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Competition has a greater effect than supplemental nutrients on the growth of *Sorghastrum nutans* and *Bromus kalmi*

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Abstract

Along with many environmental factors, nutrient availability and competition influence the success of grasses on the prairie (Tilman, 1999.) This study examines the influence of these factors on the growth of two grass species: Sorghastrum nutans and Bromus kalmii. Both species received a supplemental nutrient treatment in both competition and noncompetition scenarios. We predicted that nutrients would increase biomass, growth rate, and height, and that supplemental nutrients would give B. kalmii an advantage over S. nutans when the two species were competing. The addition of nutrients, however, rarely yielded significant results. Instead, interspecific competition had a greater impact on the growth of both species. Similar to other studies (Haugland and Froud-Williams, 1999), the provision of ample nutrients failed to eliminate the effects of competition. Perhaps this is because plants continued to compete at the root hair level for nutrients, space, and moisture.

Introduction

The preservation of prairie has become necessary as agricultural exploits have nearly eradicated this natural habitat, and critical to preservation is knowledge. It is important to understand the interaction of biotic and abiotic elements in the prairie. Abiotic factors like light, space, and resources often dictate patterns of plant growth. The availability of nutrients often dictate species composition and relative abundance among other community characteristics. Potassium, nitrogen, and phosphorus are all elements necessary for plant growth. They are involved in the metabolic processes of plants and are often used to synthesize complex molecules that are incorporated into the structure of the plant and aid in the maintenance of homeostasis. As these vital elements cannot be synthesized, plants must obtain them from the environment (Encyclopedia Britannica Online).

Competition for limited resources leads to greater biodiversity in communities, a good sign of a healthy community, increasing community stability but decreasing population stability. Higher diversity also leads to higher productivity by increasing the chances that a more productive species will be present, and by providing a more heterogeneous environment, allowing greater niche differentiation and specialization. Additionally, low levels of limiting resources and great biodiversity increase a community's resistance to invasion. Nutrient availability affects interspecies competition and thus the diversity, composition, and success of the entire community (Tilman, 1999).

Grasses are the most common plants on the prairie. Their rhizomes make them well adapted to the climatic conditions as well as the occasions of fire and grazing (Knapp et al, 1998). These extensive roots also allow grasses greater surface area through which to absorb nutrients. For our study, we chose two common prairie species, *Sorghastrum nutans* and *Bromus kalmii*, and observed each under four different treatments: control (which received no treatment), supplementary nutrient levels, competition, and competition in conjunction with supplementary nutrient levels. *S. nutans*, also known as Indian grass, is a perennial, warm-season grass, and a major component of the tall grass vegetation which once dominated the prairies of the central and eastern United States (USDA plant materials page). *B. kalmii,* also known as Prairie Brome, is a common prairie grass that favors wet to mesic conditions. We chose these species because while they are capable of existing under similar conditions, they represent different adaptations to the prairie. *S. nutans* has vigorous seedlings, but develops slowly under the strain of competition, leading us to hypothesize that *B. kalmii*, ordinarily a subdominant species of grass, will be dominant in the competition pots. *S. nutans* seedlings are also negatively affected by nitrogen (USDA plant materials page). We hypothesized further that nutrient-spiked *S. nutans* replicates will show less growth than their unspiked counterparts, *B. kalmii.*

Methods

Planting

We filled 60 3.5 cm x 3.5 cm x 3 cm pots _ full with moist Jiffy Mix soil. In 20 pots we planted 20 *Sorghastrum nutans* seeds. In 20 more we planted 20 *Bromus kalmii* seeds. Lastly, we planted 10 seeds of *S. nutans* and 10 seeds of *B. kalmii* in each of the remaining 20 pots to simulate competition. These cold-stratified seeds came from the Prairie Moon Nursery in Minnesota. After planting, we topped off all pots with a thin coat of moist soil, randomized the pot arrangement, and placed them under 34 W fluorescent growth lamps approximately six inches above the soil surface. Plants were stored at room temperature (~22° C or 70° F). We maintained moist soil conditions by misting when necessary.

