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Implementation of Wireless Sensor Networks for Real-Time Irrigation Management in Nursery and Greenhouse Production Environments

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Abstract:

Concern over the intensive use of groundwater, deterioration of surface waters and various state and federal nutrient and water management regulations, are making us re-examine the efficiency of irrigation management strategies in the nursery and greenhouse industry. Plant water requirements vary by day, season and microclimate, depending on any number of environmental and plant developmental factors; precision irrigation scheduling is extremely difficult, particularly when upwards of 400 species of plants are grown by a single operation. We have deployed and are optimizing three wireless sensor networks in field (soil), container and greenhouse (soilless substrate) production environments, to monitor real-time root and aerial environmental data on a wide-area basis. We are using these sensor networks to precisely monitor the real-time water use of plants with substrate moisture, temperature and electrical conductivity sensors. We are using a more advanced non-commercial network developed by Carnegie Mellon to automatically monitor and control irrigation and nutrient applications, by using soil matric potential measurements as set points. We have shown that this automatic monitoring and control can reduce water use, leaching of nutrients and overall runoff compared to cyclic irrigation (timed) irrigations, the current best management practice. This data can be accessed anywhere, and at any time, through a web-based graphic-user interface. Since the sensor nodes are portable, growers can rapidly deploy them in specific areas of the operation, to maximize the utility and cost of the sensors. Also, as these networks are scaleable, additional nodes can be added, allowing for an operation to grow and/or improve their sensor network at any time. We will discuss the features and cost of each sensor network, illustrate the data gathering capabilities and discuss data management issues. We will also discuss the installation, challenges and the utility of these networks for real-time decision making for growers.

Impact Statement:

We have deployed and are evaluating three wireless sensor networks to provide real-time data for irrigation management, and to reduce nutrient leaching from the root zone in ornamental production environments. Initial results have shown that irrigation water applications in container production systems can be reduced by at least 50%, with significant reductions in nutrient leaching. With further optimization, we anticipate that further significant reductions in water use are possible. Sensor networks will however require significant upgrades in hardware and software capabilities to make them more user-friendly and easily deployed by growers.

Category: Conservation and Resource Management
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