The Type and Quantity of Plant Litter Influences the Plant Functional Group Growth in an Alpine Meadow

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Introduction

Plant functional group (PFG) diversity in a grassland is an important measure of productivity and health. Litter is known to be major driving factors of soil-grass feedbacks in natural grassland. The shift in PFG composition is a significant change that can result many ecological consequences such as litter composition and dynamics (Dong et al., 2019). Decomposition of litter can affect the nutrient and allelochemicals cycling of soil, which affects seed germination and establishment of seedlings (Yuan et al., 2015). Furthermore, PFG characteristics can vary via inputs of the quality or quantity of litter (Galvánek & Lepš, 2012). These compositional changes can result in variation heterogeneity of community PFG composition. More recently, alpine grasslands have undergoing retrogressive succession of spread and dominance by unpalatable noxious weeds, accumulating large amount of litter (Tang et al. 2015). However, quantitative tests of their importance in community dynamics are lacking, and their effects on the PFG characteristics of this special ecosystem are unknown. In this study, we investigated the effects of three species litter representing different successional stages of grassland on dynamics of PFG structure. Our aim was to elucidate the potentially interactive relationships between litter mass and litter species of different stage at PFG characteristics that can provide insights for sustainable management of grasslands.

Materials and Methods

The study was conducted at the Qinghai-Tibet Plateau Research Base of Southwest Minzu University (31°47'34" N, 102°33'07" E, 3485 m.a.s.l.), China. The study area belongs to continental monsoon climate. Annual mean temperature is 1.4°C and mean annual precipitation is 791.95mm. The soil type is classified as Mat Cry-gelic Cambisols. A randomized complete block design was used in the experiment with four replications of each treatment. Each plot was 2 * 2 m and the buffer of each plot was 1 m. During the early plant growing season in May 2019, we added five levels of litter mass (0, 100, 200, 400 and 600 g/m^2) of *Elymus nutans* (En), *Kobresia setchwanensis* (Ks), *Ligularia virgaurea* (Lv). PFG (grasses, sedges, legumes and forbs) composition,

coverage, height, aboveground biomass were then measured by randomly selected 0.5 * 0.5 m sample quadrats within each plot during the peak growing season in mid-August 2019. We used ANOVA to test statistically significant effects. Means were separated by the LSD test at the 5% probability level, using SPSS software version 20.5 (SPSS Inc., Chicago, IL, USA).

Results & Discussion

We found that litter addition significantly impacted the PFG characteristics however these impacts varied with litter species, the mass of the added litter and the type of PFG (Figure 1). Litter addition did not impact the plant species richness of grasses, sedges and legumes but for forbs decreased with increasing mass of added litter (P<0.05). Species richness of forbs were significantly higher in Ks litter addition than Lv (P<0.05) (Figure 1a). Greater litter mass addition may reduce species recruitment and seedling establishment of forb, other functional groups are clonal plants and will not be affected. Litter addition had no significant effect on plant height of all PFGs (Figure 1b). The relative biomass and coverage of grasses and legumes significantly increased with the increasing mass of added litter, while the relative biomass and coverage of forbs significantly decreased with increase litter mass (P<0.05). The reduction in forbs relative biomass was partly attributable to the decrease in the coverage for the forbs. The greater coverage of litter mass increased the physical and chemical effects of litter inhibit the growth of vegetation, thereby reducing the coverage of forbs. In addition, litter addition caused competitive species (grasses and upper layer forbs) to grow rapidly, suppressing the forbs biomass accumulation of species located in the lower layer of the plant community. As a consequence, plant functional composition (relative biomass and relative coverage) was altered. The relative biomass and coverage of sedges were significantly higher in Lv addition than Ks and En. The relative coverage of grasses was significantly lower in Lv addition than Ks and En (P<0.05). The physical and chemical differences of litter type may produce differences in decomposition and plant community structure. Thus, the different feedback for different functional groups by litter type, it is possible that changes in light, nutrient and allelochemicals availability that were caused by the litter, drove a shift in vegetation composition by impacting on recruitment and on plant growth.

Conclusions & Implications

Our study demonstrates that litter species and mass are major drivers that influences the PFG composition in an alpine grassland, highlighting the importance of litter in maintaining grassland PFG structure and ecosystem functions. Litter dynamics may have the potential to shift PFG succession of the plant community, as the vegetation-litter feedbacks in alpine grasslands in the QTP can provide insights for use of litter and improvement of grassland ecosystem.

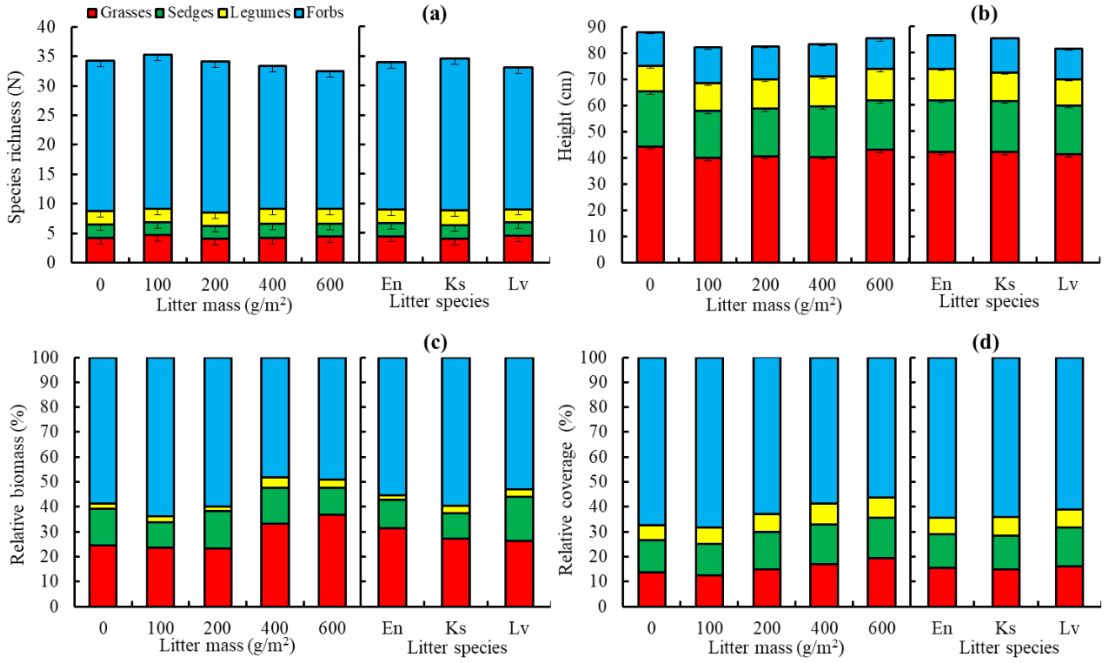

Figure 1. The effects of litter addition on species richness(a), height(b), relative biomass(c), relative coverage(d) of PFG.

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