# Rice yield increase of 30 percent enabled by use of a photosynthesis 'switch,' researchers learn

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Scientists at the University of Arkansas System Division of Agriculture have found that they can harness photosynthesis – the process that plants use to convert light energy to chemical energy – to increase rice yields

by up to 30 percent.

A research group led by Andy Pereira of the Crop, Soil, and Environmental Sciences Department faculty examined a protein that acts as a "switch" to activate genes that can enhance the photosynthesis activity of rice plants. The researchers discovered that the protein, known as higher yield rice (HYR), could enable the plants to survive stress, thrive and increase productivity.

The results of the research are published in *Nature Communications*, an online multidisciplinary journal of the natural sciences. The project received support from the U.S. Department of Agriculture National Institute of Food and Agriculture and the National Science Foundation.

"The regulator HYR does regulate photosynthesis, a complex process," said Pereira, who holds the Anheuser-Busch and Arkansas Wholesalers Professorship in Plant Molecular Genetics. "I saw in the greenhouse that the plants using the HYR regulator were much greener than any others. It was because of more chlorophyll. It had higher photosynthesis. All the rest followed."

What followed was a process that capitalized on nature's use of photosynthesis, in which plants take in carbon dioxide and expel oxygen. If rice and other plants are under too much stress, photosynthesis will shut down. "That might be a good survival mechanism, and many plants want just to survive," Pereira said. "But we don't want crops to just survive. We want them to keep producing."

A plant's natural reaction under stress is to shut down photosynthesis to keep it from producing reactive oxygen, which is damaging to the plant. This is where the HYR regulator protein comes in by keeping the whole photosynthesis machinery active and maintaining productivity, Pereira explained.

Before Pereira's research on the project began a few years ago at the Virginia Bioinformatics Institute at Virginia Tech – where he remains an adjunct faculty member – there was consensus among scientists that increasing photosynthesis capacity would probably increase productivity and yield. No one had proven it until Pereira's group demonstrated grain yield increases as high as 29.7 percent by using the HYR regulator.

The research showed that a plant needs to have the higher capacity to increase its production. "Increased light will produce more photosynthesis, but if a plant doesn't have the capacity to use it, there won't be more production. HYR increases photosynthesis, which increases sugars, which increases biomass and finally leads to more grain yield among normal rice cultivars," Pereira said.

Higher photosynthesis leads to greater stress tolerance in HYR rice plants. The increased tolerance enables higher rice grain production under drought and heat stress with maintenance of good grain quality. "Most importantly, the suite of genes regulated by HYR is the blueprint for development of similar rice varieties using non-GMO methods," Pereira added.

Two patents related to the project are currently pending. One from the Division of Agriculture covers plants' tolerance of temperature and improvement of grain quality, an important factor because grain quality is reduced under high nighttime temperatures. The other is through Virginia Tech and covers drought tolerance and improvement of grain yield.

**More information:** "Coordinated regulation of photosynthesis in rice increases yield and tolerance to environmental stress." *Nature Communications* 5, Article number: 5302 DOI: 10.1038/ncomms6302

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