Researchers report rice gene that confers broad-spectrum resistance to β-triketone herbicides

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Genomes of the genus *Oryza*, including both domesticated and wild species, have been well characterized because of the importance of rice to the global food supply. The wealth of genetic variation in rice

varieties has allowed the identification of useful genes for crop breeding by map-based cloning methods. With regard to large-scale farming, in particular, weed control with the use of appropriate herbicides is critical for efficient crop production. To date, a variety of herbicides have been developed and are widely applied in fields of major crops. On the other hand, long-term reliance on individual herbicides can result in the emergence of weeds that are resistant to the applied agent. The development of new combinations of herbicides and of herbicide resistance genes for introduction into crop species is thus desirable as a solution to this problem.

Several years ago, rice varieties that are sensitive to benzobicyclon (BBC), a b-triketone herbicide that is a potent inhibitor of 4-hydroxyphenylpyruvate dioxygenase (HPPD), were identified in Japan. In response to this finding, researchers at Saitama University initiated a collaborative effort to identify the rice gene that confers resistance to BBC.

They identified this gene by map-based cloning and named it HIS1 (for HPPD INHIBITOR SENSITIVE 1). Genealogy analysis revealed that a dysfunctional his1 allele has been inherited by BBC-sensitive rice strains from an indica rice variety, and a genome database search uncovered conservation and diversification of multiple HIS1-LIKE (HSL) genes in the plant kingdom, suggestive of important biological roles for HSL proteins.

Forced expression of HIS1 in Arabidopsis conferred resistance not only to BBC but also to four additional b-triketone herbicides, whereas that of rice HSL1 bestowed resistance to only tefuryltrione. HIS1 encodes a novel Fe(II)/2-oxoglutarate–dependent oxygenase, and the researchers found that the HIS1 protein detoxifies BBC and other b-triketone herbicides by catalyzing their mono-oxidation.

The researchers have thus identified a novel rice gene that confers resistance to multiple herbicides and whose orthologs appear to be widely conserved in important crop species. They also show that these natural genes are potentially valuable tools for breeding of new herbicide -resistant crops. The researchers therefore believe that the findings will be of interest to the researches in agriculture and plant sciences.

More information: Hideo Maeda et al. A rice gene that confers broad-spectrum resistance to β-triketone herbicides, *Science* (2019). DOI: 10.1126/science.aax0379

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