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Conference Details

Communication Type:Oral Presentation
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Conference Title:Plant Biology 2017, American Society of Plant Biologists
Communication Title: A component of the algal carbon concentrating mechanism increases both yield and water use efficiency in Camelina sativa

ABSTRACT

The projected increases in global population growth, and the desire to transition to a sustainable, bio-based economy are resulting in ever increasing demands on agricultural productivity. Environmental conditions and metabolic regulatory mechanisms exert major constraints on agricultural yields by limiting carbon fixation in photosynthetic tissues of crop plants. One of the major limitations occurs when O2 competes with CO2 at the active site of ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco), resulting in the oxygenation of ribulose 1,5 bisphosphate (RuBP). This reduces the productive carboxylation reaction and leads to the generation of phosphoglycolate, which must be recycled via the photorespiratory pathway at a significant energy cost and net loss of fixed carbon. Photorespiration accounts for a 30-40% decrease in the efficiency of carbon fixation in C3 photosynthesis, the pathway of carbon fixation used by the majority of crops and about 85% of all terrestrial plant species. One promising strategy to address this issue is provided by aquatic algae, which have evolved carbon concentrating mechanisms (CCMs) to increase Rubisco carboxylase activity. In an effort to enhance CO2 assilimilation and mitigate the negative impacts of photorespiration, we explored the algal CCM as a potential source of genes for engineering increased productivity in C3 crops. In this report, we demonstrate that the introduction of a mitochondrial carrier component of the CCM from Chlamydomonas reinhardtii, significantly increased photosynthetic efficiency in the oilseed crop, Camelina sativa, even though it reduced stomatal conductance. This resulted in increased tolerance to drought and produced up to 50% and 75% increases in seed and oil yields in field trials, respectively. These studies show that it is possible to break the trade-off between water use efficiency and yield, and illustrate the positive effects on photosynthesis and crop productivity by engineering components of algal CCM into vascular plants.

COMMUNICATION OUTCOMES

My research aims to increase photosynthetic efficiency in plants in order to maximize crop productivity. One of the major inefficiencies in photosynthesis stems from the ability of Rubisco, the enzyme responsible for fixing CO2, to incorporate molecular oxygen. Incorporation of oxygen instead of CO2 results in the formation of a toxic intermediate called glycolate that needs to be metabolized and recycled through an energy expensive pathway called photorespiration. Photorespiration is a significant limitation to crop productivity in major crop plants. There are several national and international research projects to address this limitation, however, most attempts so far met with limited success.

Ours is one of the first reports with significant success in increasing photosynthetic efficiency by decreasing the harmful effects of photorespiration. Our strategy increased drought tolerance and seed yied.

I will be presenting these results in Plant Biology 2017, annual meeting of the American Society of Plant Biologists in Honolulu on Jun 27, 2017. The meeting is from Jun 24-28, 2017.