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Growth of Petunia as Affected by Substrate Moisture Content and Fertilizer Rate

Alem Peter [1], Paul Thomas [1], Marc van Iersel [1], and Stephanie Burnett [2]
[1] Department of Horticulture, University of Georgia, Athens, GA 30602
[2] Department of Plant, Soil, and Environmental Sciences, University of Maine, Orono, ME 04469

BACKGROUND

The cost of producing floriculture crops has increased due to increased cost of labor and fertilizer. Water scarcity and increasingly strict regulations regarding runoff pose additional challenges to greenhouse growers. Excessive irrigation causes most of the leaching and runoff of fertilizers and pesticides. In addition, the leaching of fertilizers is more prevalent when fertigation is used, but it can also occur with controlled release fertilizers. The resulting runoff poses a threat to ground and surface water quality, and many states regulate this runoff. Efficient irrigation methods reduce leaching and, thus, the amount of fertilizer needed to grow the plants. Reduced irrigation runoff also minimizes the environmental impact of greenhouse production and can reduce the cost of production.

In the past, irrigation automation has been a challenge due to a lack of accurate methods to measure substrate water content. With advances in sensor technology, we have been able to develop automated irrigation systems that can maintain substrate water content at a specific, grower determined level. Using this method, leaching can be prevented, but growers can leach when deemed necessary. This technology provides exciting opportunities for growers. However, fertilizer management may need to be altered, since excess fertilizer salts might no longer be leached from the substrate.

Fig. 1. Overview of the study in the greenhouse at the University of Georgia.

The objective of this research was to quantify the interactive effects of different fertilizer rates and substrate water contents on the growth of petunia under zero-leaching conditions. As part of this research, our goal was to develop guidelines for fertilizer rates and substrate water contents that can be used to grow high quality bedding plants.

MATERIALS & METHODS

Petunia ‘Dreams White’ seedlings were obtained from a commercial grower. Twenty-four seedlings were transplanted into rectangular containers (36 cm × 24.4 cm × 10 cm), which were filled with a peat: perlite (80:20) substrate. The substrate was kept well-watered during the first week after transplanting to stimulate growth of the seedlings.

Prior to transplanting, different amounts of a controlled release fertilizer (Osmocote 14-14-14) were incorporated into the substrate (0, 5, 10, 15, 20, 30, 40 and 60 g/container; 0 to 2.5 g/plant). Starting one week after transplanting, irrigation was controlled using an automated, sensor-controlled system. Soil moisture sensors were inserted diagonally into the substrate in each container. The sensors were connected to a datalogger and measured every 10 minutes. When the water content was below the set point, the datalogger opened an irrigation valve for 20 seconds to irrigate the container. Irrigation set points were 10, 20, 30, and 40 % water content. The EC of the substrate solution was measured multiple times during the study, using an *in situ* sensor (W.E.T. sensor). After 23 days, the plants were harvested for growth measurements.

