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Growth Reduction of Eastern Redbud (*Cercis canadensis* L.) Seedlings Caused by Interaction with a Sorghum-Sudangrass Hybrid (Sudex)[1]

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Abstract

Growth of Eastern redbud (*Cercis canadensis L.*) seedlings was significantly reduced when co-cultivated with living sudex (*Sorghum bicolor (L.)* Moench x *Sorghum sudanese* (P.) Stapf. cv. FFR 201) and when sudex leaf material was incorporated into the growing medium. The reduction in redbud growth could not be reversed with increased fertilizer rates. Increasing the amount of fresh or dried sudex incorporated into the medium reduced redbud seedling growth in a linear manner. Sudex leaf material placed on the soil surface as a mulch had no effect on redbud growth.

Index Words: *Cercis*, sudex, allelopathy, competition, covercrop

Introduction

Nurseries use cover crops to control soil erosion and reduce weed populations during production. Between production cycles, cover crops are also used as a source of green manure for the improvement of soil structure and organic matter content (1). Sudex is commonly selected as a summer annual cover crop due to its rapid growth and ability to suppress weed growth (3).

However, both sorghum and related species have been shown to have possible allelopathic interactions with agronomic crops (2, 3, 5, 6). Root leachates from hydroponically-grown sudex were shown to be phytotoxic to both monocots and dicots in a seedling bioassay (2). Iyer *et al.* (4) demonstrated an inhibitory effect on the growth of pine seedlings with the incorporation of sudex into a container soil medium.

Since little information is available concerning the interaction of sudex with commonly grown nursery stock, this present study was initiated to evaluate the potential allelopathic effect of sudex on the growth of Eastern redbud.

Materials and Methods

Each experiment was conducted under greenhouse conditions in a completely randomized block design with or without factorial treatment combinations and treatments replicated 5 times. Temperatures were maintained at 23–27° day/20–24°C night (73–81/68–75°F). Supplemental lighting was provided by 1000 W high pressure sodium vapor lamps (Energy Technics, York, PA) during October through April 1986–87. Lamps provided a photosynthetic photon flux density of 500 $\mu mol \cdot s^{-1} \cdot m^{-2}$. The container medium used throughout these experiments was a non-pasteurized artificial medium (5 parts Promix BX: 1 part perlite by vol.). The containers were watered overhead as needed and fertilized with Peters 14-15-16 (14N-6.5P-13.3K) at 200 ppm nitrogen at each watering unless otherwise stated.

Redbud seed was pre-treated with H_2SO_4 for 30 minutes, rinsed and moist stratified at 5° C (41°F) for 60 days. In seedling experiments, 5 seeds were sown in each 1 gal. (#1) container. The seedlings were thinned to 3 plants per container 3 weeks after sowing. Redbud transplants were produced in a similar manner and uniform seedlings (15 cm in height) were set into the treated containers 6 weeks following sowing.

Sudex Treatment Experiment: Sudex was grown as described above, either in 1 gal. (#1) treatment containers or in 50 × 35 × 10 cm (20 × 14 × 4 in) plastic flats for biomass production. Sudex treatments included living sudex, sudex incorporated into the growth medium and a sudex surface mulch. Incorporated sudex treatments contained fresh leaf material cut into approximately 3 cm (1.2 in) pieces and mixed throughout the growing medium. For a living

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sudex cover, treatment containers were seeded with 30 seed per container and the sudex was allowed to reach 15 cm (5.9 in) in height. The living sudex cover was trimmed and maintained at 10–13 cm (4–5 in) in height for the duration of the experiment to reduce plant shoot competition. Sudex mulch treatment consisted of leaf material cut into 3 cm (1.2 in) pieces and placed on the surface of the medium at 12.5 g (0.44 oz) dry weight per container. In addition to pots containing no sudex material, inert poplar excelsior mulch (applied at 12.5 g (0.44 oz) per container) was used as a mulch control treatment. Redbud transplants or redbud seed were introduced to the containers on July 2, 1986. Experiments were terminated on August 28, 1986, 8 weeks after planting.

Fertilizer × Sudex Interaction Experiment: A randomized complete block with a factorial arrangement of treatments was designed to observe the interaction between applied fertilizer and sudex on redbud seedling growth. Sudex treatments included sudex incorporated into the medium at 100 g (3.53 oz) fresh weight per container and living sudex (maintained as described above). Soluble fertilizer was supplied for each sudex treatment at 100, 200, 300 and 400 ppm of N with Peters 14-15-16 (14N-6.5P-13.3K) at each watering. Containers were leached with excess water once per week to reduce salt accumulation. The experiment was seeded on October 31, 1986 and terminated 5 weeks later on December 8, 1986.

