Sugar Research Australia

YCS update

September 2017

Steps forward in YCS research investigation

Researchers have taken steps forward in their understanding of the yellow canopy syndrome (YCS) dilemma that is affecting parts of the Australian sugarcane industry.

YCS was first observed in 2012 in Far North Queensland, and it has been confirmed in cane-growing regions from the Wide Bay north. Since then, there has been a concerted effort by Sugar Research Australia (SRA) to understand the cause – and management – of this mysterious syndrome.

This involves four major integrated research projects, including two led by SRA, one led by Western Sydney University, and another led by the University of Queensland.

Researchers have recently made the following observations based on the last 12 months of experiments and analysis:

- YCS severity is influenced by plant growth rate and canopy size. YCS is more prevalent after a crop has been slowed in growth followed by good rainfall or irrigation. Late crops are more susceptible to YCS in the early months of the year.
- Researchers have analysed the sugarcane genome and can rule out a group of viruses that hide within the DNA and later emerge to cause disease. This confirms that YCS is not caused by this type of endogenous virus. This breakthrough was made possible thanks to a separate SRA-funded project on the sugarcane genome.
- Analysis of all current data would suggest it is unlikely that any virus is causing YCS.
- Phytoplasmas have been identified as requiring further investigation. Phytoplasmas are a type of bacteria that can block the plant phloem.
- There are always elevated levels of sugars and starch in YCS-affected leaves. This can only occur when sugar production exceeds the export rate. Investigations are continuing around the disruption to supply and demand between the source (leaves) and sink (stalk), and whether symptom expression is triggered by abiotic (non-biological) stress.
- Gene expression and proteome data confirm that YCS is distinctly different to water stress and senescence.

Researchers said that while there has been significant progress, the cause remains undetermined.

Researchers now have a very clear understanding of the mechanism that culminates in YCS leaf yellowing. This insight has be achieved through the SRA project led by Gerard Scalia, called *Leaf sucrose: the link to diseases, physiological disorders such as YCS and enhancement of sugarcane productivity*.

According to Mr Scalia, the yellowing is the result of an export problem in the leaf. YCS-affected plants continue to build up sugars and then starch in their leaves, which isn't normal. Sugars should move out of the leaf to other parts of the plant and starch should breakdown overnight.

"Our results show elevated sucrose and starch in the leaves even very early in the morning," he said. "This leads to reduced chlorophyll content and photosynthetic rates in the leaf. The downside of this is that the leaf chloroplasts are unable to use all the light entering the leaf and this culminates in leaf yellowing and cell death. It is like it's burning up from the inside. So the parts of the leaf that are exposed to the most light and do most of the photosynthesis are most vulnerable to yellowing.

"Sucrose build-up starts well before symptoms appear and this occurs in all parts of the leaf.

"This indicates that it is not the sugars per se that directly cause the yellowing but rather the inability to export sugars that results in the yellowing."

SRA Executive Manager, Technology, Dr Frikkie Botha, said that understanding the physiology of how YCS affects plants is crucial to moving closer to understanding the cause, with this work in the lab complemented by extensive field trials conducted by SRA's Davey Olsen.

"Moving forward, the research teams have identified a number of priorities for investigation over the next six months that will help them understand key questions," Dr Botha said.

Cutting edge research continues to analyse the YCS mystery

The SRA integrated research program into YCS continues with several strategic collaborations with research laboratories and other partners both within Australia and around the world.

One of these partnerships is with the Australian Proteome Analysis Facility (APAF), Macquarie University, NSW, which is an organisation that is a world leader in the science of proteomics.

Associate Professor Mark Molloy with APAF said that the science of proteomics within APAF studies the relationship between healthy sugarcane plants and YCS-affected plants from a protein chemistry perspective.

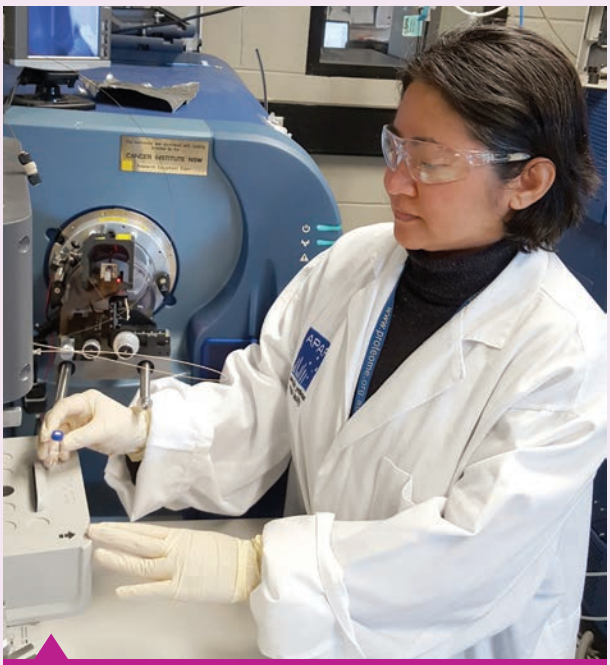
"Our specialised equipment and methods enable us to measure the changes in protein expression and protein levels of healthy and symptomatic plants, which can give insight into the plant's symptoms," Prof Molloy said.

