A. Cover Page

1. Project Title.
University of California Nursery and Floriculture Alliance Fertilizers and Plant Nutrition Education Program

2. Project Leader(s).
Lorence R. Oki  
CE Associate Specialist and Co-Director UC Nursery and Floriculture Alliance (UCNFA)  
Department of Plant Sciences, MS6  
One Shields Avenue  
University of California  
Davis, CA 95616-8780  
(530) 754-4135  
lroki@ucdavis.edu

Dave Fujino  
Executive Director California Center for Urban Horticulture and Co-Director UCNFA  
College of Agriculture and Environmental Sciences  
One Shields Avenue  
University of California  
Davis, CA 95616-8780  
(530) 752-7739  
dwfujino@ucdavis.edu

Don Merhaut  
CE Specialist, Nursery and Floriculture Crops  
Botany & Plant Sciences  
4118 Batchelor Hall  
Riverside, CA 92521-0124  
(951) 827-7003  
donald.merhaut@ucr.edu

Maria de la Fuente  
County Director Monterey County and CE Advisor Monterey, San Benito and Santa Clara Counties  
1432 Abbott Street  
Salinas, CA 93901  
(831) 759-7358  
medelafuente@ucanr.edu

3. Cooperator(s).
Jim Bethke  
County Director San Diego County and Advisor San Diego County  
University of California Cooperative Extension San Diego County  
9335 Hazard Way, Suite 201  
San Diego, CA 92123  
(858) 822-7673  
jabethke@ucanr.edu

Jim Downer  
Environmental Horticulture Advisor Ventura County  
University of California Cooperative Extension  
669 County Square Dr., Suite 100  
Ventura, CA 93003  
(805) 645-1458  
ajdowner@ucanr.edu

Andre Biscaro  
Irrigation and Water Resources Advisor  
Ventura County  
University of California Cooperative Extension  
669 County Square Dr., Suite 100, Ventura, CA 93003  
(805) 645-1465  
asbiscaro@ucanr.edu

Richard Evans  
CE Environmental Horticulturist  
Department of Plant Sciences, Mail Stop 2  
One Shields Avenue  
Davis, CA 95616-8780  
(530) 752-6617  
ryevans@ucdavis.edu
Ben Faber
Soils, Water, and Subtropical Crops Advisor
Ventura County
University of California Cooperative Extension
669 County Square Dr., Suite 100
Ventura, CA 93003
(805) 645-1462
bafaber@ucanr.edu

Chuck Ingels
Pomology, Viticulture, and Environmental Horticulture Advisor
University of California Cooperative Extension Sacramento County
4145 Branch Center Road
Sacramento, CA 95827
(916) 875-6527
caingels@ucanr.edu

Jennifer Pelham
Environmental Horticulture Advisor
University of California Cooperative Extension San Diego and Orange Counties
9335 Hazard Way, Suite 201
San Diego, CA 92123
jlpelham@ucanr.edu

Karrie Reid
Environmental Horticulture Advisor
University of California Cooperative Extension San Joaquin County
2101 E. Earhart Ave, Ste 200
Stockton, CA
(209) 953-6109
skreid@ucanr.edu

Maggie Reiter
Environmental Horticulture Advisor
University of California Cooperative Extension Fresno, Tulare, Madera, and Kings Counties
550 E. Shaw Avenue, Suite 210-B
Fresno, CA 93710
(559)-241-7504
mkreiter@ucanr.edu

Steve Tjosvold
Environmental Horticulture Advisor Monterey and Santa Cruz Counties
University of California Cooperative Extension
1432 Abbott Street
Salinas, CA 93901
(831) 763-8013
satjosvold@ucanr.edu

4. Supporter(s).
California association of Nurseries and Garden Centers (CANGC)
Nursery Growers Association (NGA)
Belmont Nursery

5. CDFA Funding Request Amount/Other Funding.
$ 129,687.93

6. Agreement Manager.
UC Regents
Office of Research, Sponsored Programs
1850 Research Park Drive, Suite 300
Davis, CA 95618-6153
Phone (530) 754-7700
Fax (530) 754-8229
Email: awards@ucdavis.edu
B. Executive Summary

Problem statement
Fertilizers are an essential part of greenhouse and nursery plant production. Crops in these production systems are grown in substrates that are “synthetic” in that they contain very little or no natural mineral soils. Since there is little to no fertility provided by these substrates, all of the nutrition must be provided for healthy and productive growth.