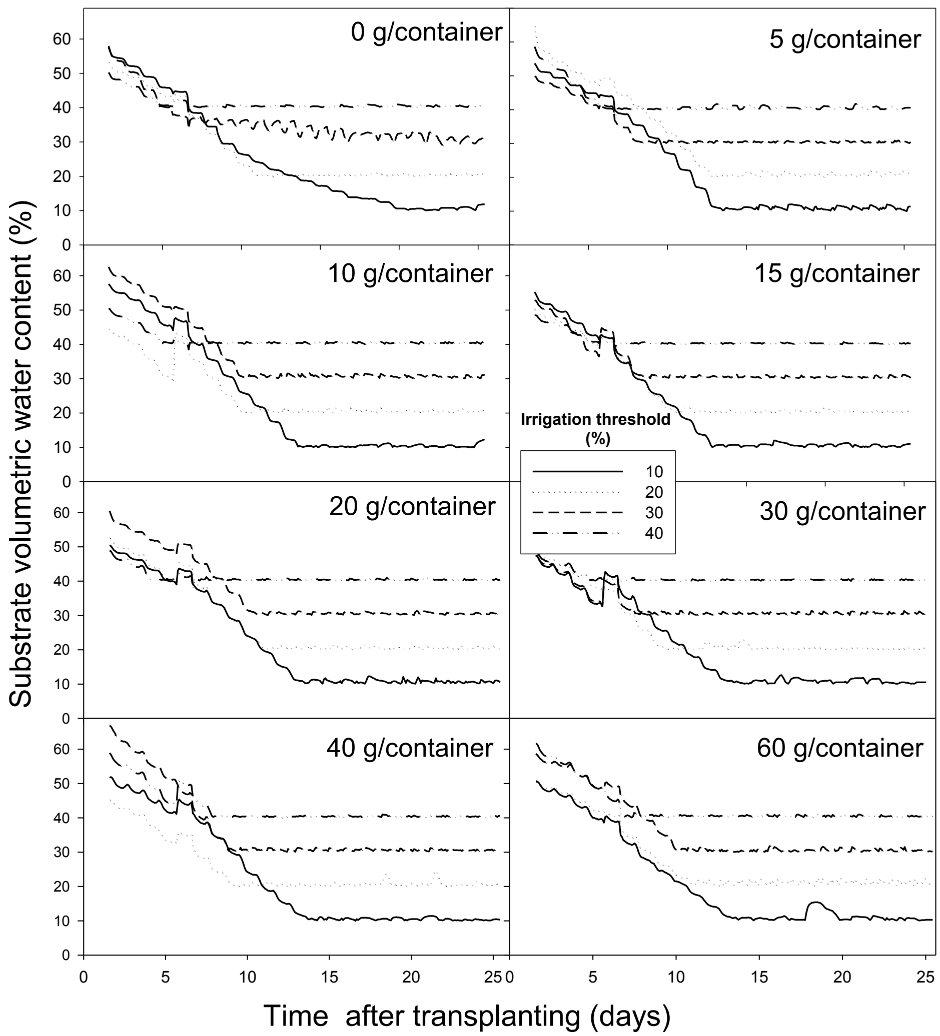

Fig. 2. The substrate water content as maintained by a soil moisture sensor-controlled automated irrigation system. Different fertilizer rates (0 to 60 g/container) were used to study the effects of substrate water content and fertility on petunias.

RESULTS

The use of an automated, sensor controlled irrigation system maintained the substrate water content at precise levels (Fig. 2). The combination of different substrate water contents and fertilizer rates greatly impacted growth of petunias.

Shoot dry weight reached a maximum at fertilizer rates of 1.3 to 1.7 g/plant and decreased at higher fertilizer rates (Fig. 3). The decrease in shoot dry weight at high fertilizer concentration may have been caused by salt stress. Pore water EC was approximately 3.1 to 3.4 mS/cm in treatments with the highest shoot dry weight (Fig. 4). Substrate water content had a significant effect on plant growth. : There was an approximately a 66% increase in shoot dry weight as the water content set point increased from 10 to 40%.

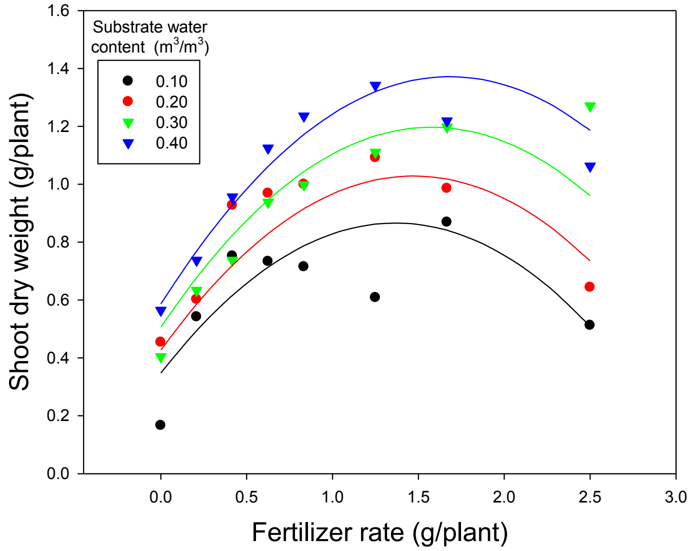

Fig. 3. Shoot dry weight of petunias grown with different rates of controlled release fertilizer at four different substrate water contents. Colored lines indicate the result of regression analysis.

The size of fully expanded leave increased both with increasing substrate water content and with increasing fertilizer concentrations. Substrate water content had the most impact on leaf size, which doubled as the VWC set point increased from 10 to 40%. Leaf area increased by 16 – 34% as the fertilizer rate increased from 0 to 2.5 g/plant. This confirms our earlier findings that leaf size is a very sensitive indicator of drought stress. Plant water use was greatly affected by substrate water content, and increased from 120 to 375 ml/plant (over the entire 23 day period) as the set point increased from 10 to 40%. This corresponds to an average irrigation volume of 5.2 to 16.3 ml/plant/day. Daily water use was also influenced by weather conditions. Warmer, brighter days resulted in higher water use.

