Soil moisture sensor-based irrigation reduces water use and nutrient leaching in a commercial nursery

Marc W Van Iersel
University of Georgia

Matthew Chappell
University of Georgia

Soil Moisture Sensor-Based Irrigation Reduces Water Use and Nutrient Leaching in a Commercial Nursery

Marc van Iersel[1], Rose Mary Seymour[2], Matthew Chappell[1], Frank Watson[3] and Sue Dove[1]

[1] Dept of Horticulture, University of Georgia, Athens, GA 30602
[2] Dept of Biological and Agricultural Engineering, University of Georgia, Athens, GA 30602
[3] Cooperative extension, McDuffie Co., University of Georgia, Thomson, GA, 30824

mvanier@uga.edu

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Significance to Industry: High quality irrigation water is becoming increasingly scarce and it is becoming more important to use the available water efficiently. One approach to more efficient irrigation is the use of soil moisture sensors to control irrigation. Soil moisture sensors can detect when the substrate water content drops below a grower-defined set point and can be used to automatically turn on the irrigation when needed. Using this approach on a hydrangea crop in a commercial nursery from May 6 – July 23, 2008 resulted in large water savings: plots irrigated using standard irrigation practices used 133,000 gallons during this period, as compared to only 23,300 gallons for plots with soil moisture sensor-controlled irrigation. Excessive irrigation in the control plots also resulted in more nutrient leaching: on June 13, substrate EC in control plots was 0.94 mS/cm, while substrate EC in soil moisture sensors-controlled plots was 1.51 mS/cm. Thus, soil moisture sensors are a highly effective tool for reducing both water use and nutrient leaching.

Nature of Work: Continuing population growth and increased urbanization threaten water availability for agriculture, including greenhouses and nurseries. Thus, efficient water use is increasingly important. More efficient irrigation practices not only reduce water use, but also save energy and reduce leaching and runoff of fertilizer. In addition, better water management may reduce the incidence of root diseases and may be used for growth control (Burnett and van Iersel, 2008). One method for improving irrigation practices is the use of soil moisture probes to open and close solenoid valves based on the amount of water in the substrate. The objective of this work was to quantify water savings that can be achieved using soil moisture probes for irrigation control.

Seven bays in an unheated greenhouse at a large commercial nursery were used for this research in spring and summer of 2008. Each bay contained several hundred 'Mini Penny' hydrangeas in #2 containers filled with a bark-based substrate. Irrigation in four of the seven bays was controlled with a Moisture Clik irrigation controller (IL200-MC, Dynamax, Houston, TX), which uses a dielectric soil moisture sensor (SM200) to measure substrate water content. Since these controllers use a single probe, irrigation in each bay was controlled based on the substrate water content in a single container.

The irrigation controllers were set to come on when the substrate water content dropped below approximately 0.20 $m^3 \cdot m^{-3}$. To prevent irrigation at night and keeping the foliage wet, the Moisture Clik controllers were connected to a timer to power the controllers from 8 am to 5 pm. Irrigation in the other three bays was controlled by nursery personnel, according to their regular irrigation practices. Each bay was equipped with a water meter, and irrigation volumes were recorded with dataloggers. Two soil moisture probes (EC-5, Decagon, Pullman, WA) were installed in each plot and connected to dataloggers (EM50, Decagon) to monitor the substrate water content. Substrate solution EC was measured with a SigmaProbe (Delta T devices, UK) on June 13. Other than irrigation, plants were produced using the standard cultural practices of the nursery.

Results and Discussion: Water savings from soil moisture sensor-controlled irrigation became apparent quickly (Fig. 1, top). During the first 10 days of the experiment, control plants received approximately 6200 gallons/bay, while plants irrigated using the Moisture Clik controllers received less than half of that amount. The Moisture Clik controllers also proved to be the more reliable system, since control plants did not get irrigated on May 17 and 18 (a weekend), during which the substrate water content in control plots dropped to as low as 0.05 $m^3 \cdot m^{-3}$ (Fig. 2). A more detailed look at the irrigation data shows that control plants were watered using a timer. On May 14, irrigation in the control plots came on for 20 minutes every hour from 8 am to 12 pm. Control plots received approximately 1200 gallons during this period, while Moisture Clik-controlled plots received less than 200 gallons during this same period. Differences in water use between the two treatments became larger during the summer, as the frequency of irrigation in the control plots was increased. Over the course of the experiment (May 6 – July 23), control plots received 133,500 gallons of water compared to 23,270 gallons in Moisture Clik-controlled plots, a savings of 83%. Overall, substrate water content in Moisture Clik-controlled plots was more stable than that in control plots (Fig. 2). Moisture Clik controllers not only reduced water use, but also reduced leaching. Substrate solution EC on June 13 was 0.94 mS/cm in control plots as compared to 1.51 mS/cm in Moisture Clik-controlled plots, indicating that more fertilizer had been leached out of control pots. Overall, these findings are similar to those of Ristvey et al (2004), who showed that using TDR probes for irrigation control resulted in water savings of 60-85% (with similar reductions in leaching of N and P) compared to cyclic irrigation.