Another challenge to greenhouse and nursery production in California is that the majority of these crops are grown in containers although there is some field production of specific nursery and floricultural crops. In either case, since these crops are grown in highly intensive systems, high plant densities and shortened crop times, there is also a high demand for resources including water, energy, labor, and nutrients.

Improper management of plant nutrition can affect crop health. Both under- and over-applying fertilizers can result in poor crop quality, which not only has negative economic impacts, but also can result in polluting surface and ground water.

Objectives, Approach, and Evaluation
The overall project objective is to provide greenhouse and nursery growers with knowledge to improve crop plant nutrition and fertilizer management. To achieve this, the project will develop an educational program for greenhouse and nursery growers on the proper and efficient use of fertilizers. The five objectives for this project are:

1. Improve the current workshop courses
   This will be done by first defining the learning objectives for the project. Then using evaluations from the current workshops, the project team will assess the program materials. From the assessment, the program will be improved. Teaching materials will be developed and translated into Spanish.

2. Information will be provided in a course of half day workshops with each workshop providing training on a specific topic that addresses the learning objectives determined by the project team. Nursery and greenhouse growers that attend all of the workshops will earn a certificate indicating that they have completed the workshop course. Six workshop courses will be provided in 2017 and 2018, with up to four of them in the first year. The 2017 workshops will be assessed and adjusted as necessary to meet the learning objectives. Workshops will also be conducted in Spanish.

3. Videos will be produced of the workshop program divided into shorter topics in both English and Spanish.

4. The videos will be posted online at the UCNFA website. Website activity will be monitored using Google Analytics. Final versions of the videos will be made available to CDFA FREP.

5. Workshop program impact will be assessed in two ways: Short term learning will be measured by conducting short quizzes to assess knowledge before and after each workshop. Workshop evaluations will also be used to determine attendee satisfaction. Longer term impact will be assessed using a survey after the workshops have been presented to determine actual and potential implementation of lessons learned.

   Success of the videos will be determined by the number of visits to the videos posted online. Additional information in “hits” may include time spent at each video including the number of complete views, most and least visited video, and other measures.
Audience
This program will be targeted to greenhouse and nursery growers. However, growers of field produced nursery and floriculture crops will also benefit from the information presented.
C. Justification
1. Problem.
According to the 2014-2015 Agriculture Statistics Review, the value for Nursery Products in 2014 was $3.22 billion and for Floral Products was $470 million for a combined total of $3.69 billion. This places the combined Nursery and Floral Crops as the number 5 agricultural crop commodity in the state below, in order with values provided in billions: Milk and Cream ($9.36), Almonds (shelled) ($5.89), Grapes ($5.24), and Cattle and Calves ($3.72). In addition, Nursery and Floricultural crops are in the top 10 agricultural commodities in 31 of California’s 58 counties that reported agricultural production in the survey. According to CDFA, there are 2,664 nurseries in the state licensed as “producers”, growers of nursery and floriculture products.

Fertilizers are an essential part of greenhouse and nursery plant production. Crops in these production systems are grown in substrates that are “synthetic” in that they contain very little or no natural mineral soils. Since there is little to no fertility provided by these substrates, all of the nutrition must be provided by fertilizers for healthy and productive growth.

Another challenge to greenhouse and nursery production in California is that the majority of these crops are grown in containers, although there is some field production of specific nursery and floricultural crops. In either case, since these crops are grown in highly intensive systems of high plant densities and compressed crop times, there is also a high demand for resources including water, energy, labor, and nutrients. The recommended fertilization rates of some floricultural crops can be very high compared to other agronomic crops. For example, a liquid feed program for poinsettia typically provides nitrogen at 250 ppm but can be as high as 400 ppm.

