

# 我国半干旱荒漠草原典型植被群落对土壤入渗特性的影响

侍世玲<sup>1</sup>, 赵飞燕<sup>1</sup>, 任晓萌<sup>2</sup>, 蒙仲举<sup>6</sup>, 党晓宏<sup>3</sup>, 吴小龙<sup>4</sup>

(1. 内蒙古农业大学沙漠治理学院, 内蒙古 呼和浩特 010018; 2. 内蒙古气象科学研究所, 内蒙古 呼和浩特 010051; 3. 内蒙古包头市林业和草原局, 内蒙古 包头 014030; 4. 中国热带农业科学研究院环境与植物保护研究所 海口 571101)

**摘 要:** 从土壤表面入渗形成土壤水的过程称为土壤入渗, 是植物吸收和利用土壤水分的唯一途径, 与养分迁移、地表径流和土壤侵蚀密切相关。近年来, 全球气候变化和过度放牧等人类干扰破坏了草原生态系统的稳定性。大面积草地退化, 斑块暴露, 表面压实程度高, 易形成地表径流, 造成水土流失过程加剧。在水分限制地区, 降雨入渗是补充植物生长所需水分的主要途径。水渗入土壤是干旱半干旱区补充根区带土壤水分的关键过程。先前的研究主要集中于土壤性质和植被类型对土壤入渗过程的影响, 本文在此基础上进一步探究土壤性质、植被类型以及植被根系特征对土壤入渗速率的影响机理。因此, 本文以希拉穆仁草原 6 种典型植物群落 (蒙古韭 (*Allium mongolicum*) 群落、银灰旋花 (*Convolvulus ammannii*) 群落、克氏针茅群落 (*Stipa grandis*)、羊草群落 (*Leymus chinensis*)、洽草群落 (*Koeleria macrantha*)、短花针茅群落 (*Stipa breviflora*)) 为研究对象, 采用野外样方调查与双向指示分析法选择 6 种典型群落类型样地, 利用根系分析系统对植被根系各参数进行分析, 通过环刀法测定 6 个典型植被群落 0-30 cm 土层土壤入渗速率, 旨在量化典型植物群落对土壤入渗性能的影响, 揭示土壤入渗速率与土壤特性和植物根系之间的相互作用, 并确定影响希拉穆仁草地土壤入渗性能的主要因素。结果表明: 希拉穆仁草原不同典型植被群落在不同土层上的土壤入渗速率有显著差异, 总体上随土层深度的增加逐渐降低, 洽草群落在 0-5 cm 土层的入渗速率最大, 而银灰旋花群落的入渗速率最小, 分别为 4.25 mm · min<sup>-1</sup> 和 0.53 mm · min<sup>-1</sup>。土壤容重、总孔隙度、有机质、根系特征与土壤入渗速率具有较强的相关性。路径分析表明, 土壤容重、初始含水率、毛管孔隙度和黏粒含量是影响该地区土壤入渗的主要因素, 其他因素通过改变土壤容重间接影响入渗速率。综上所述, 土壤容重是决定研究区土壤入渗速率的重要限制因素, 其他因素间接影响。这些结果有助于了解半干旱区草原不同植被群落在土壤入渗, 径流量以及土壤侵蚀等方面的差异, 为该地区土壤退化的防治管理和草地恢复提供理论和实践帮助。

关键词: 土壤入渗; 植被群落; 根系特征; 荒漠草原

## Soil infiltration properties are affected by typical plant communities in a semi-arid desert grassland in China

**Abstract:** A process of infiltration from the soil surface to form soil water is known as soil infiltration; this is the only way for plants to absorb and use soil water. This process is closely related to nutrient migration, surface runoff, and soil erosion. In recent years, human disturbances such as global climate change and overgrazing have undermined the stability of grassland ecosystems. Large-scale grassland degradation, patch exposure, high degree of surface compaction, easy to form surface runoff, resulting in increased soil erosion process. In water-limited areas, rainfall infiltration is the main way to supplement the water required for plant growth. Water infiltration into soil is a key process to supplement soil moisture in root zone in arid and semi-arid areas. Previous studies mainly focused on the effects of soil properties and vegetation types on soil infiltration process. On this basis, this paper further explored the influence mechanism of soil properties, vegetation types and vegetation root characteristics on

<sup>6</sup> 蒙仲举为通讯作者

soil infiltration rate. Therefore, this paper takes six typical plant communities ( *Allium mongolicum* community, *Convolvulus ammannii* community, *Stipa grandis* community, *Leymus chinensis* community, *Koeleria macrantha* community, *Stipa breviflora* community ) in Xilamuren grassland as the research object. Six typical community types were selected by field quadrat survey and two-way indicator analysis. The parameters of vegetation roots were analyzed by root analysis system. The soil infiltration rate of 0-30 cm soil layer in six typical vegetation communities was determined by cutting ring method. The effect of typical plant communities on soil infiltration performance was quantified, the interaction between soil infiltration rate and soil characteristics and plant roots was revealed, and the main factors affecting soil infiltration performance in Xilamuren grassland were determined. The results indicated that the infiltration rate of the *Koeleria macrantha* community was highest at the soil depth of 0–5 cm, while that of the *Convolvulus ammannii* community was lowest, reaching  $4.25 \text{ mm} \cdot \text{min}^{-1}$  and  $0.53 \text{ mm} \cdot \text{min}^{-1}$ , respectively. The soil infiltration rate of different plant communities gradually declined with the increment of soil depth. The strongest correlations were found between bulk density, total porosity, organic matter, root characteristics, and soil infiltration rate. The bulk density, initial water content, capillary porosity, and clay content were the primary influencing factors acting on soil infiltration in the region. Other factors indirectly impacted the infiltration rate by modifying bulk density, which was a crucial limiting factor determining the infiltration rate in the research region. The study's findings will give theoretical and practical assistance for the prevention and management of soil deterioration and grassland restoration in this area.

**Keywords:** Soil infiltration, Plant community, Root properties, Semi-arid desert grassland.