Irrigation of Organic Greenhouse Cucumber with a Low Cost Wireless Soil Moisture Sensor

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INTRODUCTION

- **Soil moisture sensors (SMS)** which are based on the measurement of soil dielectric properties to monitor water content or matrix potential of the root zone are alternative tools in irrigation management to increase WUE (Pardossi et al., 2009).
- By using soil moisture sensors to control irrigation, up to 50% of water can be saved, while maintaining crop yields and quality (Balendonck et al. 2010; 2013).
- Existing soil moisture sensors are relatively expensive, and while sensors only measure locally and moisture content may vary largely within a valve section (large special variability), their use can become very costly. Therefore, low cost soil moisture sensor is needed, particularly for small scale farmers (Balendonck, 2015).

AIM

The purposes of this study were to compare different irrigation strategies regarding WUE, and introduce a new low cost soil moisture sensor to keep the technology easily accessible for small-scale growers, and give them possibilities for saving water, fertilizer, energy and operational costs. The study was aimed at organic greenhouse cucumber irrigation scheduling since organic production has potential as a niche market for out-of-season produce due to the recent trends in consumer preferences for the high quality and safe products.

MATERIAL AND METHODS

Where: Faculty of Agriculture of Ege University
When: During fall and spring growing seasons of 2013-2014.
Crop: Cucumber (*Cucumis sativus* L.) cultivar TNT 1077 F1
Growing cycle:
AUTUMN: 5th of September - 21st of December 2013
SPRING: 4th of March - 06 June 2014
Soil: Sandy loam neutral in reaction and low in organic matter.
Treatments: Low cost, short-range, wireless soil moisture **sensor patented as AquaTag** (Sensortag Solutions, The Netherlands) was compared to **irrigation based on Class-A pan evaporation** in both growing seasons.
Experimental design: Randomized plots with 4 replicates.

In **sensor controlled irrigation**, soil water content was allowed to be depleted to 20% of available water content of the plant root zone. Totally ten sensors were placed in soil at 15 cm depth in two replications. Measurements were carried out once per day with the hand-held meter. Additionally four of soil moisture sensors (SM 200, Delta T-UK) were placed 45 cm depth in the same plots. Irrigation was started when the soil moisture level reached to 30% of soil moisture which was equal to %20 of water depletion of available water capacity of soil based on the average of five AquaTag sensors. Irrigations were terminated according to the calculation of water dose based on the data obtained from soil properties, root depth and wetted area of the system for the treatment.

In irrigation treatment based on **Class A Pan evaporation**, Class A pan was located inside the greenhouse. Irrigation intervals varied from 3 to 4 days in this treatment (twice irrigation in a week). The equation for the calculation of amount of irrigation water is given below

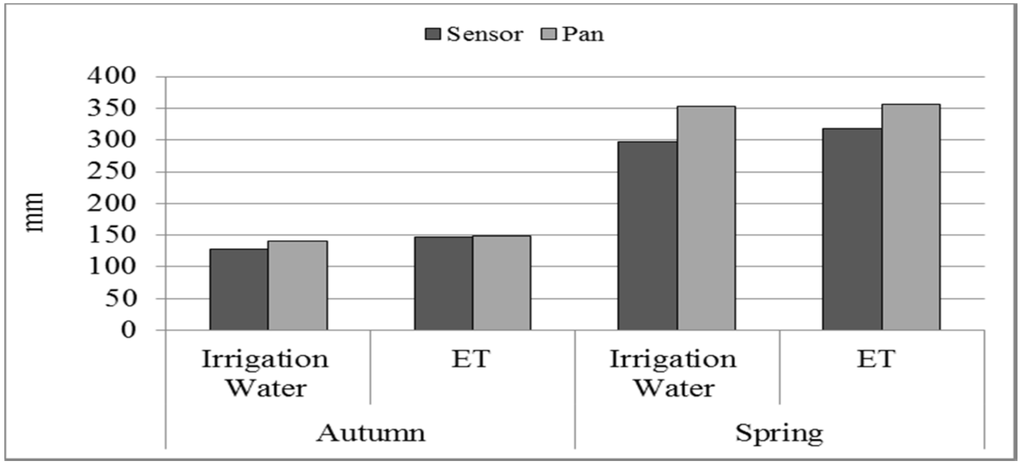
$$I = A * Epan * kcp$$

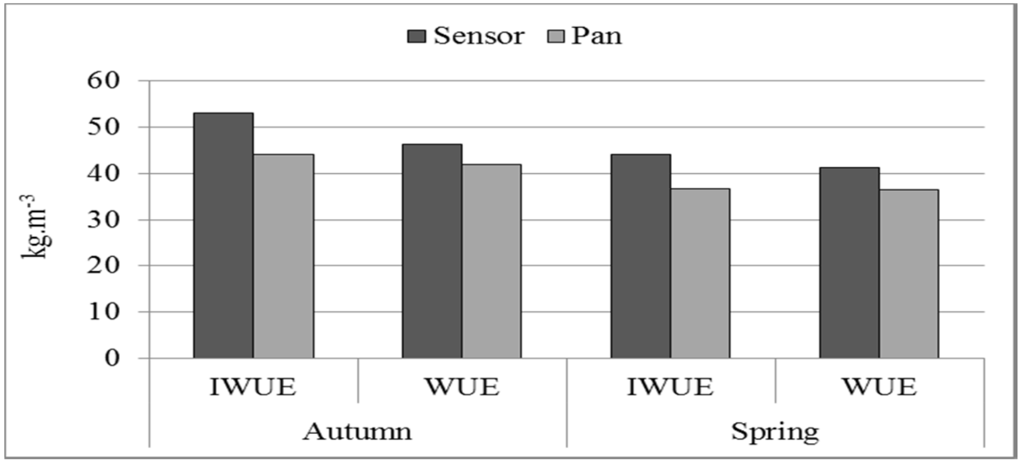
RESULTS

Effects of treatments on yield parameters

Treatments	Fall			Spring		
	Yield (kg m^{-2})	Total fruit number (no m^{-2})	Average fruit weight (g)	Yield (kg m^{-2})	Total fruit number (no m^{-2})	Average fruit weight (g)
Sensor	6.81	77.2 a	88.1 b	13.12	131.8 a	99.6 b
Pan	6.21	66.7 b	92.9 a	12.96	111.0 b	117.3 a
P	*0.163*	*0.024*	*0.024*	*0.892*	*0.000*	*0.000*

Effect of different irrigation strategies on applied irrigation water amount, crop evapotranspiration and water use efficiencies





CONCLUSION

- According to overall results of two consecutive cycles, **a higher yield with less irrigation water volume was obtained from the sensor controlled irrigation treatment.** This lead to higher water use efficiencies based on total yield in this treatment. Calculated average water-saving ratio in sensor controlled irrigation treatments in comparison with Class-A pan practice showed that it could be obtained **17 % water saving with sensor controlled irrigation** in both growing seasons.
- With respect to the application of root zone sensors in irrigation at farm level, it seems that the use of this technology will take some time, since the costs for the equipment are still relatively high for small size farms. Moreover, effective policies for the dissemination and transfer of smart water application technology to commercial operations, including grower training are needed.
- Therefore, **a low cost, short-range, wireless soil moisture sensor (AquaTag) seems to be promising** because of keeping the technology easily accessible for small-scale growers, and give them possibilities for saving water, fertilizer, energy and operational costs for irrigation scheduling