Fertilization

Nine days after planting, after the plants had germinated, we applied 25 mL of 500 ppm Peters Professional Water Soluble 20-20-20 Fertilizer solution to half of the *S. nutans*, *B. kalmii*, and competition pots. As a control, we applied 25 mL of distilled water to the non-fertilized pots. We thereafter watered the fertilized pots separately from the non-fertilized pots to prevent the nutrients from leaching off the soil and kept the pots elevated to prevent pooled, nutrient-filled water from contaminating non-fertilized pots.

Measurement

We randomly selected two individuals of each species from each pot and measured height every 3-4 days, beginning with the first day of fertilization, to determine growth rate. At the end of two weeks we measured total biomass of each pot. We clipped all above-ground biomass, dried all plant matter for 24 hours in a 60° C oven, and weighed total biomass.

Analysis

We had to double the competition biomass data to account for the halving of the seeds of each species in the competition replicates. We then used a two-way ANOVA to determine the effect of competition and nutrient availability on growth rate, height, overall biomass, and their interaction.

Results

Nutrients

The addition of nutrients significantly affected neither the growth rate nor the height of either species. *S. nutans* showed no difference in biomass in the presence of supplemental nutrients, but the nutrient-fed *B. kalmii* plants did have significantly higher biomass than the unfertilized plants (see Table 1).

Competition

The presence of interspecies competition, on the other hand, significantly decreased the biomass, height, and growth rate of all *B. kalmii* in both the nutrient group and the control group (Figures 1 and 2). In *S. nutans*, competition significantly decreased biomass and growth rate, but not overall height (Table 1).

Table 1. Significance of treatments. Treatments were competition : no competition and nutrient : no nutrient. The table indicates which of the two categories (competition or nutrient) showed significant results for each indication of growth. There was no significant interaction between competition and nutrient treatments.

SPECIES	HEIGHT	GROWTH RATE	BIOMASS
S. nutans	No significant results.	**Competition** (F=6.01; P=0.020)	**Competition** (F=9.54; P=0.004)
B. kalmii	**Competition** (F=5.83; P=0.021)	**Competition** (F=5.35; P=0.027)	**Competition** (F=8.98; P=0.006) **Nutrient** (F=7.18; P=0.013)

Figure 1

Average growth rate where A1=supplemental nutrients with competition, A2=supplemental nutrients without competition, B1=no supplemental nutrients with competition, B2=no supplemental nutrients without competition.

