Project No: 25-0499

Reducing Orchard Nitrate Leaching to Groundwater with HFLC and AgMAR: Ground-Truthing and Guiding the ILRP Assessment Tool

Project Leader: Thomas Harter
UC Davis
thharter@ucdavis.edu

Abstract

Growers in California are subject to regionally varying regulations on the discharge of nitrate to groundwater. In the Central Valley, agricultural water quality coalitions have chosen a multi-pronged approach to understanding nitrogen losses from individual fields and farms, which includes grower reporting, modeling, and long-term management practice evaluation at the site scale. For the past seven years, we have established and maintained one of these sites, an almond orchard near Modesto that switched from conventional to high frequency low concentration (HFLC) fertigations in 2018. With funding from FREP and Almond Board of California, we primarily monitor water and nitrogen fluxes into and out of the orchard (irrigation, fertilization, ET, and harvest), water and nitrogen fluxes in and below the root zone (7 vadose zone monitoring stations), and water levels, nitrate, and water chemistry in first-encountered groundwater (20 monitoring wells). The proposed project funds several focused investigations while continuing the core monitoring project and updating a groundwater-vadose zone model: 1) Evaluation of the effects of AgMAR; 2) Assessment of irrigation and fertigation uniformity within the orchard; 3) Evaluation of soil nutrient dynamics in young orchards; 4) Implementation of on-site ET measurements. Project results will be communicated to the Agricultural Water Quality Coalitions to calibrate the modeling tools used in the Irrigated Lands Regulatory Program and with growers and consultants to inform and guide irrigation and nutrient management practices.

Project Objectives

1. Continue HFLC management, monitoring, and assessment (including integrated groundwater-vadose zone modeling) of the almond orchard water and nitrogen fluxes, years 9 to 11 (established in 2018).
2. Assess potential benefits and water quality pitfalls of AgMAR in the orchard.
3. Assess irrigation and nitrogen distribution uniformity related to micro-irrigation.
4. Assess nutrient requirements of young orchards planted into recycled orchard soils.
5. Assess evapotranspiration from the orchard.
6. Improve pathways to regulatory compliance of the orchard industry with ILRP requirements.

Project No: 25-0500

Nitrogen Runoff and Leaching Loss from Nursery Production

Project Leader: Christopher Shogren
UC Cooperative Extension Los Angeles County
cjshogren@ucanr.edu

Abstract

Nitrogen application rates in container nursery production are among the highest in California agriculture, ranging from 1,000 to 7,000 lbs N/acre annually. This high input use, combined with variability in fertilizer types, irrigation practices, and soilless substrates, contributes to significant nitrogen losses through runoff and leaching—posing both environmental risks and economic challenges. In response to nitrate contamination of groundwater, the State Water Resources Control Board requires growers to complete Irrigation and Nitrogen Management Plans, which rely on crop-specific nitrogen removal coefficients. However, container nursery systems are highly diverse, with thousands of plant taxa, varied container sizes, and non-standard growing media. Unlike traditional crops, container plants are sold with fertilizer and substrate intact, making accurate nitrogen removal estimation nearly impossible under the current regulatory framework. This project seeks to quantify nitrogen runoff and leaching from common combinations of irrigation method (drip vs. overhead), fertilizer type (controlled release vs. water-soluble), and soilless substrates with varying carbon-to-nitrogen ratios. Research will be conducted under field-scale, realistic nursery conditions to generate practical, actionable data. Findings will support the development of best management practices to improve nitrogen-use efficiency, reduce fertilizer losses, and protect groundwater quality. Results will be shared with nursery producers, UC Cooperative Extension, and water quality regulators to inform decision-making and explore more appropriate compliance strategies for nursery production systems.

Project Objectives

1. Measure and compare nitrogen losses for plants grown with a single fertilizer and irrigation method from soilless substrates of different carbon:nitrogen ratios.
2. Measure the percentage of nitrogen lost through leaching and runoff for both controlled-release and water-soluble fertilizer applications throughout the production cycle.
3. Measure and compare nitrogen losses for overhead and drip irrigation methods with controlled-release and water-soluble fertilizer applied.

Project No: 25-0501

Development of Diagnostic Tools to Support Site-Specific N Management Decisions in Organic Cropping Systems

Project Leader: Paul Zerbe
Soil Health Lab LLC
paul.zerbe@soilhealthlab.com

Abstract

Nitrogen (N) management in agroecosystems that use organic fertility products, such as organic farming, is challenging because plants rely on soil organisms to mineralize N from fertilizers and other sources. While models to estimate plant-available N are emerging, uncertainty remains high - especially with varied input types. Products like guano, bloodmeal, and liquid fertilizers mineralize quickly but are costly, while mixed feedstock pellets tend to mineralize more slowly. With fertility inputs being a major cost and regulatory limits on N use in place, optimizing rate, source, timing, and placement is complex. A field-specific diagnostic tool is urgently needed to guide effective N management, support yield goals, and ensure regulatory compliance. This research will provide growers with decision-support tools to optimize organic N management at the field level. Our framework will help identify which fields can perform well with lower-cost inputs and which require more intensive investment, improving both efficiency and profitability. Beyond this project, the approach offers a scalable model for developing field diagnostics that support informed decision-making in complex farming systems.

Project Objectives

1. Assess management history, grower perceptions on N management challenges, and a suite of soil properties for 120 organic vegetable fields in the Salinas valley.
2. Evaluate relationships between soil properties, management history and grower perceptions on N management challenges.
3. Develop a preliminary diagnostic tool and interpretation guide to support N management decisions in organic production.
4. Conduct field trials to validate the interpretation guide/scoring system of the diagnostic tool. Field trials will compare the effect of different fertility programs on yield and plant quality metrics.
5. Refine diagnostic tool, release as a commercially available service and disseminate research findings.

