ALLELOPATHIC EFFECTS OF KENTUCKY BLUEGRASS ON NORTHERN RED OAK AND YELLOW-POPLAR

by T.E. Kolb

Abstract. Allelopathic effects of Kentucky bluegrass *(Poa pratensis)* on seedling growth of northern red oak *(Quercus rubra)* and yellow-poplar *(Liriodendron tulipifera)* were investigated. Foliage extracts and leachates from potted Kentucky bluegrass did not reduce the growth of either species in a Hagerstown top soil over a 139-day period from seed germination. Removal of northern red oak cotyledons at the one-flush stage reduced growth of the stem and root, but did not affect susceptibility to bluegrass foliage extractives and pot leachates. The results suggest that previously reported detrimental interference between Kentucky bluegrass and seedlings of northern red oak or yellow-poplar can be attributed to competition rather than allelopathy.

Lawn grasses may reduce the growth of ornamental trees by competition for soil resources (3, 4) and allelopathy (1, 7). Competition is the removal or reduction of some factor from the environment by one plant that is required by another plant sharing the same habitat (6). In contrast, allelopathy is any effect by one plant on another plant through the production of chemical compounds that escape into the environment, and includes both positive and negative effects (6). Competition and allelopathy are components of interference, which refers to the overall influence of one plant on another plant.

In a previous study (2), I grew seedlings of northern red oak *(Quercus rubra)* and yellow-poplar *(Liriodendron tulipifera)* in the presence and absence of a trimmed sod of Kentucky bluegrass *(Poa pratensis)*. Intereference by bluegrass roots reduced the first-year growth of both species whether plants were grown from seed or one-year-old seedlings. It was not clear whether the detrimental effect of bluegrass root interference on these species was due to competition between root systems, allelopathy, or a combination of both, since bluegrass allelopathy has been reported on forsythia *(Forsythia intermedia)* (1). This study examined the possibility of detrimental allelopathic effects of Kentucky bluegrass leaves and roots on seedlings of northern red oak and yellow-poplar.

Methods

Pre-stratified seeds of northern red oak and yellow-poplar were planted on April 17, 1986 in a glasshouse (University Park, Pennsylvania). Seeds of northern red oak were obtained from a single, open-pollinated tree located in Huntingdon County, Pennsylvania, while yellow-poplar seeds of unknown parentage were obtained from the Pennsylvania Bureau of Forestry. Two northern red oak seeds were planted in each of 48 3.8-liter nursery pots divided into 6 experimental blocks. Approximately 50 yellow-poplar seeds were planted in each of 48 3.8-liter pots divided into 12 experimental blocks. Pot medium for both species was a Hagerstown silty clay loam top soil. Nutrient analysis on this soil prior to the study indicated a pH of 6.3, phosphorus concentration of 90 kg/ha, potassium concentration of 0.336 meq/100 gm, magnesium concentration of 1.03 meq/100 gm, calcium concentration of 6.48 meq/100 gm, and nitrogen concentration of 0.120 (% of soil dry weight).

Date of epicotyl emergence from the soil surface was measured on all pots for 40 days following planting. Date of emergence for yellow-poplar averaged 30 days from planting and did not vary by more than seven days among pots. Date of emergence for northern red oak averaged 31 days from planting and ranged from 17 to 40 days among pots. On day 40, the number of seedlings per pot was reduced to one based on uniformity in date of epicotyl emergence for each respective species.

Seedlings of each species were exposed to weekly applications of each of four bluegrass foliage extractive/pot leachate treatments between 48 and 132 days after planting. Five days prior to the initial treatment application, cotyledons were randomly removed from half of all northern red oak seedlings in each block to assess the role of cotyledonary reserves in seedling response to

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possible allelochemicals. At this date, all northern red oak seedlings had produced only one stem flush. Thus, each block of northern red oak included seedlings with and without cotyledons for each of four bluegrass extractive/leachate treatments.

Treatments used in the study were: 1) 100 ml deionized water (control), 2) 100 ml 50% green foliage extract, 3) 100 ml 100% green foliage extract, 4) 200 ml of liquid consisting of 100 ml 100% green foliage extract plus 100 ml bluegrass pot leachate. Foliage extracts were prepared by soaking freshly clipped bluegrass leaves from outdoor sodded plots in distilled water in a 1:10 (fresh weight foliage:water) ratio for 24 hours at 20°C. This solution was vacuum filtered through Whatman No. 2 Qualitative Filter Paper to remove organic debris. Pot leachate was obtained by adding 600 ml of deionized water to each of 12 pots of bluegrass sod growing in the same Hagerstown soil in the glasshouse. Water was slowly added to each pot to assure penetration into soil occupied by bluegrass roots. The resultant leachate was collected and vacuum filtered to remove soil particles. Fresh foliage extract and pot leachate were prepared weekly for each application of treatments. In addition to these treatments, the level of soil moisture in pots was monitored using a Mark III Moisture Meter (Rick and Associates, Bellaire, TX), and intermediate waterings with deionized water in equal portions per pot were performed to maintain soils in a well-watered condition. Pots containing trees and grass received no supplemental fertilization during the study.

