Improving rice breeding using a biotechnology approach

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in a rice hull

- The technique of isolated microspore culture is streamlining the time required to produce true breeding rice plants
- The breeding program is aimed at producing high yielding, cold tolerant rice varieties that will reduce low temperature yield losses

Cold damage is the main yield-limiting factor of the Australian rice industry. Low temperature during the rice panicle formation stage causes average annual yield reductions of 5–10%. Severe unpredictable cold snaps which occur on average every 3–4 years can result in yield losses of 20–40%.

Deep water can help reduce the cold impact but this practice does not completely avoid cold damage. Further if the need for deep water was removed by the development of cold tolerant rice varieties, there would be savings of input costs to growers and higher water use efficiencies could be achieved. The importance of rice growing in southern New South Wales demands improvements in the cold tolerance of rice cultivars. Cold-tolerant rice cultivars will provide a more constant and reliable yield, which will benefit the supply to export markets.

The critical time of low temperature damage to rice crops is early January and late February, where in Griffith the average minimum temperature is about 16°C. This temperature is low enough to cause some damage to young panicles. In a 'cold snap' year, this temperature could be around 12°C. Current commercial cultivars cannot tolerate such a low temperatures.

In a Rice CRC project, we carried out research on the development of biotechnology to improve rice breeding, with particular reference to cold tolerance breeding. An isolated microspore culture technique has been developed to produce double haploid plants (true-breeding plants) from the hybrids of crosses. Production of true-breeding progenies by isolated microspore culture takes just one generation, something that would take six to eight generations using conventional plant breeding techniques. This research project is continuing with RIRDC funding.

To improve cold tolerance of Australian rice varieties, several cold tolerant varieties have been introduced to Australia from China. Some of these varieties are native to high altitude regions, where average daily temperature in the rice growing season ranges from 15°C to 18°C, and the average minimum temperature ranges from 8°C to 15°C. These varieties have been used in crosses with commercial Australian varieties. We have carried out cold tolerance testing to identify cold tolerant individual plants from the offspring of crosses between Chinese varieties and Australian varieties, and then backcrossed selected cold tolerant offspring with Australian varieties so as to incorporate genes for cold tolerance into Australian rice backgrounds. More crosses are being carried out in order to transfer cold tolerance into recently released Australian varieties.

Isolated microspore culture is being used to produce double haploid plants from these crosses. Some double haploid plants have been produced and handed over to rice breeders at NSW Department of Primary Industries at Yanco for cold tolerance breeding.

We are also collaborating with CSIRO Plant Industry in Canberra to study the genetic basis for cold tolerance, and develop molecular markers for selecting cold tolerant plants using Chinese cold tolerance germplasm and doubled haploid plants. Isolated microspore culture and molecular markers together will significantly improve breeding efficiency, which will rapidly and accurately incorporate cold tolerance into Australian rice varieties.

Rice farmers and the rice industry in general will greatly benefit from the outcomes of this project. Cold-tolerant rice will have stable yield potential under adverse weather conditions, improved water use efficiency and contribute to the overall improved sustainability of rice production.

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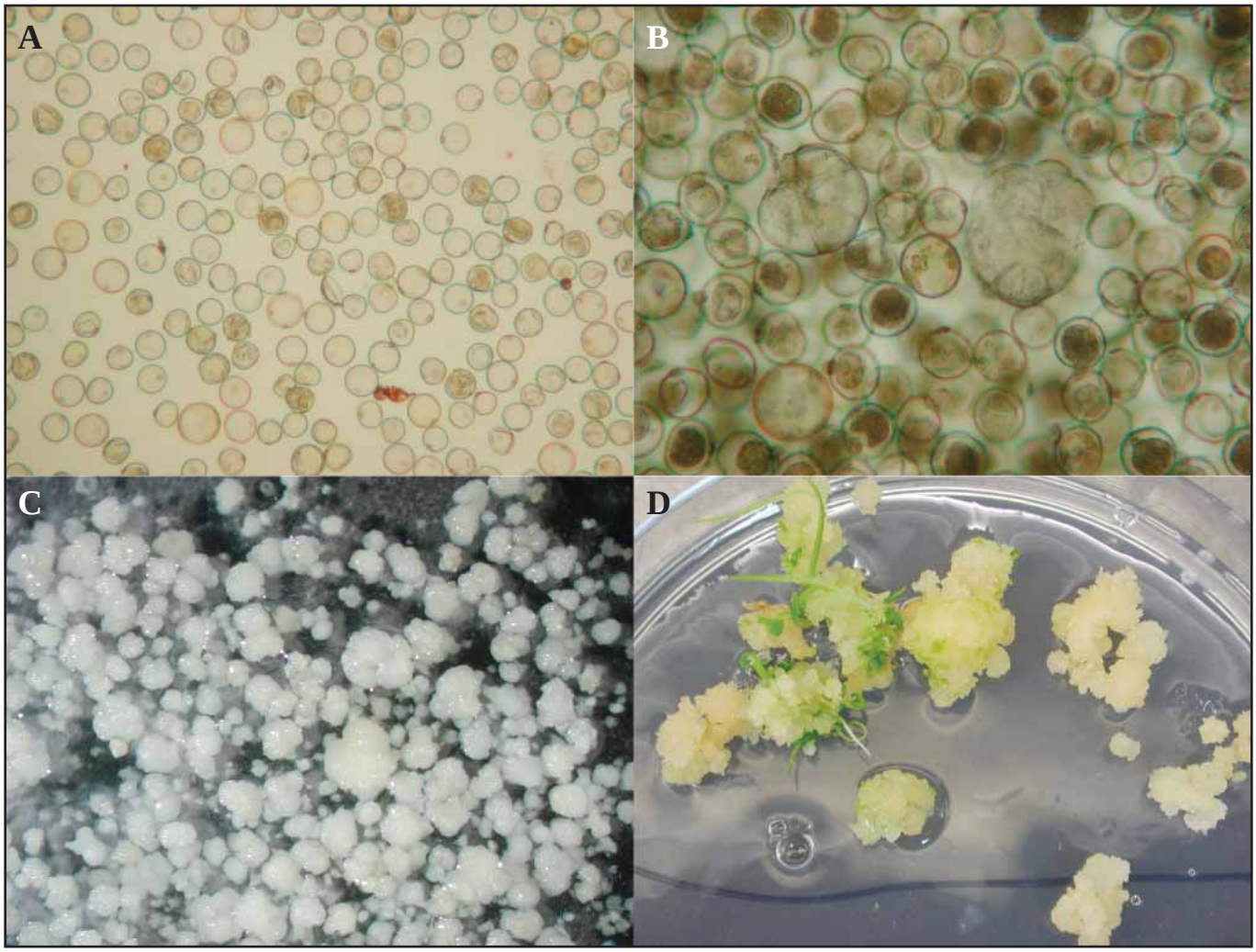

Figure 1: The stages of isolated microspore culture: A - fresh isolated microspores; B - cell division of culture microspores; C - calli; D - haploid plantlets regnerated from calli.