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Stoichiometric homeostasis of vascular plants in the Inner Mongolia grassland

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Abstract Stoichiometric homeostasis, the degree to which an organism maintains its C:N:P ratios around a given species- or stage-specific value despite variation in the relative availabilities of elements in its resource supplies, is a key parameter in ecological stoichiometry. However, its regulation and role in affecting organismal and ecosystem processes is still poorly understood in vascular plants. We performed a sand culture experiment and a field nitrogen (N) and phosphorus (P) addition experiment to evaluate the strength of N, P and N:P homeostasis in higher plants in the Inner Mongolia grassland. Our results showed that homeostatic regulation coefficients (H) of vascular plants ranged from 1.93 to 14.5. H varied according to plant species, aboveground and belowground compartments, plant developmental stage, and overall plant nutrient content and N:P ratio. H for belowground and for foliage were inversely related, while H increased with plant developmental stage. H for N (H_N) was consistently greater than H for P (H_P) while H for N:P ($H_{N:P}$) was consistently greater than H_N and H_P. Furthermore, species with greater N and P contents and lower N:P were less homeostatic, suggesting that more homeostatic plants are more conservative nutrient users. The results demonstrate that H of plants encompasses a considerable range but is stronger than that of algae and fungi and weaker than that of animals. This is the first comprehensive evaluation of factors influencing stoichiometric homeostasis in vascular plants.

Keywords Ecological stoichiometry · N:P ratio · Developmental stages · Steppe · Plant functional groups

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Introduction

The expanding sophistication of techniques in biology and ecology at all levels of biological organization has resulted in an increasingly fragmented knowledge base, making it challenging to integrate research across different scales and organisms (Vogel 1998; Elser et al. 2000b). However, entities at all levels of organization from molecules to biosphere are composed of various chemical elements in diverse ratios. Ecological stoichiometry, the study of the balance of multiple chemical elements in ecological interactions and processes (Elser et al. 2000b; Sterner and Elser 2002), makes it possible to connect studies of various levels of organization, diverse organisms, and different habitats (Elser et al. 2000b; Elser and Hamilton 2007). Stoichiometric theory is becoming a powerful framework for ecology and biology (Elser et al. 2000a; Sterner and Elser 2002; Karimi and Folt 2006), especially for research on the cycling of chemical elements and trophic transfer (Vanni 2002; Hessen et al. 2004).

Stoichiometric homeostasis is a central concept in ecological stoichiometry. Homeostasis represents the ability of organisms to maintain constant conditions in the body despite fluctuations in the environment (Kooijman 1995).