Growth performance of container-grown flowering dogwoods with different shade intensity and color©[a]

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INTRODUCTION

Flowering dogwood (*Cornus florida*) is considered an aristocrat of native flowering trees of the USA and has a broad range extending through most of the eastern states and westerly through Iowa and south to Texas (Dirr, 2009). This species is one of the most beautiful and important small flowering trees utilized in the nursery and landscape industry. A multitude of species and cultivars of dogwood have been a staple in nursery cultivation. Today, the demand for container-grown dogwoods has increased as the demand for containerized trees has continued to grow over the last 20 years. However, dogwoods are a challenging crop to produce in container culture, especially when bare root liners are used as the initial transplant into containers; unacceptable levels of mortality and poor growth occur. Reasons for poor dogwood growth during the first growing season are anecdotally related to overwatering, underwatering, over fertilizing, poor root structure, environmental stress, or transplanting delay from the bare root harvest. Flowering dogwoods are considered an understory tree. Producers are successfully growing other native understory species under shade cloth (Phillips et al., 1991), but most producers continue to grow container-grown dogwoods in full sun.

Studies have shown that temperatures in black plastic containers can exceed 43.3°C (110°F) in full sun (Johnson and Ingram, 1984). Shade treatments of 40% black or white shade cloth were used to reduce root zone temperatures after transplanting dogwoods into containers and resulted in larger plants compared to plants grown in full sun (Montague et al., 1992). The objective of this research was to evaluate shade intensity and shade color on the growth of two cultivars of bare root dogwood liners after transplanting into nursery containers.

MATERIALS AND METHODS

Cornus florida L. 'Cherokee Princess' and *C. florida* 'Comco No.1', Cherokee Brave™ flowering dogwood PP 10166, bareroot flowering dogwood liners were obtained from a commercial nursery in Winchester, Tennessee. The size of the dogwood liners ranged from 41-61 cm (18-24 in.). Liners were potted into a #5 nursery container (Classic 1600, Nursery Supplies, Chambersburg, Pennsylvania) with pine bark substrate amended with 3.3 kg m^{-3} (5.6 lbs yd^{-3}) 19-5-9 (19N-2.2P-7.5K) Osmocote Pro 12 to 14 month controlled release fertilizer (Everris, Dublin, Ohio), 0.7 kg m^{-3} (1.2 lbs yd^{-3}.) Micromax (Everris, Dublin, Ohio) and 0.6 kg m^{-3} (1 lbs yd^{-3}) of AquaGro (Aquatrols, Paulsboro, New Jersey). Before plants were moved into their respective shade treatments, height and trunk diameter measured at 15 cm (6 in.) were recorded and used to grade plants into replications for small, medium, and large size. On 25 February, plants were moved onto a gravel pad in full sun or into one of three shade treatment structures [2.4×3.0 m in size (8×10 ft)]: a 50% black, 50% white, or 30% black shade cloth (Dewitt, Sikeston, Missouri). Each treatment was replicated four times and contained eight plants of each cultivar at an outdoor facility at the Nursery Research Center in McMinnville, Tennessee.

Cyclic irrigation was applied twice daily in early spring and increased to three applications during periods of increased heat throughout the summer. Water was applied using a 160° Spot-Spitter fan emitter (Roberts Irrigation Company, Inc., San Marcos, California). Leachate was collected bi-weekly from two plants of each cultuvar, among the

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four treatments (full sun, black 30%, black 50%, and white 50% shade). Electrical conductivity and pH (data not shown) were determined using a Myron L Agri-Meter (Myron L Company, Carlsbad, California) immediately after leachate samples were collected. The remaining leachate was then stored at 5.5°C (42°F) for further spectrophotometer analysis of nitrate nitrogen and orthophosphate.

Two plants from each replication were harvested on 7 July 2014, and two additional plants were harvested on 13 August 2014. Height, trunk diameter, leaf area, and internode length were recorded for each plant. Plants were severed at the substrate level, all tissue bagged and dried at 57°C (135°F) for 10 days to obtain shoot dry weight. The substrate was gently removed from the roots with compressed air and all roots were dried as described above to obtain dry weight.