Project No: 25-0502

Advancing Irrigation and Nitrogen Management of Cantaloupe in Southern California using Field Experiments and Remote Sensing

Project Leader: Amir Verdi
UC Riverside
amir.verdi@ucr.edu

Abstract

The overall goal of this project is to enhance the sustainability of cantaloupe production in Southern California by developing science-based irrigation and nitrogen application recommendations for the major soil types in the region. In addition, reliable information about the spatial variability in crop growth and yield at the field level will be generated, which is vital for growers to move toward precision agriculture and, if needed, variable application of agricultural inputs, including water and nitrogen. To accomplish this, two cantaloupe irrigation and nitrogen management field trials will be conducted in Riverside and Holtville, CA. Over two years, the response of a commercial cantaloupe variety to nine treatments (3 irrigation levels × 3 nitrogen rates) will be evaluated under field conditions. Multispectral and thermal drone data will be collected multiple times during the growing seasons. Analysis of variance will be performed to determine the impact of irrigation and nitrogen treatments on crop yield. Remote sensing yield prediction models will be developed using a range of statistical methods, from simple linear regression to advanced AI-based models, utilizing a composite dataset from both sites and years. The utility of PlanetScope data for early-season yield prediction will be explored, and separate models for yield mapping at harvest time will be developed using drone data. The outcome of the research will be added to the California Crop Fertilization Guidelines and project results will be presented and discussed at local and state grower meetings, FREP conferences, and UC Cooperative Extension events in Imperial and Riverside counties.

Project Objectives

1. Evaluate the response of cantaloupe to different irrigation and nitrogen amounts for heavy and coarse soil types in the Southern California agriculture region.
2. Develop recommendations for irrigation and nitrogen management of cantaloupe in the region.
3. Develop and evaluate statistical yield predicting remote sensing-based models using drone and satellite data *(based on the findings from our previous study in alfalfa, we hypothesize that remote sensing can also effectively predict the yield of other crops, including cantaloupe in the region)*.

Project No: 25-0503

Nutrient Management: A Collaborative Approach between Agriculture and Regulatory Programs in the San Diego Region

Project Leader: Valerie Mellano
San Diego Region Irrigated Lands Group
val@sdfarmbureau.org

Abstract

Agriculture is a high value component of the overall economy in San Diego County. The agricultural community is comprised of mostly small farms producing specialty crops, with considerable variability in crops and topography, in grower experience and knowledge, languages spoken, race, heritage and age. San Diego agriculture has also long grappled with nitrate contamination of surface water. Growers in the area are regulated under both the MS4 program and the General Agricultural Order, and the San Diego Region Irrigated Lands Group (SDRILG) assists approximately 1100 irrigated agricultural producers with grower monitoring requirements. Recently, the San Diego Regional Water Quality Control Board directed area coalitions to focus on best management practices (BMPs) to achieve water quality goals. This project will 1) analyze the specific BMP needs collaboratively with regulatory program staff and 2) support the SDRILG in providing data-driven outreach and education to its members. This will allow for implementation of the most effective BMPs for the unique agricultural operations in our area and provide education to growers on their effective use.

Project Objectives

1. Determine where and how BMP adoption will have the greatest impact by reviewing the most common nitrogen management-related violations found during farm inspections by Regional Board and MS4 program staff during the past five years. Organize by watershed and crop type and prioritize violations that can best be addressed through appropriate BMPs.
2. Establish and extend BMPs that will assist growers in meeting regulatory requirements for surface and groundwater contamination.
3. Define methods to assist those who are not able to access training and other information due to “Low Tech” capacity within the SDRILG.
4. Create a Resource Collection available to members of the SDRILG and others that will assist them in learning about and implementing BMPs for nitrogen management on their farms.

Project No: 25-0504

Developing Tools and Information to Enhance Water-Nitrogen Use Efficiency and Sustainability of Avocado Production Systems

Project Leader: Aliasghar Montazar
UC Cooperative Extension San Diego, Riverside and Imperial Counties
amontazar@ucanr.edu

Abstract

Avocados are shallow-rooted trees and careful water and nitrogen management is critical to ensure optimal yield and high-quality fruits. This is even more important under avocado crop production systems in southern California due to uncertain water supplies, mandatory reductions of water use, and the rising cost of water. Additionally, growers face increasing salinity in water sources and must leach salts to maintain yields while minimizing water quality issues to comply with the Irrigated Lands Regulatory Program requirements. Optimizing N applications along with appropriate irrigation management practices to reduce N leaching are extremely important but need to be managed in relation to salt leaching. This study will address these issues by conducting extensive field experiments and data collection in 15 commercial avocado sites in southern California. The aim of the work is to develop new N and water management tools and information that can provide solutions to enhance the competitiveness of the avocado industry though greater capacity of sustainable practices resulting in reduced inputs (N and water), and increased efficiency, yield, and economic return. A long-term impact of the study will be achieving a higher ratio of harvested N to cropland N inputs, which may contribute significantly to reduced nitrate contamination and water quality improvement.

Project Objectives

1. Assess the impact of water-nitrogen grower practices in avocado trees growth and fruit quality, N removal, N soil availability and leaching.
2. Evaluate the usefulness of Soil Solution Access Tubes, soil nitrate quick test, and leaf analysis as tools for nitrogen and salt management in avocados orchards.
3. Develop N-removal crop coefficient value/s in California avocado production systems.
4. Provide data and demonstration trials and adapt the CropManage web-based tool for water and N management in avocados.
5. Disseminate tools and information developed by the project to avocado growers and stakeholders.