A. Project Information

Project title: Expanding the California Fertilization Guidelines to support nutrient management decisions for minor annual crops

Agreement number: 16-0610-SA

Report type: Annual Report

Time period covered: January 1, 2017 – June 30, 2018

Project leader:

Daniel Geisseler, CE Nutrient Management Specialist, University of California, Department of Land, Air and Water Resources, One Shields Ave., Davis, CA, 95616. (530) 754 9637, djgeisseler@ucdavis.edu

B. Objectives

The objectives of this proposal are:

1. provide growers and crop advisers with information about nutrient management for annual crops about which insufficient information is available for detailed crop-specific guidelines
2. Create an educational tool to highlight the effect of major factors that determine N use efficiency in the field, such as irrigation management, soil type, root system, and the interactions between these factors.

C. Abstract

California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production to reduce nitrate leaching to the groundwater. For many crops, a comprehensive overview and synthesis of the current research on fertilizer use and management has long been missing. With support from FREP, we have been closing this gap by writing online fertilization guidelines for 30 major crops grown in California.

While the crops featured on the website are grown on a large proportion of California's cropland, growers in the state produce a variety of other crops. For many smaller-acreage crops, very little information on nutrient management under California's conditions is currently available, which makes writing crop-specific guidelines relevant for California a challenging task.

For this project, we have written general guidelines for nitrogen, phosphorus and potassium management of annual crops grown in California. We have also created an N calculator for 20 minor crops and a tool that allows users explore the interactions between plants, soil and irrigation and their effect on nitrate leaching. The three tools are available online and linked with the California Fertilization Guidelines website.

D. Introduction

Due to elevated nitrate levels in groundwater in agricultural areas, California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production to reduce nitrate leaching to the groundwater. For many crops, a comprehensive overview and synthesis of the current research on fertilizer use and management has long been missing. With support from FREP (projects 11-0485-SA and 15-0231), we have been closing this gap by writing fertilization guidelines for major crops grown in California. Currently, guidelines for 30 crops are available online in a user-friendly, interactive format (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Guidelines.html).

The California Fertilization Guidelines have become an important resource for growers and crop advisers who need nutrient management related information for a variety of crops. The guidelines have been highlighted as a resource at the N management training for Certified Crop Advisers and the self-certification training for growers. With regulatory pressure increasing, the need for research-based information on crop management will likely increase their popularity in the future.

While the crops featured on the website are grown on a large proportion of California's cropland, growers in the state produce a variety of other crops. While it may be argued that smaller-acreage crops have little effect on the overall quality of groundwater in California, nutrient management decision made for these crops may affect the quality of local aquifers and wells. Furthermore, growers need research-based information for the crops they grow, independent of the total acreage in California. For many of these minor crops, very little information on nutrient management under California's conditions is currently available, which makes writing crop-specific guidelines relevant for California a challenging task.

However, by reviewing the relevant literature for more than two dozen crops over the last few years, we have gained a very good overview and understanding of practices that ensure efficient use of fertilizer under California conditions. Many of these practices not only depend on the kind of crop grown, but also on the cropping system, crop management, climatic conditions, and soil type. When combined with crop-specific information, such as N removed at harvest, total N uptake and growth stage when harvested, management practices that ensure high N use efficiency can be identified and described. We have compiled the available literature to create a database of N removed at harvest by most crops grown in the Central Valley, and so have already collected some of the relevant information.

E. Work Description

Task 1 (addressing Objective 1): Create a generalized nutrient management web page discussing efficient nutrient management practices.

The generalized guidelines have been written, reviewed by two nutrient management experts and posted online.

Task 2 (addressing Objective 1): Create a simple N calculator.

The N calculator based on crop N uptake and N removal at harvest has been created for 20 crops (Table 1).

Table 1: List of crops that will be included in the N calculator.

