Row Cover Management of Field-Grown *Cercis canadensis* and *Lagerstroemia (indica x fauriei)* 'Muskogee'[1]

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Abstract

Field-grown *Cercis canadensis* and *Lagerstroemia (indica* x *fauriei)* 'Muskogee' with or without trickle irrigation and three row cover management systems, including a summer leguminous cover crop, pine bark mulch or bare cultivation, were evaluated. *Cercis* plants grown with lespedeza clover as a row cover had less plant growth than those bare cultivated or mulched with pine bark, even with supplemental irrigation. Mulched plots exhibited higher stomatal conductance rates attributable to high canopy temperatures. *Lagerstroemia* plants with no cover grew as well as those with a cover of mulch or clover, when sufficient water was available from either rainfall or irrigation. Clover interplantings decreased the height and number of branches in *Lagerstroemia* without supplemental irrigation, but did not affect the water relations significantly.

Index words: water potential, stomatal conductance, mulch, *Lespedeza striata*, irrigation, crape myrtle, Eastern redbud.

Significance to the Nursery Industry

Soil and water management is important to both field and container nursery growers. Row management, practices used to protect the soil, conservation of water, and reduction of weeds are important aspects of field nursery production. This study was undertaken to evaluate water conservation practices that may be used during the normally hot dry summers in the mid-south. Three row cover systems (summer leguminous cover crop, pine bark mulch or bare cultivation), two irrigation levels, trickle irrigated and not irrigated, were evaluated for their effects on plant growth and water relations of field-grown woody plants. Clover did not reduce plant growth of crape myrtles when irrigated; however, when the crape myrtles were not irrigated, plant growth was reduced. Clover reduced redbud growth regardless of irrigation. Pine bark mulch did not affect redbud or crape myrtle growth. When selecting cover crop alternatives to bare cultivation for water and soil conservation, supplemental irrigation may be necessary to support good plant growth. The use of mulches may not improve plant growth, but may prevent soil loss due to erosion, prevent soil water loss due to evaporation, and reduce the need for chemical weed control; however, mulches such as pine bark may be cost prohibitive for even small-scale nurseries.

Introduction

Row management is an important aspect of field nursery production. Methods of row cultivation are selected to protect the soil, conserve water and reduce weeds within the row. Cultivation can increase soil erosion and require large expenditures in chemical and mechanical weed control. Hogue and Neilsen (11) reported herbicide treatments can increase fruit tree growth and vigor, presumably by reducing water and nutrient competition from weeds. However, herbicides are not favored by some growers due to the possibility of herbicide residue leaching into the water supply, and the threat of herbicide drift onto adjacent plants.

Alternative methods of row management include the use of mulch within the row and herbaceous cover crops within and between the rows (6, 7). The use of mulch in nursery rows is reported to enhance the growth and vigor of young fruit trees, with or without irrigation (11). However, studies on nursery stock interplanted with grasses have shown that grasses have a detrimental effect on the vigor and growth of apple trees, especially when newly transplanted (11). This effect was attributed to competition for water and/or nutrients. Additional hazards of grass interplantings include pests in the grass cover and the expense of establishing and maintaining the cover (4). Advantages of a grass cover include less water run-off, protection of the soil from erosion and traffic, moderation of extreme soil temperatures, and reduction of weeds (6, 7). The best grass cover for interplanting in the nursery situation is low growing, resistant to drought and shade, and provides a thick dense cover for weed reduction (4).

One possible method that has not been widely studied is the use of legumes as a cover within the row. Many growers interplant nursery crops with winter cover crops of red clover (*Trifolium pratense*) to add organic matter and nitrogen to the soil, and for weed control and soil conservation (7). Soil loss from simulated field nursery conditions was reduced when lespedeza was used as an aisle cover (6). Bould and Jarrett (2) studied the effect of four cover crops: wild white clover (*Trifolium repens*), perennial ryegrass (*Lolium perenne*), timothygrass (*Phleum pratense*), and natural sward, in combination with fertilizer treatments on apple trees. They concluded that the grasses retarded the growth and vigor of the trees compared to those grown under clover and natural sward. Pine bark and hardwood bark mulches are commonly used by the landscape industry for water and soil conservation, but may be cost prohibitive even in small-scale nurseries

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The objective of this study was to compare the effects of three methods of row cover management, including a summer leguminous cover crop, pine bark mulch or bare cultivation, and irrigation, on plant growth and water relations of two woody ornamental plant species in a field nursery.

