WATER USE

EFFECT OF CONTAINER DRAINAGE AREA ON GROWTH, APPEARANCE, WATER USE AND LEACHATE OF PETUNIA (*Petunia x hybrida*) AND LEMON THYME (*Thymus pulegioides* L.).

Abstract

Plastic containers have revolutionized the nursery industry and have several advantages over other types of containers, among them, increased water retention in the media when compared to more porous containers, versatility and convenience for transportation to retail centers and from the retail centers to the consumer's home. Plastic containers vary in shape and size, as do the position and size of drainage holes. Plants require a sufficiently aerated medium to thrive; as such, the main factor influencing aeration is the potting medium. Other factors, however, such as drainage holes, influence aeration. Water shortages in the United States and particularly in California require growers to become more efficient in their water use. Some growers have expressed concerns that more drainage holes in a container result in "wasted" water. This perception could lead to the rejection of containers with larger drainage holes with the belief that an increased amount of water and frequency of irrigation will be required; however, additional drainage in a container might result in better plant quality due to the increased root aeration and increased salt leachate. We studied growth characteristics for petunia (greenhouse and nursery grown) and thyme (greenhouse grown) using two different peat-based media in two types of plastic containers with different drainage areas. Irrigation frequency was determined based on a calibration curve, and the amounts of water applied and leached were monitored. Quality ratings, shoot and root fresh and dry weights, number of flowers, and volume were measured. Container drainage and potting medium affected the amount of water retained, used, and required. It also affected plant size. Plants in containers with more drainage area required more frequent irrigation but less water per irrigation. Leachate, plant quality and shoot weight were not affected by drainage area or potting media. Drainage area and potting media affected root weight. Containers with more drainage resulted in plants with heavier roots than those grown in containers with less drainage. Good quality plants can be produced in containers with high or low drainage area. It is possible to grow good quality plants in containers with more drainage area and using less water per irrigation. Irrigation frequency and amount of water applied need to be adjusted depending on the drainage area of the container selected.

Objective:

- Determine if container drainage area affects plant water usage, leachate and plant quality.

Materials and Methods

Plant Type and source:

Petunia 'Picotee Purple' in 806 containers and lemon thyme plugs were obtained from a local grower.

Pot type and potting media:

Two types of containers similar in color and in two different sizes were tested. For the greenhouse production trial the containers had a capacity of 1.34 (Poppelmann Plastics LLC, Claremont, NC) and 1.37 quarts (Dillen Products, Middlefield, OH). The drainage areas were 13.6 cm^2 (12 holes) and 7.6 cm^2 (8 holes) respectively. The pots tested in the lemon thyme greenhouse production trial were 1 quart in volume and had 10.4 cm^2 (Poppelmann Plastics LLC, Claremont, NC) and 6.9 cm^2 (Dillen Products, Middlefield, OH) of drainage area. Sunshine Mix #1 (78% peat 22% perlite, Sun Gro Horticulture, Bellevue, WA) and Pro-Mix Mycorise Pro (Premier Horticulture Inc., Quakertown, PA) were used as growing media for the greenhouse production trials; Sunshine Mix #1 with 5lbs of slow release fertilizer per cubic yard (Sun Gro Horticulture, Bellevue, WA) was used for the nursery field trial.

Greenhouse Production Trial:

The treatments tested were:

- 8 holes + Sunshine
- 8 holes + Pro-mix
- 12 holes + Sunshine

- 12 holes + Pro-mix

Ten plants of petunia per treatment were transplanted and placed in a climate controlled greenhouse at 75/65 ºF day/night temperature, ambient light and humidity. They were fertilized with 200ppm N of 20-10-20 once a week. Average height (H), width at the widest point (W1) and width perpendicular to the widest width (W2) of each plant was measured at transplant and 4 weeks after transplant, which was used to calculate the volume of each plant (V=HxW1xW2). A fresh weight of roots and shoots was taken, followed by oven drying at 65ºC until dry or approximately 48 hours. Dry weight was then recorded. The overall quality of the plants was assessed by using a scale from 1 (dead) to 5 (mounded, proportional form, with good density, ground coverage and attractive appearance).To determine the frequency of irrigation and the amount of water used per plant per irrigation, a calibration curve for each treatment was determined. Ten plants per treatment were watered to saturation, allowed to drain for 10 minutes and weighed. During the next two days, the pots were weighed every 4 hours during the day and then every 12 hours until the plants needed water based on their appearance. The moisture content of the media was measured at the same intervals with a WaterScout SM 100 sensor (Spectrum Technologies, Inc.). The irrigation frequency for each treatment was calculated by counting the number of hours from saturation to the moment the plants needed water. Once plants filled the pots the frequency of irrigation was determined by plant appearance and by measuring the % moisture content of 4 pots per treatment. The amount of water used by the plant and lost by evaporation was calculated by subtracting the weight of the medium contained in the pots when the plants needed water from the weight of the medium at saturation. The plants were watered by hand and the amount of water applied was measured by placing four containers among the plants, measuring the time each plant was irrigated until run off occurred and then placing the watering wand in the container for the same length of time. The water collected was measured using a graduated cylinder. The amount lost by leachate was calculated by subtracting the amount of water used per plant from the amount of water applied per irrigation. These steps were performed every time water was applied to each treatment.

Nursery field trial:

Twenty plants of petunia were transplanted into two types of containers as described for the greenhouse production trial. Plants were placed outdoors in a commercial operation and grown using standard practices. The plants were watered using a sprinkler system and the frequency of irrigation determined visually by the aspect of the plants and medium. Ten plants per treatment were randomly selected and the number of flowers, average height (H), width at the widest point (W1) and width perpendicular to the widest width (W2) of the plants was measured 5 weeks after transplant. Volume, shoot and root fresh and dry weight and quality were measured as previously described.

Lemon Thyme Greenhouse Production Trial:

Forty plugs of Lemon Thyme were planted in two types of 1 quart containers filled with Sunshine #1 mix. The combination of pots and media resulted in a total of four treatments with ten plants per treatment. Plants were placed in a climate controlled greenhouse at 75/65 ºF day/night temperature, ambient light and humidity and fertilized with 200ppm N of 15-5-15 once a week. The plants were watered by hand and the frequency of irrigation determined by inspecting the plants and the medium in each pot. Six weeks after planting, a fresh and dry weight of roots and shoots was taken as previously described.

Experimental Design and Data Analysis:

All plants were placed in a complete randomized design. Greenhouse experimental data were analyzed using SAS version 9.1 (SAS System). Proc GLM was used to do the analysis of variance and Student's t-test (p=0.05) was used to separate means. Outdoor experimental data was analyzed using JMP version 8.0 and Student's t-test (p=0.05) was used to separate means. A logarithmic transformation was used on all variables studied. When the interaction between pot drainage and potting media was not significant and only the effect of pot or potting media was significant, results are presented for the data pooled by pot or medium.

Results

Greenhouse Trial: Based on the calibration curve, recently planted petunia plants needed water when the medium moisture content reached 32 to 34% (Figure 1). Plants in 12-hole pots required water every 4 days during the first two weeks, while plants in 8-hole pots required water every 5 days. The frequency of irrigation progressively decreased when the plants filled the containers. The amount of water used per plant was different among treatments (Figure 2). This is related to the water holding capacity of the medium in

each pot. Pots with less drainage area retained more water than pots with more drainage area, Pro Mix medium retained more water than Sunshine mix. Twelve-hole pots dried more often that 8-hole pots, requiring more irrigations; however, they required less water per irrigation for run off to occur. The amount of water applied per plant was dependent on pot type; the interaction between medium and pot type was not significant. Pots with less drainage area required more average water per irrigation than pots with more drainage (Figure 3). This is probably due to the need to apply more water per plant for run off to occur in pots with less drainage. The amount of water leached was similar in all treatments and was not affected by type of medium or pot drainage area (Figure 4). Plant volume and root fresh weights were influenced by pot drainage but not by medium. Plants in pots with less drainage had more volume, which indicates a bigger plant size, than plants in pots with more drainage (Figure 5). Shoot fresh and dry weights were similar in both types of pots (Figures 6 and 7). Root fresh weight was higher in plant grown in pots with more drainage than in plants in pots with less drainage area (Figure 6). However, root dry weight was similar in both groups of plants (Figure 7). All plants had similar quality ratings. The general aspect of the plants can be seen in Figure 8.

