应用生态学报 » 2011, Vol. 22 » Issue (03): 673-680   DOI:

施氮和大气CO_2浓度升高对小麦旗叶光合电子传递和分配的影响

张绪成1,2**,于显枫1,马一凡1

1甘肃省农业科学院农业部西北作物抗旱栽培与耕作重点开放实验室| 兰州 730070；2中国农业大学资源环境学院| 北京 100094

Effects of nitrogen application and elevated atmospheric CO_2 on electron transport and energy partitioning in flag leaf photosynthesis of wheat.

ZHANG Xu-cheng1,2, YU Xian-feng1, MA Yi-fan1

1Ministry of Agriculture Key Laboratory of Northwest Crop Drought-resistant Farming, Gansu Academy of Agricultural Sciences, Lanzhou 730070, China|2College of Resources and Environment, China Agricultural University, Beijing 100094, China

摘要

采用开顶式气室盆栽培养小麦，设计2个大气CO_2浓度（正常：400 μmol·mol^{-1}；高：760 μmol·mol^{-1}）、2个氮素水平（0和200 mg·kg^{-1}土）的组合处理，通过测定小麦抽穗期旗叶氮素和叶绿素浓度、光合速率（P_n）-胞间CO_2浓度（C_i）响应曲线及荧光动力学参数，来测算小麦叶片光合电子传递速率等，研究了高大气CO_2浓度下施氮对小麦旗叶光合能量分配的影响.结果表明：与正常大气CO_2浓度相比，高大气CO_2浓度下小麦叶片氮浓度和叶绿素浓度降低，高氮处理的小麦叶片叶绿素a/b升高.施氮后小麦叶片PSⅡ最大光化学效率（F_v/F_m）、PSⅡ反应中心最大量子产额（F_v'/F_m'）、PSⅡ反应中心的开放比例（q_p）和PSⅡ反应中心实际光化学效率（Φ_{PSII}）在大气CO_2浓度升高后无明显变化，虽然叶片非光化学猝灭系数（NPQ）显著降低，但PSⅡ总电子传递速率（J_F）无明显增加；不施氮处理的F_v'/F_m'、Φ_{PSII}和NPQ在高大气CO_2浓度下显著降低，尽管F_v/F_m和q_p无明显变化，J_F仍显著下降.施氮后小麦叶片J_F增加，参与光化学反应的非环式电子流传递速率(J_C)明显升高.大气CO_2浓度升高使参与光呼吸的非环式电子流传递速率(J_0)、Rubisco氧化速率（V_0）、光合电子的光呼吸/光化学传递速率比（J_0/J_C）和Rubisco氧化/羧化比（V_0/V_C）降低，但使J_C和Rubisco羧化速率（V_C）增加.因此，高大气CO_2浓度下小麦叶片氮浓度和叶绿素浓度降低，而增施氮素使通过PSⅡ反应中心的电子流速率显著增加，促进了光合电子流向光化学方向的传递，使更多的电子进入Rubisco羧化过程，P_n显著升高.

关键词： 大气CO_2浓度 氮素 光合电子传递速率 能量分配 小麦

Abstract:

Wheat (*Triticum aestivum*) plants were pot-cultured in open top chambers at the nitrogen application rate of 0 and 200 mg·kg^{-1} soil and the atmospheric CO_2 concentration of 400 and 760 μmol·mol^{-1}. Through the determination of flag leaf nitrogen and chlorophyll contents, photosynthetic rate (P_n)-intercellar CO_2 concentration (C_i) response curve, and chlorophyll fluorescence parameters at heading stage, the photosynthetic electron transport rate and others were calculated, aimed to investigate the effects of nitrogen application and elevated atmospheric CO_2 concentration on the photosynthetic energy partitioning in wheat flag leaves. Elevated atmospheric CO_2 concentration decreased the leaf nitrogen and chlorophyll contents, compared with the ambient one, and the chlorophyll a/b ratio increased at the nitrogen application rate of 200 mg·kg^{-1}. With the application of nitrogen, no evident variations were observed in the maximal photochemical efficiency (F_v/F_m), maximal quantum yield under irradiance (F_v'/F_m') of PSⅡ reaction center, photochemical fluorescence quenching coefficient (q_p), and actual PSⅡ efficiency under irradiance (Φ_{PSII}) at elevated atmospheric CO_2 concentration, and the total photosynthetic electron transport rate (J_F) of PSⅡ reaction center had no evident increase, though the non-photochemical fluorescence quenching coefficient (NPQ) decreased significantly. With no nitrogen application, the F_v'/F_m', Φ_{PSII}, and NPQ at elevated atmospheric CO_2 concentration decreased significantly, and the J_F had a significant decrease though the F_v/F_m and q_p did not vary remarkably. Nitrogen application increased the J_F and photochemical electron transport rate (J_C); while elevated atmospheric CO_2 concentration decreased the photorespiration electron transport rate (J_0), Rubisco oxidation rate (V_0), ratio of photorespiration to photochemical electron transport rate (J_0/J_C), and Rubisco oxidation/carboxylation rate (V_0/V_C), but increased the photochemical electron transport rate (J_C) and Rubisco carboxylation rate (V_C). It was concluded that elevated atmospheric CO_2 concentration decreased the leaf nitrogen and chlorophyll contents, while nitrogen application increased the photosynthetic electron transport rate of PSⅡ reaction center significantly, and promoted the photosynthetic electron flow towards photochemistry, making more photosynthetic electron take part in Rubisco carboxylation and leading to the significant increase of P_n.

Key words: atmospheric CO_2 concentration nitrogen photosynthetic electron transport rate energy partitioning wheat

引用本文:

. 施氮和大气CO_2浓度升高对小麦旗叶光合电子传递和分配的影响[J]. 应用生态学报, 2011, 22(03): 673-680.

. Effects of nitrogen application and elevated atmospheric CO_2 on electron transport and energy partitioning in flag leaf photosynthesis of wheat.[J]. Chinese Journal of Applied Ecology, 2011, 22(03): 673-680.

链接本文:

http://www.cjae.net/CN/ 或 http://www.cjae.net/CN/Y2011/V22/I03/673

没有本文参考文献

[1] 郑有飞,倪艳利,麦博儒,吴荣军,冯妍,孙健,李健,徐静馨. **太阳辐射减弱对冬小麦旗叶光合速率的影响**[J]. 应用生态学报, 2011, 22(06): 1457-1464.