Incorporated Sudex Rate Experiment: Sudex was incorporated into the medium at 0, 50, 100 and 200 g (1.76, 3.53, 7.05 oz) fresh weight and also at a corresponding 6.25, 12.5 and 25 g (0.22, 0.44, 0.88 oz) dry weight per container to observe the response of both fresh and dried material upon redbud seedling growth. The experiment was seeded on February 20, 1987 and was terminated 7 weeks later on April 14, 1987.

Redbud seedling or transplant height was measured weekly for each experiment. At the termination of each experiment, seedlings were carefully removed from potting containers and root systems were washed and dried. Following separation of shoots and roots, fresh weights were recorded. Samples were dried in an oven at 45°C (113°F) for 5 days and dry weights were recorded.

Table 1. Response of redbud seedlings to various sudex treatments 55 days after transplanting.

	Fresh wt (g/plant)		Dry wt (g/plant)		Final ht
Cover crop	shoot	root	shoot	root	(cm)
Control	55.6 a[z]	22.0 a	19.7 a	6.4 a	90.5 a
Excelsior mulch	50.7 a	13.1 c	17.2 a	5.2 b	85.3 a
Sudex mulch	55.2 a	14.9 bc	19.4 a	5.6 ab	89.4 a
Sudex incorporated	35.3 b	18.3 ab	12.5 b	5.2 b	66.6 b
Living Sudex cover	5.3 c	7.8 d	2.0 c	3.3 c	13.5 c

[z]Values represent the means of 15 plants. Values followed by the same letter within a column were not significantly different at the .05 level as indicated by LSD test.

Table 2. Interaction between fertilizer rate and sudex treatment on the growth of redbud seedlings 40 days after seeding.

Treatment		Shoot	Root	Final ht
Sudex	ppm N	dry wt (g)	dry wt (g)	(cm)
Bare soil				
Control	100	2.7	0.7	22.9
	200	3.5	0.9	29.7
	300	1.9	0.4	18.3
	400	1.8	0.3	16.4
Incorporated				
sudex cover	100	1.2	0.2	11.7
	200	1.2	0.2	13.4
	300	0.6	0.1	7.7
	400	0.5	0.1	5.9
Living				
sudex cover	100	0.9	0.2	11.5
	200	1.1	0.2	12.9
	300	1.1	0.2	14.1
	400	0.9	0.2	11.8

	Significance[z]		
	Shoot wt	Root wt	Final ht
Fertilizer level	**	**	**
Sudex treatment	**	**	**
Fertilizer X Sudex Trts.	ns	ns	ns

[z]ns, *, **Nonsignificant or significant at the .05 (*) or .01 (**) levels, respectively.

Results and Discussion

Growth of redbud seedlings and transplants was inhibited by co-cultivation with living sudex (Tables 1, 2). Redbud seedlings transplanted into living sudex showed minimal growth throughout the course of the experiment (Table 1) and were reduced in growth by 85% as compared to the bare soil or poplar excelsior mulch controls. However, the germination and stand establishment of redbud seed were not reduced in the presence of living sudex as compared to the control situations (data not presented).

Sudex leaf and stem tissue incorporated into the growing media consistently reduced redbud shoot growth by up to 55% when compared with the bare soil control (Tables 1, 2 and 3). This inhibition of shoot growth was only observed when fresh or dried sudex was incorporated into the medium. Dried sudex tissue used as a mulch on the surface of the growing medium had no effect on redbud growth (Table 1). This indicates a role for microbial decomposition or a requirement for high moisture content in order for the leaf material to become phytotoxic. Forney and Foy (3) incorporated sudex as a green manure crop in field studies and demonstrated strong interference with growth in field weed species. They attributed this reduction in weed biomass to both the competitive nature of sudex and also to its potential allelopathic properties.

High fertility rates did not alleviate the reduction in redbud growth in the presence of incorporated sudex tissue (Table 2). There were no significant interactions between fertilizer rate and redbud growth in the presence of living sudex or when sudex was incorporated into the growing medium. This suggests an additional mechanism for sudex interference with redbud growth besides competition for resources. The data also suggest that the mode of action of incorporated sudex tissue in reducing redbud growth was not a simple competition for N by saprophytic bacteria as the tissue decomposed. Although experiments were conducted using an artificial growth medium, microbial and fungal populations

Table 3. Response of 50-day-old redbud seedlings to increasing amounts of sudex incorporated into the growing medium.

