Increasing photosynthetic efficiency of energycane under fluctuating lights

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Project Goals:

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

Project goals are to:
1) Engineer energycane and Miscanthus to produce an abundance of natural oil that can be converted into biodiesel, biojet fuel, and bioproducts.
2) Improve how plants convert sunlight into plant matter through photosynthesis without more water or fertilizer.

Abstract

Engineering bioenergy crops to produce natural oils provides an alternative energy source that can help ensure energy security while mitigating environmental problems associated with traditional fossil fuels. The C_4 photosynthetic pathway of bioenergy grasses such as sugarcane, while the most efficient pathway, needs to be improved in order to accommodate the high energetic costs of oil biosynthesis without decreasing plant growth. Crop canopy modeling demonstrates that the rapidly changing light environment experienced by bioenergy crops in dense plantings limits photosynthetic efficiency. However, there has been little empirical research investigating the impact of rapidly changing light environments on C_4 bioenergy crops biomass production or on developing engineering strategies to improve the efficiency of bioenergy grasses in dynamic light environments. Previous modeling of C_4 photosynthesis in fluctuating light environments suggested that photosynthetic efficiency is reliant on the coordination of the C_4 and C_3 metabolic cycles. We hypothesize that large metabolite pools act as buffers to minimize changes to metabolite fluxes in rapid changes in light environments, and that this buffering helps maintain coordination of the C_4

and C_3 metabolic cycles. Increased chloroplast volume would increase this metabolite buffering capacity by increasing metabolite pool sizes, and thereby enhance the C4 photosynthetic efficiency in fluctuating light conditions. We are engineering increased sugarcane chloroplast volume by genetically manipulating various components of the chloroplast division machinery. We have already developed a methodology for estimating chloroplast volume of sugarcane leaves using confocal microscopy and a 3-D image program. Leaf microscopy, leaf photosynthetic gas exchange, and above ground biomass production in greenhouse trials will be used to select the best chloroplast modifications for future field trails.

References

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