Fertilizer Research and Education Program Pre-Proposal Template

A. Cover Page

Project Title
Advancing irrigation and nitrogen management of cantaloupe in southern California using field experiments and remote sensing

Key Personnel

Role	Name	Affiliation	Contact Information
PI	Amir Verdi	University of California, Riverside	Environmental Sciences Department, UCR, amir.verdi@ucr.edu
Co-PI	Daniel Geisseler	University of California, Davis	Department of Land, Air, and Water Resources, UC Davis, djgeisseler@ucdavis.edu
Co-PI	Jairo Diaz	University of California Agriculture and Natural Resources Division, Desert Research and Extension Center	1004 Holton Rd, Holtville, CA, 760-791-0521, jdiazr@ucanr.edu
Co-PI	Elia Scudiero	University of California, Riverside	Environmental Sciences Department, UCR, elia.scudiero@ucr.edu

Project Location
Imperial and Riverside Counties, CA

Requested Funding Amount
$300,000

Project Duration
Three years.

Funding Category
☐ Outreach, Education, and Demonstration
☒ Research and Demonstration

Funding Priority Area(s)
Please reference the Request for Pre-Proposals to determine the appropriate funding priority area(s) for this proposal. Limit to 2 target priorities.

☒ Outreach -1	☐ Research -1B	☐ Research -1D	☐ Research -2B
☐ Research -1A	☒ Research -1C	☐ Research -2A	

B. Project Summary (Max 400 words)

Problem

Melon production is significant in Southern California, with 4,800 and 3,045 acres of cultivation in Imperial and Riverside counties, respectively. Excess irrigation and nitrogen application threaten the sustainability of agricultural production in the region. Fertilizers, salts, and toxic chemicals are drained into the Salton Sea, the most impaired water body in California. Growers need management practices that reduce nitrogen exports and improve air quality while maintaining competitive yields and excellent produce quality. With the adoption of pressurized irrigation systems in melon production, there is a need to compute nutrient requirements accurately for the region's conditions. Since 2023, growers in Imperial County have been required to report nitrogen fertilizer applications. Overirrigation negatively impacts nitrogen use efficiency because it causes leaching of nitrogen into deep soil layers and risks potential contamination of groundwater resources. Consequently, to maximize farm productivity while ensuring environmental stewardship, science-based irrigation and nitrogen application recommendations should be developed for the major soil types in the region.

In addition, reliable information about spatial variability in crop growth and yield at the field level is vital for growers in the region to move toward precision agriculture and, if needed, variable application of agricultural inputs, including water and nitrogen. Remote sensing emerges as the most viable option for producing high-resolution yield maps and fertilizer and water application maps efficiently and non-destructively. The PI of this study recently developed statistical models to predict alfalfa yield in the region using multispectral drone imagery and to map root-zone soil salinity (Sapkota et al., 2023, 2024).

Impact

The novelty and impact of this project are threefold: (1) a comprehensive experimental plan to develop research-based recommendations for combined irrigation and nitrogen management for both fine- and coarse-textured soils found in the Southern California region to maximize yields, reduce costs, and protect natural resources by reducing the risk of nutrient exports; (2) evaluation of the efficacy of drone- and high-resolution satellite-based remote sensing for early detection of nitrogen and water stress in cantaloupe fields; and (3) development of a novel modeling approach for creating easy-to-use, remote sensing-based yield prediction models that growers, crop consultants, and agricultural professionals can use to create yield maps and assess yield variability across their fields, which is the first and most important step toward adopting precision agriculture in the region.

Audience

The target audience for this project is melon growers, crop consultants, and industry stakeholders in the southern California agriculture region.

C. Project Objectives (Max 100 Words)

Overall goal: enhancing the sustainability of cantaloupe production in southern California regions.

The specific objectives are to:

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*).

D. Approach (Max 500 words)

Methods

Two cantaloupe irrigation and nitrogen management field trials will be conducted at the UCR Agricultural Experiment Station (UCR AES) in Riverside and the UCANR Desert Research and Extension Center (UC DREC) in Holtville, CA. Research plots will be 30 ft long and consist of four rows on 80-inch beds. Over two years, the response of a commercial cantaloupe variety to nine treatments (3 irrigation levels × 3 nitrogen rates), replicated three times, will be evaluated under field conditions. The field site in Imperial County features heavy soil, whereas the UCR AES site has coarse soil, providing an ideal setup to compare the impact of soil type on cantaloupe yield quality and quantity.

Irrigation rates will include (I) typical growers practice, (II) a full irrigation ($ET_c = ET_o \times Kc$), and (III) an ET-based overirrigation treatment (150% ET_c). The nitrogen treatments (preplant and side-dress during the growing season) will include: (1) grower recommendations, (2) applications based on the California Fertilization Guidelines (CFG) without accounting for residual soil nitrate, and (3) CFG recommendations adjusted for pre-plant residual soil nitrate.

Soil samples will be collected pre-planting, during the season, and post-harvest at different depths (0 to 36 inches, at least three samples) and analyzed for NH_4 and NO_3. Biomass data will be collected four times during the growing season for weight and plant nutrient analysis. Plant growth and health will be monitored biweekly on sunny days near solar noon using NDVI, canopy temperature, LAI, and stomatal conductance handheld sensors. Soil moisture will be continuously monitored at multiple depths across all treatments.

Multispectral and thermal drone data will be collected monthly. Additionally, soil at both sites will be EM surveyed and mapped, and undisturbed samples will be analyzed in the lab to determine soil water retention and hydraulic conductivity. A daily time series of PlanetScope satellite data will also be collected for both research sites to track cantaloupe phenology and growth using NDVI. Yields and Brix measurements will be collected at harvest, and final drone data will be obtained just before harvest at both sites.

Evaluation

Analysis of variance (ANOVA) will be performed using SAS to determine the impact of irrigation and nitrogen treatments on crop yield. Other data including sensor measurements will be analyzed with appropriate statistical methods. 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. To evaluate grower adoption potential, participant surveys will be conducted during meetings.

Outreach

Project results will be presented and discussed at local and state grower meetings, FREP conferences, and UC Cooperative Extension events. Summary results will be shared at the end of each harvest season, and journal articles will be prepared following the completion of the third field season.

References:

Sapkota, A.*, Verdi, A*., Scudiero, E., Montazar, A. (2024). Effectiveness of Satellite and UAV-Based Remote Sensing for Delineating Alfalfa Management Zones Under Heterogeneous Rootzone Soil Salinity. Smart Agriculture Technology, 9 (2024) 100583.

Sapkota, A*., Haghverdi, A*., Montazar, A. (2023). Estimating fall-harvested alfalfa (Medicago sativa L.) yield using UAV-based multispectral and thermal images in southern California. Agrosystems, Geosciences & Environment.2023;6:e20392.