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Project Initiation

Project Data for Accession Number 1024335

Project Title

Water Management and Quality for Specialty Crop Production and Health

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** COMPLETE
Funding Source NIFA Formula	**Grant Year** 2021
Grant No.	**Cumulative Award Amt.** N/A
Proposal No.	**Multistate No.** NC1186
Project Start Date Oct 01, 2020	**Project End Date** Sep 30, 2025
Program Code	

Project Director

Oki, L.

Recipient Organization

SAES - UNIVERSITY OF CALIFORNIA AT DAVIS

University of California, Davis

DAVIS, CALIFORNIA 95616

Performing Department

Plant Sciences

Non Technical Summary

This project supports the mission of the Agricultural Experiment Station by addressing the Hatch Act area(s): of rural and community development. Any specialty crops are grown in highly intensive systems that require large amounts of resources including labor, energy, fertilizers, materials for growing substrates, and the topic of this project: water. As with all crops, water is necessary for plant growth. With specialty crops such as nursery and greenhouse ornamentals, plants are grown in high densities and production cycles are compressed to shorten crop times since infrastructure costs are much higher than with "traditional" crops.Many specialty crops are grown in soilless media that does not hold much water and provides little to no nutrients. So irrigation must be frequent and fertilizers must be provided continuously during crop growth to supply those needed plant nutrients. Since there are no tolerances of the presence of diseases and pests on these crops, pesticide usage can also be very high. So maximizing the efficient use of water is important not only for conservation, but also to minimize environmental impacts of runoff.This projects aims to study methods and practices to maximize water used for irrigation by examining the use of nontraditional sources and

improving irrigation efficiency; minimize water runoff from irrigation and storms through runoff capturing, novel treatments methods, and reuse; and assess the properties of soilless media in order to maximize plant growth and health and minimize resource use.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	10%
Applied	60%
Developmental	30%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
102	2199	1060	14%
111	2199	1060	14%
124	2199	1070	14%
133	2199	1060	14%
205	2199	1060	14%
216	2199	1060	14%
205	5360	1060	16%

Knowledge Area

[102] Soil, Plant, Water, Nutrient Relationships

[111] Conservation and Efficient Use of Water

[124] Urban Forestry

[133] Pollution Prevention and Mitigation

[205] Plant Management Systems

[216] Integrated Pest Management Systems

Subject Of Investigation

[2199] Ornamentals and turf, general/other (includes cacti)

[5360] Drainage and irrigation facilities and systems

Field Of Science

[1060] Biology (whole systems)

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[1070] Ecology

Keywords

environmental horticulture, fertilizer management, floriculture, greenhouse, growing media, irrigation efficiency, nursery, plant nutrition, recycled water, runoff management, soilless culture, substrates, water use efficiency, urban stormwater, containerized crop production, ornamental trees and shrubs

Goals / Objectives

(1) Water quality of irrigation sources. Characterize the quality of alternative or non-traditional water sources in different regions of the U.S. Determine water quality parameters and levels that are most limiting for intensive plant production systems and evaluate treatment and management options to overcome the limiting factors. (2) Improved irrigation management. Determine the water quality and quantity requirements of different plant production systems with varied container sizes and environmental conditions. Compare irrigation methods (e.g. overhead, spray stakes, drip irrigation, subirrigation) to determine how they affect total water use, plant growth and quality, and runoff water quality. Identify methods to reduce water use, leaching, and runoff and quantify results from more efficient techniques. Develop new and optimize existing irrigation methods that are easily deployed in intensive plant production systems to provide growers with real-time information regarding water requirements and environmental conditions of their crops. Evaluate the compatibility of low-quality water with irrigation methods and systems. (3) Crop production runoff management. Address research and extension needs related to enhancing containment of production runoff and improving recycled water management by identifying and characterizing critical control points within production systems, further developing chemical, physical, and biologically-based water treatment technologies and providing BMP guidelines to mitigate adverse effects of sediment, agrichemicals, and pests in production runoff, irrigation reservoirs, and other water sources. (4) Urban stormwater. Improve the design of biological urban stormwater systems to better reduce and remediate stormwater runoff from various sources, addressing issues of water volume, intensity, quality, and reuse. Focus on the use of novel biological and engineered systems and materials (e.g. organic/inorganic substrates and amendments) which mitigate runoff and pollutants, as well as the use of woody and herbaceous plants, in single or combined (treatment train approach) systems in greenhouse, nursery, and urban production environments. (5) Soilless culture and nutrient management. Assess physical, chemical, and biological properties of soilless culture systems or components for their impact on plant health and vigor, water reuse and subsequent use efficiency, nutrient delivery and retention, crop fertility, and environmental impact for a variety of important controlled environment and urban crops throughout the U.S. Expand our knowledge of how soilless culture systems affect plant productivity, root growth, plant pathogen or weed pressure, and dynamic physicochemical properties including hydraulic conductivity, pH, cation and anion exchange, plant-water availability, gas exchange and moisture retention.

