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Effect of water and clipping on aboveground productivity of four native grasses

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Introduction

The Wheatgrass-Needle & Thread association is one of the more common plant community types of the Mixed Grassland Ecoregion. The Mixed Grassland Ecoregion is mainly dominated by native cool-season grasses, such as needle-and-thread grass (*Stipa comata*), western wheatgrass (*Pascopyrum smithii*) and northern wheatgrass (*Elymus lanceolatus*)[1]. *Stipa* species are perennial bunchgrasses, Western wheatgrass and northern wheatgrass are perennial rhizomatous grasses. These species are key to rangeland productivity.

The water is the main limiting resource to the productivity of the native plants in arid and semi-arid areas[2]. Water stress can weaken the tiller growth in defoliated and undefoliated plants[3]. Additionally, bud viability of plants can also decline in defoliated compared to undefoliated perennial grasses under natural droughts[4]. Generally, the dominant species are more stress tolerant than non-dominant species[5]. Eneboe et al. (2002) reported that western wheatgrass exhibited a greater ability for compensatory growth under defoliation stress[6]. Chen et al. (2013) also noted that drought stress intensified responses of *Stipa* to defoliation in semi-arid area[7]. This poster shows the interaction of drought and defoliation on productivity of dominant grasses as a basis of plant species drought resistant strategy.

Objective

The purpose of this study was to examine the aboveground biomass of four native grasses under water stress with clipping, in order to assess the ability of drought tolerance and compensatory growth in these dominant grasses of the Mixed Grasslands Ecoregion.

Materials and methods

The study was initiated in the greenhouse at Swift Current. The experiment was designed as a randomized complete block with 24 treatments and 3 replicates. The 24 treatments consisted of 4 species: needle-and-thread grass (NTG), western porcupine grass (*Stipa spartea*) (WPG), western wheatgrass (WWG) and northern wheatgrass (NWG), 3 water treatments (70%, 85%, 100% of field capacity), and 2 levels of defoliation (clipping at the height of 5cm and no clipping).

Soil used in the pots was an Orthic Brown Chernozem that was collected from the plot area at the Swift Current Research and Development Centre. Water was applied 3 times weekly from March to August (20 weeks) in 2016. The clipping was done in 30 days after planting but before final harvest. All plant materials of cutting were dried at 70°C in a forced-air oven for 48h and weighed.

All statistical analyses were conducted using R i386 3.2.3 software. Treatment means comparisons were done using ANOVA with Tukey to determine significance (significance level: α= 0.05).

Results

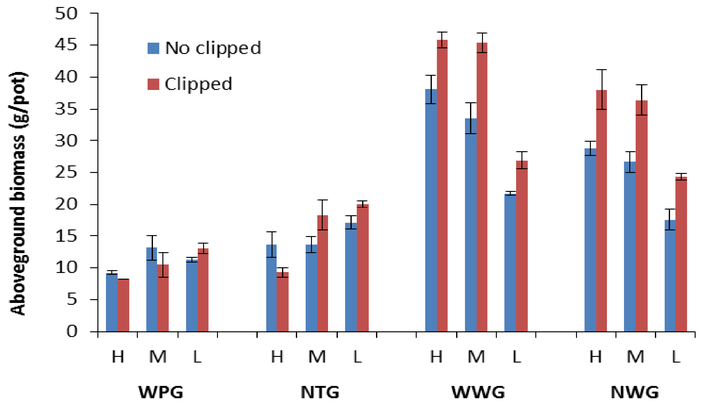

Figure 1. The mean and SE (stand error) of aboveground biomass of western porcupine grass (WPG), needle and thread grass (NTG), western wheatgrass (WWG) and northern wheatgrass (NWG) for three water treatments (H: 100%, M: 85%, L: 70% of field water capacity) with clipping and no clipping treatments.

