in trees that were not "more OFF" the following year; all Year 1 ON-crop trees had the same OFF-crop yields in Year 2 (Table 2). Thus, trees receiving foliar-applied 6-BA and urea in the ON-crop year and 6-BA in the spring had better 2-year average yields and 2-year cumulative yields, but not significantly better than most other treatments ($P = 0.1045$) (Table 3). Year 1 treatments applied to ON-crop trees had no effect on Year 2 yield (Table 2), which indicates that applications of 6-BA or cytokinin X in spring were without effect. (Note: the optimal application time is February, but due to adverse weather the applications could not be made until mid-March, which our prior data showed to be less effective).

Year 1 ON-crop trees produced more fruit of sizes tiny, small and medium than OFF-crop trees. OFF-crop trees produced more extra-large and jumbo size fruit (Table 1). OFF-crop trees treated with cytokinin X in June and July produced significantly more colossal-size fruit in the OFF-crop year compared to all ON-crop trees regardless of treatment ($P = 0.0614$). In Year 2, the OFF-crop trees (now ON-crop trees) produced more fruit of sizes sub-petite, petite, small, medium and large than the now OFF-crop trees (Table 2). In Year 2, all trees produced the same amount of extra-large fruit; Year 1 ON-crop trees treated with cytokinin X in March following the ON-crop year produced more jumbo size fruit than trees in all other treatments in Year 2, except Year 1 ON-crop trees treated with 6-BA in March following the ON-crop year; 6-BA

treated trees produced more jumbo size fruit than the Year 1 OFF-crop trees (now ON-crop trees).

Whereas the PGR treatments had some positive effects on fruit size, we failed to reduce the severity of alternate bearing and increase yield in the year following the ON-crop. This may be due to the fact that the treatments were applied before we discovered that the major period of floral bud abscission on bearing shoots of ON-crop 'Manzanillo' olive trees is from September to October. We applied the treatment to reduce olive floral bud abscission in June and July, which was likely too early to be effective.

Proposed management strategy. Given the fact that the ON-crop causes 70% to 76% of buds on bearing shoots to abscise and for those buds remaining inhibits floral development and since all four mechanisms operating during the ON-crop year in olive have a less severe effect on flowering and yield for nonbearing shoots compared to bearing shoots, it is clear that it is essential to increase the number of nonbearing shoots during the ON-crop year to successfully mitigate alternate bearing. An increase in the number of nonbearing shoots would also reduce the negative whole tree (crop load) effect on return bloom and our data show that nonbearing shoots respond better to PGRs, which would further increase return bloom and yield the year following the ON-crop. Thus, it is also important to use PGRs in the spring prior to the OFF-crop year to increase bud break and also during bloom to increase fruit set.

Inflorescence pruning or chemical inflorescence thinning during the ON-bloom would provide an effective cultural practice to help evening out the yield of ON/OFF cycles in alternate bearing 'Manzanillo' olive orchards. Most growers understandably are reluctant to thin in the ON-crop year prior to fruit set, but because inflorescences are easy to see, the degree of thinning can be adjusted to accommodate differences in bloom intensity and potential set from year to year and among trees within an orchard in a single year. Fruit removal by pruning, hand thinning or chemical thinning must be done before mid-July to reduce the inhibition of summer shoot extension growth and increase return bloom. It is difficult to see differences in set at this time. It should also be noted that the negative effects of the ON-crop of fruit are cumulative – the longer the ON-crop of developing fruit is on the tree, the more severe the impact on return bloom and yield. Thus, the goal of thinning reproductive structures in olive should be to increase the number of nonbearing shoots on ON-crop trees. Mechanical pruning does not lend itself well to creating nonbearing shoots, it tends to simply shift crop from one area of the tree to another in any given year. A chemical thinner (e.g., NAA or S-abscisic acid, which is less sensitive to temperature fluctuations than NAA) can be applied to reduce the number of fruit per shoot and the number of shoots with no fruit more uniformly around the tree.

Proposal goal, objective and research plan. Using our discovery that all four known mechanisms perpetuating alternate bearing in trees function in olive, as well as what we have learned about the timing and efficacy of PGR treatments that we have tested as branch injections and whole tree sprays, the goal of our proposal is to develop a flexible management practice that can be adapted to ON- and OFF-bloom trees to even out alternate bearing in 'Manzanillo' olive orchards, so that growers do not experience the dismally low yields an OFF-crop year. Using 'Manzanillo' olive trees, which have been subjected to light hand-pruning to maintain space and sunlight within rows and between rows, our objective is to test the following treatments: (1) untreated ON-crop (ON bloom) control trees; (2) ON-crop (ON bloom) trees sprayed with the growth inhibitor S-abscisic acid (S-ABA) (500 mg/L) at bloom to reduce fruit set, the treatment is applied as a 2-ft wide strip as the sprayer drives down the row on both sides of the tree to achieve a 30% to 40% reduction in yield; (3) ON-crop (ON bloom) trees sprayed with the growth inhibitor S-abscisic acid (S-ABA) (1000 mg/L) at bloom to reduce fruit set, the treatment is applied as a 2-ft wide strip as the sprayer drives down the row on both sides of the tree to achieve a 30% to 40% reduction in yield; (4) ON-crop (ON bloom) trees sprayed with the growth inhibitor S-abscisic acid