Beetroot	Fresh market tomatoes	Sugar beets
Bell pepper	Oats for grain	Sweet corn
Cabbage	Pumpkin	Sweet potatoes
Chile peppers	Rye for grain	Triticale for grain
Cucumbers	Small grain for hay	Watermelon
Durum wheat for grain	Sorghum for grain	Zucchini
Eggplant	Squash	

Task 3 (addressing Objective 2): Create an educational tool.

An educational tool that lets users explore the interactions between plants, soil nitrate and irrigation has been created and posted online.

F. Data/Results

The generalized nutrient management website has been created (Figure 1) and can be accessed at: https://apps1.cdfa.ca.gov/FertilizerResearch/docs/General_Guidelines.html. The website uses the same format as the crop-specific guidelines. Information on deficiency symptoms, soil tests, plant tissue testing and the four Rs of nutrient management (right amount, right place, right time, right material) are discussed for nitrogen, phosphorus and potassium. A large number of scientific articles and extension publications were used to write the guidelines.

The N calculator is also available online and can be accessed at https://apps1.cdfa.ca.gov/FertilizerResearch/docs/N_Calculator.html. The calculator is divided into two parts. By selecting a crop, entering the expected yield and some basic information on crop management, users will be provided with estimates of total N uptake, N removed from the field and a seasonal N uptake curve (Figure 2).

In a second step, users can enter information on irrigation management, residual soil nitrate, nitrate in the irrigation water and soil type (Figure 3). Based on this information, the program then calculates the N credits from residual soil nitrate, nitrate in the irrigation water and in-season N mineralization. In addition, the program calculates the amount of N fertilizer needed without leaching, the amount of N at risk leaching and the amount of N fertilizer needed to compensate for N leached. By changing the water application efficiency, users can see how that affects the risk of leaching and amount of fertilizer N needed. The calculator currently does not work in Internet Explorer. This is because Internet Explorer does not recognize input in the form of dates. The planting and harvesting dates are needed to estimate N mineralized during the growing season. We are currently working on a solution to solve this problem.

An educational tool that lets users explore how plants, irrigation and soil affect the risk of nitrate leaching is available online and can be accessed at

https://apps1.cdfa.ca.gov/FertilizerResearch/docs/ Nitrate_Tool.html. Users can select rooting depth (shallow vs. deep), growth stage (young vs. mature), irrigation type (drip vs. furrow), soil texture (fine vs. coarse), residual soil nitrate level (low vs. high), and irrigation level (low vs. high) for a total of 64 scenarios. For each scenario, a picture is displayed showing the distribution of roots, water and nitrate. The picture is complemented with a short explanation (Figure 4).

