Improving Photosynthesis in C_4 Bioenergy Crops

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Project Goals

The Renewable Oil Generated with Ultra-productive Energycane (ROGUE) project aims to engineer the two most productive American biofuel crops, energycane and *Miscanthus*, to produce a sustainable supply of biodiesel, biojet fuel and bioproducts. The three 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.**
3) **To test technologies through replicated field trials.**

Abstract

Many important C4 bioenergy crops, such as maize, sorghum and sugarcane, are tropical, warm-season forage grasses with limited productivity under chilling conditions, as compared to temperate C4 grasses, e.g. Miscanthus × giganteus, Panicum virgatum and Spartina pectinata (1). This is due to the limited amount of pyruvate orthophosphate dikinase (PPDK) and rubisco which restrain phosphoenolpyruvate (PEP) regeneration (1–3). In order to expand potential growing seasons and increase the range of latitudes where biofuel crops can grow, two main hypotheses are formed to increase photosynthetic ability of these crops under different conditions. We hypothesize that the upregulation PPDK in C4 crops by engineering PPDK native gene from closely-related species, e.g. sorghum, elevates photosynthesis and biomass. This will be tested by introducing a synthesized native Sorghum bicolor PPDK gene into Miscanthus and energycane to determine the level of photosynthetic improvement in the greenhouse and by field trials. We also plan to modulate the level of PPDK regulatory protein (PDRP) which controls posttranslational modifications of the rate-limiting PPDK under different light conditions (4–6) increases PPDK activity in plants. We will first perform the in silico modelling to understand the potential impact of modulating PDRP activity, then assemble the transgenic construct followed by transient expression of the gene in protoplasts of bioenergy crops, and finally perform physiological assessments in resulting transgenic crops.

References

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