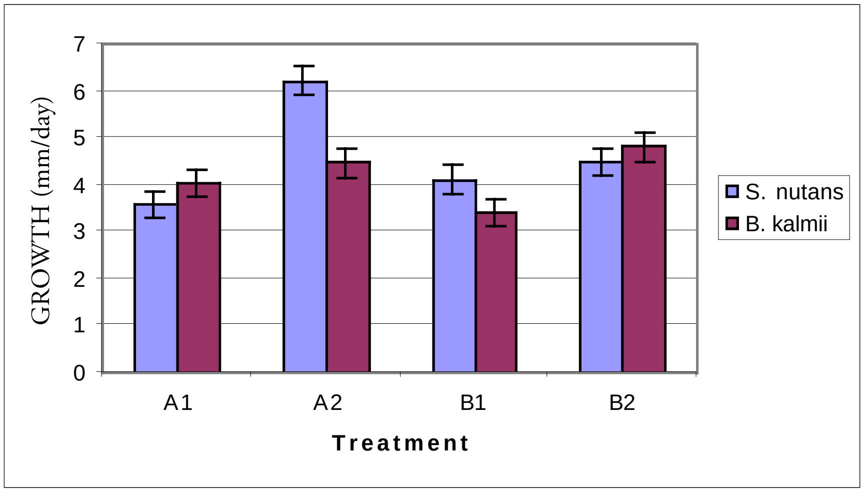
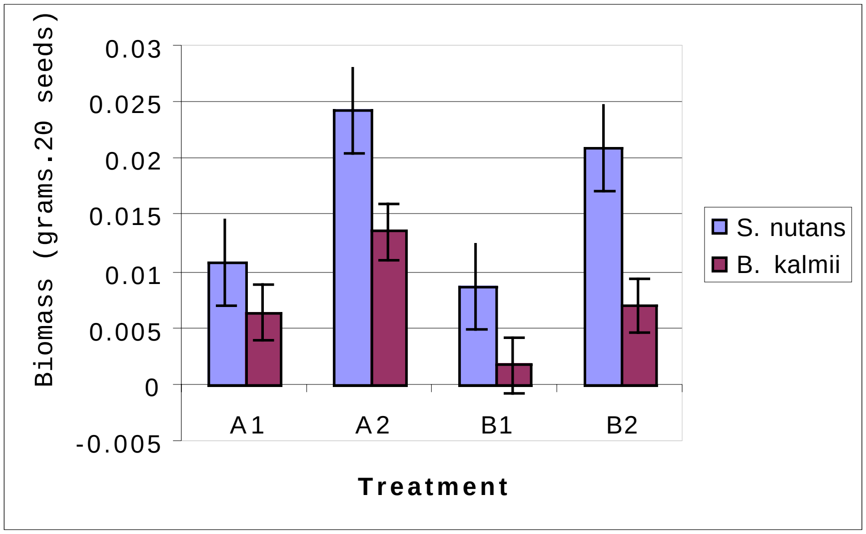


Figure 2
Average biomass where A1=supplemental nutrients with competition, A2=supplemental nutrients without competition, B1=no supplemental nutrients with competition, B2=no supplemental nutrients without competition.



Discussion

The availability of nutrients can directly affect the dynamics of the soil and hence the interacting ecosystem (Detling and Holland, 1990). We hypothesized that the availability of nutrients would directly affect the growth of plants, and more specifically, favor *Bromus kalmii*. Contrary to our hypothesis, the addition of supplemental nutrients to juvenile plants had little impact on their growth. Rather, it was interspecific competition that most significantly impacted the growth of both *B. kalmii* and *S. nutans.* Although we expected to find a more significant difference between nutrient-treated and untreated noncompetitive pots the results are not altogether surprising. The specimens were treated in their juvenile stages. They may not have had enough time to fully utilize the nutrients. In fact, germinating plants do not begin to absorb nutrients from their surroundings until the nutrients in the cotyledon of the seed are exhausted. We think that, if given more time, we may have observed more significant variation between treated and untreated noncompetitive pots.

A study conducted by Haugland and Froud-Williams showed similar results (1999). They discovered that root competition was not eliminated despite the provision of adequate water and nitrogen. Haugland and Froud-Williams hypothesized that plants continue to compete for resources at the root hair level and concluded that competition may not be eliminated by supplementing sufficient limiting resources. Another study examined the effects of nutrient patches and competitive root systems on *Elymus lanceolatus* (a rhizomatous grass) and unexpectedly found that *E. lanceolatus* was influenced by neighboring species more than local nutrient enrichments (Huber-Sannwald et al, 1998). A brome species, *Bromus tectorum*, was incorporated into this particular study. Huber-Sannwald et al noted that the clonal expansion of *E.*

lanceolatus was reduced when it encountered the fine and dense root system of the Brome. The intricate and dense root system of *Bromus kalmii* may have provided sufficient competition for the usually dominant *S. Nutans* in our study. Hence both species exhibited less growth in competition.

For further study we propose a similar study executed over a longer period of time to better understand the effects of nutrients on the growth of the plants and to examine their effects on adult grasses. A field study, examining the effects of fertilization on tracts of prairie, would be beneficial, and might incorporate the significance of natural climate conditions, topography, etc. It is important to understand the influence of nutrient availability and interspecies competition and their significance in ecological systems. Perhaps studying this interaction will bring us closer to uncovering the patterns of the prairie and the natural equilibrium that is crucial in the success of all natural environments.

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