Outdoor Commercial Production Trial: Petunia plants in the field required water every day, all plants received the same amount of water; which was applied by turning the sprinklers on between 10 to 20 minutes depending on the weather and water need. Plants grown in containers with extra drainage holes had more flowers per plant than the plants grown in the containers with less drainage area (Figure 9). All plants had similar volume and shoot fresh and dry weight; however, root fresh and dry weight of plants in containers with more drainage were significantly higher than those of plants in containers with less drainage (Figures 10 and 11). The general appearance of the plants can be seen in figure 12.

Lemon Thyme Greenhouse Production Trial: All plants had similar root fresh and dry weight and shoot fresh weight. Plants in pots with less drainage had higher shoot dry weight than the plants grown in pots with more drainage area (Figure 13), however, this difference was not due to pot type but to the medium used; Pro mix retained more water than Sunshine mix and resulted in higher dry weight of shoots. All plants were similar in size and quality. The general appearance of the plants can be seen in figure 14.

Conclusions

- Water used per plant per irrigation was affected by pot type and medium. Water retention was higher in pots with less drainage than in pots with more drainage and higher when using Pro Mix than Sunshine mix. However, container drainage area did not affect the amount of water petunia plants used during the growth cycle. Although plants in containers with more drainage required more frequent irrigation, they required less water per irrigation.
- Container drainage did not have an effect on the amount of water leached per pot.
- Petunia plants in the greenhouse and grown in containers with less drainage were bigger (higher volume) than plants in containers with more drainage area; however, petunia and lemon thyme plants in each pot type and under standard commercial practices were similar in volume.
- Petunia shoot fresh and dry weights were not affected by container drainage. Lemon thyme shoot dry weight was not affected by drainage area but by medium type. Shoot dry weight was higher in plants grown in Pro mix than in plants grown in Sunshine mix.
- Petunia root fresh weight was higher in pots with more drainage. Root dry weight in greenhouse-grown petunias were similar among container types, however, field-grown petunias had higher root dry weight when grown in containers with more drainage.
- Plant quality was the same in all plants and was not affected by growing mix or drainage area.
- Good quality petunia plants can be grown in containers with more or less drainage area with similar amounts of water leached. It is possible to grow plants in containers with more drainage area and using less water per irrigation when there is close monitoring of the water applied ad the frequency of irrigation. Irrigation frequency and amount of water applied needs to be adjusted depending on the drainage area of the container selected.

Figure 1. Percent moisture content of two potting media from two types of pots planted with petunia at various times after saturation. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Two types of media were used, Sunshine mix #1 (SG) from Sun Gro Horticulture or Pro Mix (Pmix) from Premier Horticulture Inc.

