Effects of Water Quality and Water Management on the Growth of Container Nursery Stock [1]

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EXPERIMENTAL LAYOUT

This study was conducted in six central Florida nurseries beginning April. The test plants were Fashion azalea, Hetzi Japanese holly, and blue Pacific shore juniper The fertilizer sources were an 18-6-13 experimental Osmocote, 24-4-0 High N,

Table 1. Water analysis at six container nurseries in Florida

	Nursery location					
Elements/Salts	A[x]	B	C	D	E	F
Sodium	25 ppm	5	10	32	112	5
Calcium	60	31	42	104	62	80
Magnesium	17	10	13	10	14	2
Potassium	2	2	2	1	4	0
Carbonates	0	0	1	1	1	0
Bicarbonates	120	140	162	351	176	294
Chlorides	10	10	17	66	201	10
Sulfates	6	3	7	1	8	0
Nitrates	2	0 1	3	0 1	0.1	1
Boron	0 01	0	0 03	0 01	0 03	0
EC	-- [y]	0 2	0 3	0 6	0 9	--
SAR	--	0 2	0 3	0 8	3 3	--
Adj SAR	--	0 3	0 5	1 8	5 5	--
% Sodium	18	8	12	19	53	5
pH	7 5	7 6	7 7	7 9	7.6	7 1

[x] A,B,C are nurseries that contain good water (moderate to low levels of calcium, sodium, bicarbonates, chlorides, sulfates, and boron D,E,F have marginal water (one or more of the following were high, calcium, sodium, bicarbonates, chlorides, sulfates and boron) For example, water D had high calcium and bicarbonates, and other elements were acceptable. Water F had high bicarbonates and others were acceptable

[y] EC, SAR, and Adj SAR for Nurseries A and F are not available All six water samples were done at a lab and these two were omitted without explanation

[1] **Ed. Note** This paper was presented at The Southern Region Meeting but was not able to be included among that Region's papers

17-7-12 Osmocote, 16-10-10 Nutricote, and 20-4-10 Woodace. Rates were 2.0, 2.7, and 3.2 pounds of nitrogen per cubic yard. All plants received 4 pounds of dolomite and 1.5 pounds of Micromax per cubic yard. After all mixing of chemicals and planting was done with 36 single-plant replications, six reps of all treatment (270), plants were transported to six different nurseries Three nurseries had water of good quality and three had marginal water (Table 1). Good water was defined as water containing moderate to low levels of calcium, sodium, bicarbonates, chlorides, sulfates, and boron (Table 2).

Marginal water contained one or more of the following at high levels: calcium, sodium, bicarbonates, chlorides, sulfates and boron. The plants were placed on container beds among other newly planted stock in one-gallon containers. A rain gauge was placed in each block of plants, and the owner/manager was asked to record rainfall weekly. All plants were evaluated for number of branches and were pruned in July and September. In addition, all plants were spaced in September and given a second application of herbicide. In early December, the plants were evaluated and top weight was determined. The water received by the plants at the six nurseries was 50, 63, 70, 108, 116, and 126 inches during the eight month period

RESULTS AND DISCUSSION

Because of the complexity of the study and space limitation, only the conclusion highlights are included here. All plants were of good color with no visual deficiencies of any kind, except most of the azaleas at Nursery C (50 inches water) died from insufficient water and at the end of the study the plants with Woodace were somewhat off-color at all nurseries indicating nitrogen deficiency.

Table 2. Total water received by plants over the eight month study and five key water analysis factors and three soil mix analysis factors at the end of the study

	Nursery locations						
	A	B	C	D	E	F	
	70	126	50	116	108	63	rainfall and irrigation (in)
Water	60	31	42	104	62	80	calcium (ppm)
	25	5	10	32	112	5	sodium (ppm)
	120	140	162	351	176	294	bicarbonates (ppm)
	102	41	65	146	188	87	total bases (Ca, Na, Mg, K) (ppm)
	222	181	222	497	367	381	bases and bicarbonates (ppm)
Soil	2180	2501	1626	4397	2691	4393	calcium (ppm)
mix	25	21	25	33	150	19	sodium (ppm)
	5 8	6 6	5 5	7 6	6 4	6 9	pH of mix at end of study
	1 (best)	3	4	6 (worst)	5	2	overall plant growth and quality assessment

Water Effects

1) Water application varied 150% among nurseries. This is an astounding variation for the same basic plants in a similar geographic region

2) Relative to plant growth at the various locations, it is important to note the Nursery A had excellent plants and applied moderate quantities of water. Nurseries C and B had nearly identical water quality, but Nursery C applied less water (50 inches) while Nursery B applied much more water (126 inches). To the azaleas this meant death at Nursery C and a full two-point reduction in visual quality (on a 1 to 10 scale) at Nursery B when compared to Nursery A. Juniper and holly were also affected by the limited watering at Nursery C. Junipers and hollies at Nursery B showed fewer adverse effects from the heavy watering than the azaleas in terms of top weight, but visual grade was somewhat lower because the plants tended to be more loose and open.

