

YCS update

June 2017

sra

Sugar Research
Australia

SRA committed to unearthing the cause of YCS

SRA has appointed a new chair, Dr Joanne Daly, to lead the scientific reference panel (SRP) that oversees the yellow canopy syndrome (YCS) research program.

This panel is an independent group of expert scientists that is responsible for providing scientific opinion to the direction of the research.

Dr Daly comes to this role as a former Group Executive of Agribusiness and Chief of Division at CSIRO. She has worked in CSIRO for over 30 years originally as a researcher in entomology.

The SRP met with researchers in December 2016, and will meet again in August 2017, as part of their role of working with researchers to assess what causes YCS and how to manage it.

The SRP will also call in external scientific experts to assist to ensure that they are seeking a wide opinion.

Following her first meeting, Dr Daly said: "I am strongly encouraged by the quality of work, the progress made by the researchers and their collaborative spirit."

"After three years of research, it is becoming clear that YCS will not be an easy problem to solve," she said.

"We still do not know whether YCS is caused by a biological agent, or by environmental factors, as results are not fully consistent with either cause. We cannot explain its occurrence and distribution from field-to-field and from year-to-year. My instinct is that YCS is an interaction of both biotic and abiotic factors which is why tracking down the cause will be challenging."

Notable results reported at the recent meeting included:

- Sucrose and starch accumulates in YCS affected leaves rather than the sucrose being transported into the rest of the cane plant.
- A simple dye test for starch would be an easy diagnostic test. Work is in progress to establish how specific this test is for YCS.

- Field trials have excluded soil or fungal pathogens, and water stress by itself, as causes of YCS.
- The severity of YCS seems related to the age of the plant and its growth rate at the time YCS first appears.
- Not all plants that have YCS suffer a yield penalty.

Dr Daly and SRA Executive Manager, Technology, Dr Frikkie Botha, also recently discussed with the SRA Board the future shape of YCS research investment.

SRA is moving to yearly work-plans for the four YCS research projects, and the Board supported another year of funding for YCS, taking note of the SRP's recommended shifts in research.

There will be an increased emphasis on the role insects, particularly as vectors of pathogens that might mediate YCS.

Large scale field trials will assess management options for reducing the impact of YCS on yields, including assessing breeding material for resistance to YCS.

Laboratory studies will examine mechanisms involved in YCS and will look for visual signs of possible pathogens.



Mulgrave grower **John Ferrando** with plant cane displaying severe YCS symptoms in January 2017. He has had YCS in the past, but said this year it had been the worst.



Frikkie Botha and Kate Wathen-Dunn taking samples.

Project update

Leaf sucrose: The link to diseases, physiological disorders such as YCS and sugarcane productivity

Analysis of initial protein data together with metabolite and gene expression results confirms that YCS causes a disruption to leaf metabolism. By Gerard Scalia, SRA

State of the art gene expression and metabolite analyses have shown that YCS yellowing is unique and different to yellowing caused by water stress and natural aging.

Sucrose and starch extractions from the leaf blade, mid-rib and sheath all show elevated levels with the highest amounts accumulating in the sheath and then the midrib. Our analyses also reveal that there is a disruption to carbon partitioning – that is, the proportions of sucrose and starch in the leaf is abnormal.

Our research has revealed that when the leaf has accumulated high levels of sucrose there is a preference for it to make starch rather than more sucrose and this happens well before the leaf turns yellow.

Interestingly, investigation of larger plants which appear to have recovered from a YCS event reveals that sucrose and starch levels in the new growth is normal.

This would suggest that, given the right conditions, the crop can grow out of this disorder.

While we are still unclear as to what initially causes sucrose to accumulate in the leaf, the collective data suggests that there is a supply and demand problem between the leaf and the stalk.

If the leaf (factory) manufactures more sucrose than the stalk (warehouse) can store, and there is no safety mechanism to shut down production (sucrose synthesis), the result will be accumulation.

Alternately, if there is a blockage in the supply route between the factory and warehouse, then the result will also be accumulation.

However, all investigations so far have failed to identify such a blockage. Based on this, we have now shifted our attention away from the leaf with a focus on the stalk internode region.