Materials and Methods

Plant materials for this study were container-grown [3.8 l (#1)] *Cercis canadensis* L., Eastern redbud seedlings, and *Lagerstroemia* (*indica* L. x*fauriei* Koehne) 'Muskogee' NA 38448, PI 427114 (8), crape myrtles. These were field-planted at the Mississippi Agricultural and Forestry Experiment Station Plant Science Research Center (88.8° W, 33.5° N) in August, 1988. The soil was a Leeper fine silty clay loam (fine, montmorillonitic, non-acid, thermic Chromudertic Hapludalf) (3) where the pH was 7.8 in 1989 and 8.1 in 1990. Two weeks prior to planting, 445 kg/ha (396 lb/A) sulfate of potash magnesia (26% K, 15% S, and 10% Mg), 148 kg/ha (132 lb/A) chelated iron and 119 kg/ha (106 lb/A) simple super phosphate were incorporated into 1 × 30 m (39 in × 98 ft) rows. Ammonium nitrate, 238 kg/ha (212 lb/A), was applied in late May of 1989 and 1990.

The nursery plot consisted of four rows, two rows for each species, with 30 plants each on one m (39 in) centers oriented north and south. The rows were separated by a 3 m (10 ft) strip of grass sward, mowed regularly. The rows were divided into three 10 m (33 ft) × 1 m (3.25 ft) sections each and randomly assigned one of three cultivation treatments: 1) bare cultivation; 2) cover of Kobe lespedeza clover, *Lespedeza striata* (Thunb. ex J. Mur.) Hook and Arn.; and 3) cover of coarsely shredded pine bark mulch applied April 1, 1989 10 cm (4 in) deep, 1 × 3m (39 in × 10 ft). Each row was initially randomly assigned one of two irrigation treatments, irrigated [trickle irrigated at 3.8 l/hr (1 gal/hr) for 48 hours whenever the soil tension measured –40 centibars or less] or not irrigated. Soil water tension was measured with a "quick draw" tensiometer (SoilMoisture Probe, Model 2900, SoilMoisture Equipment Corp., Santa Barbara, CA). Due to heavy rainfall during the early summer of 1989, irrigation was applied only three times to the irrigated rows. There were 10 plants within each cultivation and irrigation treatment combination.

Lespedeza clover was first planted April 1, 1989 and again April 15 after a heavy rain, but by April 29 only scant germination was noted. Plots were then replanted May 2 with seed from a different source and a heavy stand of clover was obtained by May 16, 1989. Fluazifop-butyl (Fusilade) was applied to the lespedeza and to bare cultivated plots in late June to eliminate weedy grasses, and isopropylamine salt of glyphosate (Roundup) was used on the bare cultivation plots, as needed, to control any remaining weeds throughout the growing season.

Plant growth was measured in March 1990 (prior to bud break for 1989 growth) and November 1990 by determining plant height (from the soil line to the growing point) and caliper [10 cm (4 in) from the soil line] of *Cercis* and *Lagerstroemia* and number of branches for *Lagerstroemia* only. These data were analyzed as a modified split plot design separately for each species using irrigation as the main plots and row cover treatments as the sub-plots with 10 single

Table 1. Irrigation and row cover effects on height, average caliper, and number of branches of *Cercis canadensis* and *Lagerstroemia* 'Muskogee' after the 1989 and 1990 growing seasons.

		1989			1990		
Irrigation	Cover	Height (cm)	Caliper (mm)	Branches (no./plant)	Height (cm)	Caliper (mm)	Branches (no./plant)
Cercis canadensis							
Irrigated	Bare	157	13.2	—	215	37.9	—
	Clover	105	10.2	—	150	23.5	—
	Pine Bark	141	14.4	—	204	34.5	—
Not Irrigated	Bare	165	14.8	—	193	31.6	—
	Clover	120	12.4	—	142	21.7	—
	Pine Bark	169	14.2	—	175	32.4	—
ANOVA[z]	Cover	****	****	—	****	****	—
	Cover*Irr	NS	*	—	*	**	—
	LSD[y]	6	0.1	—	8	0.1	—
Lagerstroemia 'Muskogee'							
Irrigated	Bare	138	13.8	16.5	203	16.5	66.7
	Clover	131	10.0	14.3	199	14.9	53.6
	Pine Bark	132	12.6	15.5	196	13.3	51.1
Not Irrigated	Bare	141	13.8	18.4	191	14.7	35.9
	Clover	123	11.2	12.1	199	13.4	38.7
	Pine Bark	143	13.8	17.3	183	12.5	37.8
ANOVA[z]	Cover	NS	****	***	NS	***	***
	Cover*Irr	NS	NS	NS	NS	NS	NS
	LSD[y]	8	0.1	1.1	6	0.1	1.2