Shoots of 16 plants per plot were harvested at the end of the experiment, and no differences in shoot dry weight or marketability were observed. However, these data may not be completely reliable, since all plants were pruned in early July, which may have masked differences in growth that could have occurred before then. An unexpected side effect of the Moisture Clik controllers was a drastic increase in weed pressure. We suspect that the excessive irrigation in control plots may have resulted in a water-logged soil and low survival of weed seedlings. Reducing the irrigation volume may have created more favorable conditions for weeds. Overall, this study shows that soil moisture sensors can be used in commercial nurseries to control irrigation. This can result in major water savings, although the exact magnitude of savings is likely to differ among nurseries due to differences in irrigation practices and crops. Future research will also address whether soil moisture sensors can be used to impose a mild, controlled drought stress that might reduce stem elongation and decrease the need for plant growth retardants.

Literature Cited

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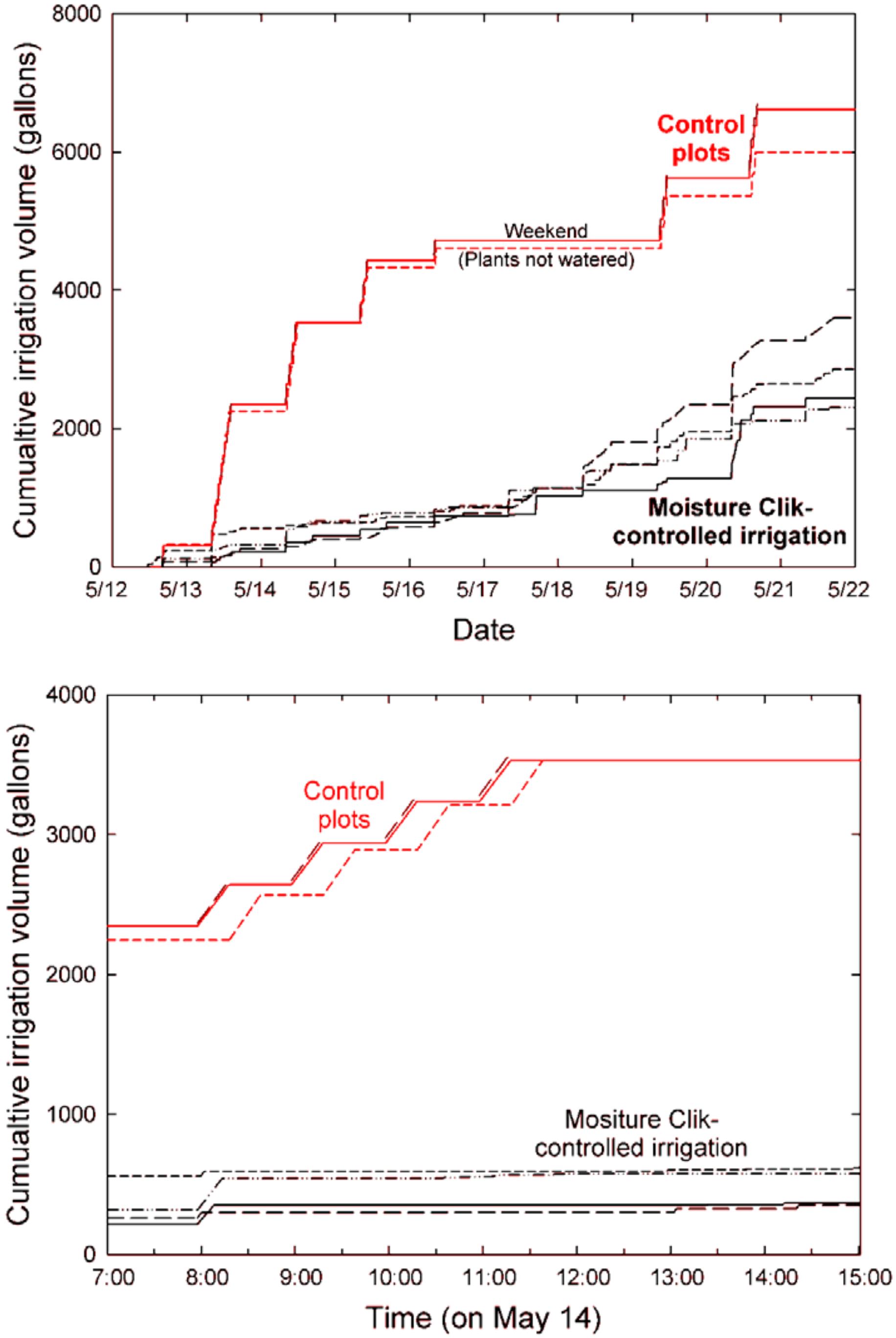

Figure 1. Comparison of irrigation volume using standard nursery practices (control) and using a Moisture Clik irrigation controller. The Moisture Clik applies water based on substrate water content. The top figure shows water use during a 10-day period, while the bottom figure provides more detailed data for a single day.

