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研究论文

不同氮效率水稻全生育期内对增硝营养的响应及其生理机制

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摘要 通过添加硝化抑制剂（二氰胺，DCD）来控制硝化作用的水培试验方法，研究了氮高效水稻品种南光和氮低效水稻品种ELIO的籽粒产量对增硝营养(NH_4^+：NO_3^-比例为100：0和75：25)的响应，同时从产量构成、不同生育时期水稻生长、氮素吸收和同化4个方面研究了造成其产量差异的生理机制。结果表明：增NO-3营养可以显著促进氮高效水稻品种南光的生长，从而使其籽粒产量水平提高21%，而对氮低效水稻品种ELIO的籽粒产量没有显著影响。进一步分析表明：在增NO-3营养条件下，南光的穗粒数增加了25%，结实率增加了16%，而氮低效水稻品种ELIO的结实率和穗粒数在两种营养条件下没有显著变化；增NO-3营养可以促进南光对氮素的吸收，使其在苗期、分蘖盛期、齐穗期和成熟期对氮素的吸收量平均增加了36%，进而促进了其生长，干物质积累量在四个生育时期平均增加了30%；南光叶片硝酸还原酶和根系谷氨酰胺合成酶的活力在增硝营养条件下分别增加了100%和95%，说明增硝营养促进了南光对NH+4和NO-3的同化利用。与氮低效水稻品种（ELIO）相比，氮高效水稻品种（南光）对增硝营养表现出较强的生理响应。

关键词 水稻；氮效率；增硝营养；产量； 机制

分类号 Q14

Enhancement effect by nitrate on rice plant during the whole growth period and its physiological mechanisms

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Abstract Along with the increasing scarcity of global water resource and gradual seriousness of drought, there is an urgent need of developing water-saving technologies, such as intermittent irrigation or even aerobic cultivation of rice. Moreover, the rhizosphere of rice roots is actually in partial oxidized status due to the released oxygen by rice roots. In well-drained soils, ammonium (NH_4^+) converts rapidly to nitrite and then to nitrate (NO_3^-), so NO_3^-nutrition is becoming more and more important for N nutrition of rice plants. Solution culture experiments were carried out to study the effects of NO_3^- on the yield of two rice cultivars with different nitrogen use efficiency (NUE). For more mechanisms of responses of rice to NO_3^-, yields components, rice growth, N uptake and assimilation were also studied at different growth stages. Nitrification inhibitor, dicyandiamide (DCD) was applied to prevent nitrification and denitrification in nutrient solution. The results obtained were as follows. Compared with those of 100/0 NH_4^+-N/ NO_3^--N, a ratio of 75/25 NH_4^+-N / NO_3^-N increased the spikelets per panicle of Nanguang cultivar (high NUE) and increased its grain yield by 21%, while the yield of ELIO cultivar (low NUE) has no significant differences in the two nutrient solutions. NO_3^-addition increased total N accumulation and dry matter production in Nanguang by 36% and 30%, respectively, averagely for the four growth stages, while the increased effect of NO_3^- was not found in ELIO cultivar. In the mixture of $NO_3^-$and NH_4^+- nutrient solution, the nitrate reductase activity in the leaves and glutamine synthetase activity in the roots of Nanguang were increased by 100% and 95%, respectively, compared to the 100% NH_4

$^{+}$- treatment. All these results showed that the increased spikelets per panicle and improved nitrogen uptake and assimilation by NO_3^- might contribute to the increased grain yields of Nanguang. Rice cultivar with high NUE has stronger response to NO_3^- than the rice cultivar with low NUE, suggesting that there might be a relationship between NO_3^- nutrition and NUE.

Key words rice _ nitrogen use efficiency _ NO-3 _ grain yield _ mechanisms

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