[z]Analysis of Variance where tests of significance were NS, *, **, *** and ****; not significant, or signficant at $P \leq 0.05, 0.01, 0.001$ and 0.0001, respectively.
[y]Least Significant Difference where $P \leq 0.05$.

plant replications (16). The whole plot irrigation was not tested in the model as a main effect because it was not truly replicated (13). Analysis of variance was conducted using General Linear Models and Type III sums of squares (9) and mean separations were conducted using the Least Significant Difference (LSD) test at the 0.05 level (16).

Stomatal conductance, transpiration rate and leaf temperature were determined with a steady-state porometer (Model 1600, LiCor, Inc., Lincoln, NB) at 0900 CST and 1300 CST on two days, two days apart during August of 1989 and 1990. Water potential was determined with a Scholander-type pressure chamber (Plant Water Status Console, SoilMoisture Equipment Corp., Santa Barbara, CA) at 0400 CST, 0900 CST, and 1300 CST on the same days as stomatal conductance. The plants measured were randomly selected using three plants per cultivation treatment per row. One leaf sample from each plant was used to measure water potential. Two out of each group of these three plants were randomly selected for use with the porometer, and two leaves per plant were measured. The same plants were used on each of the two days. Analysis of variance procedures were conducted as previously described except for stomatal conductance where the whole plot irrigation was tested using the two measurement days as blocks.

Results and Discussion

Due to the unusually large amount of rainfall during the spring and early summer of 1989, water stress was minimal for both irrigated and non-irrigated plants and few differences in plant growth due to irrigation for either species were observed (Table 1). Rainfall during 1990 was near normal and supplemental irrigation increased plant growth about 12% for *Cercis* and 13% for *Lagerstroemia* after two growing seasons (Table 1). This increase was most evident with increased caliper for *Cercis* and increased branching for *Lagerstroemia*.

Cercis grown with a cover of clover had the smallest caliper compared to the other row cover treatments, regardless of irrigation level, over both growing seasons (Table 1). *Cercis* grown with clover began losing leaves before the end of the growing season. Many plants were completely defoliated at the end of both growing seasons although plants in the other plots were in full leaf. Hogue and Neilsen (11) reported a similar detrimental effect of grass interplantings on nursery stock with newly planted trees. *Lespedeza cuneata* residues have been shown to be allelopathic to warm-season grasses (12); however, no allelopathic information on *Lespedeza striata*, which was used in this study, has been reported. Seedling growth of *Cercis* was reduced by allelopathic root leachates from a sorghum-sudangrass hybrid (10). Bould and Jarrett (2) reported that white clover, compared to grasses, did not have a detrimental effect on apple trees. Using pine bark mulch as a row cover did not increase the height of *Cercis* or the height, caliper, or branch number of *Lagerstroemia*, regardless of irrigation treatment, compared to bare cultivated rows (Table 1) as was observed by Hogue and Neilsen (11) with fruit trees. After two seasons, the caliper of *Cercis*, not irrigated and mulched with pine bark, was similar to irrigated *Cercis* with bare cultivation (Table 1). With irrigation, pine bark mulch appeared to stunt growth

Table 2. Irrigation and row cover effects on midsummer predawn (0400 CST), morning (0900 CST), and afternoon (1300 CST) water potential of *Cercis canadensis* and *Lagerstroemia* 'Muskogee' after the 1989 and 1990 growing seasons.

