Postprint: Soil Ecological Stoichiometry Characteristics of Pinus sylvestris var. mongolica Plantations at Different Stand Ages in the Horqin Sandy Land

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Abstract

This study investigated Pinus sylvestris var. mongolica plantations of different stand ages (15, 25, 35, and 45 years) in the Horqin Sandy Land, examining the contents of soil organic carbon, total nitrogen, and total phosphorus in the 0–100 cm soil layer and their ecological stoichiometric characteristics, and exploring the vertical distribution patterns of soil carbon, nitrogen, and phosphorus stoichiometric characteristics and their variations with stand age. The results showed that: The contents of soil organic carbon, total nitrogen, and total phosphorus in the 0–20 cm soil layer of the four plantations were 7.34 $g \cdot kg^{-1}$, 0.39 $g \cdot kg^{-1}$, and 0.19 $g \cdot kg^{-1}$, respectively, all of which were lower than the national average. With increasing stand age, organic carbon content, C/N, and C/P all showed increasing trends; total nitrogen and total phosphorus contents exhibited an initial increase followed by a decrease (with a significant reduction in the 45-year-old stand); while N/P showed no significant change. With increasing soil depth, the variation trends of organic carbon and total nitrogen contents were basically consistent, both showing a gradual decreasing trend; however, the organic carbon and total nitrogen contents in the 0–20 cm soil layer of each stand accounted for less than 1/3 of the total contents; C/N and C/P showed opposite trends (C/N increased while C/P decreased); whereas the vertical distribution of total phosphorus content and N/P was relatively uniform with little variation. In summary, the contents of organic carbon, total nitrogen, and total phosphorus in the soils of Pinus sylvestris var. mongolica plantations in the study area were extremely low; however, afforestation with Pinus sylvestris var. mongolica increased the soil carbon, nitrogen, and phosphorus nutrient contents; soils of Pinus sylvestris var. mongolica plantations at all stand ages were simultaneously limited by nitrogen and phosphorus nutrients, but the limitation by

nitrogen became more significant with increasing soil depth.

Full Text

Soil Ecological Stoichiometry of Pinus sylvestris var. Mongolica Planted Forests with Different Ages in Horqin Sandy Land

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Abstract

Soil organic carbon (C), total nitrogen (N), and total phosphorus (P) were measured from 10 cm to 100 cm soil depth in Pinus sylvestris var. mongolica planted forests of four different ages (15-, 25-, 35-, and 45-year-old) in Horqin sandy land. To provide a theoretical basis for sustainable management of P. sylvestris planted forests, the dynamic regulation of these elements was investigated with respect to forest age and soil depth. The results showed that the contents of soil organic C, total N, and total P were 2.51–8.27 $g \cdot kg^{-1}$, 0.12–0.45 $g \cdot kg^{-1}$, and 0.14–0.21 $g \cdot kg^{-1}$, respectively, all below the national average level in China. As forest age increased, soil organic C, C/N, and C/P ratios increased; total N and total P contents first increased and then significantly decreased at 45 years, while N/P showed no significant change. With increasing soil depth, both organic C and total N decreased, with contents in deeper layers being less than one-third of that in the 0–20 cm layer. While C/N ratio increased, C/P ratio decreased, showing opposite trends. The vertical distribution of total P and N/P did not change significantly. Our findings indicated that although soil organic C, total N, and total P contents were extremely poor in Horqin sandy land, these planted forests increased soil C, N, and P nutrient storage. However, soil fertility declined in the 45-year-old forest. Nitrogen and phosphorus were the limiting nutrients in different aged P. mongolica planted forests, and nitrogen limitation became more significant with increasing soil depth.

Keywords: *Pinus sylvestris* var. *mongolica* planted forest age; soil; ecological stoichiometry; Horqin Sandy Land

3.3 Vertical Distribution Characteristics

The vertical distribution of soil nutrients showed distinct patterns across different soil layers. In the 0–20 cm depth layer, soil organic carbon, nitrogen, and phosphorus contents accounted for approximately one-third of the total measured profile (0–100 cm). Previous studies have demonstrated that surface soil layers (0–20 cm) contain the highest concentration of nutrients and microbial

activity in forest ecosystems. In the 0–40 cm layer, nutrient contents represented about one-half of the total profile, indicating that the majority of soil nutrients were concentrated in the upper layers. The C/N and C/P ratios exhibited contrasting vertical trends, with C/N increasing with depth while C/P decreased, suggesting differential nutrient cycling processes along the soil profile.

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Note: Figure translations are in progress. See original paper for figures.