Managing Water Use & Quality in Specialty Crops

Greenhouse, nursery, and urban production systems, especially those using containers, hydroponics, or engineered substrates, often face challenges in efficient irrigation and fertilization management. Poor water and nutrient management wastes resources, raises production costs, and reduces crop yield and quality. Furthermore, excessive irrigation and fertilization can cause runoff and leaching that pollute surface and groundwater.

Researchers at land-grant universities across the country are working together to optimize irrigation and fertilization for greenhouse, nursery, and urban production environments.

Supported by capacity funding, the multistate project framework facilitates the coordination needed to address the complex issues facing the specialty crop industry. Working together enhances efficiency and impact. Project members can access expertise, resources, tools, and equipment from each other's institutions and a wider variety of crops and growing environments so they can offer more thoroughly tested solutions and tailored options. Project members have leveraged activities and insight from this group to secure several federal grants, which have generated transformative research outputs that directly support the U.S. nursery industry. Coordinated Extension and outreach efforts deliver research results and practical information to specialty crop growers, consultants, and other industry personnel nationwide.

By reducing resource use, shortening production timelines, and improving plant growth and quality, this work will enhance producer profits and maintain a steady supply of affordable, high-quality ornamental, medicinal, and edible plants for consumers. Better water and nutrient management will also reduce the industry's impact on the environment.

Multistate Research Fund IMPACTS

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Research Highlights

Project members determined the water quality and quantity requirements of various nursery, greenhouse, and urban production systems. They also identified plant varieties, container types, substrates, and precision tools and methods—including AI and sensors—that reduce water use, leaching, and runoff.

In particular, project members conceptualized and are leading national and global efforts in "stratified substrates," a technique that can reduce container crop water requirements by at least 25%. Project members have also been at the forefront of efforts to optimize container root systems through cyclical irrigation and using white plastic containers instead of black containers. These practices help lower rootzone temperatures, increase root and shoot biomass, and improve fertilizer efficiency, decreasing water use and agrochemical leaching while maximizing blooms.

Project members established baseline levels of forever chemicals (PFAS), microplastics, heavy metals, microbes, and other contaminants in irrigation water and runoff from nursery, greenhouse, and urban production systems. Researchers also created models to predict water quality issues and evaluated treatment and management options that reduce environmental and human health risks and improve the sustainability and efficiency of agricultural production.

Scientists shed light on ways to enhance the effectiveness of riparian buffers, bioreactors, and floating wetlands, which remove sediment, excess nutrients, and other contaminants from irrigation drainage and runoff before it enters retention and stormwater ponds. Researchers demonstrated that low-cost 300-gallon woodchip bioreactors can remove more than 95% of phosphates (the leading cause of freshwater eutrophication), 70% of pesticides, and some nitrate from irrigation runoff. Growers can tailor bioreactors to maximize contaminant removal while retaining valuable nutrients for reuse. Other studies showed substrate amendments with biochar and limestone reduce crop uptake of heavy metals.

Project members developed an online tool commercial nurseries can use to estimate the costs and benefits of installing a water recycling system. Recycling water can help reduce runoff and growers' input costs, but some agrochemical residues and pathogens can be toxic to plants when recycled, so the right data, tools, and infrastructure are key to determining the return on investment in this technology.

Project members improved stormwater systems for vertical farms, roof-top gardens, green roofs, and other urban production environments, where runoff volume and quality are highly regulated and have major economic impacts.

Outreach Highlights

To deliver research results and practical information to specialty crop growers, consultants, and other industry personnel, project members developed online and print materials, contributed to an online learning center, and conducted field days and workshops. Project members also made site visits to help growers monitor issues and implement tailored solutions.

Project members are developing a free online compendium of North American substrates to better inform growers and manufacturers about the variety, regionality, and properties of substrate components. The robust search engine helps users identify substrates by type and origin and compare two or more materials. AI will be incorporated to enhance website functionality.

Project members created the “Blooms and Beyond” podcast to share research results with growers in a timely manner. It also provides Spanish content to improve accessibility.

In 2025, online extension courses on irrigation and nutrient management, watering methods, and container substrates engaged 381 participants. Participants showed measurable knowledge gains and indicated plans to adopt practices that will reduce resource use and lessen environmental impacts.

Growers and communities are realizing the benefits of adopting research-based irrigation and fertilization tools and practices.

Based on research results, nurseries throughout the **eastern U.S.** adopted white containers. One early adopter found that switching to white containers cut container costs by **40%** and shortened production time by **30%**, saving an estimated **$5,100** to **$7,300** per acre per year.

Following a workshop, **Tennessee** nursery producers planned to improve substrate, irrigation, and fertilization management practices for container-grown nursery crops. Growers anticipate these changes will save an average of **$42,923** per nursery. The projected total economic impact across participating operations is nearly **one million dollars**.

After adopting recommended automated systems, a nursery in **Tennessee** reduced manual irrigation time and labor by **25%**. These systems also helped growers decrease nitrogen applications by approximately 30,000 grams across 10,000 plants.

Plant and irrigation trials across the **western U.S.** identified water-wise plants and strategies that have helped the nursery, greenhouse, and landscape industries comply with state water conservation regulations and reduce strain on state water budgets. Trial findings have also guided state landscape water use policy and permitting.

Using sensor-based systems, growers in **Oregon** and **Maryland** enhanced irrigation scheduling, improving water use efficiency and reducing runoff.

Growers in **South Carolina** and **North Carolina** adopted wireless technology to remotely sense and control irrigation of trees up to a one-quarter mile away. The technology allows more plants to be irrigated simultaneously and reduces pump run-time costs and labor costs.

California nurseries reported more uniform and healthier crops due to custom irrigation and fertilizer programs.

New substrate materials and stratification techniques helped **Florida** growers reduce water, fertilizer, and peat.

Precise data helped **Arkansas** growers schedule production timelines and refined the quality of container-grown ornamental and edible peppers for key markets.

As a result of research and outreach, over **74%** of conifer growers in the **Great Lakes region** are more confident in implementing practices to improve seedling survival, and over one-third of Christmas tree growers now apply wood chip mulch to support tree survival and growth.

Operations in **Virginia** and **Georgia** integrated new irrigation and integrated pest management tactics, which reduced resource use and production costs.

Research is being incorporated into **Michigan’s** highway planting management policy.

Data on water retention by green roofs were key to developing the contract price for **Maryland’s** stormwater retention credit program, which provides tax credits, rebates, and fee reductions for installing green infrastructure to manage stormwater.