(S-ABA) (500 mg/L) at bloom to reduce fruit set, the treatment is applied as a 2-ft wide strip as the sprayer drives down the row on both sides of the tree to achieve a 30% to 40% reduction in yield, trees are also sprayed with 6-BA in mid-July to increase summer vegetative shoot growth, at the beginning of September to increase floral bud retention, and the following February to increase spring bud break; (5) OFF-crop (OFF bloom) control trees; and (6) OFF-crop (OFF bloom) trees sprayed with the ethylene biosynthesis inhibitor aminoethoxyvinylglycine (AVG) at 10% bloom to increase fruit set and yield in the OFF-crop year.

Selection of these PGRs was based on their known abilities: (i) 6-BA to increase summer vegetative shoot growth during the ON-crop year (results of our research with olive and avocado) and to increase spring bud break (results of our research with olive; also avocado); (ii) S-ABA to reduce flowering and fruit set, increase fruit size during the ON-crop year and increase yield the following year (avocado); and (iii) AVG to increase fruit set (walnut and cherry). The PGRs proposed for use, 6-BA as MaxCel, S-ABA as ProTone and AVG as ReTain are all products of Valent BioSciences$_{TM}$, which will contribute financially to the research.

Literature Cited:

Dag, A., A Bustan, A. Avni, I. Tzipori, S. Lavee and J. Riov. 2010. Timing of fruit removal affects concurrent vegetative growth and subsequent return bloom and yield of olive (*Olea europaea* L.). Scientia Hort. 123:469-472.

Sibbett, S. 2000. Alternate bearing in olive trees. California Olive Oil News. Vol. 3, Issue 12.

BUDGET REQUEST – Lovatt and Fichtner
Budget Year: 1 January 2016 – 31 December 2016

Funding Source: California Olive Committee

Salaries and Benefits:		
Postdocs/RA's		
Toan Khuong- Assistant Specialist @ $ 4,362/mo. variable time equivalent to 25% x 1 mo. (Under my supervision, assists in laying out the experiment in the orchard, making maps, treatment applications, harvest, fruit size determination, data management, data sheets, data entry, and statistical analyses of the data.)		1,091
SRA's and Lab/Field Assistance		
Lab Assistant I @ $ 15.07/hr x 100 hours. (To assist with laying out the experiments in the orchards, treatment applications, harvest, fruit size determination.)	1,507	
Subtotal	Sub2	2,598
Employee benefits:		
TK = $1,091x 76.11%	830	
TBA Lab Asst I = $1,507 x 2.76%	42	
	Sub6	872
	TOTAL	3,470
Supplies and Expenses	Sub3	5,638

Recharge to the Lindcove REC: use of olive grove, water, fertilizer,
Weeding, pest management, pruning, and harvest = $5,638

Equipment Sub4 0

Travel Sub5 2,937

5 roundtrips to Exeter
(520 mi x 5 = 2,600 mi x $0.6014 = $1,564;
UCR vehicle rental 10 days x $47.268/day = $473
$90/day per diem (Lindcove Trailer plus meals) x 2 people x 5 trips (1.5 days each) = $900

SUBCONTRACT

Sub7 4,000

Elizabeth Fichtner, Farm Advisor, Orchard Systems, Cooperative Extension,
4437 S. Laspina St., Tulare, CA 93274

Department account number: AO1082 TOTAL 16,045

Originator's Signature Carry Roatt Date 10/19/2015

COOPERATIVE EXTENSION

County Director: Allison Ferry Alvee (acting CD) Date 10/20/2015

Program Director: _____ Date _____

AGRICULTURAL EXPERIMENT STATION

Department Chair: Michael L. Roose Date 10/20/2015

UC COC LIAISON OFFICER: _____ Date _____

BUDGET SUBCONTRACT

Budget Year: 1 January 2016 – 31 December 2016

Elizabeth Fichtner
Farm Advisor, Orchard Systems, Cooperative Extension,
4437 S. Laspina St., Tulare, CA 93274

Funding Source:

Salaries and Benefits:

Postdocs/RA's/SRA's and Lab/Field Assistance

215 hours of labor for Student Assistant II/Lab Assistant I ____ 3,203

Subtotal Sub2

Employee benefits: Sub6 ____ 0

TOTAL ____ 3203

Supplies and Expenses Sub3 ____ 0

Field supplies: bags, ribbons, cooler box

Equipment Sub4 ____ 0

Travel Sub5 ____ 400

SUBTOTAL ____ 3603

UC ANR Overhead @11% Sub6 ____ 396
$3603 x 11% =

SUBCONTRACT TOTAL ____ $4,000

Elizabeth Fichtner, Farm Advisor, Orchard Systems, Cooperative Extension,
4437 S. Laspina St., Tulare, CA 93274

Elizabeth J. Fichtner

Originator's Signature Date 10/20/2015

COOPERATIVE EXTENSION

County Director: Allison Fernyhough (acting CD) Date 10/20/2015

Program Director: _____ Date _____

AGRICULTURAL EXPERIMENT STATION

Department Chair: _____ Date _____

UC COC LIAISON OFFICER: Elizabeth J. Fichtner Date 10/20/2015

Table 1. Effect of a proprietary natural cytokinin (CKX) applied to OFF-crop trees and CKX and 6-benzyladenine (6-BA) plus low-biuret urea applied to ON-crop trees in June and July, with CKX and 6-BA also applied to the ON-crop trees the following spring on the Year 1 yield and fruit size distribution of 'Manzanillo' olive trees located at the Lindcove REC, Exeter, CA.

