New Results

Enhanced photosynthetic efficiency for increased carbon assimilation and woody biomass production in hybrid poplar INRA 717-1B4

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ABSTRACT

Increasing CO_2 levels in the atmosphere and the resulting negative impacts on climate change have compelled global efforts to achieve carbon neutrality or negativity. Most such efforts focus on carbon sequestration through chemical or physical approaches. We aim to harness the power of synthetic biology to enhance plants' natural ability to draw down and sequester carbon, thereby positively affecting climate change. Past decades of scientific progress have shed light on strategies to overcome the intrinsic limitations of carbon drawdown and fixation through photosynthesis, particularly in row crops in hopes of improving agricultural productivity for food security. Incorporating a photorespiration bypass in C3 plants has shown promising results of increased biomass and grain yield. Despite their globally dominant role in atmospheric carbon flux, the drawdown rates of most trees are currently limited by their C3 photosynthetic metabolism, and efforts to improve the photosynthetic capacity of trees, such as by reducing energy loss in photorespiration, are currently lacking. Here, we selected a photorespiration bypass pathway and tested its effectiveness on photosynthetic enhancement in hybrid poplar INRA717-IB4. The design includes a RNAi strategy to reduce the transportation of the photorespiration byproduct, glycolate, out of chloroplast and a shunt pathway to metabolize the retained glycolate back to CO_2 for fixation through the Calvin-Benson cycle. Molecular and physiological data collected from two repeated growth experiments indicates that transgenic plants expressing genes in the photorespiration bypass pathway have increased photosynthetic efficiency, leading to faster plant growth and elevated biomass production. One lead transgenic event accumulated 53% more above-ground dry biomass over a five month growth period in a controlled environment. Pilot projects with photosynthesis-enhanced trees in the field are in progress. Our results provide a proof-of-concept for engineering trees to help combat climate change.

Competing Interest Statement

The authors have declared no competing interest.

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