Irrigation	Cover	1989 Predawn (MPa)	1989 Morning (MPa)	1989 Afternoon (MPa)	1990 Predawn (MPa)	1990 Morning (MPa)	1990 Afternoon (MPa)
Cercis canadensis							
Irrigated	Bare	–0.17	–0.77	–0.77	–0.33	–1.60	–1.62
	Clover	–0.17	–0.77	–0.83	–0.28	–1.88	–2.03
	Pine Bark	–0.17	–0.78	–0.80	–0.40	–2.18	–2.37
Not Irrigated	Bare	–0.15	–0.72	–0.82	–0.57	–2.67	–2.83
	Clover	–0.09	–0.73	–0.87	–0.57	–2.31	–2.57
	Pine Bark	–0.22	–0.73	–0.83	–0.31	–2.35	–1.76
ANOVA[z]	Cover	**	NS	NS	NS	NS	NS
	Cover*Irr	*	NS	NS	****	****	****
	LSD[y]	0.12	0.10	0.09	0.09	0.09	0.09
Lagerstroemia 'Muskogee'							
Irrigated	Bare	–0.09	–0.38	–0.73	–0.16	–1.09	–1.16
	Clover	–0.09	–0.45	–0.78	–0.17	–0.82	–1.06
	Pine Bark	–0.07	–0.52	–0.80	–0.23	–0.77	–1.05
Not Irrigated	Bare	–0.11	–0.62	–0.78	–0.31	–1.13	–1.35
	Clover	–0.11	–0.55	–0.82	–0.29	–0.77	–1.42
	Pine Bark	–0.09	–0.58	–0.80	–0.42	–1.30	–1.45
ANOVA[z]	Cover	NS	NS	NS	NS	NS	NS
	Cover*Irr	NS	**	NS	**	**	**
	LSD[y]	0.10	0.07	0.10	0.10	0.10	0.10

[z]Analysis of Variance where tests of significance were NS, *, **, *** and ****; not significant, or signficant at $P \leq 0.05$, 0.01, 0.001 and 0.0001, respectively.
[y]Least Significant Difference where $P \leq 0.05$.

Table 3. Irrigation and row cover effects on morning (0900 CST) and afternoon (1300 CST) stomatal conductance of *Cercis canadensis* and *Lagerstroemia* 'Muskogee' during August of 1989 and 1990.

		1989		1990	
		Stomatal Conductance ($cm\ sec^{-1}$)			
Irrigation	Cover	Morning	Afternoon	Morning	Afternoon
Cercis canadensis					
Irrigated	Bare	0.98	0.36	0.93	1.17
	Clover	2.00	0.38	1.21	1.13
	Pine Bark	2.25	1.14	1.10	1.49
Not Irrigated	Bare	2.83	0.97	1.45	1.31
	Clover	1.51	0.34	0.65	0.70
	Pine Bark	3.43	0.96	0.56	0.62
ANOVA[z]	Cover	NS	****	***	***
	Irrigation	NS	NS	****	****
	Cover*Irr	NS	**	NS	NS
	LSD[y]	0.37	0.06	0.09	0.09
Lagerstroemia 'Muskogee'					
Irrigated	Bare	2.66	0.62	1.35	1.01
	Clover	1.53	0.35	1.45	0.86
	Pine Bark	2.41	0.70	1.29	1.03
Not Irrigated	Bare	2.29	0.52	0.54	0.38
	Clover	2.20	0.15	0.77	0.50
	Pine Bark	3.39	0.93	0.57	0.29
ANOVA[z]	Cover	NS	**	NS	NS
	Irrigation	NS	NS	****	****
	Cover*Irr	NS	NS	**	**
	LSD[y]	0.57	0.10	0.13	0.13

[z]Analysis of Variance where tests of significance were NS, *, **, *** and ****; not significant, or signficant at $P \leq 0.05, 0.01, 0.001$ and 0.0001, respectively.
[y]Least Significant Difference where $P \leq 0.05$.

of *Lagerstroemia*, compared to bare cultivation, as illustrated by reduced caliper and branch number after two seasons (Table 1).

Height of *Lagerstroemia* plants were similar for all treatment combinations during 1989 and 1990 (Table 1). Caliper of *Lagerstroemia* plants grown with clover during 1989 were the smallest compared to bare cultivation or pine bark mulch, whether irrigated or not (Table 1). During 1990, irrigated *Lagerstroemia* plants, grown with bare cultivation, had the greatest number of branches and those grown with pine bark mulch had the fewest (Table 1). *Lagerstroemia* plants during 1990 without irrigation had fewer branches than irrigated plants and those plants grown with bare cultivation had fewer branches than those grown with clover and pine bark mulch (Table 1).