A collaborative effort with SRA's Dave Olsen and Jaya Basnayake during the current YCS season has enabled us to investigate this further.

We recently completed an intensive data gathering and tissue sampling exercise of KQ228[®] stalks from a growth regulator trial in the Burdekin. Some of the data collected involved measuring internode volume, water content, photosynthetic rate and leaf area to name a few. Internode and leaf tissue, together with xylem sap, were snap frozen in liquid nitrogen in the field and returned on dry ice to Brisbane for further processing.



Leaf and stalk measurements.

Extractions from these samples will be analysed at SRA Indooroopilly or despatched to world class laboratories in Sydney, Melbourne and South Korea.

This approach should give us a greater understanding of the contributing factors causing the accumulation of sucrose in the leaf that ultimately culminates in the expression of leaf yellowing that we all know as YCS.



Gerard Scalia and Frikkie Botha measuring internode volume.



¹³C labelling in the field.

SRA acknowledges the funding contribution of the Queensland Department of Agriculture and Fisheries towards this research activity.

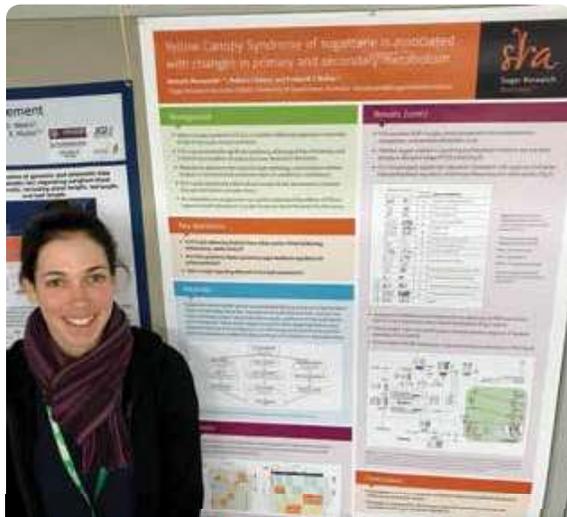
Overseas lessons generating new ideas for YCS research

An important aspect of working on the yellow canopy syndrome (YCS) puzzle is ensuring that the research team is aware of the latest observations overseas.

**Is there anything similar in overseas sugarcane industries?
Is there anything similar in other crops? How does it compare to other known overseas disorders?**

This process has been ongoing since the YCS research program began, and progressed further earlier this year when SRA Senior Technician, Molecular Genetics, Annelie Marquardt, travelled to the United States and attend the International Plant & Animal Genome conference (PAG).

PAG is the largest ag-genomics conference in the world and scientists attend to hear about and present research and problems of world-wide agriculturally important crops.



Annelie Marquardt with the poster she presented to the International Plant and Genome conference.

“Sugarcane has its own workshop within the conference, and those who take part are largely experts on sugarcane and its genetics. To share our problem of YCS to this audience was a very beneficial experience because it initiated discussion from those unfamiliar with YCS, around what other factors it could be caused by, whether they have seen anything similar in other countries, and novel thoughts on new directions to investigate to find the cause,” Ms Marquardt said.

“Positive feedback also provided verification of SRA’s methods looking into the molecular side of leaf yellowing to understand what is happening inside YCS-symptomatic leaves.”

As part of the trip, she also visited a research group lead by Prof David M Braun at University of Missouri.

Ms Marquardt explained that while they do not work on sugarcane, they do leading research on leaf sugar accumulation, and what causes it in maize leaves.



A maize plant with defective leaf sucrose transport studied by Prof David M. Braun’s lab team at the University of Missouri.

“Maize is one of the closer related crops to sugarcane and so this work can be applied to understanding how and where sugar is building up in YCS. This is allowing me to better understand which processes are affected in sugar metabolism in YCS which allows us to progress in narrowing down what is causing these symptoms in the first place.”



Maize vascular tissue (which transports sugars and water through leaves among other things) under a microscope using a light filter. They use this technique (with different filters) to pinpoint where certain sugar transporters function.

** Annelie travelled as part of a James E. Irvine Memorial Travel Grant from the International Consortium of Sugarcane Biotechnology; the QAAFI RHD (Research Higher Degree) Travel Award; and an SRA Travel and Learning Award.*