棉花氮素利用效率动态调控机理的探讨

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摘要： 了解低氮供应条件下植物氮素利用效率的调控机理是提高作物生产力的关键。旨在阐明低氮（0.5 mmol·L^{-1}）和高氮（5.0 mmol·L^{-1}）条件下不同基因型棉花的形态、光合作用和生长发育对氮素吸收、同化和利用的潜在机理，选用了氮高效型（HM-2270、GH-Uhad）和氮低效型（Z-50、FH-444）棉花材料。HM-2270 的根系和地上部干物质质量最大，而 FH-444 和 Z-50 的最低。HM-2270 的叶面积、上表皮细胞面积、气孔密度和气孔指数最高，下表皮气孔密度最大、气孔指数最高。在所有条件下，GH-Uhad 和 FH-444 分别在叶片上、下表皮表现出更大的表皮细胞面积。FH-444 的胞间 CO_2 浓度较高。氮高效型棉花在净光合速率、蒸腾速率、气孔导度和叶绿素含量方面表现相似，但与氮低效型差异显著。此外，HM-2270 的核酮糖 -1,5- 二磷酸羧化酶 / 加氧酶、蔗糖磷酸合成酶、硝酸还原酶和谷氨酰胺合成酶的活性均较高，GH-Uhad 次之。氮处理在 6～24 h 后，诱导了硝酸盐转运体 NRT1.1、NRT2.1 和 NRT 2.2 编码基因的表达。在氮高效基因型棉花中观察到硝酸盐转运体基因表达的最大峰值，与氮低效基因型相比，它们保持其表达的时间更长。综上所述，氮高效基因型棉花的氮响应介导了发育可塑性，而这些发育可塑性与高效的氮素吸收、较高的酶活性和维持光合作用密切相关，有助于维持植株体内的氮稳态和促进植物生长。

关键词： 棉花；氮利用效率；碳氮代谢；硝酸盐转运蛋白

Exploring the mechanisms regulating the dynamics of nitrogen use efficiency in cotton

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Abstract: Understanding the mechanisms of nitrogen (N) use efficiency in plants under low N supply is crucial to improve crop productivity. This study aimed to elucidate the potential mechanisms involved in N uptake, assimilation and its utilization associated with morphology, photosynthesis and growth of different cotton genotypes i.e. N-efficient (HM-2270, GH-Uhad) and N-inefficient (Z-50, FH-444) grown under low-N (0.5 mmol·L^{-1}) and high-N (5.0 mmol·L^{-1}) conditions. HM-2270 produced maximum root and shoot dry weight, while minimum root and shoot dry weight was observed for FH-444 and Z-50. Likewise, highest leaf area, epidermal cells area (EPCA), stomatal density (SD) and stomatal index on adaxial surface was noted for HM-2270, while maximum SD on abaxial surface and highest no. of epidermal cells and greater EPCA exhibited by GH-Uhad and FH-444 respectively, on both surfaces under all conditions. Higher intercellular carbon dioxide concentration was found in FH-444. However N-efficient genotypes behaved alike for net photosynthetic rate, transpiration rate, stomatal conductance and chlorophyll content, but significantly differ from N-inefficient genotypes. In addition, the activities of ribulose-1,5-bisphosphate carboxylase/oxygenas, sucrose phosphate synthase, nitrate reductase, and glutamine synthetase were higher in HM-2270, followed by GH-Uhad in both N regimes. The N supply induced the expression of nitrate

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transporters (NRT1.1, NRT 2.1 and NRT 2.2) in tested genotypes after 6 to 24 h of N treatments. Maximum peaks for transporter’s expression were observed in N-efficient genotypes and they maintained the expression for longer time as compared with N-inefficient genotypes. In conclusion, the above mentioned N responses mediate the developmental plasticity related to efficient N uptake. High enzymatic activities and sustaining photosynthesis contribute to N-homeostasis and plant growth under different N concentrations.
Keywords: cotton; nitrogen use efficiency; carbon and nitrogen metabolism; nitrate transporter