"These proteome expression results can then be interpreted with known metabolic pathways of the plant to further understand the origin and method of attack by YCS."

"The collaboration with SRA has produced the most detailed proteome characterisation of YCS infected plants to date, and along with other molecular investigations, have the potential to unlock the mysteries of YCS and eventually lead to the correct way to manage and/or prevent the outbreak of YCS."

SRA Executive Manager, Technology, Dr Frikkie Botha, said that YCS continues to be a priority investment.

"YCS continues to cost the sugarcane industry losses in production revenue for growers and millers in different regions," Dr Botha said.



Pictured above is **Thiri Zaw**, APAF Principal Scientist – Mass Spectrometry.

"It continues to be a serious concern, as the worst-affected farms can suffer yield losses of 40 percent or more. Some crops also experience less severe impacts and have recovered by harvest."

YCS continues to impact across the industry

Grower and planting contractor, Ed Morris, has seen yellow canopy syndrome (YCS) in the Herbert district since it first appeared there in 2012.

In that time, and from the cab of his tractor planting, he has seen the full spectrum of YCS symptoms and impacts – everything from severe yellowing, to minor yellowing, and from severe yield and CCS loss to relatively minor losses where crops have recovered.

He has seen it in a range of varieties – some worse than others – and also observed the apparent random pattern at which it spreads, both within a paddock and within a district.

He said the first year he witnessed YCS, it was with a client in a crop that had a crop that had "terrible sugar" and cut about 40 tonnes per hectare (TCH).

He said there was some recovery in the ratoon crops, but that crop continued to suffer as it had already had significant stool losses from the first attack of YCS.

This year, Mr Morris saw it in his family's cane at the worst levels so far.

He said while in 2017 the reports of YCS in the Herbert were less than previous years, he had seen it particularly bad in a small area of Q247$^{\Phi}$.

"We planted it in 2015, and it just had normal yellowing as most varieties would have, but we soon realised something was wrong as the sticks were rubbery and we could tie knots in them," Mr Morris said.

"So we stopped planting it and only did about 1.2 hectares.

"But at harvest this year it performed incredibly poorly, and far worse than the Q240$^{\Phi}$ and Q208$^{\Phi}$ on either side of it that were planted into the same conditions.

"The yield worked out to be about 50TCH, with CCS at 6.4. I'd never had cane condemned before, so that was very disappointing.

SRA researchers have observed YCS in all varieties, although with differences in symptom expression. Further work is planned for the year ahead to better understand variety response to YCS.

"This is a big problem facing the industry, and it is a big problem that we still don't know what it is," he said.

"We appreciate the effort SRA is putting in, and we are also keen to hear more."

Pictured above: Ed Morris.

Researchers working across multiple projects met with the YCS Scientific Reference Panel in early August to discuss the last 12 months of findings.

Review workshop further dissects **YCS research findings**

Lead scientists working on the yellow canopy syndrome (YCS) research program met in August to dissect their latest findings on YCS from trials and experiments over the last 12 months.

These meetings are also an opportunity for the Scientific Reference Panel (SRP) to provide insight and guidance to the research projects that are tackling this problem for the Australian sugarcane industry.

The SRP is an an independent group of expert plant scientists responsible for providing supporting scientific opinion about the direction of the project and scientific support. It is led by Dr Joanne Daly.

As part of the recent meeting, the group also heard further external insight from two specialist scientists.

These were Associate Professor Alex Johnson from the University of Melbourne, who has expertise in abiotic stress tolerance, metal homeostasis, and plant nutrition; and Dr Owain Edwards from CSIRO, who has expertise in insect-plant interactions, insecticide resistance, and ecological / environmental genomics.

Dr Daly thanked the two experts for providing their insights to the research teams, by providing new theories to be tested and analysed.

“Both Owain and Alex provided the group with focus for their research and ideas for future analyses for future experiments,” she said.

Dr Owain Edwards and **Associate Professor Alex Johnson** provided external insight to the YCS research program.