Sudex treatment (g/container)	Fresh wt (g/plant) shoot	Fresh wt (g/plant) root	Dry wt (g/plant) shoot	Dry wt (g/plant) root	Final ht (cm)
Fresh Sudex					
0	7.5 a[z]	4.1 a	2.6 a	1.1 ab	44.2 a
50	7.6 a	3.9 a	2.6 a	1.4 a	43.6 a
100	6.1 b	2.8 b	2.1 b	0.9 b	37.7 b
200	1.5 d	0.9 c	0.5 d	0.2 c	11.8 d
Dried Sudex					
6.25	5.6 bc	3.3 ab	2.0 bc	1.0 b	36.7 bc
12.5	4.8 c	3.3 ab	1.6 c	0.9 b	32.1 c
25.0	2.1 d	1.7 c	0.6 d	0.3 c	17.3 d

[z]Values represent the means of 15 plants. Values followed by the same letter within a column were not significantly different at the .05 level as indicated by LSD.

were noted within the medium. Laboratory experiments also indicate that sudex residue was inhibitory to plant growth under both sterile and nonsterile soil conditions (unpublished data). However, the inhibition of growth of redbud at the highest fertility rates may be the effect of supraoptimal levels of the fertilizer.

Incorporated fresh or dried sudex leaf tissue was equally effective in reducing redbud growth with greater amounts of incorporated sudex resulting in a linear decrease in redbud growth (Table 3). A decreased growth rate of redbud seedlings was observed when grown in the presence of incorporated sudex, particularly during the first 3 weeks after transplanting (Figure 1). The reduction in redbud growth could be attributed to the effect of allelochemicals released from the sudex leaf tissue over time. However, the tissue toxicity appeared to diminish after 10 weeks of incorporation, while living sudex interfered with redbud growth for the duration of experiments (data not presented).

Shoot tissues of the related species, johnsongrass (*Sorghum halepense*) and sorghum (*Sorghum bicolor*) have also been shown to possess phytotoxic chemicals. The cyanogenic glycoside dhurrin and its breakdown products, p-hydroxy benzoic acid and HCN, were identified as seedling growth inhibitors in johnsongrass. Several phenolic acids were also implicated (5). Other active components in sorghum tissue have not yet been identified (6). In our laboratory studies, sudex tissues and extracts also exhibit strong phytotoxicity. The structural elucidation of these potential allelochemicals is currently under investigation.

Significance to the Nursery Industry

Sudex is being used in the nursery industry as a cover crop and green manure crop. This study indicates that living sudex and low rates of sudex incorporated into the growing medium have the potential to significantly inhibit redbud growth in a controlled greenhouse environment. Further studies are being conducted to observe the effects of sudex on field-grown crops and surrounding weed populations in the nursery. The results of future studies will determine the potential phytotoxicity of sudex tissues and extracts upon woody plants and indicate if the potential exists for the nursery industry to exploit the apparent beneficial effects of sudex on weed suppression.

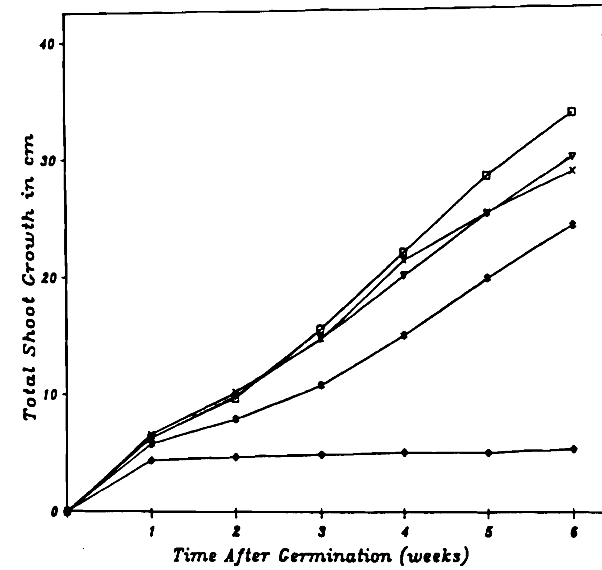

Fig. 1. Cumulative shoot growth in redbud seedlings. □ Control, X poplar excelsior mulch, ▽ sudex mulch, # sudex incorporated into the medium, ◇ living sudex.

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