Can high density, short duration grazing replace fire in a South African mesic grassland?

Nomusa Chonco and Sindiso Nkuna*

School of Life Sciences, University of KwaZulu-Natal, Scottsville, 3201

*Corresponding author, email: Chamane@ukzn.ac.za

Introduction

High-density grazing (HDG), which is the concentration of many livestock in a small area for a short duration, has become popular in the South African mesic grassland, yet little is known about its impact. HDG discourages the use of fire, based on the assertion that fire is a key contributor to the desertification of grasslands (Savory and Butterfield 1999). However, fire plays an essential role in the development and growth of most South African mesic plant species, it stimulates resprouting and reduces competition for light (Little 2015). South African mesic grasslands are found in high rainfall (> 600 mm per annum) areas. The aim of this study was to determine the impacts of high-density grazing on plant species composition and soil physical properties in a South African mesic grassland. The objectives were to compare the impact of HDG with annually burnt firebreaks; one which was grazed and the other one which was not grazed, on soil compaction, ground cover, and species composition.

Materials and Methods

The study area was located at Wakefield Farm in Forth Nottingham, KwaZulu-Natal province, South Africa (29°54'38.05" S, 29°29'55.22" E) at an altitude of 1401 m above sea level. The area has a mean annual precipitation of 843 mm, which occurs mainly during mid-summer. The stocking density for HDG was 20 LSU/ha for 5 – 7 days (max), and the rest period was 60 days. The HDG paddock has had zero burning for 15 years and is grazed 3 times a year. The annual burn firebreak with grazing has the same grazing and resting treatment as the HDG paddock. A total of 12 10 m x 10 m plots were located on three different paddocks (HDG, annually burnt firebreak with grazing and annually burnt firebreak without grazing) along the fence. Soil compaction was measured inside each plot using a dynamic cone. Ground cover was measured using a modified point intercept method inside each plot. In each 10 m x 10 m plot, 0.25 m² quadrant was placed randomly 13 times. Each plant species and its abundance was recorded. Litter mass was collected from 5 random quadrats in each 10 m x 10 m plot, oven-dried at 60°C for 48 hours and weighed. A one-way ANOVA on SPSS version 24 was used to analyse the data as well as the redundancy analysis (RDA) using CANOCO 4.5 package on the species data.

Results and Discussion

Soils under HDG and annual burning with grazing were 54% and 32% more compacted, respectively, compared to annual burning with no grazing (F = 18.53, p < 0.0001). High density grazing compared to annual burning irrespective of grazing resulted in four-fold more litter accumulation (F = 5.680, p <0.0001) that can reduce irradiation received by plants and limit growth. Furthermore, an indirect detrimental effect of excessive litter may be a potential increase in fire temperatures at the soil surface if the litter is ignited (Prior et al. 2017), and that can have a negative impact on the underground storage organs of forbs and buds that are on or just below the soil surface (Chamane et al. 2017). Grass species diversity was 10% lower under HDG and annual burning with grazing than annual burning with no grazing (p = 0.026). Forb species diversity was similar between HDG and annual burning with no grazing. However, Jaccard’s dissimilarity index showed a forb species turnover of 22%, with HDG having 3 and annual burn with and without grazing having 2 unique species, indicating that fire-dependent species may have been replaced with fire independent species under HDG.

The redundancy analysis provided an effective description of the compositional variation of grass and forb species due to HDG, annual burning with grazing, and annual burning without grazing, with axes one accounting for 18.3% for grass and 8.9% for forb species variance. (Figure 1 & 2). Monte Carlo permutation showed that HDG, annual burning with grazing and annual burning without grazing significantly affected the species composition variation for grasses (F = 5.234, p = 0.0020) and forbs (F = 2.149, p = 0.014).

Conclusions and Implications

High litter accumulation under HDG as a result of not burning in mesic grasslands can reduce irradiation received by plants and limit plant growth. The forb species turnover between HDG and annual burn may indicate that there may be some fire-dependent species lost under HDG. Annual burn in the form of fire breaks has been shown to increase plant diversity (Bachinger et al., 2016). Findings from this study indicate that HDG cannot replace the role of fire in a South African mesic grassland and may potentially have a negative impact.

Acknowledgements

Anonymous reviewers and for funding: University of KwaZulu-Natal and IG and IRC Congress 2021 for delegate sponsorship

References