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Effects of Nursery Container Color and Spacing on Root Zone Temperatures of 'Soft Touch' Holly †

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Abstract: Newly up-potted 'Soft Touch' Japanese hollies (*Ilex crenata* 'Soft Touch') were grown in Mobile, AL in 1.5 L containers to evaluate the effects of growth from black or white container colors and container spacing (jammed or spaced) in relation to root zone temperature. Two treatments, container color and container spacing, were evaluated and root ratings were reported. At termination, an interaction was observed in growth from 43 to 141 days after potting between container color and spacing. Both white container treatments and the black-jammed treatment experienced 36% and 21% more growth than black-spaced plants. Root ratings for white containers (jammed and spaced) were 42% greater than for black-spaced. Black-jammed root ratings were 25% greater than black-spaced. Black-spaced containers experienced the greatest number of time intervals over the critical temperature of 39 °C when compared to other treatments. Results suggest that 'Soft Touch' holly may be grown at final spacing when using white containers and have little impact from elevated root zone temperatures.

Keywords: root zone temperature; container color; nursery production; abiotic stress

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1. Introduction

Since the late 1950s, the effects of supraoptimal root zone temperatures (RZT) have been known to impact production of containerized nursery stock [1]. Black plastic nursery containers absorb solar radiation, and heat energy is then reradiated to the container substrate. As the heat capacity of the substrate is higher than the surrounding air, the substrate gains heat faster than it can be lost, resulting in temperatures well over ambient. Root zone temperatures have been reported in excess of 50 °C [2,3]. The effects on root growth can easily be observed on mature plants with little root growth occurring in the south-westerly portion of the container, as it has the greatest exposure to solar radiation. Many nursery growers are unaware of the impacts of RZT. With entire crop affected, it is difficult to know there is an issue without a comparison of plants with near-optimal RZT [4].

A considerable amount of research has been conducted towards alleviating elevated RZT [5]. Successful methods include pot-in-pot [6–8], container [9,10], shading [11,12], container material and design [13–15], and container color [15–17]. Irrigation has historically been thought to alleviate elevated RZT; however, research has shown otherwise. Irrigation frequency has been demonstrated to have a small impact on RZT [18]. Martin and Ingram [19] demonstrated that it takes an unrealistic amount of water to cool RZT to optimum levels.

A common practice among nursery growers is to "jam" or place containers "can-to-can" to reduce RZT and conserve space for newly potted material. By jamming plants, the container sidewalls are shielded from solar radiation. Plants are later spaced to allow for canopy growth. As plant canopies expand, they also act as a shield against solar radiation. Jamming has been a long-time practice; however, many growers are unaware of its benefit on RZT and primarily initially jam plants to better utilize space (personal observation). While space utilization is a priority, it is a laborsome process, and labor availability and cost have become significant issues in production [20]. In some situations where space is not limited, arranging plants after potting to their final spacing would allow for a reduction in labor.

Previous research has demonstrated the protection provided to the root system in jammed plants and observations of damage to root systems after spacing unacclimated plants [9]. Additionally, white containers have also been shown to reduce max RZT and exposure time significantly compared to conventional black containers [3,17]. This research differs from previous research in that it investigates the interaction of container color and container spacing. The primary objective of this research aimed to determine if white containers would allow containerized nursery crops to be placed at final spacing after potting with little impact from RZT.

2. Materials and Methods

On 11 May 2021, at the Auburn University Ornamental Horticulture Research Station (30°42′06.9″ N 88°08′48.5″ W), 324 rooted liners of ‘Soft Touch’ Japanese hollies (*Ilex crenata* ‘Soft Touch’) were potted into 1.5 L containers (Yikush Inc., Shanghai, China). Containers were black or white-on-black depending on the treatment. Liners were previously grown in 50 cell count 1.9 cubic inch cell trays. Before planting, liners were blocked by size. Containers were each filled with a substrate consisting of 100% aged, milled pine bark (Longleaf Mulch, Semmes, AL, USA) incorporated with 8.2 kg/m^3 of 15–9–12 (15N-3.9P-9.9K) Osmocote® 12–14 month slow release fertilizer (ICL Specialty Fertilizers, Dublin, OH, USA), 2.71 kg/m^3 of dolomitic lime, and 0.68 kg/m^3 Micromax® Micronutrients (ICL Specialty Fertilizers, Dublin, OH, USA).

