Enhancing seed yield and nitrogen use efficiency of Brassica napus L. under low nitrogen by overexpression of G-proteins from Arabidopisis

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Abstract:【Objective】 Heterotrimeric G-proteins, composed of Gα, Gβ, and Gγ subunits, are involved in the regulation of a variety of signaling pathways in plants. Osdep1 (Gγ subunit-encoded protein) of rice and TaNBP1 (Gβ subunit-encoded protein) of wheat are homologs of Arabidopsis AGG3 and AGB1, respectively, which are regulators of grain size and also involved in nitrogen responses. However, the function of Arabidopsis G-proteins in nitrogen utilization under different nitrogen conditions has not been fully investigated. **【Method】** overexpressing transgenic lines *AtAGB1* and *AtAGG1* (*AtGβγ1*), *AtAGB1* and *AtAGG2* (*AtGβγ2*), and *AtAGB1* and *AtAGG3* (*AtGβγ3*) were created in K407 *Brassica napus* (*B. napus*) backgrounds concurrent as well as *AtGPA1* (*AtGα1*) overexpressing lines. The yield, nitrogen utilization efficiency (NUE), and related parameters of overexpressed *Arabidopsis* G-protein were determined. **【Result】** Analysis of multiple transgenic B. napus lines showed that overexpression of *AtGα1*, *AtGβγ1*, *AtGβγ2* and *AtGβγ3* could increase the biomass of seedling plants with a well-developed root system and increased nitrogen uptake under both nitrogen conditions. Under low nitrogen, the activity of glutamine synthetase (GS), a key nitrogen assimilating enzymes, and the expression levels of genes involved in nitrogen uptake and assimilation exhibited a significant increase in root of overexpressed plants. More importantly, these properties enabled overexpressing plants to increase the number of seeds per silique only under low nitrogen condition, effectively resulting in a significant increase in yield per plant and better NUE. Especially, overexpression of AtGβγ3 increased seed yield by 31%-69% and NUE by 27%-42% compared with wild-type (WT). **【Conclusion】** These results draw the positive roles of G-protreins in regulating two key parameters, seed traits and nitrogen use efficiency, and provide a strategy that can substantially improve crop yield and nitrogen use efficiency.