Biomass Production and Soil Respiration in Experimental Riparian Grass Filter Strips

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Introduction

Grass filter strips established between cropped fields and streams have many potential conservation benefits, including trapping sediments and runoff, providing wildlife habitat, transforming nitrogen in runoff waters, sequestering soil carbon, and enhancing soil tilth. In this study, we compared five species of grasses with respect to aboveground biomass production and soil respiration (i.e., CO_2 flux), the latter being a robust measure of total soil biological activity. The information may help landowners select the best grass species for planting in streamside filters and buffer strips.

Materials and Methods

All work was conducted at the Rhodes Research and Demonstration Farm in Marshall County, Iowa. A total of twenty-four 15 m × 15 m plots were established directly adjacent to Clear Creek near the south end of the farm, on land that was previously used for corn production. Six species of grass were planted using a randomized block design, with each plot containing a single grass species. We included three C3 (cool-season) grass species, *Bromus inermis* (smooth brome), *Dactylis glomerata* (orchardgrass), and *Phalaris arundinacea* (reed canarygrass); and three C4 (warm-season) species, *Andropogon gerardii* (big bluestem), *Panicum virgatum* (switchgrass), and *Tripsacum dactyloides* (eastern gamagrass). The experimental plots were originally seeded in the spring of 2001; big bluestem was not established and so is excluded from this study. This report describes results from 2004 and 2005, when the grass filters were in their fourth and fifth years of growth.

Aboveground biomass production was measured by monthly sampling of all aboveground live and dead plant material within four randomly located 0.12-m^2 quadrats per plot throughout the growing season. Soil respiration was measured regularly throughout the duration of the study with a LI-COR® LI-6400 gas exchange system attached to a soil respiration chamber using the measurement protocols recommended by the manufacturer.

Results and Discussion

Our block design did not overcome the large amount of small-scale heterogeneity that exists in fields near streams, as evidenced by significant block × species terms in our statistical analyses. That is, there was tremendous plot-by-plot variability in site properties that influenced both grass growth and soil respiration rates. Such small-scale variability is a feature of streamside areas. We are therefore presenting all of our data as means within species, based on four plots per species, averaged across two years. This approach highlights differences among species that persisted through time, and so provides the most insight to landowners.

Grass production varied by a factor of nearly three among the planted species. Smooth brome, which is recommended for planting in Iowa filter strips, was the least productive species (Table 1), averaging just over 5,000 kg ha^{-1} y^{-1} of biomass. Eastern gamagrass consistently was the most productive grass planted, producing an average of 14,150 kg ha^{-1} y^{-1} of biomass. Generally, C_3 grasses are favored for forage production in part due to their relatively high nutritional values. We found relatively small differences in forage nitrogen (N) contents among species during summer. Live smooth brome biomass had a midsummer (June–

August) N content that averaged 1.6%. At the same times, N in live forage of the other species averaged 1.7% for orchardgrass, 1.6% for reed canarygrass, 1.3% for switchgrass, and 1.5% for eastern gamagrass. End-of-season live biomass, in contrast, averaged 2.0% N in the C3 species and 0.8% N in the C4 species.

Among species then, differences in biomass production were much greater than differences in N uptake, suggesting the different species tested had relatively similar abilities to capture N from the environment. The species varied more in biomass production. Since no harvesting was done, this biomass was left to decompose on the soil surface, potentially enhancing soil tilth.

Soil respiration is a measure of the rate at which CO_2 is produced by all biological activity within soils, including soil organisms, soil organic matter decomposition (which relates to nutrient supply), and root respiration. Although we expected that soil respiration would vary among species in parallel with differences in aboveground production, this was not the case: there was no close relationship between aboveground growth and soil respiration (Table 1). This indicates that root systems may be far more important to soil biological activity than are aboveground plant residues. It may also suggest that aboveground plant production has a very small impact on soil organic matter dynamics. If that is the case, then it may be acceptable to harvest grasses within streamside filter strips toward the end of the year. This currently is not allowed in CRP fields, but would promote removal of nitrogen from the site, potentially enhancing the N-trapping abilities of the filter strips while providing a resource to landowners.

Acknowledgments

We appreciate the assistance of Dr. Ken Moore and Roger Hintz, who planted the study site; the personnel from Rhodes Farm, who provided diverse assistance; and many graduate and undergraduate students, who did most of the work.

Table 1. Annual rates of aboveground biomass production and soil respiration over two years in experimental grass filter strips planted adjacent to Clear Creek at the Rhodes Research and Demonstration Farm, Marshall County, Iowa.

Grass Species	Biomass Production ($kg\ ha^{-1}\ yr^{-1}$)		Soil Respiration ($kg\ C\ ha^{-1}\ yr^{-1}$)	
	2004	2005	2004	2005
Bromus inermis (C3)	6,810	3,410	9,020	10,300
Dactylis glomerata (C3)	7,220	5,900	9,150	8,660
Phalaris arundinacea (C3)	12,100	5,740	9,820	11,700
Panicum virgatum (C4)	6,990	8,810	8,390	8,770
Tripsacum dactyloides (C4)	13,900	14,400	9,380	10,500