Plants were arranged in a 2 × 2 factorial design with container color × container spacing. Experimental design was a randomized complete block design with 9 blocks. Overhead irrigation was applied at a rate of 1.27 cm per day when needed. Prior to the initiation of the study, irrigation distribution uniformity was evaluated and found to be within industry standards. Blocks were arranged in a square pattern to accommodate variation in irrigation distribution (Figure 1). Each experimental unit consisted of nine plants arranged in three rows (Figure 1). Data was only collected on the center container, and surrounding containers (buffer pots) were used to simulate the environmental conditions in a nursery block. To evaluate the effects of plant density on root zone temperature, the spacing factor consisted of jammed and spaced plants. Jammed plants were arranged with containers touching on all sides and no space in between containers. Spaced treatments were spaced at approximately 12.5 cm. Jammed containers were later spaced 112 days after planting (DAP) at 12.5 cm to imitate the final spacing of the containers in a production nursery [16].

Plants were pruned to an average of 7.5 cm in height at 43 DAP with growth indices (GIs) being recorded before and after pruning. Size index [(height + widest width + perpendicular width)/3] of each plant was measured at planting, 10 DAP, 43 DAP, and at termination (141 DAP). Growth index (final size index—initial size index) was calculated for the time frames of 0 to 43 DAP (before pruning) and 43 to 141 DAP (after pruning). Substrate pH and electrical conductivity (EC) were measured using the pour through technique at 10, 30, 80, 112, and 130 DAP [21]. Substrate pH and EC measurements were recorded with an HI981-51 multi-parameter portable meter (accuracy: EC ± 2% F.S.; pH ± 0.1) (Hanna Instruments Inc., Smithfield, RI, USA). Other data collected included fresh and dry shoot biomass at pruning and termination. Biomass was recorded using Ohaus I-10 III (Ohouse Corp., Florham, NJ, USA). The following scale was used at termination to visually rate the percent root coverage of the area facing each cardinal direction (N, S, E, and W): 1 = 0% root coverage, 2 = 1 to 25% root coverage, 3 = 26 to 50% root coverage, 4 = 51 to 75% root coverage, and 5 = 76 to 100% root coverage. Additionally, severe root death, or those areas where roots were visually determined to have been killed, were also noted as 0 = no root death observed, or 1 = severe root death observed, and reported as frequency of severe root death.

