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光照强度对乐昌含笑幼苗生长及光合特性的影响

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摘 要 为探析乐昌含笑(*Michelia chapensis*)在不同光照强度下生长及光合能力的适应机制,以乐昌含笑2年生幼苗为试材,经100%(CK)、70%(T1)、50%(T2)、30%(T3)、10%(T4)全光照5个不同遮荫处理1年(3年生),进而对其生长及光合指标进行测定。结果表明,在70%全光照和100%全光照下,乐昌含笑幼苗存活率与株高、地径生长显著高于其他处理。净光合速率在70%光照强度处理时达最高值(8.553 μmol·m^{-2}·s^{-1});随着遮荫胁迫的加重,净光合速率逐渐下降,在50%全光照下净光合速率下降主要由气孔限制导致,30%全光照和10%全光照下由非气孔限制导致。与其他遮荫处理相比,100%全光照和70%全光照下乐昌含笑叶片具有更高的最大净光合速率(8.166和8.735 μmol·m^{-2}·s^{-1})、光饱和点(1215.956和1145.328 μmol·m^{-2}·s^{-1})和光补偿点(16.280和13.572 μmol·m^{-2}·s^{-1})。随着遮荫处理水平的提高,PSII反应中心实际光化学效率(Φ_{PSII})和光化学淬灭系数(q_p)逐渐增加,非光化学猝灭系数(NPQ)逐渐下降;吸收光能中光化学反应耗散能量(P)的比例逐渐增大,天线热耗散能量(D)的光能比例逐渐减小;而所有遮荫处理并未对PSII反应中心的最大光化学效率(F_v/F_m)及潜在活性(F_v/F_0)产生显著的影响。初步判断,70%全光照最有利于乐昌含笑生长,在中度和重度遮荫条件下乐昌含笑可降低光补偿点、光饱和点、净光合速率和暗呼吸速率,增加PSII反应中心开放程度、电子传递的活性和光能利用率,从而提高其在弱光环境下的生长能力。

关键词 乐昌含笑; 光照强度; 生长; 光合特性; 叶绿素荧光

Effects of light intensity on growth and photosynthetic characteristics of *Michelia chapensis* seedlings.

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Abstract: To elucidate the adaption mechanism for the growth and photosynthetic capacity of *Michelia chapensis* under different light intensities, two-year-old seedlings were treated with five shading levels of 100% (CK), 70% (T1), 50% (T2), 30% (T3) and 10% (T4) of natural light intensity for one year, after that the growth and photosynthetic characteristics were measured. The results showed that survival rate, plant height and ground diameter were significantly higher under the 70% and 100% light intensity treatments compared with other treatments. The highest value (8.553 μmol·m^{-2}·s^{-1}) of net photosynthetic rate (P_n) was recorded in the 70% light intensity treatment. With increasing shading intensity, P_n values decreased gradually. The decrease of P_n in the 50% natural light intensity treatment was mainly caused by stomatal limitation, but by non-stomatal limitation under the 30% and 10% natural light intensity treatments. Compared to other shading treatments, leaves under the 100% and 70% natural light intensity treatments had higher maximum net photosynthetic rate (8.166 and 8.735 μmol·m^{-2}·s^{-1}), light saturation point (1215.956 and 1145.328 μmol·m^{-2}·s^{-1}), and light compensation point (16.28 and 13.572 μmol·m^{-2}·s^{-1}). In particular, with increasing shading intensity, the actual photochemical quantum yield of PSII (Φ_{PSII}), photochemical quenching coefficient (q_p) and proportion of photochemical reaction energy (P) increased gradually, while non-photochemical quenching coefficient (NPQ) decreased gradually. All the treatments

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乐昌含笑幼苗在不同光照环境下的光响应模型拟合分析

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摘要：为探究不同光强下乐昌含笑(*Michelia chapensis*)光响应特征及光响应模型的适用性，以乐昌含笑 1 a 生幼苗为试材，设置 5 种光强 100%、70%、50%、30%、10%全光照处理，测定其光响应曲线，并采用直角双曲线模型(RH)、非直角双曲线模型(NRH)、指数模型(EM)、修正直角双曲模型(MRH)及修正指数模型(MEM)等 5 种模型对其进行拟合，进而利用 R_a^2、均方误差(MSE)、平均绝对误差(MAE)结合光合参数实测值与拟合值对 5 种模型拟合效果进行综合评价。结果表明，应用 RH、NRH 和 EM 模型拟合不同光强下乐昌含笑光响应曲线不符合其光合-光响应特征；MRH 模型拟合的各项光合参数与实测值最为接近，MEM 模型次之。因此，MRH 模型具有较高的拟合精度和适用性，是拟合不同光强下乐昌含笑幼苗光合-光响应特征的最适模型。

关键词：乐昌含笑；光照强度；光合作用；光响应曲线；光响应模型

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Fitting Analysis of Light Response Models of *Michelia Chapensis* Seedlings under Different Light Environments

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Abstract: In order to elucidate the light response characteristics and the applicability of light response model of *Michelia chapensis* under different light intensities, one-year-old *M. chapensis* seedlings were grown under five light intensities, including 100%, 70%, 50%, 30% and 10% of nature light. The light response curves were measured and fitted by five models, such as rectangular hyperbola model (RH), nonrectangular hyperbola model (NRH), exponential model (EM), modified rectangular hyperbola model (MRH) and modified exponential model (MEM). Then, the fitting effects of the five models were comprehensively evaluated by using R_a^2, MAE and MSE combined with the measured values and fitting values of photosynthetic parameters. The results showed that the light response curves of *M. chapensis* under different light intensities fitted by RH, NRH and EM model did not conform to its photosynthetic-light response characteristics. The photosynthetic parameters fitted by the MRH model were the closest to the measured values, followed by the MEM model. Therefore, the MRH model has high fitting accuracy and applicability, and is the most suitable model for fitting the photosynthetic light response characteristics of *M. chapensis* under different light intensities.

Key words: *Michelia chapensis*; Light intensity; Photosynthesis; Light response curve; Light response model

乐昌含笑(*Michelia chapensis*)为木兰科(Magnoliaceae)含笑属常绿高大乔木，树体高大，干形通直，树姿优美，材质细致，在用材、园林绿化、观赏等方面具有广阔的应用前景[1]。乐昌含笑目前分布及栽培区广阔，自然生长于林窗下，人工栽植时喜光，但苗期偏喜阴[2]。在造林时，一般选择与其它树种套种或混交[3]。由此可见，光强是影响乐昌含笑生长的重要因素。当前，关于乐昌含笑的研究多集中于种群分布[1]、选育[4]、

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