The experimental design was a randomized block design with four replications of eight plants per cultivar per experimental unit. All data were subjected to analysis of variance with the GLM procedure of SAS (SAS for Windows Version 9.1, SAS Institute, Cary, North Carolina) and differences among treatments were separated by a Fisher's least significant difference, $P \leq 0.05$.

RESULTS AND DISCUSSION

Plant growth

Regardless of the shade treatment, plant height growth was similar during the growing season up through the July measurement date with Cherokee Brave™ flowering dogwood (Table 1). However, by August 2014, there was a significant difference in height with Cherokee Brave™ flowering dogwood among shade treatments compared to full sun and this continued until the end of the experiment. White shade cloth yielded the greatest height growth, but overall both 30 and 50% shade provided similar height growth. Plants grown under white shade were 48% taller and plants grown under black shade were 42% taller than plants grown in full sun.

However, even with this increased height difference with Cherokee Brave™ flowering dogwood in shade treatments compared to the full sun treatment, there was only a 25% increase in total shoot dry weight with plants grown under white shade and a 6% increase with black shade (Table 1). There was very little difference in root dry weight. The 50% white shade had the greatest root dry weight followed by 30% black, full sun, and 50% black treatments.

Mean trunk diameter was similar among treatments with Cherokee Brave™ flowering dogwood at the July measurement date with exception of the plants grown under 50% black shade cloth, which was significantly less (Table 1). This trend continued until the end of the experiment. Total trunk diameter growth (final measurement — initial measurement) was the greatest in 50% white and 30% black treatments. Full sun and 50% black treatments had the least trunk diameter growth with 50% black being the smallest.

Height growth with 'Cherokee Princess' was similar among treatments at the July and August measurement date (Table 1). By September, 'Cherokee Princess' showed a significantly greater increase in height with 50% shade cloth using either black or white shade. Plants grown in full sun were 15% shorter than plants grown under 30% black shade and 23% shorter than plants grown under 50% white shade. However, there was only a 7% (30% shade) and a 2% (50% shade) increase in shoot weight as compared to full sun treatments. Root dry weight was the greatest in 50% white shade followed by 30% black, 50% black, and full sun treatments (Table 1).

Plants grown in full sun had the largest trunk diameter on 7 July and was similar to plants grown under 30% black and 50% white, but significantly different from plants grown under 50% black. Total trunk diameter growth (final caliper — initial caliper) was larger in 50% white and 30% black followed by full sun and 50% black treatments (Table 1).

Table 1. The effects of shade type on height and trunk diameter growth of Cherokee Brave™ and Cherokee Princess dogwood.

Shade treatments	Total height growth (cm)			Total trunk diameter growth (mm)			Shoot dry weight (g)			Root dry weight (g)		
	7-Jul[1]	13-Aug[1]	14- Sept[1]	7-Jul[2]	13-Aug[2]	14-Sept[2]	7-Jul	13-Aug	14-Sep	7-Jul	13-Aug	14-Sep
Cherokee Brave™ flowering dogwood												
Full sun	24.7 a[3]	47.0 c	48.5 c	4.8 a	7.8 a	11.6 ab	115.0 ab	218.1 a	285.0 c	32.5 ab	68.8 ab	164.2 ab
Black 30%	32.5 a	68.1 ab	81.1 b	5.0 a	8.7 a	12.4 a	129.4 a	243.8 a	328.3 b	35.0 a	85.6 a	175.8 ab
Black, 50%	31.5 a	61.4 b	85.7 ab	3.4 b	6.3 b	10.8 b	87.5 b	172.1 b	279.6 c	22.5 b	61.9 b	144.6 b
White, 50%	35.5 a	77.4 a	92.9 a	4.9 a	8.9 a	12.4 a	128.1 a	245.6 a	383.3 a	30.6 ab	89.4 a	188.3 a
LSD	12.5	14.1	9.5	1.1	1.5	1.2	29.8	44.5	41.1	10.3	20.7	37.0
Cherokee Princess flowering dogwood												
Full sun	34.6 a	50.7 a	50.5 c	5.1 a	7.3 a	10.7 b	118.1 a	216.9 a	298.3 ab	33.13 a	76.9 ab	150.0 b
Black, 30%	37.1 a	58.7 a	69.5 b	4.2 ab	6.7 a	11.9 a	91.3 b	201.9 a	321.7 a	31.25 a	75.0 ab	198.3 a
Black, 50%	37.4 a	59.9 a	86.8 a	3.7 b	6.1 a	10.1 b	85.0 b	168.8 a	265.6 b	23.13 a	59.4 b	161.7 ab
White, 50%	43.5 a	64.9 a	83.5 a	4.7 a	7.1 a	11.9 a	108.8 ab	202.5 a	337.8 a	30.63 a	90.6 a	203.9 a
LSD	13.1	16.1	11.3	1.0	1.9	1.1	25.6	72.1	51.0	11.19	30.6	46.5