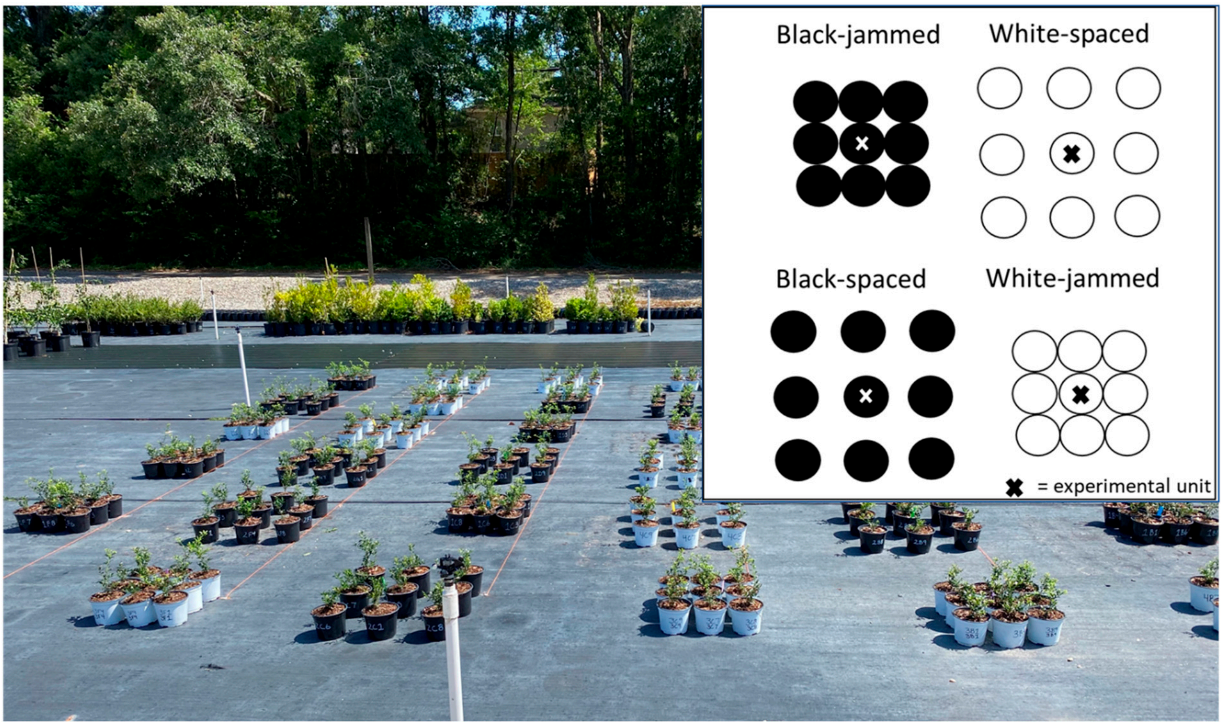

Figure 1. Experimental layout of fixed effect combinations, representing one block.

Substrate temperature was monitored by Hobo U23-003 (±0.21 °C) (Onset Computer Corp., Bourne, MA, USA) in 30-min intervals. Sensors were placed in the N, S, E, and W quadrants of the root ball at depth equal to half the height of the container and approximately 2.54 cm from the container sidewall (n = 1). Five random sunny days where daily light integral (DLI) ranged from 38 to 48 mol·m^{-2}·d^{-1} were selected to calculate time units (30 min) where substrate temperatures reached >38 °C. For the analysis, each of these days served as a replicate. Only daylight hours were used in these calculations.

All data was analyzed using a mixed model analysis of variance. The model included container color and spacing as main effects and their interaction (JMP Pro software ver. 14 SAS Institute, Cary, NC, USA). When an interaction was significant, post hoc means comparisons were conducted using Tukey's honest significance test (HSD) ($p \leq 0.05$). In cases where no interaction was detected, Student's t test was utilized for means comparisons of main effects ($p \leq 0.05$).

3. Results and Discussion

No trends in pH or EC were observed across all main effect combinations. A difference among sampling dates was observed, but this followed the anticipated release rate of the controlled release fertilizer (data not shown).

3.1. Growth and Shoot Biomass

For size index, no differences were detected across main effects or their interactions at pruning (43 DAP). No interaction was detected between container color and spacing at termination (141 DAP). Color was significant at termination, with white container-grown plants being slightly larger than black (6%). No differences were detected for growth index (final—initial), among the main effects of container color and spacing or their interactions at pruning 43 DAP (Table 1). An interaction was detected in growth index from pruning to termination. At termination, white containers, both jammed and spaced, and black containers, jammed, grew 22 and 33%, respectively, more than black containers that were grown spaced. No interactions between main effects were detected in fresh or dry shoot biomass in trimmings collected at pruning (data not shown). No interaction between main effects was detected in fresh and dry shoot biomass at termination; however, the main effect of container color was significant. White containers were 16% greater in both fresh and dry biomass when compared to black container plants. In a similar study, Keever and Cobb [22] showed, using *Rhododendron* X sp. 'Hershey's Red', that jammed containers increased plant size by 12% and shoot dry weight by 13.6% when compared to spaced. A number of recent studies have also demonstrated significant increases in plant growth when comparing plants grown in white vs. black containers [3,15,17].

Table 1. Main effects [Z] and interactions of container spacing and color on 'Soft Touch' Japanese holly growth and shoot biomass (n = 9).

		Size Index [Y]		**Growth Increase** [X]		**Shoot Biomass (g)**	
		43 DAP [W]	**141 DAP**	**0 to 43 DAP**	**43 to 141 DAP**	**Fresh**	**Dry**
		Least square means for main effect: Container Spacing					
Jammed		16.9	17.1	4.5	7.2	28.0	10.6
Spaced		15.9	16.3	4.4	6.1	26.3	10.2
Sign. of Spacing		0.2792	0.0879	0.8748	0.0207	0.4304	0.5614
		Least square mean for main effect: Container Color					
Black		16.3	16.2 b [V]	3.9	6.5	24.8 b [W]	9.6 b
White		16.7	17.3 a	5.0	6.8	29.6 a	11.3 a
Sign. of Color		0.6606	0.0291	0.1050	0.5115	0.0204	0.0316
		Interaction least square means: Container Color × Container Spacing [W]					
Black	Jammed	17.2	17.1	4.0	7.8 a [V]	26.8	10.2
	Spaced	16.7	15.3	3.8	5.2 b	22.6	9.0
White	Jammed	15.3	17.2	5.1	6.7 a	29.2	11.1
	Spaced	16.6	17.3	5.0	6.9 a	30.0	11.4
Sign. of Interactions		0.3444	0.0539	0.9010	0.0062	0.2201	0.3315