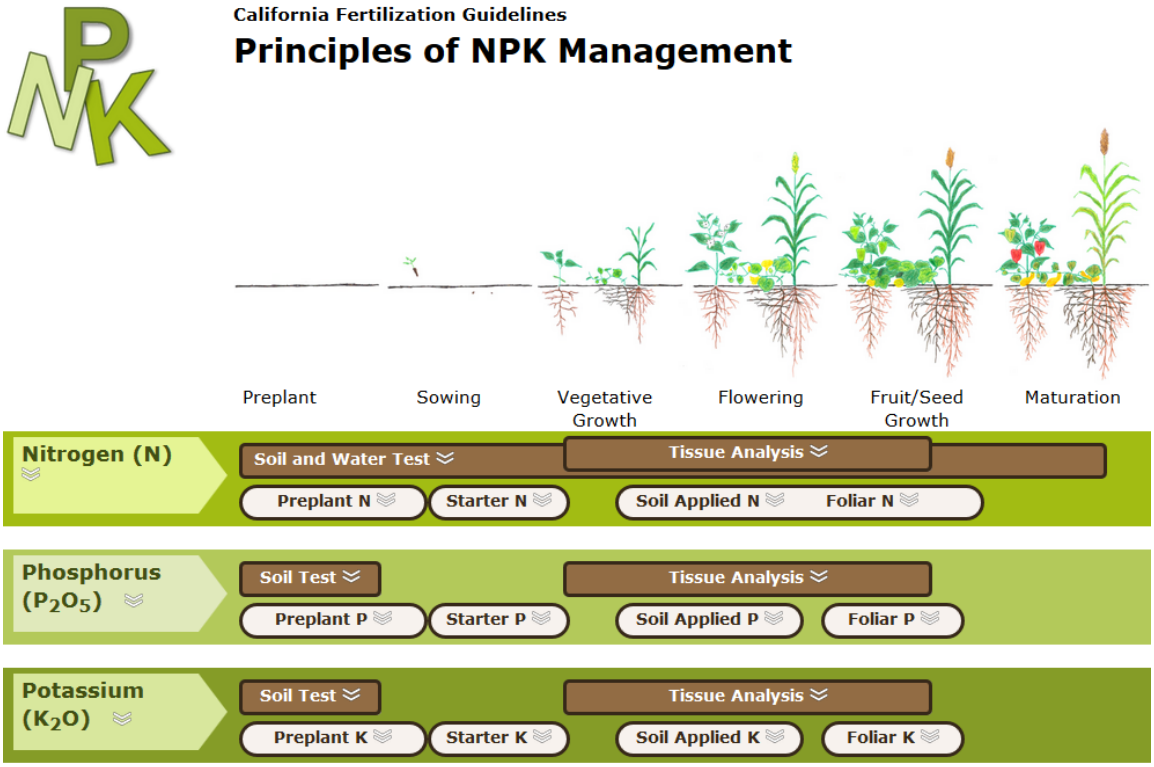

Figure 1: Screenshot of the general guidelines.

