Engineering a transgene-free, herbicide-resistant rice via CRISPR/Cas9-mediated gene replacement

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II. Abstract

We need to double our current crop production by 2050 to feed the growing world population. Rice is an important staple food in the world, but the current approaches to increase yield are too slow and should be improved. A major approach to raise rice yield is to improve herbicide resistance for effective weed control. Although herbicide resistance could be achieved by traditional mutation breeding, the process is very slow and tedious. Recently, the newly developed CRISPR/Cas9 technology has shown a lot of promise to accelerate breeding of important crops for improved agronomic traits such as herbicide resistance. Two small mutations in the rice *ACETOLACTATE SYNTHASE* (*ALS*) gene can confer strong herbicide resistance. Such mutations could be introduced by homologous recombination (HR) in rice, but the process is restricted by the inefficiency of HR. This project explores a new way to boost plant HR efficiency, which will improve the replacement of the wild-type rice *ALS* allele with a mutated version to generate a transgene-free, herbicide-resistant rice variety. This new genetic tool for molecular breeding can be implemented in other species and will significantly improve basic research and plant breeding.