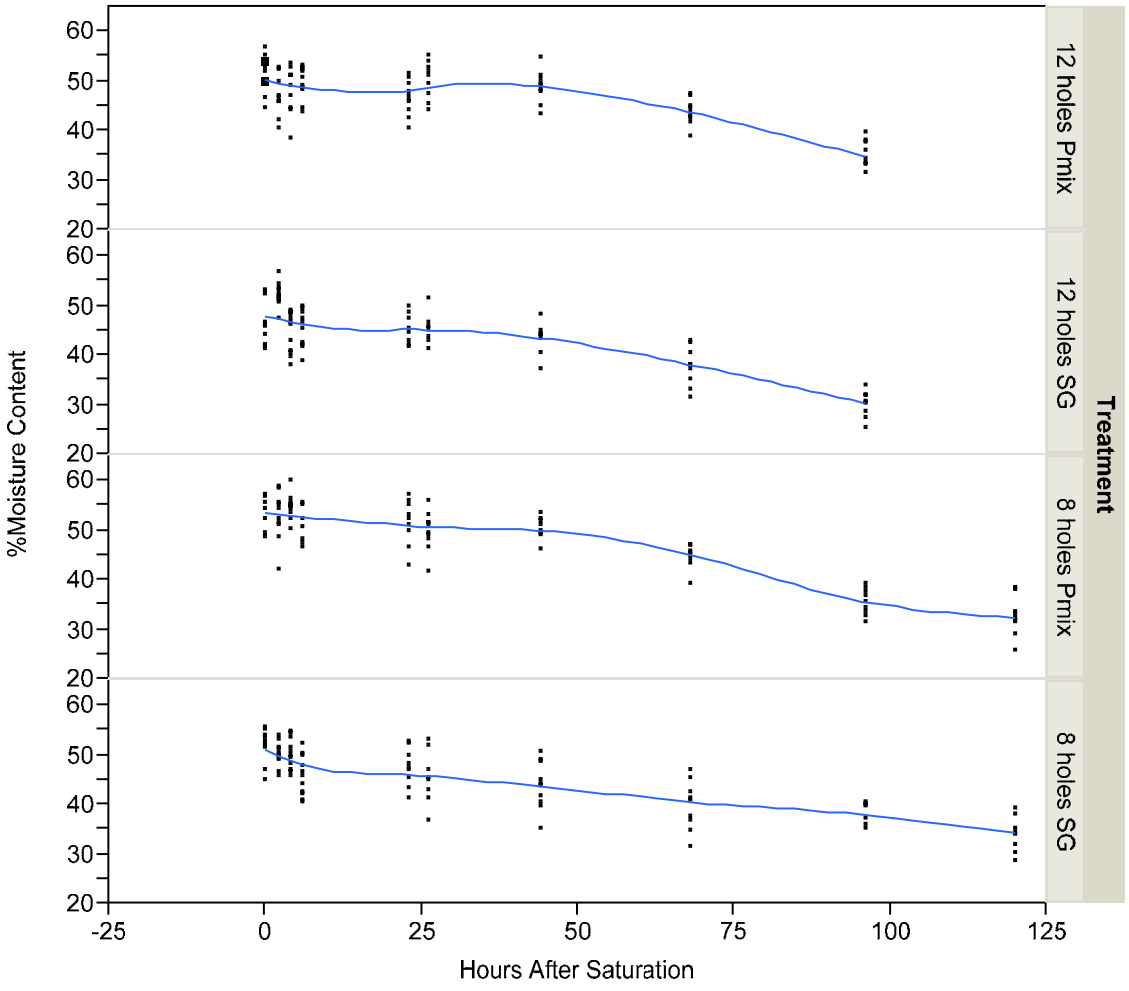

Figure 2. Mean (±SE) amount of water used per plant per irrigation. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Two types of media were used, Sunshine mix #1 (SG) from Sun Gro Horticulture or Pro Mix (Pmix) from Premier Horticulture Inc. Bars followed by different letters are significantly different, t-test (p=0.05).

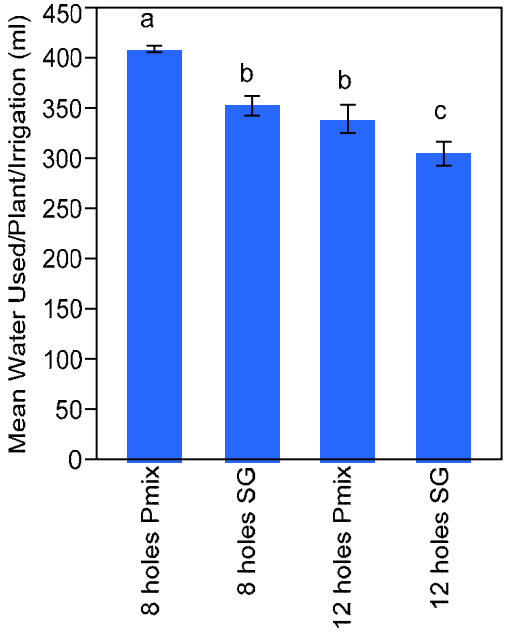

Figure 3. Average (± SE) logarithm of the water amount applied per treatment per irrigation. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