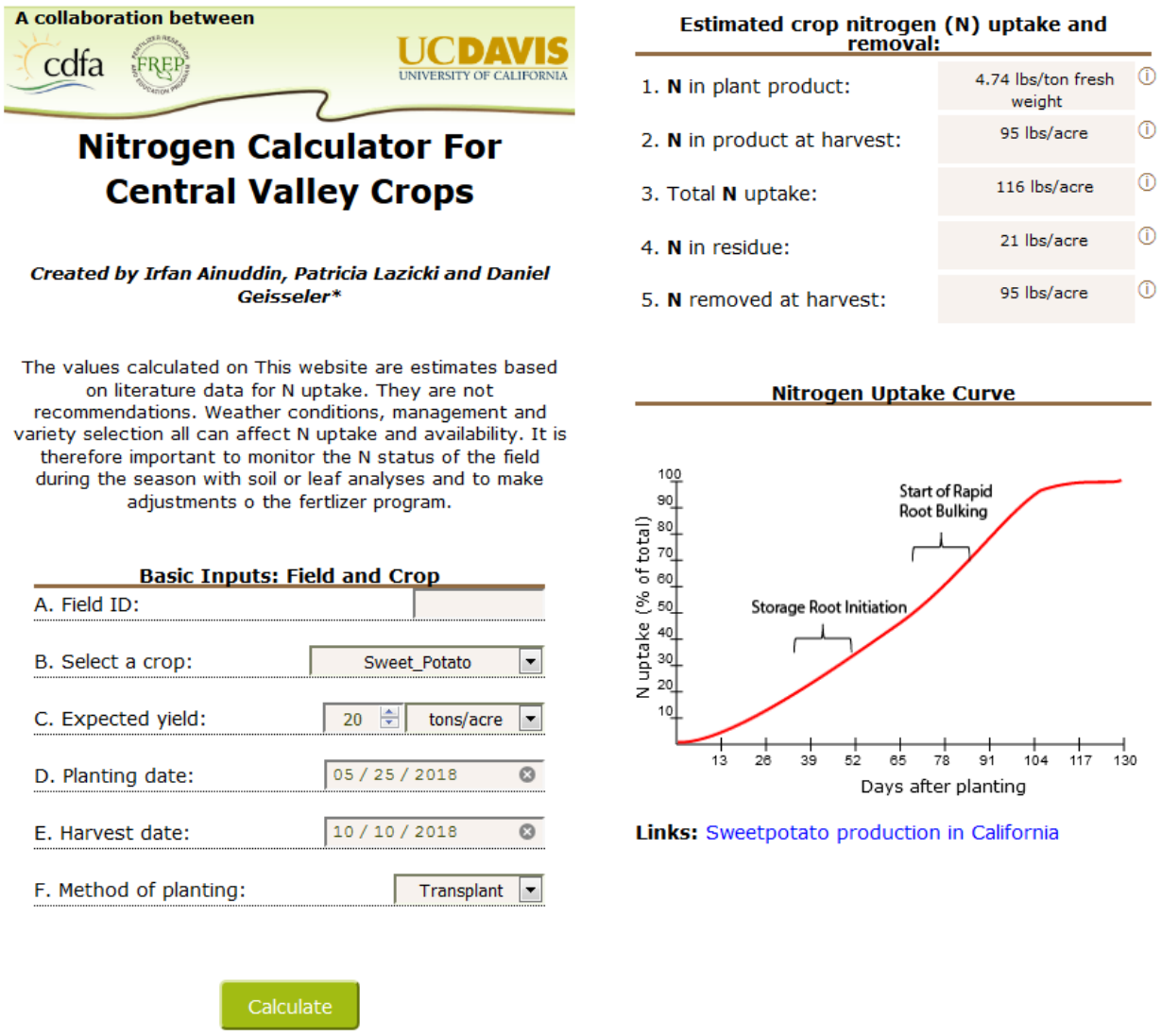

Figure 2: Input and output of the first part of the N calculator.