Improper management of plant nutrition can affect crop health and both under- and over-applying fertilizers can result in poor crop quality. Poor crop quality not only has negative economic impacts, but improperly managing plant nutrition can also result in wasted fertilizer products and the pollution of surface and ground water and other environmental impacts.

2. FREP Mission and Research Priorities.
This proposed project addresses the Education and Outreach (Technical Education) area of grower education and consists of evaluation and improvement of a current workshop program on Fertility and Plant Nutrition for greenhouse and nursery growers. The improved course of workshops will be delivered in up to four areas of the state in 2017 and 2018. Short specific topic videos will be produced and delivered on the UCNFA website.

3. Impact.
Improper management of plant nutrition can affect crop health and both under- and over-applying fertilizers can result in poor crop quality. Poor crop quality not only has negative economic impacts, but improperly managing plant nutrition can also result in wasted fertilizer products and the pollution of surface and ground water and other environmental impacts.

4. Long-Term Solutions.
Short term measures of impact will be from post-workshop evaluations and surveys of attendees. Questions may include increases in knowledge and awareness as well as intent to implement learning. Longer term measures of impact would include a follow up survey conducted at the end of the calendar year after the workshops have been provided. This survey would ask whether management practices have been implemented, are currently being implemented, have yet to be implemented, or won’t be implemented. We can look to other UC ANR surveys as examples that have been conducted for the similar purpose of measuring impact.
5. Related Research.
UCNFA had provided a workshop on this subject and was a half-day program. The UCNFA team that currently provides this training recently revised and expanded the workshop program, but has not yet provided a training using the new material.

UCNFA currently has workshops scheduled to present the revised version of this workshop (UCNFA.UCANR.edu) in 2016 consisting of a full day each in English and Spanish. Currently scheduled workshops are in Los Angeles (Carson, CA) on August 22 and 23 and in Ventura on September 28 and 29.

This project will support the continued development and improvement of these workshops. Up to five “sets” of workshops will be planned in 2017 and 2018 and may take place in the northern San Joaquin Valley, San Diego, Watsonville/Salinas, and LA/Ventura regions.

One topic that has been suggested to be added to these workshops is how to interpret soil and water analyses. This was done in a school IPM program funded by DPR on which PI L. Oki participated. In that program, attendees sent soil samples to the UC lab for analyses and the reports were reviewed by the instructors. The instructors then selected portions of various reports on interpreted the results for the attendees. This lesson took considerable effort, planning, and management to properly deliver the lesson to workshop attendees. We intend to assess, adapt, and adjust that method for the workshops and videos proposed in this project. Growers that have the ability to utilize these reports will be equipped to utilize these tools and improve management of plant nutrients.

We will also utilize this project to implement suggested changes and improvements we receive from attendees and instructors.

6. Contribution to Knowledge Base.
Since this is an outreach and education project, new knowledge will not be generated. However, information to improve nutrient management on nursery and greenhouse crops will be disseminated through workshops and videos. Growers that attend the workshops will receive information on monitoring plant nutrition and the proper management of fertilizers.

7. Grower Use.
There are two incentives for growers to adopt good nutrient management methods. The first is economic and the second is regulatory compliance. The economic incentive consists of two parts. The first is improvement in the level and consistency of crop quality. This should result in crop price stability, reduced crop loss, greater sell through, and greater revenues. The second may be reductions in fertilizer usage since there may be improvements in use efficiencies. Regulatory compliance may be achieved because of pollutant load reductions into surface and ground waters.

D. Objectives
1. Improve the workshop program that is currently delivered based on input from attendees and instructors. Topics may be reduced, expanded, and others added. Topics that may be added include training on how to read soil and water analyses and how to interpret the information for greenhouse and nursery crop fertility and irrigation management.
2. Deliver the improved workshops to nursery and greenhouse growers in the regions of the state where there are concentrations of growers such as San Diego, Ventura, San Joaquin Valley, and Watsonville/Salinas areas.
3. Utilize the delivery of the improved workshops to produce video on specific topics. Videos would topics specific and brief and recorded in both English and Spanish. The UC ANR videography group will be utilized for the production of the videos.
4. Post the videos online at the UC NFA website (UCNFA.UCANR.edu) for use and evaluation. Final versions of the videos will be made available to CDFA FREP.
5. Measure impact through surveys of workshop attendees to assess implementation of nutrient management methods.

