

# 科尔沁沙地樟子松人工林土壤真菌群落结构和功能特征

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**摘要:**【目的】系统解析科尔沁沙地不同林龄樟子松人工林土壤真菌群落结构和功能特征及其与土壤理化性质的关系,为樟子松人工林可持续经营管理提供理论依据。【方法】以科尔沁沙地幼龄林(13 a)、中龄林(22 a)、近熟林(34 a)、成熟林(41 a)和过熟林(55 a)樟子松人工林为研究对象,采用野外调查和分子生物学相结合的方法,利用 Illumina MiSeq 高通量测序和 FUNGuild 平台鉴定分析樟子松人工林土壤真菌群落。【结果】(1)科尔沁沙地樟子松人工林土壤样品中共获得 922 个 OTUs,隶属于 14 门 25 纲 67 目 98 科 254 属。子囊菌门 Ascomycota 和担子菌门 Basidiomycota 占绝对优势,优势属为美口菌属 Calostoma 和糙缘腺革菌属 Amphinema。(2)随林龄增加,共生营养型真菌及主要功能群外生菌根真菌占比均呈先减小后增大趋势,且成熟林占比最小;腐生营养型真菌及主要功能群未定义腐生真菌占比均呈先增大后减小趋势,且成熟林占比最大;病理营养型真菌分布较为均匀。(3)随林龄增加,土壤真菌网络呈先简单后复杂趋势,近熟林最为简单,过熟林最为复杂,而成熟林次之。(4)土壤真菌群落结构主要受土壤有机质、pH、碱解氮和硝态氮的驱动,腐生营养型真菌相对丰度与土壤全磷、pH 分别呈显著正、负相关性( $P < 0.05$ ),腐生营养型真菌相对丰度与土壤有机质呈极显著正相关( $P < 0.01$ )。【结论】林龄和土壤理化性质对科尔沁沙地樟子松人工林土壤真菌群落构建起到关键作用。樟子松幼龄林至近熟林阶段,共生营养型真菌大量富集占据主导地位,有利于林木快速生长;成熟林和过熟林阶段,土壤真菌群落结构相似,腐生营养型真菌发挥主导作用,且真菌网络愈加复杂并趋于稳定,有利于提高林木对外部环境抵抗能力。研究结果有助于深入理解科尔沁沙地樟子松人工林土壤真菌生态功能,并为从土壤真菌视角评价和理解林木和土壤健康提供科学依据。

**关键词:** 土壤真菌; 群落结构; 生态功能; 林龄; 樟子松

## Soil fungal community structure and functional characteristics associated with *Pinus sylvestris* var. *mongolica* Plantations in the Horqin Desert

**Abstract:**【Objective】To explore a firm basis for sustainable management of *Pinus sylvestris* var. *mongolica*, soil fungal community structure and functional characteristics as well as the driving soil properties were revealed in different stand ages of *P. sylvestris* plantations in the Horqin Desert. 【Method】We sampled the soil of *P. sylvestris* plantations with young-mature (13 a), half-mature (22 a), nearly-mature (34 a), mature (41 a) and over-mature (55 a), and soil fungal communities were identified by Illumina MiSeq high-throughput sequencing and FUNGuild platform. 【Result】(1) In the Horqin Desert, 922 fungal OTUs were obtained from soil samples of *P. sylvestris* plantations, and belonged to 254 genera, 98 families, 67 orders, 25 classes, and 14 phyla. Ascomycota and Basidiomycota were predominated, and the dominant genera were Calostoma and Amphinema. (2) With stand aging, the proportion of symbiotic fungi and the dominated functional groups ectomycorrhizal fungi climbed up and then declined, with a minimum in the mature plantations; the proportion of saprophytic fungi and the dominated

functional groups undefined saprophytic fungi decreased after a little increase, with a maximum in mature plantations; the distribution of pathotrophic fungi was relatively uniform. (3) With stand aging, soil fungal network showed a differentiated tendency which simplified first and then complicated. The network of nearly-mature plantations was the simplest, and the over-mature plantations was the most complex followed by the mature plantations. (4) Soil organic matter, pH, alkali-hydrolyzable nitrogen and nitrate nitrogen were the most important driving factors for soil fungal community structure. The relative abundance of saprophytic fungi was positively and negatively correlated with soil total phosphorus and pH, respectively ( $P < 0.05$ ), and the relative abundance of saprophytic fungi had a significant positive correlated with soil organic matter ( $P < 0.01$ ). **【Conclusion】** Stand age and soil properties play a key role in the soil fungal community construction associated with *P. sylvestris* plantations in the Horqin Desert. From young to nearly-mature plantations, the dominant symbiotic fungi accumulation, which benefit the rapid growth of plantations. In mature and over-mature plantations, the soil fungal community structure is similar, saprophytic fungi are the dominant species, and the soil fungal community network tend to complex and stable, which contribute to the resistance improvement of plantations to changeable environments. This improved information will provide a better understanding of soil fungal functions of *P. sylvestris* plantations in the Horqin Desert, as well as the forest and soil health from the perspective of soil fungi.

**Key words:** soil fungi; community structure; ecological function; stand age; *pinus sylvestris* var. *mongolica*.