Sugar Research Australia

CaneCONNECTION

Winter 2021

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(Cover page) Proserpine grower and harvesting contract, Craig Emmerson, has made a number of modifications to his 8810 to improve efficiency. Photo by Brad Pfeffer

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WELCOME TO THE WINTER 2021 EDITION OF *CaneCONNECTION*

Welcome to the Winter 2021 edition of CaneConnection.

As a feature in this edition, we take an in-depth look at the key outcomes and findings of the integrated research program into yellow canopy syndrome on pages 10 to 13. This program has provided many valuable scientific lessons for the industry, and further work into YCS is continuing based at Meringa, through PhD student, Hang Xu, who recently commenced with SRA and is building on the work of the YCS program.

With the harvest now in its early stages, we have also visited Proserpine for our cover story, speaking with harvesting contractor Craig Emmerson. Craig has made a series of modifications to his harvester in recent times, and has also made adjustments to practices, following on from previous work with SRA on trials. You can read more about Craig's machine on pages 6 and 7.

While we are in Proserpine, we also bring you a wrap-up on the 'Myrtle Creek' project, which has been running over the last three years and worked on practical solutions with growers to match sustainability and profitability outcomes.

This edition also has another practical look at farming systems and soil health. Looking through the eyes of Burdekin growers Mark Vass and Frank Mugica, we talk about using rotational crops to improve soil health and lift sugarcane production.

Other articles in this edition include topics such as ratoon stunting disease and nutrient management planning projects operating in the Far North.

Thanks for reading.

Brad Pfeffer

Manager, Industry Communications and Marketing

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WORKING WITH GROWERS ON PRACTICAL OUTCOMES

By Paul Calcino, SRA Meringa

In the Russell-Mulgrave catchment of Far North Queensland, growers are demonstrating their ongoing commitment to maximising farm efficiency while minimising their environmental impact via the Russell-Mulgrave Complete Nutrient Management Planning for Cane Farming (RP222C) project.

Grower engagement in the SRA-led project now spans approximately 10,000ha, with all eligible participants, plus a few newcomers, having signed up to continue the project into year two. One of the key focusses of the second year of the project is to find opportunities to implement STEPS 5 and 6 of the SIX EASY STEPS program on-farm and introduce the SIX EASY STEPS Toolbox.

With a greater focus on STEPS 5 and 6 in year two, we are working with growers to:

- ensure each block is receiving adequate nutrients
- identify on-farm constraints that impact the crops' ability to uptake nutrients
- address the constraint or refine nutrients based on guidance from the SIX EASY STEPS Toolbox where there is a reduced capacity for uptake.

Funded by the Queensland Government's Reef Water Quality Program and the Australian Government's Reef Trust in partnership with SRA, the project provides a great opportunity for growers to work one-on-one with accredited agricultural advisors to identify opportunities for improvement with their nutrient management.

Advisors develop a practical and tailored whole-of-farm nutrient management plan, including the nitrogen and phosphorus budget, aiming to maximise productivity via the full implementation of SIX EASY STEPS. The plan and associated record keeping tools ensure growers are up to date with the new nutrient and record keeping requirements under the reef regulations, which come into full effect in December 2021.

Joe Bonso, a second generation farmer from Mirriwinni who is now entering his second year of involvement in the project, spoke with SRA about his thoughts on the project.

"The change to my practices hasn't been dramatic," he said. "I'm mostly still using the same products that I've been using, but I've refined my application rates based on soil test results across the farms. I've also been able to keep the number of fertilisers down to a practical number, by rationalising their usage across the farms based on the soil requirements while making sure I stay under my nitrogen and phosphorus budgets.

"Having the physical plan and record keeping book reminds me to keep on top of the records when I finish up with a cold beer each day."

As a participant in year two of the project, Joe has worked with SRA to identify opportunities to implement STEPS 5 and 6 on-farm using guidance from the SIX EASY STEPS Toolbox.

