Speed breeders have gone potty: Or have they found the Holy Grail?

By Lloyd O'Connell

Despite all the promise of genetic manipulation, it still takes around 10 years to get a new winter cereal variety into commercial production. But two Brisbane-based researchers, drawing on a 40-year scientific collaboration, are seriously challenging this notion. Dr Ian DeLacy and Dr Mal Hunter have painstakingly pondered, designed, nurtured and ultimately implemented, a unique speed-breeding system.

And along the way, they have produced some astonishing crop yields in an equally astonishing short growing period – for many plant breeders, this is the stuff of Holy Grail legend.

Eighteen tonnes per hectare (greenhouse equivalent) of wheat seed can be produced in just 70 days compared with well watered conventional field production of perhaps 15 tonne crops in around 140 days.

Ian and Mal have shown that by using their novel speed breeding system, as many as five generations can be grown each year. But under conventional (and favourable) field conditions, a maximum of two generations are possible. This means the novel culture system takes less than half the time of conventional methods to get new varieties of winter cereals from the plant breeders to farmers.

Speed breeding system inventors Ian DeLacy (left) and Mal Hunter. The fully mature wheat in the foreground is just 13 weeks old.

How does the system work?

The speed breeding relies on an innovative plant growing system that supports rapid growth and produces high yields of high quality seed.

For around $40,000 per 20 square metres of 'greenhouse' bench space, second-hand cargo containers have been customised, insulated and air conditioned to provide the plants with stress-free conditions including continuous overhead sodium light, constant temperature (24°C) and optimum humidity.

The root-free underside of the Anova-potted wheat plants and specially designed greenhouse matting. In conventional greenhouse situations, root escapes can cause mat spoilage – through decaying roots and pathogen build up – and ultimately plant stress.

The speed and health of the culture system also relies on the unique properties of the patented Anovapot (a winner on the TV program *New Inventors* in 2005) and specially designed layered-bench matting.

This culture system retains aggressive roots within the Anovapot while promoting healthy root growth with an optimum and constant supply of moisture and nutrients (see box story next page).

Most short-day plants such as wheat, oats, barley, canola, corn and sunflower will quickly progress to flowering when exposed to longer day lengths and when grown in stress-free environments.

But it's within the reflective light coloured walls of Ian and Mal's customised cargo containers, where these researchers are pushing the speed boundaries of plant growth.

Four wheat plants are grown in each one litre Anovapot. The pots are filled with a pH neutralised smoked-peat and supplied with a mix of straight and slow release fertilisers designed to meet the full 70 day growth requirements.

Germinated wheat seeds are sown into the peat which is sub-irrigated from the continuously wet capillary matting or by a combination of overhead and sub-irrigation. There is no run-off which saves both

nutrients and water. Tests have shown water savings of up to 70 per cent over conventional methods.

In the speed breeding greenhouses, high yielding plants can be grown at any time of the year, unaffected by seasonal or climatic constraints.

Better working conditions

Preparing the flowering head and transferring pollen to receptive flower parts is carried out by plant breeders in very mild and comfortable indoor conditions – much to the ire of breeders 'enjoying' often harsh field conditions.

Much more rapid disease screening of candidate cereal varieties is also possible with this speed breeding system. In one Toowoomba trial, varietal screening for yellow spot disease was completed in 18 months. Most conventional cereal screening programs can take seven years.

The speed breeding system has an exciting potential and is attracting keen and wide interest. It is being incorporated into the Queensland DPI&F breeding program and is already being used by CSIRO and the NSW DPI for rapid generation work.

The robust and relatively inexpensive nature of the system makes it suitable for winter cereal breeding programs in any part of the world – or wherever breeders are searching for the 'Holy Grail' of rapid, stress-free, high yielding plant growth.

Ian DeLacy is a plant breeder in the school of Land and Food Sciences at the University of Queensland.
Mal Hunter is a horticultural research scientist with a special interest in pot plant culture.
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Continuous overhead hanging sodium lights give excellent canopy penetration. The greenhouse walls are fitted with light coloured panels to reflect additional diffused light back into the canopy.

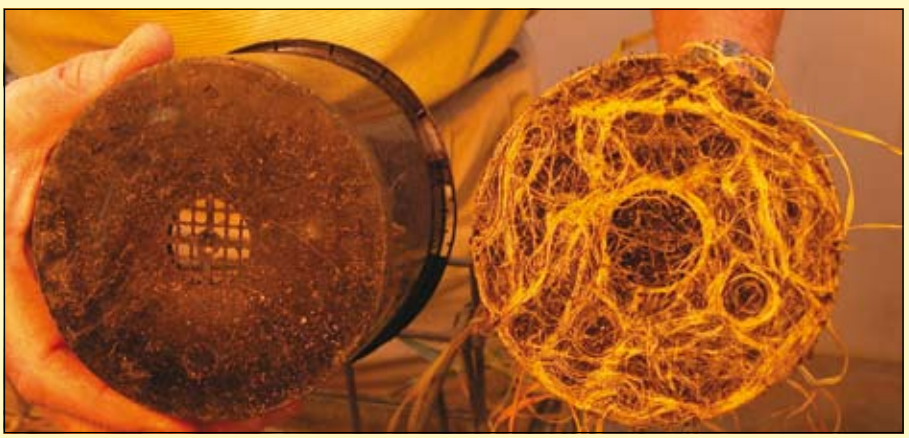
At flowering, the Anova-potted plants are transported on trolleys to other rooms where plant breeders, such as Ian DeLacy, can emasculate (remove the male parts) and pollinate wheat plants in comfortable indoor conditions while seated.

THE UNIQUE ANOVAPOT AND BENCH MATTING

The speed breeding system utilises the unique properties of the Anovapot and specially designed greenhouse bench matting. The patented Anovapot was designed by Mal Hunter to retain aggressive roots within the pot while promoting healthy root growth. At the heart of the pot design is a simple raised 'well' (see cutaway graphic) at the base of the pot. A porous concrete plug, specifically matched to the potting medium, is inserted into the well.

This plug has the dual effect of preventing the massive root escape that can occur in standard slotted pots, while allowing water that would otherwise sit at the base of the pot, to syphon out onto the bench matting to be recycled through the irrigation system. The custom-designed capillary mats hold between five and six litres of water per square metre of matting. Copper hydroxide impregnated into the mat's layers, effectively stops plant roots infiltrating the mat and reduces algal development.

In conventional greenhouse and pot situations, root escapes can cause mat spoilage – through decaying roots and pathogen build up – and ultimately plant stress. But in the speed breeding system, roots remain within the Anovapots, which allows the potted plants to be moved about for plant breeding purposes without causing root damage or plant shock.



The underside of four mature wheat plants grown in an Anovapot showing healthy root growth and zero root escapes. This allows pots to be moved without causing plant shock.