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Plant Species Effects on Diversity and Weed Invasion Resistance in Restored Grasslands

Abstract

Native grasslands provide a multitude of benefits to society including forage production, wildlife habitat, and nutrient and CO₂ uptake and storage. There has been continuing interest within the conservation community in restoring grasslands to maximize these multiple benefits. There are presently many ongoing prairie restoration projects and many being started throughout Iowa and the United States. In Iowa many small, and a few large prairie restoration projects are under way. However, projects are somewhat hampered by a lack of knowledge on how to restore the high diversity found in prairies. Prairie ecosystems are dominated by warm-season grasses such as big bluestem, Indian grass, switchgrass, little bluestem, or sideoats grama. In western Iowa, all five of these species are dominant, at least in some patches of grassland. However, plant diversity in prairie ecosystems is made up mostly of forbs, and diversity is what most people are most concerned with when they restore or reconstruct prairie. Most prairie restorations becomes heavily dominated by one or a few grass species and have a low diversity of legumes and forbs.

Keywords

Ecology Evolution and Organismal Biology

Disciplines

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Plant Species Effects on Diversity and Weed Invasion

Resistance in Restored Grasslands

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Organismal Biology

Introduction

Native grasslands provide a multitude of benefits to society including forage production, wildlife habitat, and nutrient and CO₂ uptake and storage. There has been continuing interest within the conservation community in restoring grasslands to maximize these multiple benefits.

There are presently many ongoing prairie restoration projects and many being started throughout Iowa and the United States. In Iowa many small, and a few large prairie restoration projects are under way. However, projects are somewhat hampered by a lack of knowledge on how to restore the high diversity found in 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 are dominant, at least in some patches of grassland. However, plant diversity in prairie ecosystems is made up mostly of forbs, and diversity is what most people are most concerned with when they restore or reconstruct prairie. Most prairie restorations become heavily dominated by one or a few grass species and have a low diversity of legumes and forbs.

Materials and Methods

We suggest that understanding how dominant warm-season grasses suppress total plant diversity and prevent weed invasions is a key issue for reconstructing prairies, and in 2002 and 2003, we established two long-term experiments to study this process. The first experiment (Experiment 1) 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 three 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. Because plots remained weedy through 2004, we plan to set up a new experiment with transplants during the 2005 growing season.

The second experiment (Experiment 2) involved planting transplants into plots so that they contain either monocultures or four-species mixtures. Four-species mixtures were planted with three levels of species evenness, or distribution of relative abundance, to further test for diversity effects on weed invasion resistance. Half of the plots were planted in 2003 and sampled in 2004, and the other half were planted in 2004 and will be sampled in 2005.

During the 2004 growing season, plots were monitored for prairie species establishment in Experiment 1, and for weed invasion in Experiment 2. Transplants were also grown in greenhouses for the new transplant experiment to be planted in 2005.

Results and Discussion

Experiment 1. Biomass of prairie species was suppressed by the biomass of weeds (i.e., species not in the mix) ($P < 0.01$). In 2003, 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/m². Weed biomass accounted for 41% of the variation in prairie biomass. Prairie biomass was unrelated to surface soil moisture. Plots were mowed repeatedly throughout the 2004 growing season to knock back the weeds.

During the 2004 growing season, plots became strongly dominated by low growing weeds, which were defined as plants not in the prairie mix. Such plants included crown vetch, which developed a thick low-growing mat in 60% of the plots, and smooth brome, which dominated 82% of the plots. Other common weeds were bindweed (37%), sour dock (17%), and cheatgrass (8%). Lamb's-quarters is now down to 2% frequency due to mowing. Mowing seemed to enhance the dominance of crown vetch and smooth brome. These negative effects of

mowing should be taken into account when a mowing regime is planned for prairie reconstructions. Mowing will knock back tall weeds like lamb's-quarters, but may favor shorter species like crown vetch. Companion experiments done by Losure, Wilsey, and Moloney have shown that crown vetch establishes very poorly when prairie plots are heavily shaded by taller species. Mowing combined with targeted treatment of crown vetch and smooth brome might work to better establish prairie species.

Experiment 2. Plots that were planted with four-plant species had less weed biomass on average than the plots planted with a single species ($P < 0.01$). Furthermore, mixtures that included an equal representation by tall grasses and tall forbs (i.e. had high evenness) had less biomass than the plots dominated by the single tallgrass big

bluestem ($P < 0.05$). There was no effect of evenness when short forbs and grasses were combined with tall species.

There was also variation among single-species plots. Plots containing early-emerging or cool-season tall species had lower weed biomass than short or later-emerging or warm-season species because most weeds emerged during late spring and early summer.

Taken together, these results suggest that diverse prairie plantings that contain early-emerging tall forbs will prevent weed invasion better than plantings with only the grass big bluestem. Further sampling will be made during 2005 to develop a better understanding of how species identity and diversity prevent weed invasion.