[1]Total height growth=Height measured on Sept 14, 2014-initial height measured on Feb 25, 2014.

[2]Total trunk diameter growth=Trunk diameter measured on Sept 14, 2014-initial trunk diameter measured on Feb 25, 2014.

[3]Means within columns followed by the same letter are not significantly different. Means separated using Fisher's protected LSD, α=0.05.

Light intensity

Phillips et al. (1991) reported that the light intensity with 20 or 55% shade cloth or shade color did not affect plant growth. However, our data shows that height, trunk diameter, and shoot dry weight were affected by the color of the shade and the percent intensity of the shade. Our data did agree with Montague et al. (1992) that dogwood under 40% white shade had some growth parameters that were larger than black shade at 30 or 50% and full sun and that any shade resulted in larger trunk diameters.

Root zone temperatures

Root zone temperatures during this study differed significantly between treatments. Root zone temperature for full sun treatments were recorded up to 41.1°C (106°F) and often exceeded ambient air temperature. Phillips et al. (1991) reported no difference in ambient air temperature. However, the root zone temperature was significantly less with plants grown under white shade than plants under black shade. Root zone temperatures were not greatly reduced until a 50% shade cloth was used. There were very few days that root zone temperatures exceeded 37.7°C (100°F) in both 50% white and black shade treatments (data not shown).

Container leachate

Container leachate collected from a subset of plants for both Cherokee Brave™ and 'Cherokee Princess' dogwood showed a similar response among treatments for electrical conductivity, and orthophosphate at most sampling dates with the following exceptions (Figure 1). On 21 May, the electrical conductivity, and orthophosphate levels were lower for full sun than the shade treatments; and orthophosphate had elevated levels on 16 July (full sun) and 28 August (full sun and 30% black) with Cherokee Brave™ flowering dogwood. The container leachate from 'Cherokee Princess' had similar levels of electrical conductivity, and orthophosphate at most sampling dates. As expected, electrical conductivity, and orthophosphate were initially high and remained so for about 12 weeks after potting; then stabilized around 0.2 to 0.3 dS m^{-1}. So with either cultivar, light intensity was not a major component of fertilizer release patterns in the container substrate.

Shade treatments regardless of color or density did have an effect on the plant growth of Cherokee Brave™ flowering dogwood and 'Cherokee Princess' dogwood. Plants grown under 50% black and 50% white had more height growth than plants under 30% black or plants in full sun. However, plants responded more dramatically from July to September than from February to July. This may be a result of the transplanting shock of the bareroot liners into container culture. Light intensity was not a major component of fertilizer release patterns in the container substrate. More research is needed to reduce the initial transplanting shock and refine the period and longevity of shade intensity of container grown dogwoods.