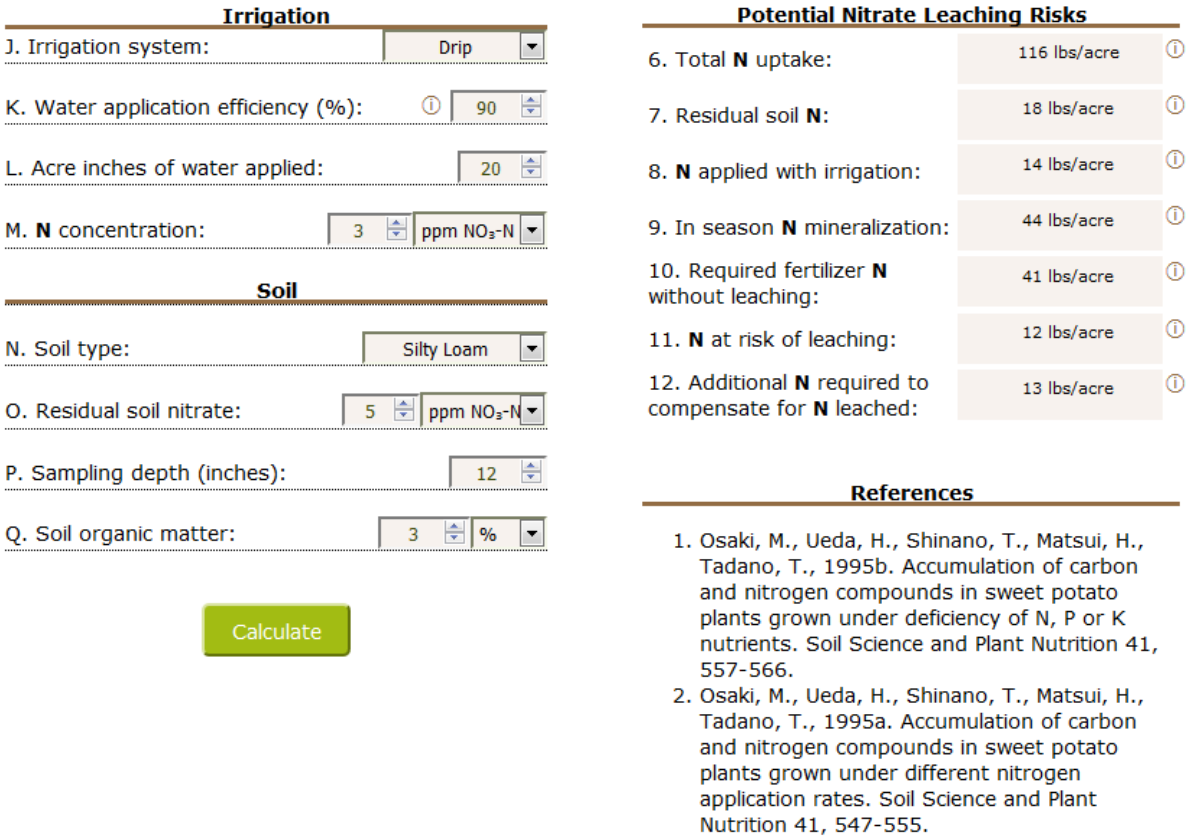

Figure 3: Input and output of the second part of the N calculator.

