

# 根系损伤强度对不同规格白杨物候及生长特性的影响

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**摘 要:**【目的】探究不同形态大小与断根起苗移栽强度对白杨当年物候变化及生长特性的影响,为形态差异毛白杨响应根系损伤及应对措施提供理论依据和指导。【方法】采用双因素试验设计,季末在 20 加仑桶种植的一年生“北林雄株一号”白杨中筛选大苗(高 308.75cm、胸径 15.94mm、地径 28.47mm)、中苗(高 238.00cm、胸径 11.07mm、地径 24.20mm)和小苗(高 138.92cm、胸径 6.59mm、地径 14.87mm)3 种形态苗木,次年 3 月断根幅度以地径为基础形成低强度损伤(P1-15 倍地径)、中等强度损伤(P2-7.5 倍地径)和高强度损伤(P3-3.75 倍地径),模拟不同断根起苗强度,同时设置不损伤对照组(CK)模拟未断根苗木。处理后观测成活率及干梢率,定期观测叶、根物候,逐月测定树高、胸径及地径生长,通过拟合 logistic 生长曲线确定速生期关键物候指标,结合生长季末终态差异特征,综合分析苗木形态大小对根系损伤强度的响应情况。【结果】根系损伤强度和不同形态大小对白杨当年物候变化及生长特性影响显著。随着树木形态的增大和根系损伤强度的增加,树木的干梢率显著上升,大树的中、高损伤强度对干梢率的响应尤为显著;随着形态增大及根系损伤增强显著推迟了展叶始期、展叶盛期,但提前了季末落叶期,速生期单叶面积随着根系损伤显著降低,新根萌发期在所有损伤处理都比未损伤处理提前;通过 logistic 模型拟合的曲线显示,根系受损的树木生长曲线比对照组更加平缓。随着大小的增加地径最大生长速率逐渐变小。在大苗和中苗中,随着损伤强度的增强,茎高最大生长速率、胸径最大生长速率均表现出速率显著下降的趋势,而小苗中各生长速率没有差异。任何处理的成活率、速生期开始、结束日期及速生期持续时间没有显著差异;随着苗木形态的变大,季末苗木树高、胸径、地径、H/RCD 及 DBH/RCD 都逐渐增大,地径增量逐渐减小。而树高、胸径增量,在对照组及损伤强度低的处理下随着树高逐渐增大,但在中高强度损伤下表现为逐渐降低的趋势,H/DBH 的变化没有明显规律。随着损伤强度的增加,树高、胸径、地径及其增量,H/RCD 及 DBH/RCD 都逐渐降低,H/DBH 除大苗高强度处理显著高于其他外,其他大小随着损伤强度增大也逐渐减小。PCA 分析也验证了物候及生长变量的相关性和变化趋势。【结论】除轻度损伤外,中、重度根系损伤强度均对不同形态大小白杨产生不利影响,随着损伤强度增加均表现出生长指标的降低以及叶物候的推迟,但提前了根系萌发时间。形态大小对相同损伤强度苗木季末生长响应有差异,根系损伤对更大的苗木影响的幅度更大,只有地径增量表现出相反的趋势。因此,应充分考虑苗木形态大小和起苗强度的叠加效应,对于揭示毛白杨造林当年缓苗机理具有重要意义。

关键词:根系损伤;形态大小;造林规格;毛杨

## Effects of root damage intensity on the growth and photosynthetic characteristics of hairy poplars of different sizes

**Abstract:** 【Objective】 This study aims to investigate the effects of different morphological sizes and root

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pruning intensities on the phenological changes and growth characteristics of *Populus tomentosa* within the same year, providing a theoretical basis and guidance for understanding the response and mitigation strategies of *Populus tomentosa* to root damage based on morphological differences. **【Methods】** A two-factor experimental design was employed, selecting large (height: 308.75 cm, DBH: 15.94 mm, basal diameter: 28.47 mm), medium (height: 238.00 cm, DBH: 11.07 mm, basal diameter: 24.20 mm), and small seedlings (height: 138.92 cm, DBH: 6.59 mm, basal diameter: 14.87 mm) from one-year-old “Beilin Male No. 1” *Populus tomentosa* planted in 20-gallon containers. In March of the following year, root pruning intensities were simulated based on the basal diameter to create low (P1-15 times basal diameter), medium (P2-7.5 times basal diameter), and high (P3-3.75 times basal diameter) damage levels, along with an undamaged control group (CK). Post-treatment, survival rate and dieback rate were observed, phenological phases of leaves and roots were periodically monitored, and tree height, DBH, and basal diameter growth were measured monthly. Logistic growth curves were fitted to determine key phenological indicators during the rapid growth period, and final growth characteristics at the end of the growing season were analyzed to assess the response of seedlings to root damage. **【Results】** Root damage intensity and seedling size significantly affected the phenological changes and growth characteristics of *Populus tomentosa*. As seedling size and root damage intensity increased, the dieback rate rose significantly, with large trees showing particularly pronounced responses to medium and high damage intensities. Increased size and root damage significantly delayed the leafing start and full leaf stages but advanced the end-of-season defoliation period. Single leaf area during the rapid growth period decreased significantly with increased root damage, and new root initiation occurred earlier in all damage treatments compared to the control. Logistic model curves showed that trees with root damage had flatter growth curves than the control group. As size increased, the maximum growth rate of the basal diameter decreased. For large and medium seedlings, increased damage intensity significantly reduced the maximum growth rates of stem height and DBH, while small seedlings showed no significant differences in growth rates. Survival rate, start and end dates of the rapid growth period, and its duration did not differ significantly across treatments. At the end of the season, as seedling size increased, tree height, DBH, basal diameter, H/RCD, and DBH/RCD all increased, while basal diameter increment decreased. Tree height and DBH increments increased with tree height in the control and low damage treatments, but decreased under medium and high damage treatments. H/DBH showed no clear pattern. With increasing damage intensity, tree height, DBH, basal diameter, their increments, H/RCD, and DBH/RCD all decreased. PCA analysis confirmed the correlations and trends among phenological and growth variables. **【Conclusion】** Moderate and severe root damage had adverse effects on *Populus tomentosa* of different sizes, reducing growth indicators and delaying leaf phenology, but advancing root initiation time. Responses to the same damage intensity varied among different-sized seedlings, with larger seedlings being more affected by root damage, whereas basal diameter increment showed the opposite trend. Therefore, it is crucial to consider the combined effects of seedling size and root pruning intensity, which is significant for understanding the mechanisms of *Populus tomentosa* transplantation survival in the first year.

**Key words:** root damage; morphological size; silvicultural specification; *Populus*