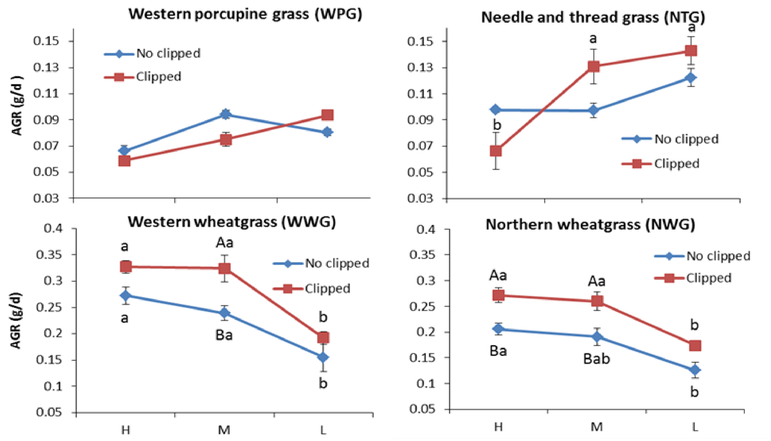

Figure 2. Results of ANOVA for response average absolute growth rate (AGR) of plant species to the different water and clipping treatment. Letters indicates significant effect (p<0.05), clipping effect by upper case letters and water level by different lower case letters.

Compared with WPG and NTG, the aboveground biomass of WWG and NWG was always higher (p<0.01) in all treatments (Figure 1). The aboveground biomass of WWG (43% of biomass) and NWG (39% of biomass) was significantly reduced under the low water treatment (70% of field capacity) when compared with high water treatment (100% of field capacity) (p<0.05). However, no significant difference was observed on aboveground biomass of WPG and NTG under all water treatments.

For WWG and NWG, clipping resulted in a positive improvement in aboveground biomass, especially under the high (WWG: 20.3% NWG: 32%) and medium water treatment (WWG: 35.6% NWG: 36.6%) (p<0.05). Additionally, Biomass of WPG and NTG was decreased under high water (100% of field capacity) and increased under two lower water treatments (85% and 70% of field capacity) after clipping, but they were not significant (p>0.05).

There was a significant rise in the average absolute growth rate (AGR) of NTG (0.07g per day) from high water treatment to low water treatment after clipping (p<0.05) (Figure 2). For WWG and NWG, the negative effect of dryness and the positive effect of clipping on their AGR were significant (p<0.05). The AGR of WWG and NWG after clipping was increased by 0.065g and 0.066g per day under high water treatment. The AGR for both wheatgrasses was also increased by 0.085g and 0.071g per day under medium water treatment.

Conclusions

The results show that the two *Stipa* species (WPG and NTG) exhibited a better drought tolerance than WWG and NWG under the same water conditions. We noted that WWG and NWG needed more water to maintain plant productivity in this greenhouse experiment.

For WWG and NWG, compensatory growth was common after defoliation, but the positive effect of clipping was higher under the well-watered treatment than under the low water treatment. For *Stipa*, they only exhibited compensation under the low water treatment, so relatively dry conditions can stimulate the compensatory growth of *Stipa* species. Consequently, WWG and NWG have the potential to improve the resilience of pastures after grazing and mowing disturbance. However, *Stipa* species would have more resistance than WWG and NWG in natural plant communities with more frequent drought events. Further study is also needed to determine the adaptive strategies of plant species under disturbance and environmental stress.

References

1 Bailey A.W., Schellenberg M. P. and McCartney D. (2010). Management of Canadian prairie rangeland [M]. Ottawa, Canada: Agriculture and Agri-Food Canada.

2 Wang Z. and Schellenberg M. P. (2012). Drought and N addition in the greenhouse experiment: Blue grama and Western wheatgrass[J]. Journal of Agricultural Science and Technology, B 2: 29-37.

3 Busso C.A. and Richards J.H.(1995). Drought and clipping effects on tiller demography andgrowth of two tussock grasses in Utah[J]. Journal of Arid Environments, 29(2): 239-251.

4 Flemmer A. C., Busso C. A. and Fernández O.A. (2002). Bud viability in perennial grasses: water stress and defoliation effects[J]. Journal of range management, 55:150-163.

5 Wilson S.D. and Keddy P.A.(1986). Species competitive ability and position along a natural stress/disturbance gradient[J]. Ecology, 67(5): 1236-1242.

6 Eneboe E.J., Sowell B.F. and Heitschmidt R.K., et al. (2002). Drought and grazing: IV. Blue grama and western wheatgrass[J]. Journal of Range Management, 73-79.

7 Chen L.P., Zhao N.X., Zhang L.H., et al. (2013). Responses of two dominant plant species to drought stress and defoliation in the Inner Mongolia Steppe of China[J]. Plant ecology, 214(2): 221-229.

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