

盐胁迫对油菜幼苗生长和光合特征的影响

刘国红, 姜超强, 刘兆普, 梁明祥, 殷祥贞, 郑青松

南京农业大学资源与环境科学学院

Effects of Salt Stress on Growth and Photosynthetic Traits of Canola Seedlings

LIU Guo-Hong, JIANG Chao-Qiang, LIU Zhao-Pu, LIANG Ming-Xiang, YIN Xiang-Zhen, ZHENG Qing-Song

College of Resources and Environmental Sciences, Nanjing Agricultural University

摘要

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摘要 采用盆栽砂培试验,研究了不同浓度(0、50、100、200、300 mmol·L⁻¹) NaCl胁迫10和30 d对油菜(*Brassica napus*)幼苗干质量、叶绿素(Chl)含量、净光合速率(P_n)、气孔导度(G_s)、细胞间CO₂浓度(x_i)、蒸腾速率(R_t)、水分利用效率($E_{w,u}$)和气孔限制值(L_s)等的影响。结果表明,在NaCl胁迫下,油菜幼苗植株干质量显著降低,长期高盐胁迫下干质量降低更显著;随NaCl浓度的增加,Chl含量、Chl a/Chl b比值均呈先升高后降低的变化趋势,处理10 d, Chl含量、Chl a/Chl b比值在NaCl浓度为200 mmol·L⁻¹条件下达最大值,处理30 d,在NaCl浓度为100 mmol·L⁻¹条件下达最大值。在50~100 mmol·L⁻¹ NaCl胁迫下,油菜叶片的 P_n 、 x_i 和 L_s 受影响均很小,高盐胁迫下,其 P_n 、 G_s 和 R_t 均显著下降,而 $E_{w,u}$ 和 L_s 则显著上升。相关分析显示,植株干质量与Chl含量、Chl a/Chl b比值间无相关性,与Na⁺、Cl⁻含量, $E_{w,u}$ 和 L_s 间呈显著负相关($P<0.01$),与根冠比,K⁺、Ca²⁺含量,K⁺/Na⁺、Ca²⁺/Na⁺比值,K⁺与Na⁺的选择性比率[S(K⁺,Na⁺)],Ca²⁺与Na⁺的选择性比率[S(Ca²⁺,Na⁺)], P_n 、 G_s 、 x_i 和 R_t 间呈显著正相关($P<0.01$)。上述结果表明,200 mmol·L⁻¹ NaCl胁迫10和30 d、300 mmol·L⁻¹ NaCl胁迫10 d,油菜幼苗光合抑制主要来自气孔限制,而300 mmol·L⁻¹ NaCl胁迫30 d,气孔限制和非气孔限制在油菜幼苗光合抑制中均具有重要作用。Na⁺、Cl⁻、K⁺、Ca²⁺含量, $E_{w,u}$ 、 L_s 、根冠比,K⁺/Na⁺、Ca²⁺/Na⁺比值,S(K⁺,Na⁺),S(Ca²⁺,Na⁺), P_n 、 G_s 、 x_i 和 R_t 均可以作为油菜生长盐适应性的评价指标。

关键词: 油菜 幼苗 盐胁迫 光合特性 气孔限制

Abstract: A pot experiment was carried out using canola in sand culture to explore effects of 10 and 30 days of NaCl stresses(0、50、100、200、300 mmol·L⁻¹) on biomass, chlorophyll (Chl), net photosynthetic rate (P_n), stomatal conductivity (G_s), intercellular CO₂ concentration (x_i), transpiration rate ($E_{w,u}$) and stomatal limitation (L_s) of canola seedlings. Results show that NaCl stress decreased significantly plant dry weight, especially when the salt was high in concentration and existed for a long time; with increasing NaCl concentration, chlorophyll (Chl) content and Chl a/Chl b ratio both displayed a variation pattern of ascending first and descending later, and peaked under the stresses of 200 mmol·L⁻¹ NaCl, for 10 days and under the stresses of 100 NaCl for 30 days. P_n , x_i and L_s in canola leaves growing under the stress of 50 and 100 mmol·L⁻¹ NaCl stresses were not much affected, but, P_n , G_s , x_i and R_t were markedly decreased when the stress was higher, however, in this case, $E_{w,u}$ and L_s increased significantly. Correlation analysis indicated that biomass (dry weight) of canola was insignificantly related to Chl content and Chl a/Chl b ratio, but significantly and negatively related to Na⁺, Cl⁻ content, $E_{w,u}$ and L_s , and significantly and positively related to root/shoot ratio (R/S), K⁺, Ca²⁺ content, K⁺/Na⁺, Ca²⁺/Na⁺ ratio, K⁺ and Na⁺ selectivity ratio [S(K⁺, Na⁺)], Ca²⁺ and Na⁺ selectivity ratio [S(Ca²⁺, Na⁺)], P_n , G_s , x_i and R_t . The findings indicate that in seedlings under the stress of 200 mmol·L⁻¹ NaCl for 10 or 30 days, or 300 mmol·L⁻¹ NaCl for 10 days, stomatal limitation was the major restraint of photosynthesis. But when the stress was increased to 300 mmol·L⁻¹ NaCl for 30 days, both stomatal and nonstomatal limitations played important roles in restraining photosynthesis. Na⁺, Cl⁻, K⁺ and Ca²⁺ contents, $E_{w,u}$, L_s , R/S, K⁺/Na⁺, Ca²⁺/Na⁺, S(K⁺, Na⁺), S(Ca²⁺, Na⁺), P_n , G_s , x_i and R_t can all be regarded as indexes for evaluation of canola in salt adaptability.

Keywords: canola seedling salt stress photosynthetic trait stomatal limitation

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Corresponding Authors: 郑青松 南京农业大学资源与环境科学学院 Email: qszheng@njau.edu.cn

About author: 刘国红(1984—),女,山东临沂人,硕士生,主要从事植物耐盐与分子生物学方面的研究。E-

mail: hongguo8888@126.com

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