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Fine-Tuning Florigen Increases Field Yield Through Improving Photosynthesis in Soybean

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Crop yield has been maintaining its attraction for researchers because of the demand of global population growth. Mutation of flowering activators, such as florigen, increases plant biomass at the expense of later flowering, which prevents crop maturity in the field. As a result, it is difficult to apply flowering activators in agriculture production. Here, we developed a strategy to utilize florigen to significantly improve soybean yield in the field. Through the screening of transgenic lines of RNAi-silenced florigen homologs in soybean (*Glycine-max-Flowering Locus T Like*, *GmFTL*), we identified a line, *GmFTL*-RNAi#1, with minor changes in both *GmFTL* expression and flowering time but with notable increase in soybean yield. As expected, *GmFTL*-RNAi#1 matured normally in the field and exhibited markedly high yield over multiple locations and years, indicating that it is possible to reach a trade-off between flowering time and high yield through the fine-tuning expression of flowering activators. Further studies uncovered an unknown mechanism by which *GmFTL* negatively regulates photosynthesis, a substantial source of crop yield, demonstrating a novel function of florigen. Thus, because of the highly conserved functions of florigen in plants and the classical RNAi approach, the findings provide a promising strategy to harness early flowering genes to improve crop yield.

Keywords: high yield, florigen, *FT*, photosynthesis, soybean, vegetative growth

INTRODUCTION

The global crop demand for human consumption and livestock feed is forecasted to increase by 110% from 2005 to 2050 (Tilman et al., 2011). However, advances in breeding, genomics, and transgenic technology are predicted to increase yield by up to 20% (Long et al., 2015). Therefore, there is an urgent need to develop innovative approaches to increase crop yields. Photosynthesis provides a substantial means to adjust crop yields (Ort et al., 2015). Regulation of photosynthesis happens at multiple levels (Long et al., 2006; Parry et al., 2007), which could serve as targets to

hypocotyl in *Arabidopsis thaliana*. *Plant Mol. Biol.* 71, 39–50. doi: 10.1007/s11103-009-9507-9

Yoo, S. K., Chung, K. S., Kim, J., Lee, J. H., Hong, S. M., Yoo, S. J., et al. (2005). CONSTANS activates SUPPRESSOR OF OVEREXPRESSION OF CONSTANS 1 through FLOWERING LOCUS T to promote flowering in Arabidopsis. *Plant Physiol.* 139, 770–778. doi: 10.1104/pp.105.066928

Zhang, L., Wang, R., and Hesketh, J. D. (2001). Effects of photoperiod on growth and development of soybean floral bud in different maturity. *Agron. J.* 93, 944–948. doi: 10.2134/agronj2001.934944x

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