

A. Project Information

Report type: Final Report

Time period covered: July 1, 2015 – June 30, 2017

Project title: Online Fertilization Guidelines for Agricultural Crops in California

Agreement Number: 15-0231

Project leaders:

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B. Objectives

The overall goals of the project were to expand the information accessible through the FREP database and fertilization guidelines and to make the guidelines more interactive and user-friendly. The specific objectives were:

1. Keep database and guidelines up to date by entering new information.
2. Develop web-based nutrient management guidelines for an additional twelve crops grown in California.
3. Make the guidelines more interactive and user-friendly.
4. Increase the awareness level of the guidelines among potential users.
5. Write final report.

C. Summary

For many crops, no comprehensive overview and synthesis of the current research on fertilizer use and management is available. With the FREP project 11-0485-SA, which started in spring 2012, we have been closing this gap by creating the online California Fertilization Guidelines. Each of the 16 guidelines provides a synthesis of current nutrient management research for a major California crop. In our current project, we have created 12 additional guidelines, raising the total number of guidelines to 28, some of them covering two similar crops. While reviewing the literature for each crop, we performed an analysis of the existing research

gaps in California. Furthermore, we redesigned the website to make it easier to navigate and useable for different device screen sizes. To make the guidelines more interactive we have added quiz questions for each crop. We have also developed a site with region-specific nitrogen management case studies, to make the guidelines more applicable to growers in different parts of the state.

In addition, we have updated the contents of the FREP database with information from new projects. All FREP projects, both completed and ongoing, are now summarized in the FREP database.

To promote user awareness, we have added links to the guidelines in various relevant websites and presented the guidelines at 20 professional meetings.

D. Introduction

For many crops, no comprehensive overview and synthesis of the current research on fertilizer use and management has been available to California growers. The FREP project 11-0485-SA, which started in spring 2012, has been closing this gap for some major crops. We created a user-friendly, web-based database of FREP-funded research and wrote crop-specific online fertilization guidelines for 16 important crops grown in California. These two products provide growers and other stakeholders with information on past funded research, and summarize nutrient management practices in an accessible, intuitive format. With the current project, we wrote fertilization guidelines for an additional 12 crops, made the website interface more interactive and user-friendly, and updated the contents of the database with new information.

E. Work Description

Task 1 (addressing Objective 1): Enter key information of FREP-funded projects into the existing database when their final reports are submitted.

The close collaboration with FREP ensures that they forward us the final reports as the researchers submit them, allowing us to enter their key information into the database in a timely manner. All FREP projects, both completed and ongoing, are now summarized and indexed in the database. We will continue to update the database with both newly funded and newly completed projects.

Task 2 (addressing Objective 1): Incorporate new research findings into the existing guidelines.

We updated supplementary info sheets with information from the newly completed crops, and continued to collect and incorporate new relevant research findings into the existing guidelines and supplementary information.

Task 3 (addressing Objective 2): Write nitrogen, phosphorus and potassium fertilization guidelines for twelve additional crops.

In addition to the 16 crops mandated by our previous project (11-0485-SA), we have published online guidelines for nitrogen, phosphorus and potassium management in **prunes/plums, peaches/nectarines, potatoes, avocados, dry beans, onions, celery,**

carrots, olives, safflower, sunflower and melons. We also included information on fertilizing with other nutrients (i.e. zinc or boron) for tree crops on which it is standard practice. In addition, for each of the crops we have written an overview of the history of their cultivation in California, as well as a webpage presenting data on nitrogen uptake during the growing season, nitrogen partitioning in the plant and nitrogen removed with the harvested plant parts (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/N_Uptake.html).

Task 4 (addressing Objective 3): Add quizzes about fertilization of specific crops

We have added a quiz to the guideline for each individual crop. The quizzes include a set of answers with an explanation and a reference to where the information can be found in the guidelines.

Task 5 (addressing Objective 3): Add case studies of efficient N fertilizer use based on field trials.

To collect the information needed, we have prepared a questionnaire. In addition, we have prepared several sample case studies from published literature and data from California field trials to allow growers to conceptualize how the information will be used. These case studies shall serve as an example. The website is now available online at https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Case_Studies.html

We are committed to expanding the site and adding more case studies.

Task 6 (addressing Objective 3): Make the website more user-friendly and better adapted to devices with smaller screen sizes

We redesigned the website to make it easier to navigate, and easier to use on tablets and smart phones (Figure 1). In the new design, a user can open and close pop-up boxes by clicking on them, rather than by hovering the cursor over or away from a field as in the previous design. The layout design also now adjusts for different widths of screens, from smartphones to tablets and desktop screens. We replaced all of the old guidelines, N uptake pages and supporting pages. We also updated and redesigned the PDF files containing plant and tissue sampling instructions and background information about the production of specific crops to match the new style.

Task 7 (addressing Objective 4): We promoted the guidelines and encouraged their use by decision makers in the field in different ways.