Year 1 tree status	Year 1 treatment	Total yield (kg/tree)	Fruit size distribution (pack out) based on fruit diameter in mm (No./100 fruit/tree)							
			Tiny (< 16)	Small (16 to < 17)	Medium (17 to < 19)	Large (19 to < 20)	X-large (20 to < 22)	Jumbo (22 to < 24)	Colossal (24 to < 26)	Super Colossal (> 26)
OFF	Control	44.4 c[z]	1.2 b	0.8 b	13.1 b	17.4 a	53.9 a	13.3 a	0.3 ab	0.0 a
OFF	CKX	48.5 c	0.9 b	1.2 b	10.7 b	15.5 ab	52.8 a	18.4 a	0.5 a	0.0 a
ON	Control	155.3 b	19.4 a	24.8 a	42.8 a	9.7 bc	3.2 b	0.1 b	0.0 b	0.0 a
ON	CKX+urea	157.9 b	25.7 a	23.6 a	37.6 a	9.6 bc	3.2 b	0.1 b	0.0 b	0.0 a
ON	6-BA+urea	170.4 a	27.6 a	26.8 a	39.5 a	4.6 c	1.4 b	0.0 b	0.1 b	0.0 a
P-value		< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0043	< 0.0001	< 0.0001	0.0614	--

[z] Values in a vertical column followed by different letters are significantly different at the *P*-value specified by Fisher's Protected LSD Test.

Table 2. Effect of the Year 1 applications of a proprietary natural cytokinin (CKX) applied to OFF-crop trees and CKX and 6-benzyladenine (6-BA) plus low-biuret urea applied to ON-crop trees in June and July, with CKX and 6-BA also applied to the ON-crop trees the following spring on the Year 2 yield and fruit size distribution of 'Manzanillo' olive trees located at the Lindcove REC, Exeter, CA.

Year 1 tree status	Year 1 treatment	Total yield (kg/tree)	Fruit size distribution on (pack out) based on fruit weight (g) (kg/tree)								
			Sub-petite (2.21-2.66)	Petite (2.67-3.08)	Small (3.09-3.58)	Medium (3.59-4.22)	Large (4.23-5.07)	X-large (5.08-7.27)	Jumbo (7.28-9.76)	Colossal (9.77-13.97)	Super Colossal ≥ 13.98
OFF	Control	149.4 a[z]	8.7 a	20.1 a	32.3 a	43.1 a	30.4 a	14.8 a	0.1 c	0.0 a	0.0 a
OFF	CKX	130.2 a	5.8 a	15.9 a	26.0 a	35.7 a	26.2 a	19.7 a	0.8 c	0.0 a	0.0 a
ON	Control	42.1 b	0.5 b	0.9 b	2.3 b	5.8 b	12.8 b	18.3 a	1.5 bc	0.0 a	0.0 a
ON	CKX+urea	47.9 b	0.2 b	0.3 b	1.8 b	6.1 b	10.7 b	25.0 a	3.7 a	0.0 a	0.0 a
ON	6-BA+urea	45.0 b	0.2 b	0.4 b	0.8 b	4.0 b	10.3 b	26.5 a	2.8 ab	0.0 a	0.0 a
P-value		< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	0.1794	0.0002	0.4160	--

[z] Values in a vertical column followed by different letters are significantly different at the *P*-value specified by Fisher's Protected LSD Test.

Table 3. Effect of the Year 1 applications of a proprietary natural cytokinin (CKX) applied to OFF-crop trees and CKX and 6-benzyladenine (6-BA) plus low-biuret urea applied to ON-crop trees in June and July, with CKX and 6-BA also applied to the ON-crop trees the following spring on the 2 year average yield and 2-year cumulative yield of 'Manzanillo' olive trees located at the Lindcove REC, Exeter, CA.

Year 1 tree status	Year 1 Treatment	2-year average (kg/tree)	2-year cumulative (kg/tree)
Off	Control	96.9 ab[z]	193.8 ab
Off	CKX[y]	89.3 b	178.7 b
On	Control	98.7 ab	197.4 ab
On	CKX + N	102.9 ab	205.8 ab
On	6-BA + N	107.8 a	215.7 a
Year			
1		115.3 a	--
2		83.0 b	--
P-value			
Treatment (T)		0.1045	0.1045
Year (Y)		<0.0001	--
T x Y		<0.0001	--

[z] Values in a vertical column followed by different letters are significantly different at the *P*-value specified by Fisher's Protected LSD Test.