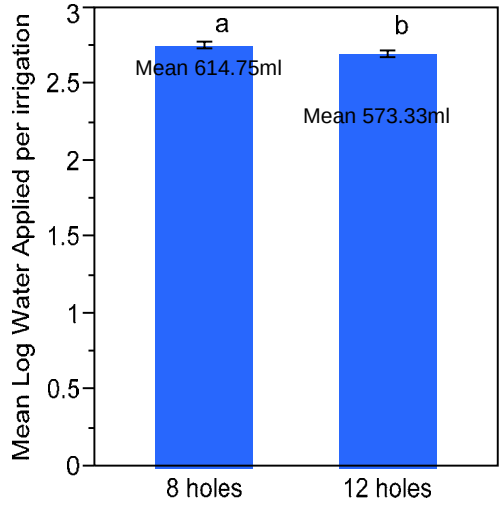

Figure 4. Mean (±SE) water amount leached per plant. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

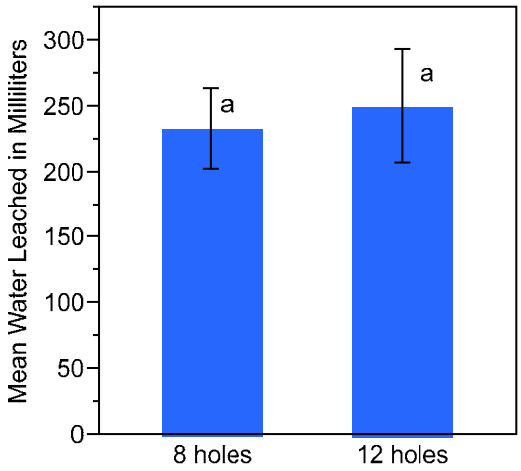

Figure 5. Mean (± SE) volume of petunia plants four weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

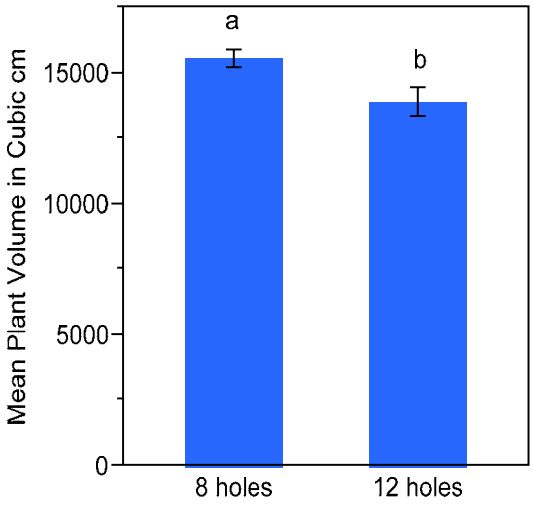

Figure 6. Mean (± SE) shoot (SFW) and root (RFW) fresh weight of petunia plants four weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

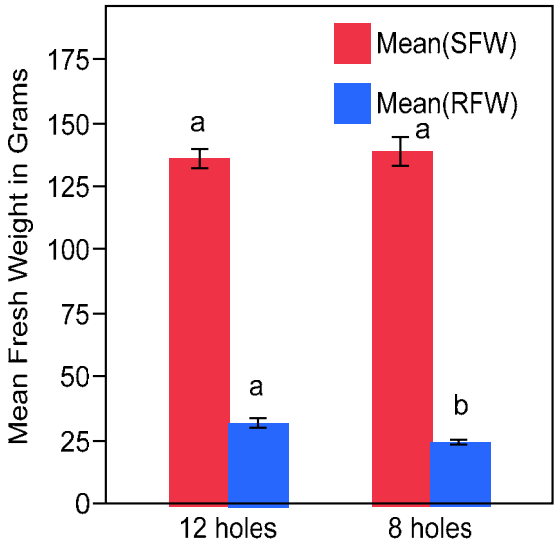

Figure 7. Mean (± SE) shoot (SDW) and root (RDW) dry weight of petunia plants four weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