The guidelines were presented at 20 meetings with a total attendance approaching 1,000 people. A number of other agricultural information websites have added links to the guidelines. For a complete list of outreach activities, please see Part I. Outreach Activities Summary.

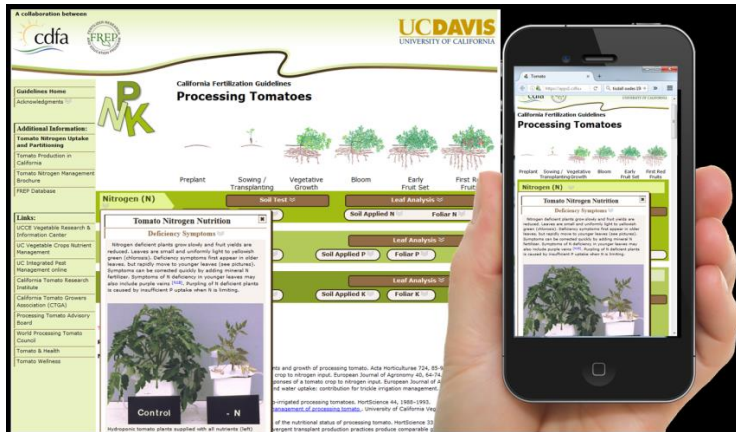


Figure 1. All pages are now easier to navigate and use on different screen sizes.

Task 8 (addressing Objective 5): Write final report.

The final report has been written and submitted in July 2017.

F. Data/Results

The online database of FREP-funded research and the crop-specific online fertilization guidelines provide growers and other stakeholders with information on past funded research, and summarize nutrient management practices in an accessible, intuitive format.

G. Discussion and Conclusions

The California Fertilization Guidelines can be accessed here:
<https://apps1.cdffa.ca.gov/FertilizerResearch/docs/Guidelines.html>

H. Project Impacts

With increasing regulatory pressure to improve nutrient use efficiency in crop production, California growers need reliable information on crop nutrient demand and sustainable nutrient use. The FREP database and the California Fertilization Guidelines provide research-based information for a large number of crops. The sites are user-friendly and easy to navigate. These sites are important resources for growers and crop advisers when making nutrient management decisions. Based on Google statistics, the start page of the California Fertilization Guidelines has been accessed more than 180 times each month between July 2016 and June 2017. These numbers do not include users who go directly to a crop-specific page.

I. Outreach Activities Summary

- Links to the guidelines have been added to the following sites:
 - UCCE Vegetable Research & Information Center:
http://vric.ucdavis.edu/veg_info_topic/fertilization.htm

- University of California - Agronomy Research & Information Center:
<http://agric.ucdavis.edu/>
- University of California- Fruit and Nut Research & Information Center:
<http://fruitsandnuts.ucdavis.edu/>
- Solution Center for Nutrient Management:
http://ucanr.edu/sites/Nutrient_Management_Solutions/
- California Pistachio Research Board:
<http://www.calpistachioresearch.org/>
- UC Davis Olive Center:
<http://olivecenter.ucdavis.edu/front-page>
- Olive Oil Source:
<https://www.oliveoilsource.com/>

We have contacted webmasters of other sites with related content contacted and asked them to add a link to the guidelines on their sites.

- The guidelines were presented at the following events:
 - Geisseler, D., Lazicki, P.A., Horwath, W.R., 2015. Fertilization Guidelines for Major Crops in California. Poster presented at the California Department of Food and Agriculture - Fertilizer Research & Education Program Conference, Seaside, CA, November 05-06, 2015.
 - Geisseler, D., Lazicki, P., Duncan, R., 2015. Fertilization Guidelines for Peaches and Nectarines. Handout prepared for the attendees of the North San Joaquin Valley Cling Peach Day, Modesto, CA, December 4, 2015.
 - Geisseler, D., Lazicki, P., Horwath, W.R., Moradi B., Online fertilization guidelines for major crops in California. Poster presented at the California Almond Conference, Sacramento, CA, December 8-10, 2015.
 - Geisseler, D. Use of Online Resources for Nutrient Management Decisions and Nitrogen Budgeting. San Joaquin County and Delta Field Crops Meeting, Stockton, CA. January 8, 2016. 70 Attendees.
 - Cady, M., Geisseler, D. Nutrient management tools and resources. Nitrogen Management Training Program for California Certified Crop Advisers, Fresno, CA. January 20, 2016. 90 Attendees.
 - Lazicki, P., Geisseler, D. Online Fertilization Guidelines for Nutrient Management Decisions and Nitrogen Budgeting. California Pepper Commission Annual Meeting, Five Points, CA. February 24, 2016. 20 Attendees.
 - Geisseler, D. Online Fertilization Guidelines for Nutrient Management Decisions and Nitrogen Budgeting. CARE – UC DAVIS/IPO Workshop, Davis, CA. March 1, 2016. 20 Attendees.
 - Geisseler, D, Nutrient Management. California Farm Academy Training, Winters, CA. March 1, 2016. 30 Attendees
 - Geisseler, D. Research and Outreach Activities in Nutrient Management. Agronomic Crops Program Team Meeting, Davis, CA. March 22, 2016. 30 Attendees.

