

Are frost resistant crops coming in out of the cold?

■ By Sandra Kerbler, Nicolas Taylor and Harvey Millar

RESearchers from The University of Western Australia have found that an enzyme in plants, ATP Synthase, plays a critical role in how plants respond to the cold.

The discovery, published in *New Phytologist*, could be used to produce frost-resistant crops, which would save the agricultural industry millions of dollars every year.

The new findings could prevent the impact of significant weather events, such as record low temperatures in the Western Australian wheatbelt this year, which wiped out a million tonnes of wheat.

Dr Nicolas Taylor from UWA's School of Molecular Sciences and the ARC Centre of Excellence in Plant Energy Biology (PEB) said that as the climate changes it is becoming increasingly important to understand how plants respond to temperature.

"In our study we observed plants in near-freezing conditions and saw there was a decrease in the production of ATP, a plant cell's main energy currency, which led to reduced growth," Nicolas said.

"Based on a number of international studies it was previously thought that other components of energy production were more sensitive than this enzyme, but we were surprised to identify ATP Synthase as the culprit."

The finding has led to new revelations about plant responses to temperature.

Dr Sandra Kerbler, from UWA and PEB said the benefits of understanding a crucial enzyme for energy production being so sensitive to cold was of great use to the agricultural industry and to the future of producing frost-resistant crops.

"The research has changed previous thoughts of how plants cope with temperature stress and has highlighted new angles for investigation," Sandra said.



Dr Nicolas Taylor from UWA's School of Molecular Sciences.

"A better understanding of how a plant's energy production is altered in response to changing temperatures could inform how we breed plants that are more adaptive to climate change."

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New Phytologist article title: Cold sensitivity of mitochondrial ATP synthase restricts oxidative phosphorylation in *Arabidopsis thaliana*



Frost-resistant crops would save the Australian agricultural industry millions of dollars every year.

FROST IN CANE – AUSTRALIA

Frosts occur in sugarcane growing areas south of Mackay but more significant frost induced losses occur in South Qld and Northern NSW because of the greater frequency and severity of frosting events.

Production losses – NSW

In 2010 the NSW Farming Systems Group's Final report – Better frost tolerant varieties for NSW – found that frost damage to sugarcane crops affects about one third of the NSW cane growing lands reducing production by 10–30 per cent and costing the industry up to \$2.5 million about one in three years.

Frost damage occurs when freezing ruptures plant cells. The most significant type of damage to the plant is death of the growing point. Other types of damage are leaf burn and death of the eyes down the cane stalk.

Death of the growing points occurs at temperatures below -2.0°C . The extent of death will be affected by the minimum temperature reached, the length of time at frosting temperatures and the previous hardening of the crop by exposure to mild frosts.

Research by Weaich, Neilsen and Hughes (1995) showed that for the Broadwater mill area based on 29 years of temperature records from frost prone sites that:

- In 20 per cent of years there were no frost problems (minimum temperature $>-2.0^{\circ}\text{C}$)
- In 60 per cent of years crop management and variety determined frost damage (temperatures from -2.0 to -3.4°C) and
- In 20 per cent of years farmers may have experienced frost damage beyond their control (temps $<-3.4^{\circ}\text{C}$), which can only be alleviated by breeding cultivars with improved frost resistance.

Pushing production boundaries – North Burnett – Queensland

The Summer 2017 issue of SRA's CaneConnection carried a report – Gayndah trials assess frost tolerance – that looks at the potential to push the boundaries of current sugarcane production further west by expanding into frost-prone areas.

Working with the team from Isis Central Sugar Mill, SRA is conducting four variety trials, including a Final Assessment Trial (FAT) near Gayndah and these are expected to run for two more years.

A FAT features about 175 different varieties – or potential new varieties – that have progressed through years of development through the SRA breeding program. FATs assess new varieties in the field and provide valuable data to help local Regional Variety Committees.

Plant breeder Roy Parfitt said the three-year trial would rate each variety based on how it performed after frost events. The plots at Gayndah, and one site in particular, were hit with some significant frost events in 2017, which has provided plant breeder Roy Parfitt and his team with valuable data to assess.

"We walk through and we slice stalks of each of these 175 varieties and then we look at the growing point and find out how damaged it is and we give that a rating," he said.

"We also give the damage to the leaves a rating and if the frost is quite severe the actual eyes on the stalk will also be affected and they would also start dying and we count those, how many eyes are dead.

"We put all of that together and we get an indication of whether the variety is tolerant or totally susceptible to frost."

For more information: Managing frost damage – SRA Fact Sheet – www.sugarresearch.com.au

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SRA plant breeder Roy Parfitt showing frost damage in one of the varieties within the Gayndah Final Assessment Trial.
(PHOTO: SRA)