

Stand spatial structure is more important than species diversity in enhancing the carbon sink of *Quercus acutissima* forest in the Loess Plateau of China

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Abstract: The relationship between stand structure and function is of great interest in forest management research. However, the roles of species diversity and the spatial structure of trees, as the core information of stand structure, in influencing carbon sink function are still uncertain. This study examined the effects of stand spatial structure (angular scale index, mingling degree, aggregation index and competition index of trees) and species diversity (Simpson index, Shannon–Wiener index and Pielou index of trees, shrubs and herbs) on the carbon stocks of *Quercus acutissima* forest. Structural equation modeling (SEM) was applied to test the effects of the selected index on carbon stocks. The results showed that the stand spatial structure and species diversity influenced the ecosystem carbon sink indirectly through biomass (trees and litter) and soil carbon (0–100cm). The aggregation index (1.03 ± 0.03), competition index (2.84 ± 0.15) and species diversity of trees (0.41–0.85) were the most important driving factors affecting the carbon stock ($141.56 \pm 8.77 \text{ Mg/hm}^2$). Stand spatial structure had positive direct effects (path coefficients 0.764 and 0.890) on biomass and soil carbon, while species diversity had negative direct effects (–0.320 and –0.206). Therefore, the stand spatial structure played a more important role than species diversity in forest carbon sinks, so it should be adjusted preferentially in forest management. Our results provide important insights into the climate change mitigation potential associated with the structure-based management of forests.

黄土高原林分空间结构在提高栎林碳汇方面比物种多样性更重要

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摘要: 林分结构与功能的关系是森林管理研究的重要意义。然而, 物种多样性和树木的空间结构作为林分结构的核心信息, 在影响碳库功能中的作用尚不确定。本研究探讨了林分空间结构(角尺度指数、混合度、聚集指数和竞争指数)与物种多样性(乔木、灌木和草本的 Simpson 指数, Shannon-Wiener 指数和 Pielou 指数)对栎林碳储量的影响。我们采用了结构方程模型(SEM)来检验所选指标对碳储量的影响。结果表明, 林分空间结构和物种多样性通过生物量(树木和凋落物)和土壤碳储量(0 - 100cm)间接影响了生态系统的碳汇。树木的聚集指数(1.03 ± 0.03)、竞争指数(2.84 ± 0.15)和物种多样性($0.41 - 0.85$)是影响碳储量($141.56 \pm 8.77 \text{ Mg/hm}^2$)的最重要的驱动因素。林分空间结构对生物量和土壤碳含量有正直接影响(路径系数分别为 0.764 和 0.890), 物种多样性对土壤碳含量有负直接影响(-0.320 和 -0.206)。因此, 林分空间结构在森林碳汇中比物种多样性更为重要, 在森林管理中应优先调整。我们的研究结果为与基于结构的森林管理相关的气候变化缓解潜力提供了重要的见解。