Efforts to 'turbocharge' rice and reduce world hunger enter important new phase

November 30 2015

Credit: Earth100/Wikipeidia

A long-term project aimed at improving photosynthesis in rice is entering its third stage, marking another step on the road to significantly increased crop yields that will help meet the food needs of billions of people across the developing world.

Led by scientists at Oxford University, this phase of the project will build on the work carried out in the first two stages, with the ultimate aim being to 'supercharge' photosynthesis in rice by introducing more efficient traits found in other crops.

Rice uses the C3 photosynthetic pathway, which in hot dry environments is much less efficient than the C4 pathway used in plants such as maize and sorghum. If rice could be 'switched' to use C4 photosynthesis, it would theoretically increase productivity by 50%.

As well as an increase in photosynthetic efficiency, the introduction of C4 traits into rice is predicted to improve nitrogen use efficiency, double water use efficiency, and increase tolerance to high temperatures.

And with almost a billion people around the world living in hunger, boosting rice productivity is crucial to achieving long-term food security—particularly in areas such as South Asia and sub-Saharan Africa, where 80% of the food supply is provided by smallholder farmers.

Professor Jane Langdale, Professor of Plant Development in the Department of Plant Sciences at Oxford University, and Principal Investigator on Phase III of the C4 Rice Project, said: 'Over 3 billion people depend on rice for survival, and, owing to predicted population increases and a general trend towards urbanization, land that currently provides enough rice to feed 27 people will need to support 43 by 2050.

'In this context, rice yields need to increase by 50% over the next 35 years. Given that traditional breeding programmes currently achieve around a 1% increase in yield per annum, the world is facing an unprecedented level of food shortages.'

Professor Langdale added: 'The intrinsic yield of rice, a C3-type grass, is

limited by the inherent inefficiency of C3 photosynthesis. Notably, evolution surmounted this inefficiency through the establishment of the C4 photosynthetic pathway, and importantly it did so on multiple independent occasions. This suggests that the switch from C3 to C4 is relatively straightforward. As such, the C4 programme is one of the most plausible approaches to enhancing crop yield and increasing resilience in the face of reduced land area, decreased use of fertilizers, and less predictable supplies of water'.

Phases I and II of the programme were focused on identifying new components of the C4 pathway—both biochemical and morphological—as well as validating the functionality of known C4 enzymes in rice. Phase III will refine the genetic toolkit that has been assembled and will focus both on understanding the regulatory mechanisms that establish the pathway in C4 plants and on engineering the pathway in rice.

Robert Zeigler of the International Rice Research Institute (IRRI) described the project as 'one of the great undertakings in plant sciences of the early 21st century'. He said: 'Unless we can translate our work into meaningful products adopted by rice farmers worldwide, this will remain simply an academic pursuit. The unique partnerships that characterise this programme should make sure this happens.'

More information: c4rice.com/

Provided by Oxford University