Development of Sustainable Transformation of Miscanthus × giganteus to Improve Photosynthesis

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**Project Goals**

Renewable Oil Generated with Ultra-productive Energycanes—or ROGUE—is engineering the two most productive American bioenergy crops—energycane and Miscanthus—to produce a sustainable supply of biodiesel, biojet fuel, and bioproducts.

The main objectives of this work are:

1) To improve the conversion of sunlight into plant biomass/metabolites through photosynthesis without the need for increased quantities of either water, or fertilizer.
2) To transfer ROGUE technologies from the lab bench to crops through an efficient pipeline.

**Abstract**

Improving photosynthetic efficiency of bioenergy crops, such as Miscanthus × giganteus and energycane, would provide sustainable sources of energy and bioproducts to achieve zero net greenhouse gas emission in future. These highly productive C₄ crops utilize the NADP-ME type C₄ photosynthesis. In this type of photosynthesis, the amount of pyruvate orthophosphate dikinase (PPDK) and rubisco limit the regeneration of phospho(enol)pyruvate (PEP) (Long et al., 2013, Wang et al., 2008, Naidu et al., 2003). Research also demonstrated improvement in photosynthetic efficiency under fluctuating light when photoprotection response time is accelerated by overexpression of genes involved in non-photochemical quenching (NPQ): zeaxanthin epoxidase (ZEP), violaxanthin de-epoxidase (VDE) and Photosystem II subunit S (PsbS) (Kromdijk et al., 2016). We propose that the overexpression of PPDK will alleviate rate limitation in C₄ photosynthesis, while increasing expression of NPQ-related genes can improve photosynthetic efficiency in Miscanthus. Although M. × giganteus is an ideal candidate of bioenergy crop with minimal invasive potential, the propagation of this feedstock is limited by the sterility of the plant due to its triploid genome (Boersma & Heaton, 2014). Biolistic transformation of Miscanthus is generally performed on calli induced from immature inflorescences collected during the summer (Sobańska et al., 2019). However, this is a limitation to develop a continuous transformation system and has been a bottleneck of our effort to understand the effect of overexpressing the photosynthetic genes. In this study, we used calli induced from immature inflorescence and stem
meristemic tissue of \textit{M. \times giganteus} for biolistic transformation and performed a proof-of-concept experiment using fluorescent protein construct to check the efficiency of the systems. Preliminary data suggested that the transformed calli from stem meristemic tissue could be transformed and regenerated. These two embryogenic callus induction systems would provide a continuous source of calli for transformation to study the effect of photosynthetic genes, such as PPDK, VDE, ZEP and PsbS in \textit{Miscanthus}.

References / Publications


Funding Statement

This research was supported by the DOE Office of Science, Office of Biological and Environmental Research (BER), grant no. DE-SC0018254.