- Geisseler, D. Introducing my research and outreach activities. College of Agricultural and Environmental Sciences - Dean's Advisory Council Meeting, Davis, CA. April 20, 2016. 40 Attendees.
 - Geisseler, Daniel, Horwath, William R., Lazicki, Patricia A. California Fertilization Guidelines. California Department of Food and Agriculture - Fertilizer Research & Education Program Conference, Modesto, CA, October 26-27, 2016.
 - Geisseler, D. Soil Nitrogen Cycle and Nitrogen Management. Point Blue Ecologist Meeting, Norden, CA, September 21, 2016.
 - Geisseler, D. Soil Nitrogen Cycle and Nitrogen Management. Course PSSC 453 - Soil Fertility & Plant Nutrition at Chico State University, Chico, CA, September 28, 2016.
 - Geisseler, D., Horwath, W.R., Lazicki, P.A. California Fertilization Guidelines. California Department of Food and Agriculture - Fertilizer Research & Education Program Conference, Modesto, CA, October 26-27, 2016.
 - Geisseler, D. Decision Support Tools for Nutrient Management in Processing Tomatoes. California Tomato Conference, Napa, CA, November, 14, 2016.
 - January 12, 2017. Geisseler, D., "Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes", Presenter, South Sacramento Valley Processing Tomato Production Meeting, Woodland, CA, January 12, 2017, 150 Attendees.
 - January 25, 2017. Geisseler, D., "Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes", Presenter, Northern San Joaquin Valley Processing Tomato Meeting, Modesto, CA, January 25, 2017, 80 Attendees.
 - February 22, 2017. Geisseler, D., "Research to Support Irrigation and Nutrient Management Decisions in Processing Tomatoes", Presenter, UCCE Vegetable Crop Research Update, Five Points, CA, February 22, 2017, 70 Attendees.
 - March 7, 2017. Jacuzzi, N., Geisseler, D., "Nutrient management tools and resources", Other, Nitrogen Management Training Program for California Certified Crop Advisers, Fresno, CA, March 7, 2017, 100 Attendees.
 - March 16, 2017. Geisseler, D., "Nutrient Management", Invited Speaker, California Farm Academy Training, Davis, CA, March 16, 2017, 20 Attendees.
- The guidelines were used in fall 2015 for a class exercise in the course Principles of Soil Science at UC Davis. Approximately 80 students attended the class.
 - We are also collaborating with FREP to produce brochures that contain a summary of key aspects of N management for specific crops. These brochures are very well received at meetings and field days. Currently the brochures for 10 crops are downloadable in PDF form from the FREP website. Two have been translated into Spanish.

J. Factsheet/Database Template

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Grant Agreement Number: 15-0231

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Start Year/End Year: 2015 – 2017

Location: Statewide

County: Statewide

Highlights:

- The online California Fertilization Guidelines were expanded by adding information for an additional 12 crops
- The guidelines are based on research results from studies carried out in California and elsewhere.
- The website can be found at <https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Guidelines.html>
- A set of quiz questions was added to each crop

Introduction: For many crops, no comprehensive overview and synthesis of the current research on fertilizer use and management has been available for California growers. The FREP project 11-0485-SA, which started in spring 2012, has been closing this gap for some major crops. We created a user-friendly, web-based database of FREP-funded research and wrote crop-specific online fertilization guidelines for 16 major crops grown in California. These two products provide growers and other stakeholders with information on past funded research, and summarize nutrient management practices in an accessible, intuitive format. With the current project, we wrote 12 additional fertilization guidelines, some of them covering two similar crops, made the website interface more interactive and user-friendly, and updated the contents of the database with new information.

Methods/Management:

We wrote guidelines for nitrogen, phosphorus and potassium management in prunes/plums, peaches/nectarines, potatoes, avocados, dry beans, onions, celery, carrots, olives, safflower, sunflower and melons and made them available on the California Fertilization Guidelines website. The guidelines are based on research results from studies carried out in California and elsewhere. We also included information on fertilizing with other nutrients (i.e. zinc or boron) for tree crops on which it is standard practice. In addition, for each of the crops we created an overview of the history of their cultivation in California, as well as a webpage presenting data on nitrogen uptake during the growing season, nitrogen partitioning in the plant and nitrogen removed with the harvested plant parts. To make the site more interactive, we added quiz questions to each crop.

Findings:

The products of this project are online fertilization guidelines, which can be accessed here: <https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Guidelines.html>

K. Copy of the Product/Results

The guidelines are freely available online. When finishing writing the guidelines for a specific crop, we performed an analysis of the existing research gaps in California. The gap analysis of the 12 crops that were added to the guidelines is attached below.