Dominant Grass Effects on Diversity and Functioning of Restored Grassland

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Introduction

Native grasslands provide a multitude of benefits to society including forage production, wildlife habitat, and nutrient and CO_2 uptake and storage. There has been continuing interest within the conservation community in restoring grasslands to maximize these multiple benefits. In addition to achieving the most common objectives of reducing soil erosion and increasing organic carbon and nutrient availabilities, restored grasslands also produce important wildlife habitat, and they have the potential to uptake and store greenhouse gases like CO_2. Grassland plantings have been found to increase game and non-game bird abundance and diversity and to improve deer habitat.

There are presently many prairie restoration projects that are ongoing or getting started throughout Iowa and the United States. In Iowa, many small, and a few large prairie restoration projects are getting started. However, projects are somewhat hampered by a lack of knowledge on how to restore the high diversity found in prairies. Most prairie restorations become heavily dominated by one or a few grass species and have a low diversity of legumes and forbs. It is still largely unknown how to restore the typical high plant diversity found in intact prairies.

Prairie ecosystems are dominated by warm-season grasses such as big bluestem, Indian grass, switchgrass, little bluestem or side-oats grama. In Western Iowa, all five of these species dominate, at least in some patches of grassland. Warm-season grasses can make up >90% of the biomass in any given plot, and usually make up at least 50% of the biomass (i.e., by weight). However, plant diversity of prairie ecosystems is made up mostly of forbs, and diversity is what most people are most concerned with when they restore or reconstruct prairie.

I suggest that understanding how dominant warm season grasses suppress total plant diversity is a key issue for restoring and reconstructing prairies, and in 2002, I established a long-term experiment to study this process. The experiment consisted of planting plots with different warm-season grass species as dominants, and then seeding and monitoring the establishment of a seed mix containing 23 native forb (legumes and other broadleaf plants) and 3 cool-season grass species. Cultivar seed and locally collected seeds of each warm-season grass species will be compared to determine if plant diversity of the resulting prairie is affected by the increased vigor of the cultivars. Characteristics of the dominant grass species will then be measured to identify useful variables for predicting how warm-season grass species suppress total plant diversity.

Materials and Methods

A smooth brome dominated pasture was plowed during spring 2002. Weeds were subsequently sprayed with herbicide and then, in a second trip, chopped down before seedlings emerged. Seed mixes containing a single warm-season grass species (either a cultivar or native genotype) plus a mix of 26 forb and cool-season grass species were then added to the plots. All seeds were added so that an equal number of seeds of each species were added to each plot during June and October 2002. By weight, each plot received approximately 15 lbs/acre of warm-season grass seed and 13.5 lbs/acre of forb cool-season grass seed.

Each plot is 3 meters × 4 meters, with a 2-meter buffer between each plot and a 4-meter buffer between each row. Five warm season grass species are being used (side-oats grama, little bluestem, Indian grass, big bluestem, and switchgrass), which gives 10 dominance groups (5 species × 2 groups [either locally collected seed or cultivar seed]). These five species were selected because they all, at least occasionally, dominate Iowa prairies, and they have varying heights, growth rates, and life history types (e.g., big bluestem and switchgrass are rhizomatous whereas the others are bunch grasses). There are six replicates of each dominance group for a total of 60 plots. Experimental plots were set up in a completely randomized design. Native genotypes of all warm-season grass species were obtained from the Monona County Conservation Board (big bluestem), and from seed dealers from western Iowa (other species). All were collected from prairie remnants, or in the case of side oats grama, from plantings on private land in Western Iowa. Seeds of the 26 species of forbs and cool-season grasses were also added to 6 smooth-brome-dominated plots (with six control plots receiving no seed additions) to determine how diversity of plantings compares with the diversity of over-seeded pasture plots.

During the 2003 growing season, seedling counts were made for each warm-season grass, and aboveground biomass was clipped in 0.1 m^2 quadrates to determine what proportion of the biomass was prairie species.

Results and Discussion

Germination rates were higher in cultivars than for native seeds in 4 out of the 5 species comparisons ($P<0.05$). The only exception to this general trend was that locally collected seeds of big bluestem had greater germination rates than did the big bluestem cultivars.

The number of warm-season grass seedlings varied across plant species, with the greatest number occurring in side-oats gramma plots (ANOVA, $P<0.05$). Cultivars tended to have a greater number of seedlings per m^2 in general, but there were notable exceptions (e.g., big bluestem) to this trend, and these exceptions caused the differences to be statistically non-significant.

Biomass of prairie species was suppressed by the biomass of weeds (i.e., species not in the mix) ($P<0.01$). Biomass of prairie species was strongly negatively related to the biomass of lamb's-quarters and weeds in general. Prairie biomass increased dramatically below a weed biomass of about 600 g/m^2. Weed biomass accounted for 41% of the variation in prairie biomass. Prairie biomass was unrelated to surface soil moisture.

Intensive sampling of plant species composition and diversity, soil moisture content, canopy light capture, and above- and below-ground productivity in the plots will continue for at least 3 more years.