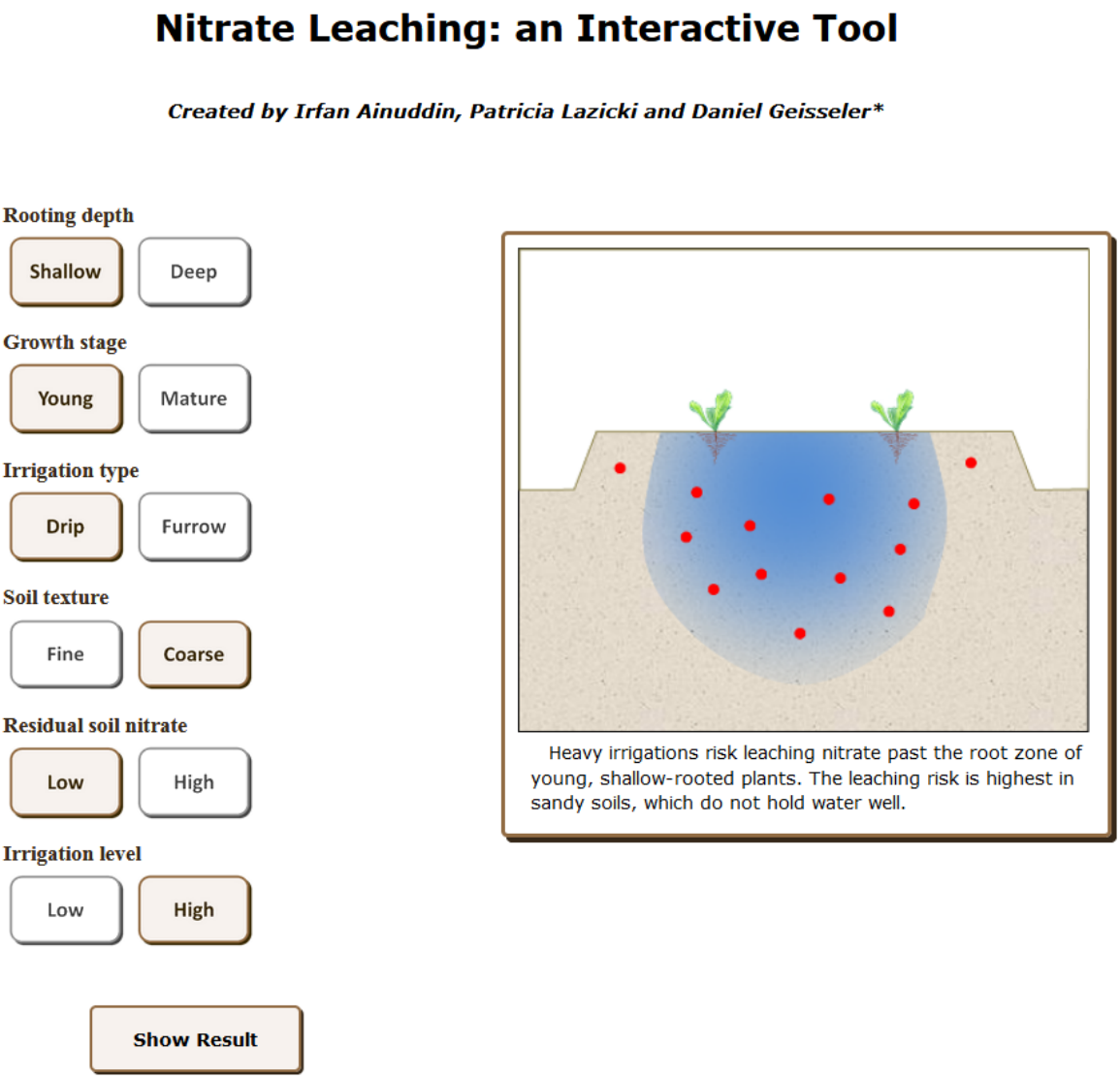

Figure 4: Screenshot of the educational tool. Users can select a scenario on the left and the result is displayed on the right. A total of 64 scenarios are possible.

G. Discussion and Conclusions

We have written general guidelines for nitrogen, phosphorus and potassium management of annual crops grown in California. We have also created an N calculator for 20 minor crops. In addition, we created an educational tool that lets users explore how plants, irrigation and soil affect the risk of nitrate leaching. The tools are available online and linked with the California Fertilization Guidelines website.

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 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. The N calculator and the educational tool make the website more interactive and let users explore factors that directly affect nitrogen use efficiency.

I. Outreach Activities Summary

The entire project is an outreach activity. As a University of California Cooperative extension Specialist I frequently present at meetings for growers and crop advisors. The fertilization guidelines are often part of my presentations.

J. Factsheet/Database Template

1. Project Title: Expanding the California Fertilization Guidelines to support nutrient management decisions for minor annual crops

2. Grant Agreement Number: 16-0610-SA

3. Project Leaders: Geisseler, D., Department of Land, Air and Water Resources, University of California, Davis

4. Start Year/End Year: 2017-2018

5. Location: Central Valley

6. County: Central Valley

7. Highlights:

- A generalized nutrient management website has been created
- A nitrogen calculator for 20 minor California crops has been created
- An educational tool lets users explore the interactions between plants, soils, irrigation and nitrate leaching

8. Introduction:

California growers are facing increasing pressure to improve nitrogen (N) use efficiency in crop production to reduce nitrate leaching to the groundwater. For many crops, a comprehensive overview and synthesis of the current research on fertilizer use and management has long been missing. With support from FREP, we have been closing this gap by writing online fertilization guidelines for about two dozen major crops grown in California.

The objectives of this proposal were to

- Provide growers and crop advisers with information about nutrient management for annual crops about which insufficient information is available for detailed crop-specific guidelines

- Create an educational tool to highlight the effect of major factors that determine N use efficiency in the field, such as irrigation management, soil type, root system, and the interactions between these factors.

9. Methods/Management:

A website with general information on deficiency symptoms, soil tests, plant tissue testing and the four Rs of nutrient management (right amount, right place, right time, right material) for nitrogen, phosphorus and potassium has been created.

An online N calculator for 20 crops has been posted online and linked to the guidelines. The calculator provides estimates for total N uptake, N removed from the field as well as a seasonal N uptake curve. In addition, the program lets users calculate the amount of N fertilizer needed without leaching, the amount of N at risk leaching and the amount of N fertilizer needed to compensate for N leached. By changing the water application efficiency, users can see how that affects the risk of leaching and amount of fertilizer N needed.

An educational tool that lets users explore the interactions between plants, soil, irrigation and nitrate reaching has been created and posted online.

10. Findings:

The guidelines and tools described above can be accessed on the California Fertilization Guidelines website (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Guidelines.html) or directly:

- General Guidelines (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Annual_Crops.html)
- N calculator (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/N_Calculator.html)
- Educational tool (https://apps1.cdfa.ca.gov/FertilizerResearch/docs/Nitrate_Tool.html)