

Cold tolerant rice

Australian rice growers are constantly faced with the threat of a 'cold snap' that can turn a potential crop of rice into nothing but hay. CSIRO Plant Industry researchers have made important breakthroughs in understanding what's happening in the rice plant that prevents pollination when a cold snap occurs and importantly what can be done to address it to improve yields and possibly reduce water use.

Growing rice in Australia

About 150,000 hectares of rice is grown in Australia producing about 1.2 million tonnes of rice per year. Over 85 per cent of the crop is exported and the industry is valued at \$650 million per year.

The cold snap

Rice is a tropical plant and doesn't have an inbuilt resistance to cold yet but in Australia and elsewhere it is grown in temperate regions that experience cold temperatures at the start and end of the growing season. Cold at the time of flowering is especially damaging. Every three to four years these cold temperatures are compounded by a 'cold snap' – a lower than usual drop in temperature that causes the crop to fail.

In Australia the annual loss in rice production due to cold is estimated at 5 – 10 per cent or around \$44 million, and cold snaps can cause losses between 30 and 40 per cent.

No pollen means no grain

Cold snaps cause a reaction in the plant that prevents sugar getting to the pollen. Without sugar there is no starch build-up which provides energy for pollen germination. And without



Rice growers could improve production and possibly save water with the development of a suitable cold tolerant rice variety.

pollen, pollination cannot occur so no grain is produced.

CSIRO has found that all the ingredients for starch are present but they are not getting into the pollen grain where they are needed.

A cell layer surrounding the pollen, called the 'tapetum', is responsible for feeding the pollen with sugar. The tapetum is only active for 1-2 days – so if a cold snap occurs at this time then there is no further chance for pollen growth.

But the sugar can't freely move into the tapetum and pass through it to the pollen. Instead the sugar has to be broken down then transported in bits to the pollen.

It's a bit like moving your bed from one room to another. First you have to pull it all apart then you move it to another room in pieces and put it all back together again.

'Invertase' is the catalyst that helps break down the sugar to transport it into the tapetum before it is transported to the pollen. Quantities of invertase are less in conventional rice when it is exposed to cold temperatures, but they remain at normal levels in a cold tolerant variety when it experiences cold.

By comparing a cold tolerant strain of rice with conventional rice CSIRO has found that the gene responsible for invertase looks exactly the same in the cold tolerant variety as it does in conventional rice. So the invertase gene itself does not make the rice plant cold tolerant – but instead a mechanism that regulates the invertase gene is different.

Early research is indicating that the invertase gene is regulated by the hormone abscisic acid (ABA). CSIRO has experimented with injecting plants with ABA – the resulting rice plants are sterile, just like they would be if they experienced a cold snap. Also, ABA levels increase when conventional rice is exposed to cold, but they remain the same in the cold tolerant variety.

CSIRO has found a gene that plays a vital role in making ABA and is now testing it to see if it is the key gene that assists with cold tolerance.

Breeding a cold tolerant rice

The cold tolerant variety of rice that has been found has excellent tolerance to cold, but has very poor grain quality.



Dr Rudy Dolferus at CSIRO Plant Industry is aiming to help rice breeders breed a cold tolerant rice variety with his research by identifying useful genes.

Breeders in the NSW Department of Primary Industries have started to breed the favourable cold tolerant trait into commercial varieties while excluding the poor grain quality trait. But just like with any conventional breeding this involves a bit of hit and miss and is time consuming.

CSIRO hopes to correctly identify the gene responsible for the cold tolerance trait then find a DNA marker that flags its location. This DNA marker can be used by breeders to speed up their breeding work and improve accuracy.

Water use in rice

All rice in Australia is grown under irrigation where our growers follow the most efficient rice growing practices in the world producing the highest yield per hectare with low water use.

Irrigation water in rice is used to provide moisture for the rice plants and to act as a buffer against cold. The mass of water around the rice plants prevents temperatures dropping as low as they would otherwise – providing protection against the cold.

Cold tolerant rice varieties could therefore lead to a saving in water use for the industry because water would not have to be used to buffer against the cold.

For further information contact:
CSIRO Enquiries
Bag 10 Clayton South VIC 3169

Phone: 1300 363 400 (National local call)
+61 3 95452176 (International phone)

Fax: +61 3 9545 2175

Email: enquiries@csiro.au

Disclaimer

CSIRO gives no warranty and makes no representation that the information contained in this document is suitable for any purpose or is free from error. CSIRO and its officers, employees and agents accept no responsibility for any person acting or relying upon the information contained in this document, and disclaim all liability for any loss, damage, cost or expense incurred by reason of any person using or relying on the information contained in this document or by reason of any error, omission, defect, or mis-statement contained therein.