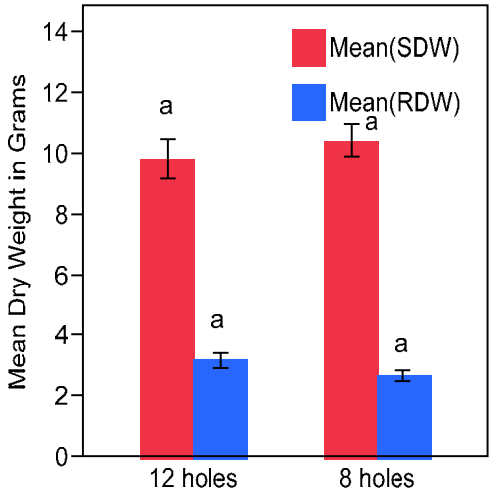

Figure 8. Petunia plants four weeks after planting. Two types of pots were used, one with 12 holes (A, 13.6cm^2 open drainage area) and 8 holes (B, 7.6cm^2 open drainage area). Two types of media were used, Sunshine mix #1 (2) from Sun Gro Horticulture or Pro Mix (1) from Premier Horticulture Inc.

Figure 9. Mean (± SE) # flowers of field-grown petunia plants 5 weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

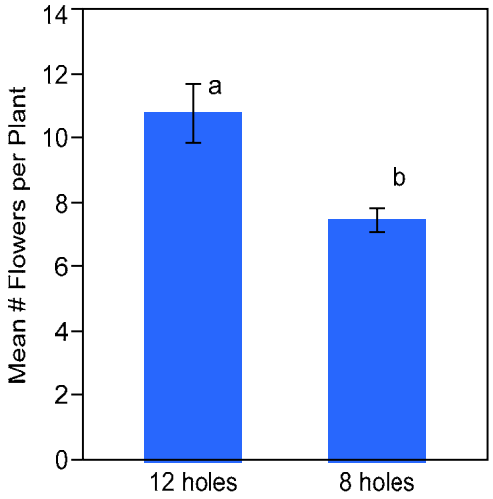

Figure 10. Mean (± SE) shoots (SFW) and roots (RFW) fresh weight of field-grown petunias 5 weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

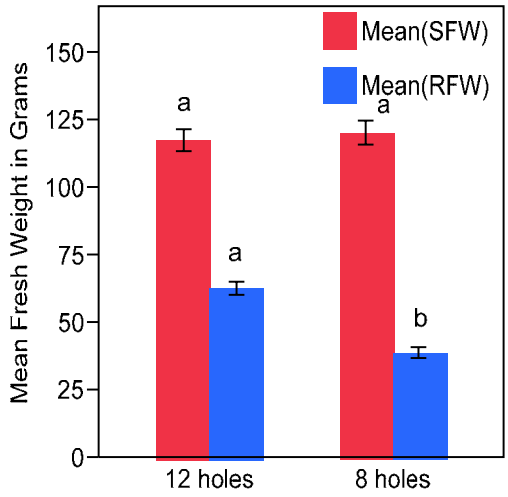

Figure 11. Mean (± SE) shoots (SDW) and roots (RDW) dry weight of field-grown petunias 5 weeks after planting. Two types of pots were used, one with 12 holes (13.6cm^2 open drainage area) and 8 holes (7.6cm^2 open drainage area). Bars followed by different letters are significantly different, t-test (p=0.05).

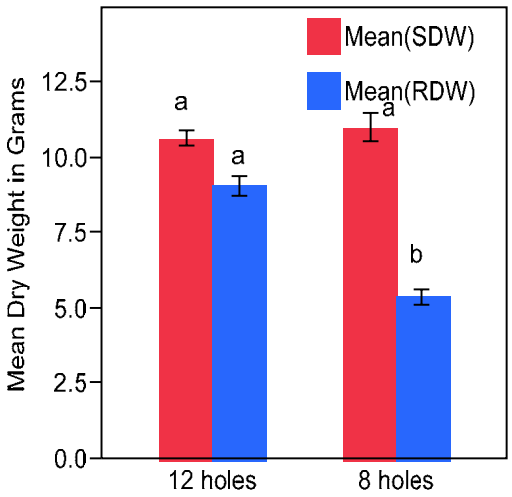

Figure 12. Field-grown petunia plants five weeks after planting. Two types of pots were used, one with 12 holes (A, 13.6cm^2 open drainage area) and 8 holes (B, 7.6cm^{2}open drainage area)