E. Work Plans and Methods

   1. Improve program
      a. Define learning objectives
         The current program delivered will be shared among project participants to reexamine learning objectives. Learning objectives will be defined and organized into specific workshops.
      b. Program assessment
         The workshop program, in conjunction with evaluations from the 2016 presentations, will be reviewed to assist with an assessment of the program.
      c. Program adjustment and rebuilding
         Adjustments will be made accordingly for improvements and additional learning modules developed to meet learning objectives. Topics for each workshop will be determined and agendas developed.
      d. Teaching materials (powerpoint slides and handouts) will be translated into Spanish.
      e. Syllabi for each workshop will be written describing the content to be taught.
   2. Objective 2- Deliver program
      a. Workshops using the revised program will be organized and delivered in four regions based on grower density.
      b. Instructors among the project team will be identified for each workshop date and location.
      c. Up to four events will take place in 2017.
      d. After the first year (2017), workshops will be revisited and evaluated to determine success in meeting learning objectives.
      e. Adjustments will be made based on the assessment of the year 1 presentations
      f. Additional workshops, up to a total of six for both years, will be provided using the newly adjusted program.
   3. Objective 3- Produce videos
      a. Short videos on specific topics will be developed.
         i. The workshop syllabi and programs may be used to develop scripts for videography of the workshop content
         ii. Videos will be produced, taped, and edited to develop online training.
   4. Objective 4- Post videos
      a. Videos will be posted on the UCNFA website for use and evaluation
         i. Videos in their final edited form will be made available to CDFA FREP.
   5. Objective 5- Measure impacts
      a. Short term learning
         i. The workshops will include questionnaires at the beginning of the workshop and another at the conclusion to assess increases of attendee knowledge and awareness.
         ii. Attendees will also complete evaluations of the workshop to assess program effectiveness.
      b. Long term impacts
         i. Workshop attendees would be asked to participate in a survey after the first year that workshops have been conducted to assess longer term impacts.
ii. The follow-up survey will be developed by the project team and distributed by email. Information will be sought regarding the implementation of management methods presented in the workshops.

iii. All response results will be compiled, analyzed, and reported.

c. Impact of videos

i. Effectiveness of the online videos will be measured by tracking the number of views of the videos. Specific information will be gathered on the number of complete and incomplete views of each video, multiple views by a single user, identifying the videos with the most and least views, and other measures.
<table>
<thead>
<tr>
<th>Task</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Program improvement and delivery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review current program</td>
<td>Jan - May</td>
<td>Jan - May</td>
</tr>
<tr>
<td>Revise program</td>
<td>June</td>
<td>June - Nov</td>
</tr>
<tr>
<td>Deliver</td>
<td>Dec - Jan</td>
<td>Dec - Nov</td>
</tr>
<tr>
<td>Review evaluations and assess</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Videography</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine topics</td>
<td>Jan - June</td>
<td>June - Dec</td>
</tr>
<tr>
<td>Taping</td>
<td>July</td>
<td>July - Dec</td>
</tr>
<tr>
<td>Editing</td>
<td>Aug - Sep</td>
<td>Aug - Dec</td>
</tr>
<tr>
<td>Retaping</td>
<td>Oct</td>
<td>Oct - Nov</td>
</tr>
<tr>
<td>Postproduction</td>
<td>Nov - Dec</td>
<td>Nov - Dec</td>
</tr>
<tr>
<td><strong>Video Website Posting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Website monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Workshop impacts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop learning</td>
<td>Jan - May</td>
<td>Jan - May</td>
</tr>
<tr>
<td>Learning survey analyses</td>
<td>June</td>
<td>June - Nov</td>
</tr>
<tr>
<td>Impact survey</td>
<td>July</td>
<td>July - Dec</td>
</tr>
<tr>
<td>Data analyses</td>
<td>Aug - Sep</td>
<td>Aug - Dec</td>
</tr>
<tr>
<td><strong>Video impacts</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
See work plan above.
The description of the current workshop program offered by UCNFA follows:

Workshop description: These workshops will provide in-depth training on essential plant nutrients and the use of fertilizers for the floriculture and container nursery industries. Understanding when and how to use fertilizer will not only produce a healthier crop but also reduce cost of production and excess fertilizer and pesticides in runoff. Plant health is also a key component of an Integrated Pest Management Program and optimizes the efficacy of pesticides and reduces the damage caused by insects and diseases. Participants will be able to:

- Identify and understand the role of plant nutrients and their role in plant growth.
- Determine the appropriate fertilizer program for individual nurseries.
- Describe and identify fertilizer types and how to incorporate them into a fertilizer program.
- Customize fertilizer application programs to individual needs to optimize nutrient uptake and reduce damage from over or under fertilization.

Workshop title: Optimizing Plant Nutrition of Containerized Crops Through Fertilizer, Water and Media Management

The program is broken down into 4 areas.

1) Essential plant nutrients. (45 minutes)
   Macronutrient, Micronutrients and nonessential nutrients. We will provide a list of the nutrients, briefly state their role in plant growth and their mobility in the plant, and their role in plants. Understanding this area of plant physiology specific to plant nutrition will aid in diagnosing field problems and properly collecting tissue samples and keeping proper records.

2) Determining the fertilizer program for your nursery. (2 hours)
   This section of the program is broken down into three parts: water, media and crop. We will discuss what parameters are crucial and not crucial to plant nutrition in container production. We will also demonstrate how to measure and correct some of these parameters.

   a) Irrigation water quality and nutrients derived from water. We will describe pH, alkalinity, EC, bicarbonates, and other aspects of water that impact fertility status. Some portable equipment will be demonstrated to easily monitor water quality on site.
   b) Planting Media Quality. We will highlight what to look for in planting media, both physical and chemical properties of substrates that are used to make growing media. In this section we will demonstrate some methods to monitor media performance.
   c) Crop Type. What type(s) of crop will be grown? There are different crops, and many nurseries are growing long-term crops such as woody ornamentals, and short-term color and succulents. These crops have different water and nutrient requirements and we will point out aspects to improve this – separating crops out by these specific needs. We will also point out some fertilizer differences to meet the needs of pH preferences – acid vs. slightly neutral.

3) Fertilizer Types. (1.5 hours).
   We will describe the different types of fertilizers available and highlight how they work. Specifically, we will review different types of granular and liquid
fertilizers and micronutrient chelates. We will also review how to calculate fertilizer applications.

a) Soluble Fertilizers – We will describe special formulations, winter/vs. summer issues and general BMPs regarding the mixing and management of solutions.
b) Controlled Release Fertilizers – We will describe types, release characteristics, performance, and general BMPs when using these products.
c) Organic Fertilizers – We will describe some types currently available, how nutrients are released from these products, and BMPs.

4) Monitoring Crop Fertility Status. (1.5 hours)
This portion of the workshop will review how to monitor fertility status through media, water and tissue analyses. We will describe what should be monitored, how to monitor, and how to interpret lab reports. We will have a samples lab report for media, water and tissue and review them. The final part of this section will be essentials of proper record keeping.

Additional topics and exercises that may be included are: collecting water, tissue, and soil samples and compliance with the nitrogen management plan requirements. Information on nitrogen management plans will require consultation with Regional Water Quality Control Board staff to review lessons and messages.

3. Experimental Site.
NA

F. Project Management, Evaluation, and Outreach
1. Management.
Nursery and greenhouse outreach programs are organized by UCNFA (UC Nursery and Floriculture Alliance). The Project Leaders are Co-Directors of UCNFA and the project participants are also on the UCNFA Administration Committee which has been meeting monthly since 2009 via telephone to discuss and organize program activities.

Project oversight will be by the UCNFA Co-Directors and will be managed by the UCNFA program support staff person.

