北京石质山区主要景观树种根系功能性状对干瘠环境的适应

韦柳端 徐程扬*

（北京林业大学城市林业研究中心，干旱半干旱地区森林培育及生态系统研究国家林草局重点实验室，

森林培育与保护教育部重点实验室，北京 100083）

摘 要:【目的】以北京石质山区主要观赏树种（黄栌、山桃、山杏、元宝枫、栓皮栎）为研究对象，采用挖掘法获取树木细根，测定细根参数。分析干瘠立地中不同树种根系功能性状的变化及差异，研究不同树种在干瘠环境中的适应对策。【方法】根据田间持水量和石砾含量分别设置 4 个干瘠梯度（轻度、中度、重度、极度），探讨干瘠环境下 5 种树种根系功能性状的差异及其对干瘠胁迫的适应途径。【结果】（1）干旱、瘠薄均对树木根系功能性状产生影响，其中根系性状对干旱的敏感度比瘠薄及交互作用大。5 种树种根系功能性状在不同干瘠环境下均发生显著变化，树木主动调节根系构型适应干瘠立地。此外，不同树种同一性状的变化也各不相同，植物根系在适应极端干瘠环境中，通过改变根系性状，表现出显著的差异。（2）随着干瘠胁迫的加剧，5 种树种根系形态、根系化学计量学性状发生不同的变化，不同树种根系分枝模式存在差异。随着干旱的加剧，黄栌根系构型为鲱鱼骨分枝模式，而元宝枫、山桃、山杏、栓皮栎根系由鲱鱼骨分枝模式转变为叉状分枝模式，趋向于构建紧缩型的根系构型。随瘠薄胁迫的加剧，黄栌、元宝枫、山桃根系分枝结构变化不明显，介于鲱鱼骨分枝模式和叉状分枝模式之间；山杏、栓皮栎利用鲱鱼骨分枝模式拓展营养空间。（3）调整根系功能性状的协同或权衡关系、实现对资源利用的高效性，是树木适应不同土壤干瘠环境的重要方面，并且 5 种树种根系性状的协同或权衡关系差异较大。黄栌、元宝枫、山桃、山杏、栓皮栎利用不同性状之间的权衡和协同提高对土壤资源的吸收和利用效率，提高抗干瘠能力。（4） 树木对干瘠胁迫都有一定的适应能力和适应策略，能够通过自身根系的结构、形态的变化来适应不同程度的干瘠胁迫。通过权衡碳分配、碳消耗，不同树种对干瘠环境适采取了不同的生态适应策略，具有明显的差异。

关键词: 观赏树种；干瘠立地;根系功能性状;适应对策

Adaptation of root functional traits of ornamental tree species to dry and barren site in stony mountainous area of Beijing

WEI Liu-duan [1] XU Cheng-yang [1*]

（Research Center for Urban Forestry of Beijing Forestry University, The Key Laboratory for Silviculture and Conservation of Ministry of Education, Key Laboratory for Silviculture and Forest Ecosystem in arid and semi-arid area of State Forestry and Grassland Administration, Beijing 100083, China）

Abstract:【Objective】In this study, the main ornamental tree species in the rocky mountainous area (*Cotinus coggygria*, *Acer truncatum*, *Amygdalus davidiana*, *Armeniaca sibirica*, and *Quercus variabilis*) were used as the research object, and the fine roots of the trees were obtained by excavation method, and the fine root parameters were determined. Analyze the changes and differences in root functional traits of different tree species in dry and barren sites, and study the adaptation strategies of different tree species in dry and barren environments. 【Method】According to the field water holding capacity and gravel content, four dry barren gradients (light, moderate, severe, extreme) were set up respectively to explore the differences in root functional traits of the five tree species in dry barren environments and their adaptive ways to dry barren stress.【Result】The result showed: (1)Both of drought and barrenness had affect on the functional traits of tree roots, among which root traits were more sensitive to drought than barrenness and interaction. The root functional traits of the five tree species changed significantly in different dry and barren environments, and the trees adjusted the root architecture to adapt to dry and barren environment. In addition, the changes of the same traits of different tree species were also different. Plant roots had shown significant differences in adapting to extreme dry and barren environments by changing root traits. (2)With the intensification of dry and barren stress, the root morphology and root stoichiometric properties of the five tree

species have different changes, and the root branching patterns of different tree species are different. With the intensification of drought, the root system of *Cotinus coggygria* had a herringbone-like branch branching pattern, while the root systems of *Acer truncatum*, *Amygdalus davidiana*, *Armeniaca sibirica* and *Quercus variabilis* had changed from a herringbone-like branch pattern to a dichotomous branch pattern, tending to construct a compact root system configuration. With the intensification of infertility stress, the branch structure of the root system of *Cotinus coggygria*, *Acer truncatum*, and *Amygdalus davidiana* did not change significantly, which was between the branching pattern of Dichotomous branch and herringbone-like branch pattern. *Armeniaca sibirica* and *Quercus variabilis* used the branching pattern of herringbone-like branch to expand nutrient space. (3)Adjusting the synergy or trade-off relationship of root functional traits and realizing the efficient use of resources were important aspects for trees to cope with different soil dry and barren environments, and the synergy or trade-off relationship of root traits of the five tree species was quite different. *Cotinus coggygria, Acer truncatum, Amygdalus davidiana, Armeniaca sibirica*, and *Quercus variabilis* utilize the trade-off and synergy between different traits to improve the absorption and utilization efficiency of soil resources, and improve the resistance to barrenness. (4)Trees had certain adaptability and strategies to dry and barren stress, and could adapt to varying degrees of dry and barren stress through changes in the structure and morphology of their own root systems. 【Conclusion】By weighing carbon allocation and carbon consumption, different tree species had adopted different ecological adaptation strategies to dry and barren environments, which had obvious differences.

Key words: ornamental tree species; dry and barren sites; root functional traits; adaptation strategies