Australian Government
Australian Centre for International Agricultural Research

Crops

Breeding for low chalk in rice

Overview

Chalk is a defect in mature grains of rice which causes the grain to become brittle and susceptible to breakage during the milling process. The incidence of chalk is likely to increase as average global temperatures rise.

Higher temperatures also reduce the head rice yield (the unbroken intact white rice grains obtained by milling brown rice to remove the bran). Rice with a high percentage of broken rice grains is sold at a much lower price, often for animal feed, resulting in reduced income for rice growers. Diverting rice grains from human food to animal feed may also affect food security, considering that rice feeds around half of the world's growing population.

The Australian rice industry grows up to 1 million tonnes in a good year with large year-to-year variation depending on water availability. With 80% of the production exported, exports are typically worth A$200-300 million. The value of the Australian crop decreases 10% when affected by chalk. A similar loss in revenue also occurs for rice produced elsewhere. The development of rice cultivars not prone to forming chalk, even at elevated temperatures, will enhance the market value of rice across the value chain.

A previous project (CIM/2006/176) mapped the genetic variation for the low-chalk trait, despite a widely held belief that environmental variation for the trait would detract from finding a genetic basis.

A second project (SRA/CIM/2014-024) revisited those results and fine-mapped the genetic region to chromosome 5, linked to low chalk through genome-wide association studies.

KEY FACTS

ACIAR Project No. CIM/2016/046
Duration: February 2017 – December 2018 (2 years)
Target areas: Philippines
Budget: A$150,000

Project Leader
Nese Sreenivasulu, International Rice Research Institute (IRRI)

Key partners
International Rice Research Institute

ACIAR Research Program Manager
Dr Eric Huttner

Objective

The aim of this project is to advance previous work and functionally characterise the genes found on a small region of chromosome 5 by the previous project, identify specific haplotypes and test genetic markers in breeding programs to ensure their suitability for reducing chalk.

Specifically, the research aims to:

- Validate the transfer of low-chalk characters into a high-chalk line through marker-assisted selection.
- Functionally validate three candidate genes using genome editing in the chromosome 5 fine-mapped region to test their relevance in regulating rice chalkiness.
- Develop a business model for applying the results in partnership with the national rice breeding programs of the partner countries and private companies.

Expected scientific results

- Whole-genome sequencing of low-chalk (<2%) and high-chalk lines (>20%) identified based on diagnostic haplotypes of chromosome 5.
- High-density F2 mapping population developed between low-chalk and high-chalk lines and fine-mapping target genes to define the functional markers to breed low chalk.
- Gene-based diagnostic markers tested in a set of advanced pre-breeding material and late-generation breeding materials to ensure their suitability in reducing chalk.
- Cis factors on fine-mapped chromosome 5 and trans regulatory factors in other chromosomes that explain the genetic variation for low chalk identified through transcriptome-wide association studies.
- Top three candidate genes functionally validated using CRISPR/Cas9 genome editing technology to prove that the target genes influence the chalk phenotype.
- Results of the work shared with partners and the hybrid rice consortium members prior to publication.
- Business model developed in partnership with national rice breeding programs, and knowledge shared on exploring public-private partnerships for the development of low-chalk inbred and hybrid breeding lines.

Expected outcomes

- The research will provide a proof of concept that grain chalk can be addressed through genetics. Public and private rice breeders will apply the tools developed in the project to reduce the occurrence of chalk in future rice varieties.

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