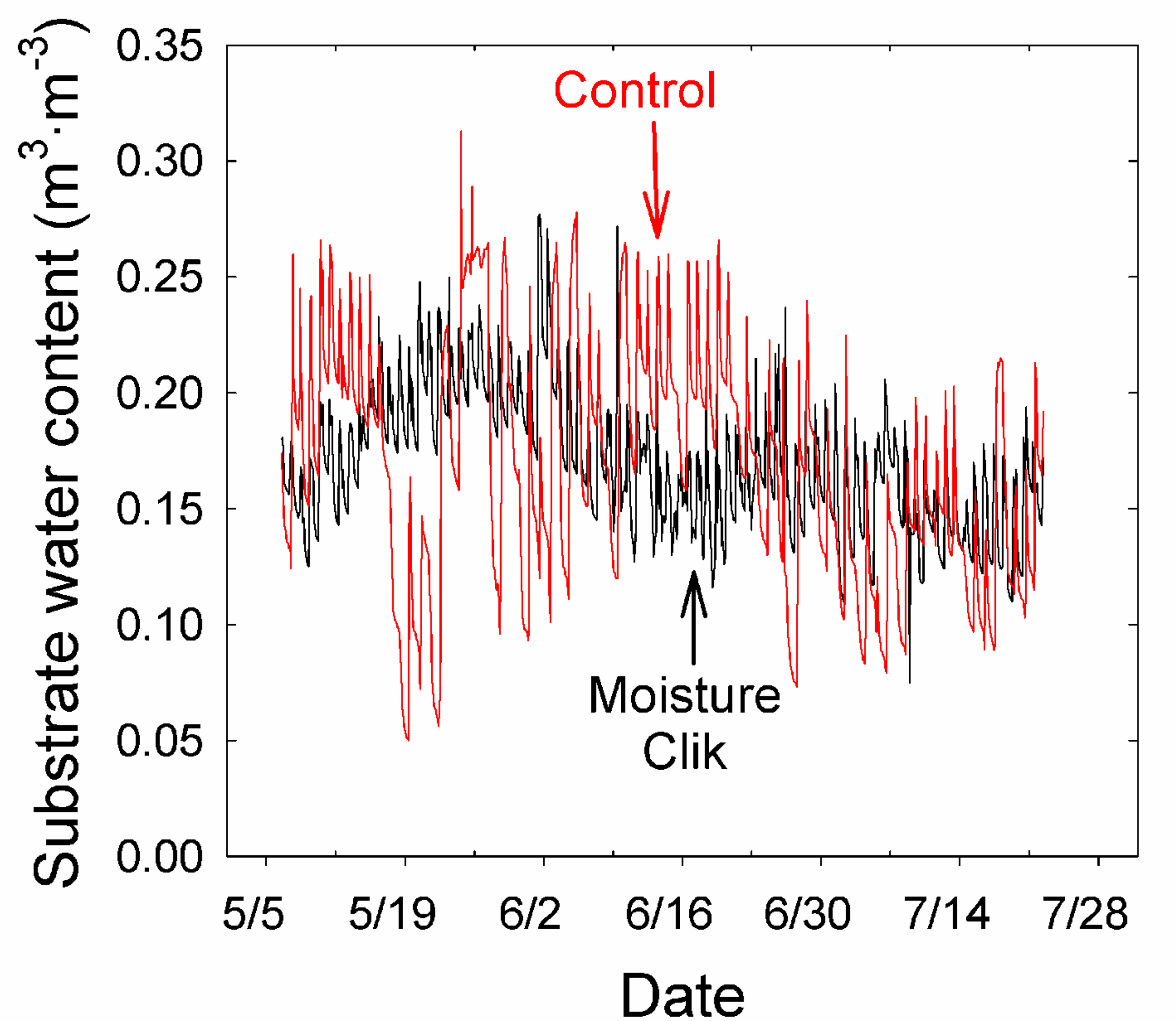

Figure 2. Substrate water content of hydrangeas irrigated using standard nursery practices (control) or irrigated using a Moisture Clik irrigation controller as measured with EC-5 soil moisture probes over a 2½ month period. Note that the Moisture Clik results in much more stable water contents in the substrate.