2. Evaluation.
Objective 5 focuses on measuring learning and impact. Increases in knowledge and awareness tend to be shorter term benefits. Impacts assessments may be conducted using questions about actual or intended implementation of the knowledge gained.

3. Outreach.
This project focuses on outreach and education and will include up to 6 workshops delivered to greenhouse and nursery growers in 2017 and 2018. In addition, videos of topics covered in the workshops will be produced and posted on the UCNFA website in 2018. Articles in the UCNFA newsletter, trade journals, and other media about the program may be included as well.
G. Budget Narrative

a. Personnel Expenses.

25% FTE Program Representative for project management
Program Representative I at $18.66/hr, 2,088 hrs/year, 25% FTE, 3% escalation per year.
Benefits rate= 51.3% for first 6 months, 52.8% for the next 12 months and 54.4% for the final 6 months.

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total salaries</td>
<td>$19,773.26</td>
<td></td>
</tr>
<tr>
<td>Total benefits</td>
<td>$10,447.49</td>
<td></td>
</tr>
</tbody>
</table>

b. Operating Expenses.

- **Supplies:**
  - Total Supplies: $12,012.00
  - Year 1: $8,412.00
  - Year 2: $3,600.00

  For each workshop course (4 workshops per course)
  - Meeting supplies (nametags, pens, paper, folders, others) $50.00 each workshop
  - Printing, handouts $400.00 each workshop

  For all workshop courses (6 courses, 4 workshops per class)
  - Total course supplies: $10,800.00

  Teaching instruments
  - pH / EC meters for instruction 6x$150 each
  - Calibration standards for pH/EC meters, 12x$26 each (6 pH and 6 EC)

- **Equipment:**
  - None

- **Travel:**
  - Total: $22,405.60
  - Year 1: $14,326.80
  - Year 2: $8,078.80

  Travel to workshop venues for instructors. Support for one instructor to fly to venue and a second to drive. Overnight costs for both. Each workshop course consists of four half-day workshops and there are 6 workshop courses.

  Locations may include: San Diego, LA /Riverside/San Bernardino, Central Valley, Watsonville/Salinas, and Ventura.
Instructor, driving:
$ 3,600.00  Hotel, $150/night, 4 nights, 6 courses
$  648.00  Mileage, 200 miles to/from venue, $0.54/mile, 4 trips each course, 6 courses
$  300.00  Food, $75 per diem, 4 nights, 6 courses

Instructor, flying:
$  5,376.00  Airfare, $224 round trip, 4 trips, 6 courses
$  1,680.00  Car rental, $70 per day, 4 trips, 6 courses
$  3,600.00  Hotel, $150/night, 4 nights, 6 courses
$  300.00  Food, $75 per diem, 4 nights, 6 courses

Project leaders, semi-annual meeting (4 total)
Driving (de la Fuente)
$  600.00  Hotel, $150/night, 4 nights
$  648.00  Mileage, 350 miles to/from Salinas to UCD, $0.54/mile, 4 trips
$  300.00  Food, $75 per diem, 4 nights

Flying (Merhaut)
$  896.00  Airfare, $224 round trip, 4 trips
$  600.00  Hotel, $150/night, 4 nights
$  300.00  Food, $75 per diem, 4 nights

- Professional/Consultant Services:
  Video production services (UCD ATS) for 4 shooting days, 48 days to edit, and Spanish transcription to produce up to 24 lessons in both English and Spanish (up to 48 videos) with a total duration of up to 720 minutes.
  $ 39,112.00  Total
  $  00.00  Year 1
  $ 39,112.00  Year 2

- Other Expenses: Identify and explain any additional expenses not covered by the above categories.
  None

c. Other Funding Sources
  None. The Fertilizers and Plant Nutrition workshop currently delivered by UCNFA is supported solely by registration fees and sponsorships from vendors and grower groups specifically for these events. Funds from other grants are not used for these events.

  Nominal registration fees will be charged for the events, but only to recover costs for refreshments, coffee, and other food items.

Indirect costs
Up to 25% of Modified Total Direct Costs

$ 25,937.59  Total
$  9,387.32  Year 1
$ 16,550.27  Year 2