全国大学英语四级考试
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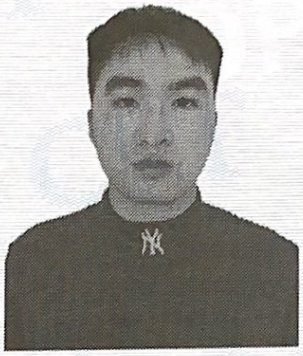

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Article

Endogenous Phytohormone and Transcriptome Analysis Provided Insights into Seedling Height Growth of *Pinus yunnanensis*

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Abstract: Plant height plays a crucial role in both the structure and quality of plants. *Pinus yunnanensis* is a distinctive species of the forest found in Southwest China, where the height of the plants significantly influences both yield performance and plant architecture. Although the phenotypes of *P. yunnanensis* seedlings with different plant heights were quite different at their seedling stage, the molecular mechanisms controlling the seedling differentiation remain poorly understood. This study is aimed to investigate the underlying mechanisms of *P. yunnanensis* seedling differentiation using phenotypic, transcriptomic, and endogenous phytohormone analyses. The *P. yunnanensis* seedlings were categorized into three grades, i.e., Grades A, B, and C, by mean ± 1/2 standard deviation method (H ± 1/2σ), and the seedling height and ground diameter were measured. We conducted the measurements of endogenous hormone levels in the young shoot apexes of seedlings at different grades during the fast-growth period (March). The DEGs were identified through transcriptome sequencing and analyzed by qRT-PCR validation. Significant differences were observed in the content and ratio of endogenous phytohormones among various grades of *P. yunnanensis* seedlings ($p < 0.05$). The ABA content in Grade A was prominently more than that in Grades B and C, and the order of the content of auxins was Grade B > C > A. Furthermore, when compared to Grade A, the ratios of auxins/CTKs, auxins/ABA, CTKs/ABA, and (auxins + CTKs)/ABA exhibited significant increases in Grades B and C. Moreover, GO functional annotation analysis indicated the more pronounced enrichment of DEGs in molecular functions. KEGG metabolic pathway analysis revealed notable differences in enrichment pathways between the pairwise comparisons. The "plant hormone signal transduction" pathway exhibited enrichment in the two groups, followed by "plant–pathogen interaction" pathway in the organism system that was enriched in the three groups. In addition, the results for endogenous phytohormone metabolism pathways indicate a significant up-regulation in the expression of *AUX1*, while *AHP* and *PP2C* exhibited significant down-regulation. To sum up, we aimed at investigating the underlying mechanisms of *P. yunnanensis* seedling differentiation using phenotypic, transcriptomic, and endogenous phytohormone analyses. The results suggested that individual phytohormones have a limited capacity to regulate gene expression, and seedling differentiation results from the combined regulation of multiple hormones. In addition, several candidate genes associated with phytohormone biosynthesis and signal transduction pathways were identified, including *AUX1*, *GH3*, *AHP*, *B-ARR*, *PP2C*, etc., which provided candidate genes for the following hormone-related gene overexpression and knockout experiments. These findings provide insights into the molecular genetic control of seedling height growth of *P. yunnanensis*.

Keywords: *Pinus yunnanensis*; seedling differentiation; plant height; endogenous phytohormones; transcriptome

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题目：云南松苗木 N、P、K 元素含量间异速生长关系对氮磷添加的响应
作者：陆庄跃，汪梦婷，贺斌，汪敢波，许玉兰，李伟，蔡年辉
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云南松苗木 N、P、K 元素含量间异速生长关系对氮磷添加的响应

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摘 要：为了解云南松(*Pinus yunnanensis*)苗木不同器官氮(N)、磷(P)、钾(K)的分布特征，分析云南松不同器官 N、P、K 含量间的分配差异，进一步探讨各器官 N、P、K 元素间的异速生长关系。采用氮、磷二因素三水平的方法开展不同施肥试验，并对苗木采样测定，研究云南松苗木 N、P、K 元素含量间异速生长关系对 NP 添加的响应。云南松苗木对 N、P、K 在不同器官间具有不同的分配策略，总体 K 变动较小，N、P 波动较大且相似，在各器官中 N、K 分配表现为萌条＞叶＞茎＞根；P 表现为萌条＞茎＞叶＞根。与对照相比，单施 N 肥、P 肥和 NP 配施均对云南松苗木生长的影响产生一定差异，总体来看 NP 配施更能促进苗木的养分合理分配，有效缓解单施 N、P 肥对植株的限制作用，使养分处于一个平衡状态，进而促进苗木的生长。随施肥时间的推移，各器官营养元素间的异速生长关系也随之发生变化，且各器官表现为 N、P 的积累速度相接近，总体表现为 K 的积累速度低于 N、P。总体而言，随施肥时间的改变，云南松苗木各器官之间元素的异速生长轨迹发生了显著变化，形成不同的营养元素分配模式。

关键词：云南松；NP 添加；营养元素；养分分配策略；异速生长关系

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Response of allometric relationship among N, P and K contents of *Pinus yunnanensis* seedlings to combined to nitrogen and phosphorus addition

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Abstract: In order to understand the distribution characteristics of nitrogen (N), phosphorus (P) and potassium (K) in different organs of *Pinus yunnanensis* seedlings and analyze the distribution variations of the contents of N, P and K among different organs of *P. yunnanensis*, and to explore the allometric relationships between each element in different organs. Different fertilization experiments were carried out by using the method of two factors and three levels of N and P, and seedlings were sampled to study the response of allometric growth relationship among N, P and K contents of *P. yunnanensis* seedlings to NP combined application. *P.*

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