[Z] Main effects included the factors container spacing and container color. Container spacing was jammed (containers touching on all sides) or spaced at 12.5 cm between containers. Container color was white or black containers (1.5 L). [Y] Size index [(height + widest width + perpendicular width)/3]. [X] Growth increase was calculated as the difference in size index between initial and 43 DAP (before pruning) and 43 and 141 DAP (after pruning). Plants were pruned at 43 DAP. [W] DAP = Days after planting with a planting date of 5 November 2021. [V] When interaction terms (spacing by color) were not significant (α = 0.05), means were separated for each main effect. Means followed by the same letter are not significantly different using Student's t test (α = 0.05). [V] When the interaction term was significant, means were separated using the Tukey method for multiple comparisons (α = 0.05).

3.2. Root Coverage Ratings

No significance was detected in the three-way interaction of container color, spacing, and container quadrant (Table 2). An interaction was detected between container color and quadrant, where white containers outperformed black containers in nearly every quadrant, with the exception of north. The north quadrant of black containers was similar to both the east and west quadrants of white containers. No interaction was detected between spacing and container quadrant. The interaction between container color and spacing was significant. White containers outperformed black containers regardless of spacing. White containers, irrespective of spacing, scored 42% greater root ratings than black-spaced and 25% greater root ratings than black-jammed (Figure 2). Keever and Cobb [22] also reported significantly lower root ratings (50% reduction) for black-spaced containers when compared to black-jammed, white-jammed, and white spaced.

Table 2. Effects of container color, container spacing, and directional quadrant on root ratings of 'Soft Touch' Japanese holly grown in combinations of container color and spacing.

Significance of Treatment Factors on Root Ratings [Z]			
Color (C) [Y]	<0.0001		
Spacing (S) [X]	0.0015		
Quadrant (Q) [W]	0.0401		
C by S	0.0116		
C by Q	0.0488		
S by Q	0.4694		
S by C by Q	0.7813		
Interaction least square mean: container color by directional quadrant			
Quadrant	Color	Rating	
North	Black	2.9	bc [V]
	White	3.6	a
South	Black	2.0	d
	White	3.6	a
East	Black	2.5	cd
	White	3.6	ab
West	Black	2.2	cd
	White	3.6	ab
Interaction least square mean: container color by spacing			
Spacing	Color	Rating	
Spaced	Black	2.1	c
	White	3.6	a
Jammed	Black	2.7	b
	White	3.6	a

[Z] Root ratings were determined as percent coverage of roots on outside of root ball. 1 = no roots; 2 = 1% to 25%; 3 = 26% to 50%; 4 = 51% to 75%; 5 = 76% to 100%. [Y] Container color was white or black containers (1.5 L). [X] Container spacing was jammed (containers touching on all sides) or spaced at 12.5 cm between containers. [W] Container quadrant = ratings on the north, south, east, and west. [V] When interaction terms (spacing by color) were not significant ($\alpha = 0.05$), means were separated for each main effect. Means followed by the same level are not significantly different using Student's *t* test ($\alpha = 0.05$). When the interaction term was significant, means were separated using the Tukey method for multiple comparisons ($\alpha = 0.05$).

Figure 2. Example of root coverage (viewing south quadrant) for each treatment (left to right), black-jammed, black-spaced, white-jammed, and white-spaced.

The presence of severe root death on roots along the container sidewalls were recorded in a binary fashion (yes/no). Black-jammed containers were the only treatments where severe root death was observed (Table 3). The greatest frequency of root death in black-jammed grown plants was observed on the south (67%) and west (78%) quadrants of the root ball. Similar to the current study, Ingram et al. [9] reported significant root death when jammed containers were spaced to final spacing. By comparing the shielded plants to jammed (and later spaced) plants, the authors concluded that the sudden exposure of solar radiation to the containers of unacclimated roots resulted in significant loss of root biomass [9].

Table 3. Frequency (%) of 'Soft Touch' Japanese holly plants exhibiting severe root death on root ball surface (n = 9).

		Container Quadrant ^{Z}			
Spacing ^{Y}	**Color ^{X}**	**N**	**S**	**E**	**W**
Jammed	Black	11	67	33	78
	White	0.0	0.0	0.0	0.0
Spaced	Black	0.0	0.0	0.0	0.0
	White	0.0	0.0	0.0	0.0

^{Z} Container quadrant represents each cardinal directions (N = north, S = south, E = east, and W = West. ^{Y} Spacing represents plants that were jammed (no spacing between containers) and spaced (12.5 cm between pots). ^{X} Containers being compared were white or black.