Seedlings from all treatments were destructively harvested on day 139 to assess growth. At this time, height growth had slowed considerably for all seedlings compared to earlier dates. Dry weights of roots, stems, and leaves were measured on all seedlings after drying at 24 hours (100°C for roots and stems, 60°C for leaves). Data for each species were analyzed by analysis of variance, and differences between treatment means assessed using Fisher's least significant difference. Date of epicotyl emergence from the soil was included as a covariate in the analysis of northern red oak data to control error variance. All treatment effects were tested at the $p < 0.05$ level.

Results and Discussion

Removal of cotyledons from northern red oak seedlings at the one-flush stage significantly reduced dry weights of the stem and root (mean reductions of 19.4% and 23.8%, respectively). Removal of cotyledons also reduced leaf dry weight (mean reduction of 15.2%) and seedling height (mean reduction of 2.7%), but the reductions were not statistically significant. The interaction of cotyledon treatments and bluegrass extractive/leachate treatments was not significant for seedling height or the dry weight of any organ. Thus, responses to extractive/leachate treatments were similar for northern red oak whether cotyledons were present or absent after development of the first stem flush.

Extractive/leachate treatments had no significant effect on height for northern red oak seedlings averaged over both levels of cotyledon removal (Table 1). Differences in dry weight between the control treatment and any extractive/leachate treatment were not significant for

Table 1. Seedling height and organ dry weights of 139-day-old northern red oaks exposed to four Kentucky bluegrass foliage extract/pot leachate treatments. Means in the same column followed by the same letter are not significantly different p 0.05.

		Dry weight (g)		
Treatment	*Height (cm)*	*Root*	*Stem*	*Leaf*
Deionized water (control)	23.67^a	5.50^{ab}	1.88^a	2.61^a
50% foliage extract	22.92^a	4.97^b	1.65^a	2.46^a
100% foliage extract	26.33^a	4.91^b	1.91^a	3.40^a
100% foliage extract + pot leachate	23.83^a	6.10^a	2.07^a	3.01^a

Table 2. Seedling height and organ dry weights of 139-day-old yellow-poplars exposed to four Kentucky bluegrass foliage extract/pot leachate treatments. Means in the same columns are not significantly different p 0.05.

		Dry weight (g)		
Treatment	*Height (cm)*	*Root*	*Stem*	*Leaf*
Deionized water (control)	10.58	1.20	0.31	0.83
50% foliage extract	9.50	1.27	0.31	0.79
100% foliage extract	9.17	1.02	0.28	0.69
100% foliage extract + pot leachate	14.42	1.74	0.49	1.09

any organ. Addition of leachate from potted bluegrass to the 100% foliage extract increased root dry weights compared to the absence of leachate. Treatments had no significant effect on seedling height or dry weights of any organ for yellow-poplar (Table 2). Although not statistically significant, overall plant size from the 100% foliage extract plus pot leachate treatment was slightly larger than that for other treatments.

Foliage extracts and pot leachate from Kentucky bluegrass showed no significant evidence of inhibiting seedling growth of either northern red oak or yellow-poplar. Stimulation of growth in both species by adding pot leachate to the 100% foliage extract was probably the result of including soil nutrients from pots with root leachate since trees in all treatments were well watered during the course of the study. Another explanation for the beneficial effect of pot leachate is that allelochemicals can be stimulatory, while higher concentrations can be inhibitory (6). Although allelopathic effects were tested in only one type of soil, these results suggest that detrimental interference between Kentucky bluegrass and either northern red oak or yellow-poplar seedlings can be attributed to mechanisms of competition rather than allelopathy.

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Abstract

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No group of hardy plants possesses more versatility and seasonal interest than Amelanchier (serviceberry). These woody plants range in form from modest shrubs to specimen trees. The low maintenance plants are suitable for both formal and naturalistic landscapes. Verifying individual Amelanchier species is extremely difficult. In the wild, species intermingle to form puzzling hybrids. To compound the problem, the nursery industry has a history of labeling all species *Amelanchier canadensis.* The common serviceberries in eastern North America are *A. arborea* (downy serviceberry), *A. canadensis* (shadblow serviceberry), *A. x grandiflora* (apple serviceberry) and *A. laevis* (Allegheny serviceberry). You can identify these four by looking at them in spring while they are flowering.