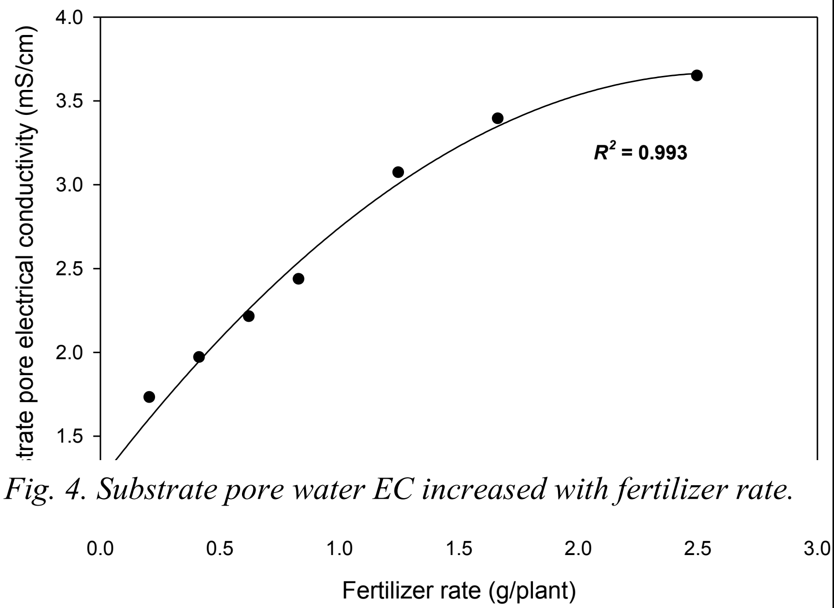

Fig. 4. Substrate pore water EC increased with fertilizer rate.

Flowering. Flowering of plants generally decreased with increasing fertilizer rates (Fig. 5). Since flowering is an important quality characteristic for petunias, growers must balance flowering and shoot growth. Shoot growth is maximized at fertilizer rates that inhibit flowering of petunia.

Important plant characteristics in commercial production, like height, leaf area and flowering, are affected by water and nutrition. Thus, maintaining a balance is critical for the production of high-quality plants. Balancing fertilization and irrigation is a challenge for many commercial greenhouse and nursery growers. Growers often use higher fertilizer rates and more water than the plants require. The result may be tall, overgrown, delicate plants that require growth regulators, adding to the cost of production. Growers can grow plants with lower fertilizer rates if leaching is minimized, and soil moisture sensors can help to achieve this. With no leaching, we grew high quality petunias with the fertilizer as low as 0.8 g/plant (20 g/tray, 7.1 lbs/yd^3 of substrate). Higher fertilizer levels reduced flowering and plant quality (Fig. 5)

CONCLUSIONS

Soil moisture sensors can be used to control irrigation and minimize leaching with petunia. Using sensor-controlled irrigation, it is possible to maintain the substrate water content at precise, grower-determined levels. In general, plant growth increases with increasing water content, but the combination of high substrate water content and high fertilizer rates resulted in excessive vegetative growth and poor flowering. The best quality plants were grown at substrate water contents of 30 or 40% and controlled release fertilizer incorporated at 3 – 7 lbs/yd^3.

IMPACTS TO THE INDUSTRY

A large percentage of fertilizer applied to plants can be lost through leaching if excessive irrigation is used. Soil moisture sensor-controlled irrigation can significantly reduce or even eliminate leaching. If leaching is reduced, growers should be able to use lower fertilizer rates to grow their crops. This will result in significant financial savings.

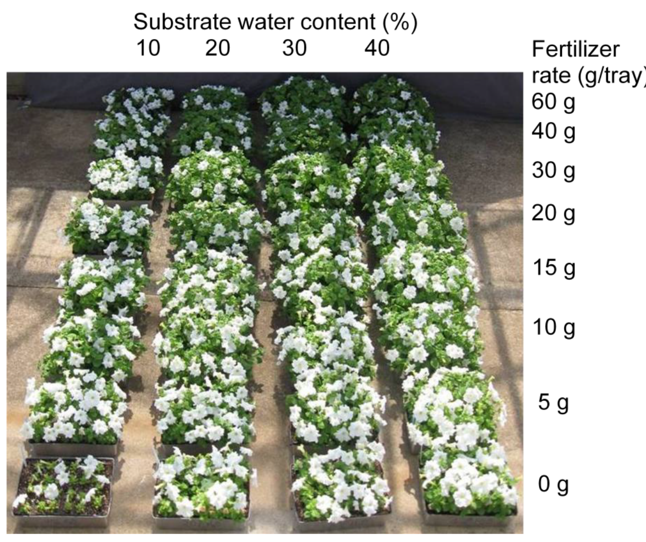

Fig. 5. Appearance of petunias grown with different rates of controlled release fertilizer and at four different substrate water contents. Plant growth increased with increasing substrate water content, but flowering was reduced with high fertilizer rates.

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For additional information contact mvanier@uga.edu

American Floral Endowment
Phone: 703.838.5211
Fax: 703.838.5212
www.endowment.org
afe@endowment.org