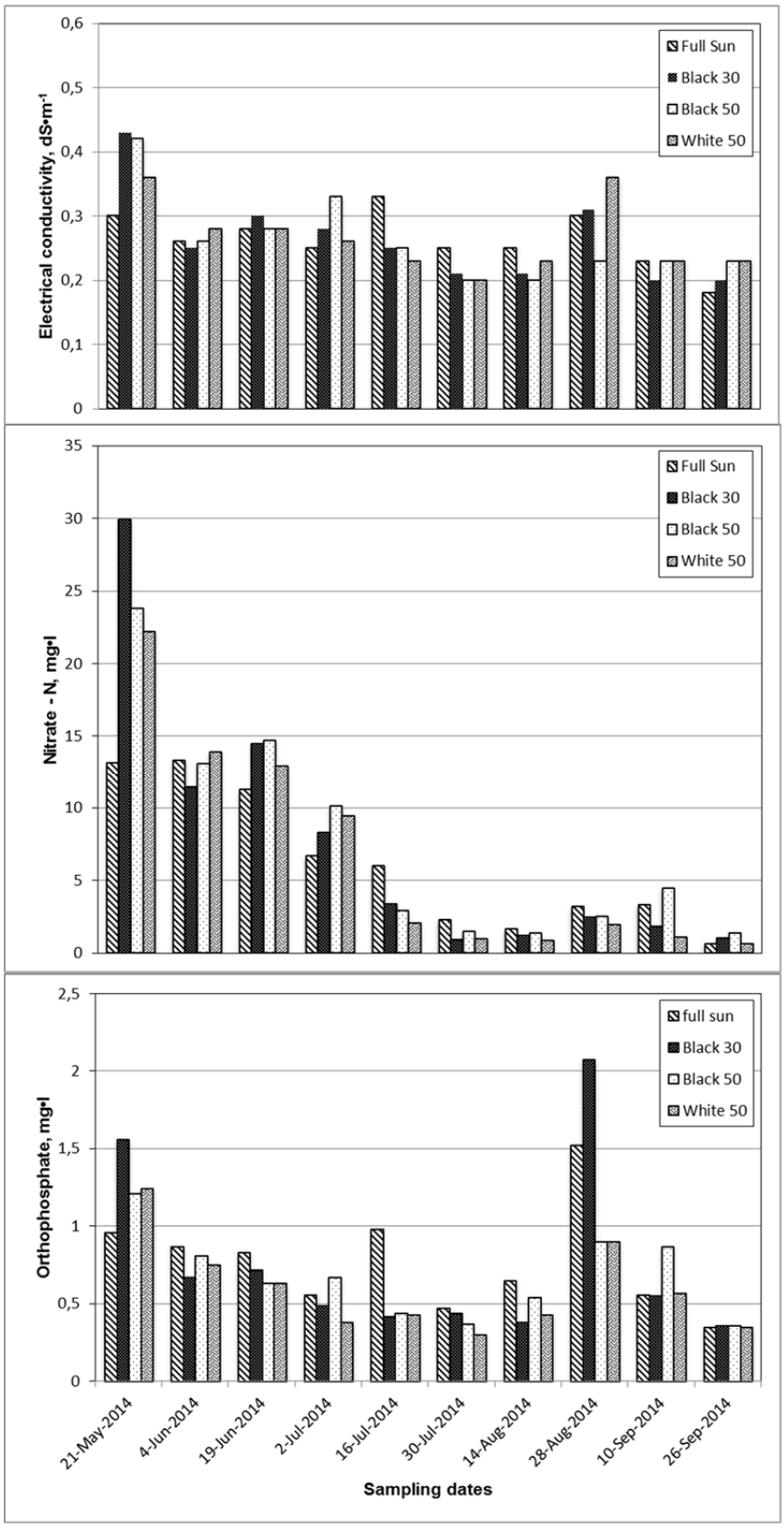

Figure 1. Electrical conductivity, nitrate nitrogen, and orthophosphate levels in leachate from container grown Cherokee Brave™ flowering dogwood. Note: top figure × axis = dS m^{-1}, middle figure × axis= mg L^{-1}, bottom figure × axis= mg L^{-1}.

Literature cited

Dirr, M.A. (2009). Manual of Woody Landscape Plants. 6th ed. (Champaign, Illinois: Stipes).

Johnson, C.R., and Ingram, D.L. (1984). *Pittosporum tobira* response to container medium temperature. HortScience *19*, 524–525.

Montague, D.T., Eakes, D.J., Gilliam, C.H., Tilt, K.M., and Ponder, H.G. (1992). Shade during container production of flowering dogwood increases growth. Proc. South. Nurs. Res. Conf. *37*, 19–21.

Phillips, E.L., Bilderback, T.E., Bir, R.E., and Torn, D. (1991). Comparison of light intensity and temperatures under white and black shade cloth. Proc. SNA Res. Conf. *36*, 105–107.