Water potential is a measure of the degree of plant water stress (13). As a plant begins to become water stressed, losing more water than it is taking up, the water potential becomes lower or more negative, and becomes less turgid. During 1989, predawn water potential of irrigated *Cercis* plants was not different between the row cover treatments (Table 2). Plants not irrigated and grown with clover had the greatest predawn water potential during 1989 compared to those mulched with pine bark. This indicated that the mulched plants were more water stressed than those grown with clover (Table 2). Water potential of *Cercis* plants measured in the morning and afternoon during 1989 were not different between any treatment (Table 2). During 1990, irrigated *Cercis* plants grown with bare cultivation had the highest morning and afternoon water potentials, the least water stress, and bare cultivated plants not irrigated were the lowest or the most water stressed (Table 2). This suggests that even without irrigation, that the clover was not seriously competing with the *Cercis* plants for water. In contrast, Andrews et al. (1) reported that apple trees had lower water potentials when grown with an alfalfa orchard floor and no supplemental irrigation compared to irrigated trees with an alfalfa, bare cultivation, or plastic mulch orchard floor. During 1990, water potential of *Cercis* mulched with pine bark and irrigated was lower and the water stress was greater, than those irrigated and grown with clover or bare cultivated, which was not expected. Irrigated *Cercis* plants mulched with pine bark had greater afternoon stomatal conductance rates during 1989 and 1990 compared to all other treatments, which may be responsible for the lower water potentials (Table 3). Pine bark mulch has been shown to increase canopy temperature by sensible heat and longwave radiation from the mulch surface, thus increasing the leaf-air vapor pressure deficit, which will increase stomatal conductance rates (17). Vapor pressure deficit and stomatal conductance of *Cercis* are highly correlated (14) as are vapor pressure deficit and canopy temperature (1).

There were few differences detected in predawn or afternoon water potentials of *Lagerstroemia* plants during either year. Water potentials during the morning were highest, least water stressed, for those grown with irrigation and bare cultivated (Table 2). During 1990, plants not irrigated and mulched with pine bark had the lowest water potential, which was a similar response to *Cercis* mulched with pine bark and irrigated (Table 2). During 1989, morning stomatal conductance of *Lagerstroemia* plants was not different between any treatment; whereas, afternoon stomatal conductance was the lowest for plants not irrigated and grown with clover (Table 3) indicating that these plants may have been water stressed competing with the clover for water, however, the water potential of those same plants was not different from any other treatment (Table 2). During 1990, morning and afternoon stomatal conductance of *Lagerstroemia* plants was greatest for irrigated plants compared to plants not irrigated (Table 3). Irrigated plants grown with clover had the greatest stomatal conductance rates compared to all treatments during the morning, but during the afternoon it was lower than the other irrigated row cover treatments (Table 3). *Lagerstroemia* plants that were not irrigated and grown with clover had greater stomatal conductance rates than those grown with bare cultivation or pine bark mulch. These greater stomatal conductance rates as well as the higher water potentials indicate that *Lagerstroemia* plants without irrigation were able to compete with the clover for water and clover may be a good row management system for *Lagerstroemia* plants for water conservation; however, since plants grown with clover had fewer branches and a smaller caliper, the clover may compete with *Lagerstroemia* for nutrients, but this was not addressed in this study. Pine bark mulch increased the stomatal conductance of *Lagerstroemia* plants compared to those grown with clover similarly to *Cercis* further supporting that the pine bark mulch increases canopy temperatures, which in turn increases stomatal conductance rates.

The use of clover as a row cover on *Cercis* decreased plant growth, even with supplemental irrigation. Mulched plots exhibited higher stomatal conductance rates attributable to high canopy temperatures. *Lagerstroemia* plants with no cover grew as well as those with a cover of mulch or clover, when sufficient water was available from either rainfall or irrigation. Clover interplantings decreased the height and number of branches in *Lagerstroemia* without supplemental irrigation, but did not significantly effect the water relations. When selecting an alternative to bare cultivation methods for water and soil conservation, such as cover crops, supplemental irrigation and fertility may be necessary to support good plant growth. The use of mulches may not improve plant growth and may increase plant water use, but may prevent soil loss due to erosion, prevent soil water loss due to evaporation, and reduce the need for chemical weed control.

There were some intertesting growth differences between *Lagerstroemia* and *Cercis* to the row cover treatments. The largest plants at the end of the study were those irrigated and bare cultivated, regardless of species. *Cercis* plants grown with clover were the smallest, and the smallest *Lagerstroemia* plants were those mulched with pine bark. *Cercis* is typically an understory species with moderately shallow roots thriving in fertile well-drained soil and adaptable to acid or alkaline soils, excluding those poorly drained (15). 'Muskogee' *Lagerstroemia* is readily cultivated under climatic and soil conditions similar to *L. indica* and grows best in soil that is heavy loam to clay in texture with a pH of 5.0–6.5 (8). *Cercis* apparently was not compatable with the clover, either through water or nutrient competition, or through some yet undetermined allelopathic response. *Lagerstroemia* was not as affected by clover and growth was less when mulched with pine bark suggesting that perhaps these plants were growing under sightly anoxic conditions (5).

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