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CONTAINER SPACING STRATEGIES MODIFY MEDIA TEMPERATURE AND PLANT GROWTH[1]

Root-zone temperatures in container-grown plants in southern states are often significantly above air temperatures due to direct solar radiation on container sidewalls (1,2,7). Production strategies which limit direct solar radiation on containers can reduce the daily maximum temperature in the growth medium (4,5,6).

Container spacing strategies have been initiated in the nursery industry as a result of research indicating the deleterious effects of supraoptimal root-zone temperatures. Some nurseries transplant liners to one-gallon containers and place them can-to-can during winter months or until the foliage of adjacent plants touch. Other nurseries move recently transplanted plants to field beds in the spring and early summer and place them on the spacing at which they will remain until marketed. Nursery operators must balance such factors as space limitations, labor cost for spacing, efficient nursery space utilization, plant growth rate, plant form, plant quality, incidence of insect and disease, and plant shoot to root ratio in developing spacing strategies. Research/demonstration plots were established at Imperial Nurseries, Inc. in Quincy, Florida to address some of these questions as they relate to three production strategies for one-gallon *Ilex crenata* `Helleri'.

Imperial Nurseries, Inc. propagates *Ilex crenata* 'Helleri' in 3 inch pots in the summer months and overwinters them in unheated greenhouses. The next spring these plants are transplanted to one-gallon or two-gallon containers and placed can-to-can in an area that can be protected from extreme winter conditions. The plants are spaced on 12 inch centers the following spring in full sun production areas. Treatments were initiated at this time (23 April, 1987) to study the effects of two spacing treatments and 1 shielding treatment on temperature fluctuations and plant growth.

Spacing treatments consisted of 1) spacing containers 12 inches on center and 2) spacing containers can-to-can for 11 weeks then spacing them on 12 inch centers. The third treatment involved spacing containers on 12 inch centers but these one-gallon containers were set inside three-gallon containers. This created a solar radiation shield for the sidewall of the inside container and provided "air space" insulation between containers. Blocks of 25 plants for each treatment were replicated 3 times. Plant height and width in two directions and temperature fluctuations were measured monthly for five plants from the center of each block of 25 plants.

Temperatures were recorded at five locations in five replicate containers for each treatment every 15 minutes for one day each month in April through September using a Model 21X Campbell

Scientific micrologger with a AM32 multiplexer and welded copper-constantan thermocouples. Thermocouple positions included the center of the growth medium and 0.4 inches inside the container sidewall on the north, south, east and west exposures equal distance from the top to bottom. Clear days were chosen for recording container medium temperatures.

Treatments were terminated on 15 September, 1987 and shoot and root dry weights were determined. After plants were severed at the root/shoot interface, a 4 inch diameter core was taken from the center of the container medium. The remaining 0.75 inch wide layer of medium on the outside of the core was divided into four sections corresponding to the north, south, east and west quadrants. Roots were harvested from the growth medium and washed before drying.

Results and Discussion

Temperature fluctuations followed daily patterns published previously (1,2). Mean temperature on 13 July in the east quadrant of containers spaced 12 inches on center increased from 23°C (73°F) at 0800 HR to a maximum of 48°C (118°F) by 1100 HR and dropped to 40°C (104°F) by 1400 HR a similar temperature to the other quadrants. The mean temperature in the west quadrant increased more rapidly than in other quadrants in the afternoon.

The maximum average temperature recorded in the west quadrant was 127°F at 5 pm, and temperatures above 122°F were maintained for over 2 hours.

The critical temperature for a 30 min exposure for *Ilex crenata* `Helleri' has been predicted to be 51ºC (123°F) (3). Temperatures in the south and north quadrants followed similar patterns with maximum temperatures in these quadrants below 45°C (113°F). There was little variation between the average temperatures recorded in the four quadrants in containers inserted in larger containers and those spaced can-to-can. The average temperature during the heat of the day was approximately 3°C (6º F) lower in containers spaced can-to-can compared to those shielded by larger containers. Temperature fluctuation pattern also varied with time of year.

Total root dry weight of plants shielded by the larger container was 68% and 58% greater than plants spaced 12 inches on center and plants initially placed can-to-can, respectively.

The shielded treatment also resulted in 169% and 125% greater root dry weight in the center core and in the south outside layer of medium, respectively. Root dry weight in the outside layer on the north and east quadrants was not influenced by treatments.
Although the total root dry weight of plants spaced 12 inches on center all summer was similar to that for plants initially spaced can-to-can, there were differences in root distribution. Root dry weight in the west quadrant was 90% greater for plants that were initially spaced can-to-can compared to those spaced 12 inches on center for the entire summer. There was a significant

negative correlation (r = -.99) between maximum temperature and root dry weight in the west quadrant.

Plants in containers shielded by the larger container had the highest root-to-shoot ratio.

It should be noted that temperatures recorded in the east and west quadrants of containers spaced can-to-can were lower than in containers spaced 12 inches on center for the entire experiment. However, when the containers were spaced to 12 inches as the canopies began to touch, injury to roots on the outside surface of the west and south quadrants was observed. Root weights from the west and south quadrants might have been different if taken before spacing containers to 12 inches on center.

Shoot dry weight was not influenced by treatment. However, due to differences in root dry weight, the containers shielded by the larger containers had the highest root-to-shoot ratio. On data collection dates June 3, July 13, and August 11, plant height was reduced 5 to 16% in plants spaced 12 inches on center compared to other treatments. These data document the observation that the plants spaced 12 inches on center initiated new growth 2 to 3 weeks later than plants in the other treatments. Plant width was not affected by treatments.

Treatments that reduced the incidence of direct solar radiation on container sidewalls reduced maximum daily container medium temperatures, especially in the west and south quadrants.

Reduced temperatures were associated with increased root growth in these regions and greater plant height.

Containers should be separated from a can-to-can configuration after shoot growth is adequate to provide some shading of adjacent container sidewalls. Failure to consider shading when spacing during summer months has resulted in death of roots in the west and south quadrants due to supraoptimal temperatures.

Trade names and companies are mentioned with the understanding that no endorsement is implied nor discrimination intended.

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