3.3. Time above Critical Temperatures

The impacts of supraoptimal RZT on roots have been well documented and comprehensively summarized in a review by Ingram et al. [5], where plant injury was classified as either direct or indirect. Direct injury was said to occur when cells are damaged or killed, and generally occurred after a 30-min exposure to temperatures between 45 °C and 57 °C. Indirect injury is often not visible and goes unnoticed because it affects physiological processes such as photosynthesis, water stress, carbon partitioning, and disease susceptibility. Critical temperatures for indirect injury were summarized across several studies to occur between 38 °C and 40 °C.

In this study, comparisons were made between treatments for the sum of time units (30 min) where temperatures were >38 °C (Table 4). An interaction between spacing and container color was only detected in the north quadrant. The main effects of spacing were significant across all quadrants where spaced containers were 100, 87, 96, and 89% greater in time above 38 °C for north, south, east, and west, respectively. For each quadrant, color was significant in time above 38 °C, with the exception of the east quadrant. Time above 38 °C in black containers was 82, 58, and 55% greater than those in white for north, south, and west, respectively. Generally, black-spaced containers experienced the greatest number of time intervals above 38 °C. Studies comparing arborvitae grown in white or black containers in 11.3 L (3-gal) also demonstrated that white containers significantly reduce time with temperatures > 38 °C ([3,15]). These studies resulted in much lower differences in the percentage of time over critical temperature when comparing white and black when compared to the current study. These lower differences when compared to the current study were likely due to the difference in container size (1.5 L vs. 11.3 L). As container size increases, so does its ability to buffer temperature change [23].

Table 4. Comparisons of time units (30 min) over 38 °C associated with container color and spacing by directional root ball quadrants (n = 5 days).

		Least Square Means for Main Effect: Container Spacing ^{Z}			
Spacing		North	South	East	West
Jammed		0.0 b ^{Y}	0.5 b	0.1 b	0.3 b
Spaced		3.4 a	3.9 a	2.6 a	2.9 a
Spacing (p-value)		0.0004	0.0007	0.0017	0.0004
Least square mean for main effect: Container Color					
Color		North	South	East	West
Black		2.9	3.1 a	2.70	2.2 a
White		0.5	1.3 b	1.40	1.0 b
Color (p-value)		0.0048	0.0325	0.2059	0.0473
Interaction treatment least square means: Container Color × Container Spacing ^{Y}					
Spacing	Color	North	South	East	West
Jammed	Black	0.0 b	0.80	0.20	0.60
Spaced	Black	5.8 a	5.40	5.20	3.80
Jammed	White	0.0 b	0.20	0.00	0.00
Spaced	White	1.0 b	2.40	2.8	2.00
Spacing × Color (p-value)		0.0048	0.1332	0.2799	0.2906

^{Z} Main effects included the factors container spacing and container color. Container spacing was jammed (containers touching on all sides) or spaced at 12.5 cm between containers. Jammed containers were spaced to 12.5 cm 112 DAP. Container color was white or black containers (1.7 L). ^{Y} When interaction terms (spacing by color) were not significant (α = 0.05), means were separated for each main effect. Means followed by the same letter are not significantly different using Student's t test (α = 0.05). When the interaction term was significant, means were separated using the Tukey method for multiple comparisons (α = 0.05).

4. Conclusions

Collectively, results suggest that spaced black containers were less productive in both shoot and root growth. Currently, black containers dominate production, and, in many cases, containers are spaced to their final spacing after potting. Our results suggest that 'Soft Touch' holly could be grown in white containers exclusively at final spacing throughout the production cycle and result in similar growth to jammed plants. Labor used in respacing 'Soft Touch' holly may be reduced or eliminated simply by utilizing white containers; however, results may vary depending on container size, crop species, and possibly crop cultivar.

