

Forest growth more affected by stand spatial structure than soil nutrients in a mixed forest: evidence from 8-year-old different forest management experiment in China.

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Abstract: 【Objective】 As the largest terrestrial ecosystems on Earth, forest ecosystems are responsible for about 25% of carbon sequestration in terrestrial ecosystems globally. As greenhouse gases (CO₂, CO et al) continue to be emitted, forests play an integral role in the global carbon cycle and in the regulation of the climate. As an essential part of the ecosystem, forest productivity not only reflects the overall energy flow and material cycle of forests, but also elucidates the pertinent interactions between forests and environmental factors. And forest growth is a crucial indicator of the productivity potential and stability of forests. Consequently, an understanding of the conditions that facilitate growth and the changes that occur in forest stands is essential for the enhancement of forest productivity and the maintenance of forest ecosystem stability. The organic matter and minerals present in the soil play a significant role in the growth of forest trees. These elements can either directly provide the nutrients that the trees require or indirectly influence soil chemical and physical properties, which in turn has an impact on the growth of the trees. And in previous studies, it was also demonstrated that stand structure is directly related to forest growth and is a fundamental factor in accurately improving forest quality and productivity. The pattern of spatial distribution in a forest of various tree species, ages, heights, and canopy layers is known as the stand structure. Among these, the forest stand's spatial structure reflects the information about the trees' spatial locations, such as their distribution pattern, species isolation and size differentiation, etc. It can also directly reflect how forest growth space is allocated, which has a significant impact on the stability of the forest stand and the growth of the trees. In addition, tree size diversity is of great importance for forest management. The greater the variability between stand sizes within a stand, the greater the spatial heterogeneity of the stand, which in turn helps to increase species diversity and improve forest growth. Furthermore, Tree species diversity is a crucial element in maintaining the stability of forest ecosystems. A diverse array of tree species can result in a rational stand structure, thereby enhancing the vigor and productivity of forest growth. Therefore, spatial structure, tree size diversity and tree species diversity were employed to describe stand structure and analyze the relationship between stand structure and forest growth in this study. We by studying forest stand structure, particularly the spatial structure and the influence of soil nutrients on tree growth, we can make targeted adjustments to the structure of the forest stand, thereby changing soil nutrients and tree growth, as well as realizing the sustainable use of forest resources and ecosystem protection. Currently, three principal practices of forest management are prevalent: TTFM, SBFM, SFCS. It is therefore postulated that the three distinct forest management practices may influence forest growth, with the effects varying according to the differences in management practices. Furthermore, these effects may be moderated by stand structure and soil nutrient factors. This approach enables us to investigate the forest management practice that is most conducive to the growth of forest trees, with the objective of optimising forest management strategies and improving forest productivity and ecosystem stability. **【Result】** The results indicate that: SBFM was able to

significantly increase basal area and biomass, and TTFM, SBFM, and SFCS were all able to significantly reduce stand mortality rate. Forest management influenced biomass by controlling soil available potassium, basal area by adjusting Shannon-Wiener and Simpson indexes of tree species diversity, and stand mortality by varying angle index and leaf area index of spatial structure as well as Gini and Var index of tree size diversity. Stand structure and soil nutrients explained 63.12% and 36.5% of the variation in forest growth, respectively. Spatial structure, tree size diversity, and tree species diversity explained 34.46%, 26.57%, and 26.58% of the variation in forest growth, respectively. **【Conclusion】** The implementation of the forest management practice was found to have an effect on forest growth. The SBFM demonstrated a notable promotion of basal area and biomass production. TTFM, SBFM and SFCS exhibited a significant reduction in stand mortality. Stand structure and soil nutrient status were improved by all three designs. Our results show that stand structure affects production, directly as well as indirectly by influencing soil nutrients. Among the various factors affecting forest production, LAI, Gini, and Var are of particular importance. In conclusion, our evidence shows that adjustments of the spatial structure are effective for promoting forest production and stability. We expect that the results of this study will improve our understanding of natural and designed forest dynamics in this important region.