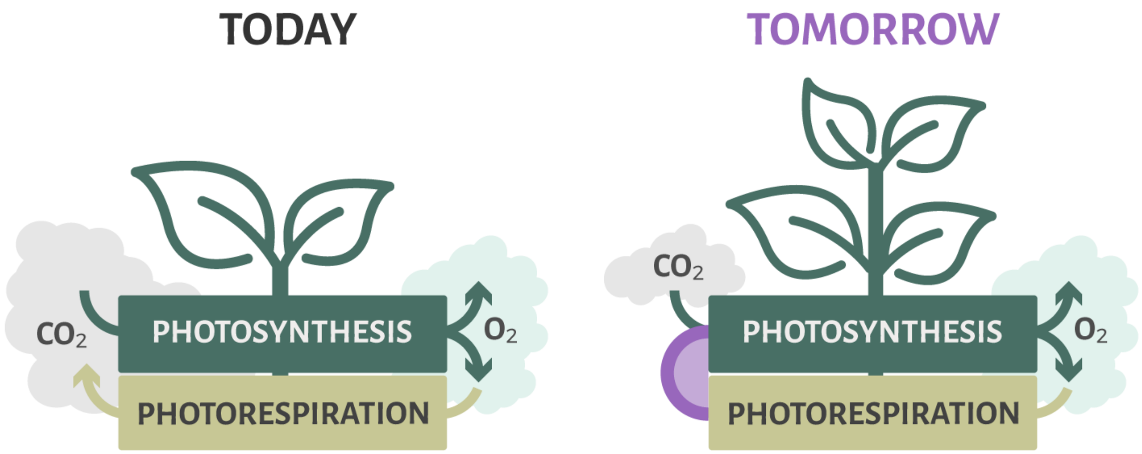
**Technology Offer**

# A method for the production of plants with altered photorespiration and improved $CO_2$ fixation

Ref.-No.: 0706-5666-IKF

## Background

Recently, many efforts have been made to improve growth and yield of crop plants. $CO_2$ fixation in plants is primarily catalyzed by the enzyme ribulose-1,5-bisphosphate carboxylase (Rubisco). The inherent inefficiency of Rubisco necessitates an additional metabolic process termed photorespiration, which results in the loss of carbon and energy. In fact, it has been estimated that plants lose approximately 25% of the fixed carbon due to photorespiration. Despite several attempts to improve $CO_2$ fixation and reduce photorespiration in plants, no suitable method was available so far that leads to an improvement in growth, productivity, and/or yield of agricultural crop plants.




Schematic representation of the plants covered in the described patent (right) compared to wild type plants (left). The carbon-neutral photorespiration realized by the implementation of the BHAC is projected to result in increased carbon fixation and crop yield.

## Technology

Scientists from the Max-Planck-Institute for Terrestrial Microbiology and the HHU Düsseldorf have developed a method for generating transgenic plants with altered photorespiration.

Their invention applies the ß-hydroxyaspartate cycle (BHAC), a metabolic pathway that they characterized in bacteria, to circumvent the naturally occurring photorespiration pathway in plants. The BHAC is carbon-neutral, while the natural photorespiration pathway of plants is carbon-negative. Furthermore, the BHAC is also more energy-efficient than natural plant


Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de

photorespiration. Taken together, these properties of the BHAC promise to increase carbon fixation and therefore crop yield in the transgenic plants.

The inventors have successfully integrated four essential genes of the BHAC in plant peroxisomes, where high concentrations of photorespiration-derived glyoxylate is present. These genes encode for enzymes that funnel the photorespiratory glyoxylate efficiently into the central metabolism of the plant.

Gas exchange measurements and metabolic profiling confirmed that the newly developed plants conserve nitrogen and accumulate signature metabolites of the BHAC. At the current stage, the prototype plants did not show any gain in the amount of $CO_2$ assimilated via photosynthesis at the expense of the $CO_2$ released by photorespiration. It was determined that several bottlenecks still mask the full potential of the BHAC, and these will be resolved in future research.

To fully appreciate the gain in carbon fixed and ultimately in yield, the pathway will be further improved, guided by kinetic and genome-scale metabolic models. Prototyping in model plants allows identifying shortcomings before moving to a target crop, thus speeding up the development process. To this end, the inventors and their collaboration partners are currently testing the newly implemented pathway in a set of model organisms of increasing cellular and anatomical complexity before moving to its final target: the sunflower, an important oilseed crop in Europe.

**We are looking for a collaboration partner to further develop this exciting project.**

## Patent Information

A PCT application was filed on 5.08.2020.

## Literature

Roell, M.S.; Schada von Borzyskowski, L.; Westhoff, P.; Plett, A.; Paczia, N.; Claus, P.; Schlueter, U.; Erb, T.J.; Weber, A.P.M.: A synthetic C4 shuttle via the β-hydroxyaspartate cycle in C3 plants. Proceedings of the National Academy of Sciences (2021) 118(21) e2022307118. DOI: *https://doi.org/10.1073/pnas.2022307118*

## Contact

**Dr Ingrid Kapser-Fischer**
Patent- & License Manager
Nutritionist, M.Sc.
Phone: +49 89 / 29 09 19-19
Email: kapser-fischer@max-planck-innovation.de



Max-Planck-Innovation GmbH
Amalienstr. 33
80799 München
www.max-planck-innovation.de