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References

1. Self, R.L.; Ward, H.S. Effects of high soil temperature on root growth of loquat seedlings in nursery containers. *Plant Dis. Report.* **1956**, *40*, 957–960.
2. Fretz, T.A. Influence of physical conditions on summer temperatures in nursery containers. *HortScience* **1971**, *6*, 400–401. [CrossRef]
3. Witcher, A.L.; Pickens, J.M.; Blythe, E.K. Container color and compost substrate affect root zone temperature and growth of "Green Giant" Arborvitae. *Agronomy* **2020**, *10*, 484. [CrossRef]
4. Ingram, D.L.; Ramcharan, C.; Nell, T.A. Response of container-grown banana, citrus and draceana to elevated root temperatures. *HortScience* **1986**, *21*, 245–255. [CrossRef]
5. Ingram, D.L.; Ruter, J.M.; Martin, C.A. Review: Characterization and impact of supraoptimal root-zone temperatures in container-grown plants. *HortScience* **2015**, *50*, 530–539. [CrossRef]
6. Martin, C.A.; McDowell, B.; Bhattacharya, S. Below ground pot-in-pot effects on growth of two southwest landscape trees was related to root membrane thermostability. *J. Environ. Hort.* **1999**, *17*, 63–68. [CrossRef]
7. Ruter, J.M. Growth and landscape performance of three landscape plants produced in conventional and pot-in-pot production systems. *J. Environ. Hort.* **1993**, *11*, 124–127. [CrossRef]
8. Young, R.E.; Bachman, G.R. Temperature distribution in large, pot-in-pot nursery containers. *J. Environ. Hort.* **1996**, *14*, 170–176. [CrossRef]
9. Ingram, D.; Martin, C.; Castro, B. Container spacing treatments influence temperature fluctuations and holly growth. *Proc. Fla. Hort. Soc.* **1988**, *101*, 328–331.
10. Irmak, S.; Haman, D.Z.; Irmak, A.; Jones, J.W.; Larsen, T.H. Rootzone temperatures of Viburnum odoratissium grown in the multiplot box system and conventional systems: Measurement and analyses of temperature profiles and predicting root zone temperatures. *HortScience* **2005**, *40*, 808–818. [CrossRef]
11. Burrows, M.W.; Fare, D.C.; Gilliam, C.H.; Eakes, D.J. Influence of shading on container-grown flowering dogwoods. *South. Nurs. Assoc. Res. Conf.* **2015**, *60*, 11–15.
12. Witcher, A.L.; Byasal-Gurel, F.; Blythe, E.K.; Fare, D.C. Container size and shade duration affect growth of flowering dogwood. *HortTech* **2019**, *29*, 842–853. [CrossRef]
13. Million, J.B.; Yeager, T.H. Fabric containers increased irrigation demand but decreased leachate loss of nitrogen and phosphorus compared with conventional plastic containers during production of dwarf Bufford holly. *HortScience* **2022**, *57*, 743–749. [CrossRef]
14. Tauer, P.K.; Cole, J.C. Effect of fabric and plastic containers on plant growth and root zone temperatures of four tree species. *J. Environ. Hort.* **2009**, *27*, 145–148. [CrossRef]
15. Witcher, A.L.; Pickens, J.M.; Blythe, E.K. Container type and substrate affect root zone temperature and growth of 'Green Giant' Arborvitae. *Horticulturae* **2020**, *6*, 22. [CrossRef]
16. Ingram, D.L.; Johnson, C.R. Influence of orientation, spacing and placement pattern of production containers on 'Formosa' azalea growth. *Proc. SNA Res. Conf.* **1981**, *26*, 20–21.
17. Markham, J.W.; Bremer, D.J.; Boyer, C.R.; Schroder, K.R. Effect of container color on substrate temperatures and growth of red maple and redbud. *HortScience* **2011**, *46*, 721–726. [CrossRef]
18. Warren, S.L.; Bilderback, T.E. Timing of low pressure irrigation affects lant growth and water utilization efficiency. *J. Environ. Hort.* **2002**, *20*, 184–188. [CrossRef]
19. Martin, C.A.; Ingram, D.L. Evaluation of thermal properties and effect of irrigation on temperature dynamics in container media. *J. Environ. Hort.* **1991**, *9*, 24–28. [CrossRef]
20. Regalbrugge, C.J. USDA Labor Survey Reveals Clouds on the Horticulture Horizon. Available online: https://www.greenhousegrower.com/management/usda-labor-survey-reveals-clouds-on-the-horticulture-labor-horizon/ (accessed on 11 March 2022).
21. Wright, R.D. The pour-through nutrient extraction procedure. *HortScience* **1986**, *21*, 227–229. [CrossRef]
22. Keever, G.J.; Cobb, G.S. Container and production bed mulch effects on media temperature and growth of 'Hershey's Red' Azalea. *HortScience* **1984**, *19*, 439–441. [CrossRef]
23. Martin, C.A.; Ingram, D.L. Container dimension affects rooting medium temperature patterns. *HortScience* **1993**, *28*, 18–19. [CrossRef]