Institute of Genetics and Developmental Biology
Chinese Academy of Sciences

GSE5

Increased seed size and grain yield

A role for Calcium-signalling in seed development?

Genome editing achieved in rice and possible in other crops

Evaluation and Licensing Opportunities

For further information on this technology and evaluation / licensing opportunities please contact:

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Tech ID: 17.621

Patent Literature

Publications WO/2018/172785, CN 110603264A, EP 3601320, US 2020/0255846, EA 201992261,

Dr Yunhai Li and his team at the Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, Beijing, have been studying genes involved in determining seed size. They have identified a novel QTL in rice using a GWAS approach with functional testing. GSE5 encodes a novel plasma membrane-associated protein. Allelic variation in rice is represented by various deletion/insertion events in the GSE5 promoter. Reduced expression or loss-of-function of GSE5 results in increased grain width, grain weight and grain yield overall. This opens the way for increased grain yields using a variety of strategies including genome editing, and in a range of important crop species.

GSE5 encodes a plasma membrane associated protein containing IQ domains (IQD) and which associates with calmodulin. The inventors have shown that GSE5 regulates grain size by influencing cell proliferation. They also identified three major haplotypes in cultivated rice (*GSE5*, $GSE5^{DEL1+IN1}$ and $GSE5^{DEL2}$) having differing degrees of expression of GSE5. The deletion 1 (DEL1) in *indica* varieties having the $GSE5^{DEL1+IN1}$ haplotype and the deletion 2 (DEL2) in *japonica* varieties carrying the $GSE5^{DEL2}$ haplotype cause decreased expression of *GSE5*, resulting in wide grains. These alleles existing in rice germplasm are however relatively weak alleles and so the inventors have generated a **loss-of-function mutant** with much stronger effects on grain width and grain weight, improving over the effect of the naturally occurring alleles. The mutant was created using a CRISPR/Cas9 genome editing approach to create a 1-bp deletion in the first exon of GSE5, resulting in a reading frame shift and loss of function.

IQD proteins are an ancient family of calmodulin-binding proteins variously reported as being involved in regulating plant development and plant stress responses. The present work is the first to indicate a possible mechanism of regulation of seed size by calcium signalling. This mechanism is likely to be conserved in plants since other crop species contain GES5 orthologues, including **wheat, maize, soybean and sorghum**.

As well as directly providing novel **germplasm for direct use in rice breeding**, the GSE5 technology permits an approach to increase seed size and crop yield in by both RNAi transgenic approaches and by **genome editing** and other mutagenesis methods. It also allows for **methods to select for improved yield** by screening plant germplasm for the level of expression of GSE5 and its homologues in a **range of crop species**.

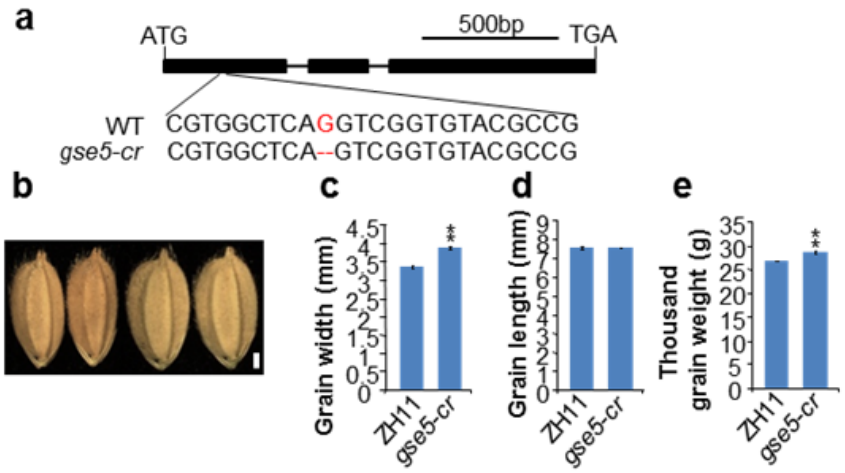
In summary:

*** Novel mutant rice for direct breeding use**

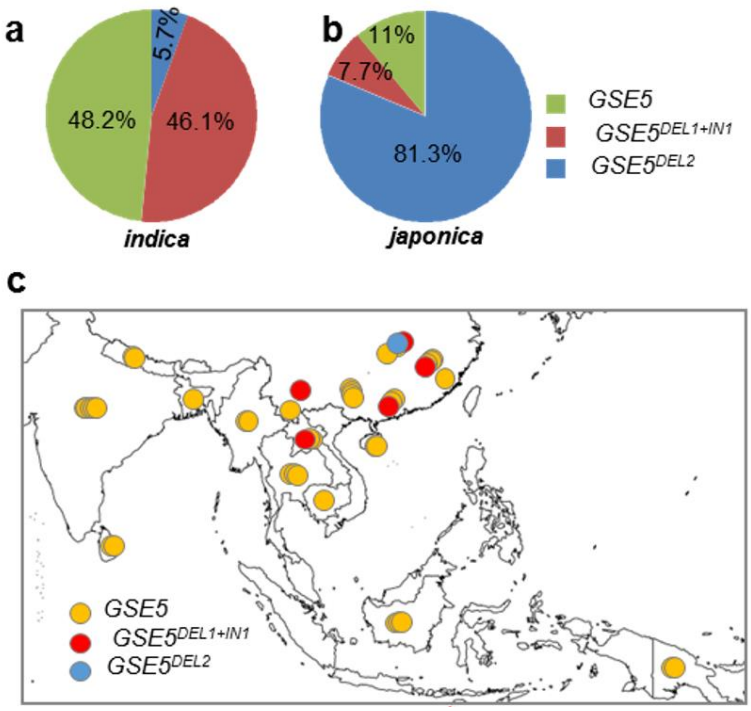
*** Methods for screening germplasm**

*** Genome editing approaches in various crop species**

The GSE5 technology is patented by PBL on behalf of IGDB. **For more information or licensing interest, please contact PBL.**



The genome edited rice GSE5 mutant created by IGDB : grain width and TGW are significantly increased over the background variety Zhonghua 11 (ZH11)



(a, b) The prevalence of *GSE5*, $GSE5^{DEL1+IN1}$ and $GSE5^{DEL2}$ haplotypes in cultivated *indica* and *japonica* varieties, respectively. 141 *indica* varieties and 91 *japonica* varieties were genotyped.

(c) Geographical origin of wild rice accessions used in the IGDB study.

References:

Duan et al (2017). Natural variation in the promoter of *GSE5* contributes to grain size diversity in rice. Mol Plant; 10(5): 685-694. DOI: http://dx.doi.org/10.1016/j.molp.2017.03.009