Research Pre-Proposal

OREGON DEPARTMENT OF AGRICULTURE
OAN NURSERY RESEARCH COMMITTEE

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Principal Investigator:
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Title: The weight of water. Investigating gravimetric based irrigation control to improve water use efficiency in container production systems.

Collaborators:
Sam Doane, Production Horticulturalist, J. Frank Schmidt and Sons
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Background

Excessive leaching in container production systems flushes nutrients past the root zone, out of the container, and into streams and ground waters. Flushing nutrients represent significant economic losses in terms of wasted fertilizer and water. Fertilizers are one of the more expensive materials used in container plant production. Flushing nutrients is generally caused by over irrigation due to the lack of current technology based protocols. Excessive irrigation is known to promote the spread of water-borne plant pathogens that cause millions of dollars in horticultural crop losses every year. To improve nursery irrigation efficiency the Nackley Lab has begun conducting research on the application of sensing systems for automated and semi-automated control of irrigation.

During 2019, in cooperation with J. Frank Schmidt and Sons and with support from the OAN-ODA nursery grant, the Nackley lab initiated an in-field evaluation of soil moisture sensors for irrigation management. Soil moisture sensors (SMS) are robust sensing systems for field conditions in mineral soils. Many SMS may not be appropriate in container production systems because of the vastly different hydraulic properties of soilless media. For example, Douglas-fir bark mix, a common constituent in Oregon production systems, has a relatively high porosity compared to mineral soils. Many SMS lack precision in soilless media at lower water-levels making it difficult to use SMS to accurately to control deficit irrigation. Gravimetric methods, using lysimeters to collect pot weight data, is a very effective method of measuring water content in soilless media.

Checking the weight of a pot is one of the most basic methods of irrigation scheduling. Experienced growers will regularly pick up pots as they walk through a can-yard to get a feel for how to adjust the frequency of watering. However, finding an automated or semi-automated means of weighing pots would increase the consistency and efficiency of irrigation control given that each grower may have different thresholds; that there is an industry-wide shortage of laborers. We, therefore, propose the creation of a gravimetric based irrigation control system for research and outreach at the North Willamette Research and Extension Center (NWREC).

Project Objectives

1) *Establish a gravimetric-based irrigation control system in the Irrigation Classroom at NWREC.*

In the Summer of 2019, the Nackley Lab initiated the development of an Irrigation Classroom at NWREC. The Irrigation Classroom developed from conversations with OAN growers at NWREC and Far West about the general lack of adoption of sensor-based irrigation control by Oregon Nurseries. The initial building phase of the classroom has focused on soil moisture sensor based systems, because of our desire to share the information learned from our previous SMS research project. As mentioned above, the SMS research revealed the inadequacies of SMS for some container systems. Therefore we propose to expand the options of sensor-based irrigation control to include gravimetric measures which we deem more suitable for container systems that use coarse media like Douglas-fir bark.

2) *Use gravimetric sensors to determine the water demand for perennial ornamental species.*

One of the major causes of inefficient irrigation of specialty crops is a basic lack of information about the specific water required for optimal growth and yields. Sensor-based control systems can optimize irrigation schedules by triggering watering events to replace the water lost from the storage zone while minimizing excessive leaching. The volume of water required for plant growth fluctuates with environmental and physiological demand. For example, small young plants growing in cooler weather do not require as much water as large plants growing in hot weather. Therefore having real-time sensing platforms that can adjust the irrigation schedule to match the plants' demands will increase irrigation efficiency and reduce waste.

Our approach will be to irrigate the soilless media in the container to container capacity (CC) and then weigh the container to determine the maximum water-holding capacity. Then we will set four different thresholds for re-watering based on diferent dry-down percentage of CC. For example, re-watering can be scheduled to occur at 80%, 60%, 40%, and 20% of CC. The irrigation event will be based on the average of four replicates at each target level. We will re-set the CC weight every two-weeks to account for the increase in weight due to plant growth.

Methods and Time Line

- Spring 2020. Hire a student researcher, set up the research project.

  The proposal requests funds for 16 load cells and a data logger, as well as funds for miscellaneous consumables like pots, potting media, plants. Also, it is our experience that irrigation systems have to be customized for each experiment so we are requesting funds for irrigation parts too. For example valves, pipes and emitters. The student will work with support from Dr. Nackley and Mr. Hill to connect the system in the NWREC Cravo.

- Summer 2020: Dr. Nackley and students will test, validate, and refine the system. Demonstrate gravimetric-sensor based control to the industry at Nursery Production open house

- Autumn 2020: Data collection, observations.

- Winter 2020. Report writing, creation of Extension publications describing the method we established and plan for grower adaptation.

The Benefit to Nursery Industry

This proposal has been developed because 1) the recognition that container production is the most common production system according to a 2016 OAN survey of growers; and 2) the widespread hypothesis that most container-grown plants are overwatered. According to personal conversations with the project collaborators, there was previous research about gravimetric irrigation control with load cells. Unfortunately none of this research was archived or made available. We aim to fill this information gap. Fortunately, there is good theoretical, and experimental framework currently available for using gravimetric measurement in container systems which will increase the likelihood of the success if this project is funded. Improving agricultural water use efficiency is important because of increasing competition for freshwater resources, increasing occurrence of weather extremes, environmental pollution, and associated energy use and operating costs. At the farm level, a minimal improvement in irrigation efficiency can greatly increase profits, and in a broader context irrigation efficiency maximizes social benefit at a time of need.

Budget summary

Student(s) wages		$7,468
Other Payroll Expenses		$743
Materials and supplies		
Data logger		$1,600
Logger enclosure		$550
16 sensors and cables		$8,240
Consumables (valves, pipe, media, pots, plants)		$1,500
Plot fee		$1000
Publication fees		$900
	Total	$22,113