Project Methods

This is a highly collaborative team with many years of experience in multistate projects together in NC1186. Objectives present significant priority areas, and a few illustrative examples are provided.Objective 1. Water quality of irrigation sources· Work with external collaborators to gather, collate, model, and interpret runoff-related water quality data from nursery and greenhouse operations across the U.S., and analyze on a regional basis.· Assess risks associated with water quality parameters that influence plant growth and categorize their potential impacts on plant production through plant studies.· Assess water quality factors that affect accumulation of biofilm, algae, and plant pathogens on irrigation systems.· Evaluate commercial practices and emerging research-based technologies in order to identify best management strategies to:· monitor and interpret water quality;· manage high levels of salts, alkalinity and specific ions;· remediate agrichemical, pesticide, and other contaminants in conventional and alternative irrigation water sources;· provide geographic analyses and visualization of water quality issues for specialty crops;· successfully produce crops and maintain urban landscapes and gardens with low quality water sources, selecting plants/crops, irrigation practices and equipment most suitable to the chemical, physical and biological profiles of water sources available in each region.· SC has constructed replicated beds to measure water infiltration vs surface flow for 3

common bed materials· SC will continue to evaluate slow sand filters for plant pathogen and agrichemical removal· CA, FL, MD, and MI, and MISC will evaluate commercial irrigation reservoirs to develop case studies and best management practices on monitoring, including chemical quality, pesticide contaminants, turbidity, dissolved oxygen, and recommended remediation methods.· Lead collaborators: CA, CT, FL, MD, MI, NC, NJ, SC, TXObjective 2. Improved irrigation· Determine the irrigation efficiency and economic returns of various impact, micro, and drip irrigation systems.· Quantify water demand by plants based on evapotranspiration (ET) and other micrometeorological measurements.· Measure plant responses to drying substrates and detect the early onset of drought stress to determine when irrigation is needed. Plant parameters to be measured could include changes in stem caliper, leaf temperature, leaf reflectance, leaf transpiration, photosynthesis, and plant growth indices.· Quantify the effects of water-related biotic and abiotic stress on plant anatomical, morphological, and physiological responses to determine how plant quality is affected.· MD will lead multi-location efforts using soil moisture and EC sensors to measure real-time substrate water and nutrient status, to control irrigation, reduce application volumes and reduce nutrient leaching. · SC will test irrigation system efficiency for a number of impact, micro irrigation and drip irrigations systems. Distribution uniformity, wear over time, influence of wind and other parameters will be tested.· Lead collaborators: CA, CT, MD, MI, OR, SC, USDA-ARSObjective 3. Crop production runoff management· Identify, adapt, and assess select filtration and chemically- and biologically-based treatment technologies to manage nutrient, pesticide, particulate, pathogenic, and biological contaminants in production runoff.· Develop and evaluate treatment technologies at laboratory, pilot, and commercial scales, focusing on the performance of individual and integrated treatment systems.· Evaluate bioreactors hydraulic retention times and placement to improve water quality as appropriate to recycling (remove pesticides but retain nutrients).· Determine ideal combination and placement of treatment technologies in series to remove/remediate various agrochemicals from discharged water.· FL will evaluate efficacy of physical particle filters and flocculation to remove suspended particles and increase water clarity in case study commercial irrigation reservoir sites.· SC will use medium scale slow sand filters to determine their effectiveness at removing plant pathogens and agrichemicals from runoff water following protocols established by members of the group.· USDA-ARS will develop Fe-enriched substrates that sorb or to filter phosphates from container leachates or other off-site release (remove all agrochemicals).· Lead collaborators: CA, CT, FL, MI, SC, USDA-ARSObjective 4. Urban stormwater· Identify research priorities and needs related to urban stormwater management, based on survey responses and stakeholder input.· Develop and integrate treatment technologies for urban/green infrastructural stormwater management systems, which link stormwater reduction structures on rooftops (e.g., green roofs and urban farms) to micro-infiltration sites (e.g., bioretention cells and functional landscapes) at ground level.· This approach would combine precision irrigation management techniques (Obj. 2) with novel soilless culture techniques (Obj. 5) to maximize stormwater retention and minimize agrichemical runoff (Obj. 3).· Lead collaborators: CA, MD, SObjective 5. Soilless culture and nutrient management· Systematically assess static and dynamic physical or chemical properties of soilless culture systems, components or formulations employing existing and new techniques.· Develop an integrated model for soilless culture chemical or physical properties, crop nutrient requirements, irrigation regime, root development and plant water uptake, and agrichemical transport to maximize resource use efficiency and minimize environmental impact.· Incorporate emerging bioassay technologies to identify the microbial communities within soilless culture systems and understand the dynamic nature of these populations and subsequent influence on plant production.· Determine how irrigation or water management methods affect plant-water availability, runoff, and reuse.· Develop sustainable-substrate matrices utilizing existing and novel substrate components for specialty crop production in accordance with current market costs.· Assess the use of suitable organic and inorganic amendments for urban crop production and green infrastructure mitigation systems, to maximize stormwater retention and minimize agrochemical runoff.· Provide regional recommendations and best management practices for sustainable, affordable soilless culture systems that maximize resource efficiency, optimize crop growth, and minimize environmental impact.· Quantify mass balance, ion concentration, and nutrient delivery in recirculating hydroponic systems with varying water quality and discharge fractions.· USDA-ARS will develop techniques for extracting and purifying DNA or RNA from soilless substrates, and using these samples to quantify and visualize microbial communities in the substrate.· USDA-ARS and OH will evaluate the stability of bacterial and other microbial communities when intentionally added to substrates for plant-growth-promoting or plant-protection purposes.· FL will develop management strategies for

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maintaining pH, salt accumulation, and maintenance of nutrient solutions of reused or discharged solutions used in hydroponics.· KY will research nutrient delivery to container-grown ornamental and edible crops using compost amendments.· Lead collaborators: CA, FL, KY, LA, MD, MI, USDA-ARS