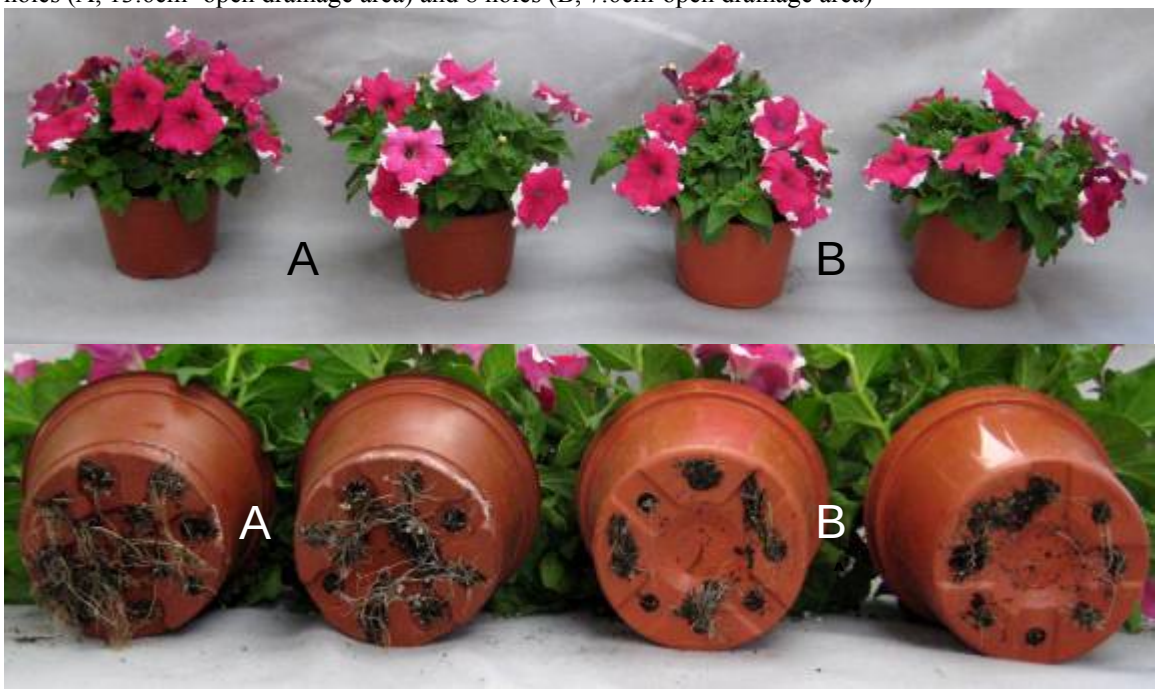

Figure 13. Mean (± SE) shoot dry weight of lemon thyme plants 6 weeks after planting. Two types of media were used, Sunshine mix #1 (SG) from Sun Gro Horticulture or Pro Mix (Pmix) from Premier Horticulture Inc. Bars followed by different letters are significantly different, t-test (p=0.05).

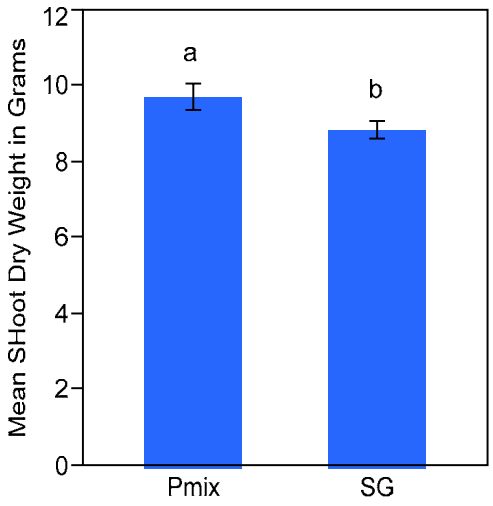

Figure 14. Lemon thyme plants six weeks after planting. Two types of pots were used, one with 12 holes (A, 10.4cm^2 open drainage area) and 8 holes (B, 6.9cm^2 open drainage area). Two types of media were used, Sunshine mix #1 (2) from Sun Gro Horticulture or Pro Mix (1) from Premier Horticulture Inc.