3) The plants of all three species with the highest visual quality (most salable) were at nurseries A and F (Table 3). These nurseries applied 70 and 63 inches of water, respectively, and applied small quantities of water frequently vs. the more widely accepted practice of allowing the plants to dry, then water thoroughly

4) Nursery F had marginal water, yet with good water management, grew excellent plants, nearly as good as nursery A that had good water (Table 2). On the other hand, Nursery C had good water but did not apply enough or allowed the plants to dry too far before re-applying, and quality was low Nursery B had good

Table 3. Main effects of nursery location on growth of three species in containers (These values are averages for all five fertilizer sources at all three rates for a specific species and location

	Nursery Location					
	A	B	C	D	E	F
Azalea						
Top wt (g)	91 a[1]	79 c	--[2]	45 e	68 d	83 b
Visual grade (1-10)	8 8 a	6 7 c	--	5 3 d	6 4 c	8 3 b
Branches/plant	21 b	18 c	--	16 c	17 c	25 a
Holly						
Top wt (g)	60 b	58 b	52 c	45 d	51 c	74 a
Visual grade (1-10)	7 6 a	7 1 b	5 7 c	5 5 c	5 9 c	7 8 a
Branches/plant	48 a	34 d	38 c	33 d	34 d	41 b
Juniper						
Top wt (g)	73 b	70 b	47 c	48 c	48 c	80 a
Visual grade (1-10)	7 9 a	6 5 b	5 7 c	5 5 c	4 1 d	6 7 b
Branches/plant	12 b	11 b	12 b	8 c	11 b	16 a

[1]Values followed by the same letter going across (left to right) are not significantly different at the 5% level (5% = less than 1 chance in 20 of being incorrect)
[2]Nearly all azaleas died

water, but applied far too much, which caused more open plant growth (leggy appearance) and a lower visual quality Also, because of the "extra" water applied, the calcium in the mix was high at the end of the study having increased with each watering.

5) The plants at Nursery E showed no visual symptoms reflecting injury from the high sodium, yet the plants in general were substantially smaller and of lower visual quality. The extent of the injury was probably compounded by the relatively high amount of water applied (108 inches) High chlorides, on the other hand, did not appear to be a factor affecting growth.

6) Calcium, magnesium and sodium in the irrigation water accumulated in the soil mix. The level of calcium in the mix was accurately projected, based on the amount of dolomite added, calcium level in the water supply, and quantity of water applied Bases (calcium, magnesium, sodium) do not leach from the container mix (or do so very slowly), thus the more water applied, the more they accumulate (Table 2).

Fertilizer Effects

1) In general, the experimental Osmocote 18-6-13 produced plants with the most branches. Plants grown with this fertilizer generally had a higher visual rating than their respective top weights would suggest because of the increased branching.

2) The most consistent performing fertilizer and rate overall for the three species at all six nurseries was 16 pounds of 17-7-12 Osmocote.

3) High-N 24-4-10 excelled only at Nursery E where sodium was high in the water, performing marginally at the other five nurseries.

4) Nutricote (16-10-10, five parts 270-day and one part 70-day) produced good growth of azaleas and holly but only at the 21-pound rate compared to the 16-pound rate of either Osmocote. Growth of junipers was not favored by Nutricote.

5) Woodace 20-4-10 grew plants of good quality for the first four to five months of the study. However, by September foliage color suggested that available nitrogen was low, especially at the nurseries that watered heavily.

6) All of the fertilizers at the high rate at Nursery B produced reasonably good plants even though an excessive amount of water was applied If fertilizer rate was low or medium; plant quality was only fair to poor

7) Where water was the limiting factor, Nursery C, none of the fertilizers appreciably improved plant growth over the other, and high rates were generally detrimental.

8) At Nurseries E and D, where water quality was marginal, there was no advantage to using more than the 12-pound rate of any fertilizer.

CONCLUSIONS

1) The best plants were from Nursery A with good quality water and good water management (70 inches). However, careful water management with marginal quality water can result in good container nursery stock as found with Nursery F

2) Poor water management, even with good water, can result in limited growth or loss of size and quality

3) Small amounts of water applied frequently provided better plant growth than heavier applications less frequently

4) Water quality and water management DO influence how a slow-release fertilizer performs Some of the variation of slow-release fertilizer influence on

plant growth observed throughout the container nursery industry can be attributed to water quality and water management.

5) Most minerals in the irrigation water do not leach, but rather accumulate in the soil mix The more water applied, the greater the accumulation.

6) All of the slow-release fertilizers in the study resisted leaching of nitrogen even at very high water rates. The only exception was plants with Woodace which began to yellow sooner at Nursery B (126 inches) vs. Nursery A (70 inches). This suggests leaching