"This year I'm planning on making nutrient refinements on some of my older ratoons. I'm going to be sending them to fallow or replant next year so they're good candidates for it. By refining my rates where appropriate, I'll be able to save a few tons of fertiliser too," he said. ■

Anyone looking for more information on nutrient refinement can find information in the SIX EASY STEPS Toolbox located by scanning your smartphone camera over the QR code.

Australian Government

Queensland Government

(Right) Burdekin grower Frank Mugica is using legumes to boost soil health and farm profitability

MAKING EVERY HECTARE COUNT

By Brad Pfeffer, SRA

When Frank Mugica thinks about ways to maximise profitability and productivity from his farm, he uses an analogy about supermarket shelves.

When you walk into Woolworth or Coles, each inch of shelf space is a mini slice of real estate, competing for attention from the customer. Each piece of space has to deliver for the business by being profitable and keeping customers walking through the cash registers.

Frank thinks of his farming country in a similar way. Each hectare of the farm needs to be making a return on investment as well as supporting the overall farm picture in terms of productivity and profitability.

During a visit to family members in South America, he uncovered a similar line of thinking in their agricultural sector. On that tour, he saw farmers were making every hectare count, with ground only sitting idle when the weather was too wet.

It was this line of thinking that led Frank to growing legume cash crops in rotation with sugarcane in recent years, with the dual aims of improving soil health to lift cane production, and also lift overall farm profitability.

The Mugica family farm is about 120 hectares not far from the Kalamia Mill in the Burdekin, producing about 12,500 tonnes of cane each year. Within that area, they typically farm about 45 hectares of legumes each year, growing two crops back-to-back.

This process starts with the area to be fallowed being cut in the first cane harvesting round. This area is then planted to soybeans which are grown through to February and then usually followed by mungbeans before putting the land back to cane in May or June.

Just like in the supermarket shelves where the Pepsi and Coke are competing for space, Frank's country doesn't sit idle for long.

"It needs good time management trying to fit everything in," he said. "If the blocks need laser-levelling, that happens after the cane harvest, and then I go in with legumes and am back with cane in an autumn plant."

He said the system started largely by chance.

"One year we had a lot of rain in May and I was first in the harvesting group and had to cut my fallow first," he explained. "I didn't want to leave that soil sit for so long, so went with legumes."

"I was able to get the soybean crop off by December, so still had a window for another quick crop. That was the process that woke me up to start changing my system."

He said there was a small decrease in cane production as he learnt how to grow new crops and integrate them into his farming system, but he now feels his sugar per hectare has increased and yields have improved.

"I also feel it's easier to cultivate the soil now, so I'm using less horsepower. By breaking the monoculture, I'm seeing the results with the cane.

"Through this process I'm improving my farm return and cane productivity, so it's a win for everybody."

Frank bought the farm not far out of Ayr in 2011, having previously cut cane and run cattle at Dalbeg until that time.

He has made changes to the new farm, including reducing the paddocks from eight or nine down to five as well as doing intensive soil mapping through an external agency and laser levelling.

"Things are busy, but as you learn the system it gets easier. When we had cattle things were busy too – but back then we were working in the dust in the yards. At least now if I'm spraying beans it's in an air-conditioned cab."

He has also applied gypsum to improve the water-holding capacity of the soil, targeting site-specific variable rate application through GPS with good results.

"When I first started with the variable rate, the harvester driver commented that the block was cutting better than my plant cane, and that it was a uniform size from top to bottom," he said.

"The year before it was like a yo-yo, and that was when I'd used a traditional broadcasted rate, so the precision agricultural approach was cheaper in the end as well."

In addition, he has tried enhanced efficiency fertilisers, following his involvement in the EEF60 project, led by CANEGROWERS and delivered by SRA.

"In the trials here, I believe the slower release fertilisers delivered a benefit. When I initially started farming in 1991, we used to do split applications of fertiliser, so I think of it a bit like that, as it's helping me match the fertiliser to the plant growing process."

"For me, I think it has been important to look at those other constraints first, like water holding capacity, and then look at the EEFs. The project helped with EM mapping at the start and really helped answer a lot of questions that I had."

Overall, he said information was critical and that the Burdekin had great opportunities at its disposal through service providers like SRA, BPS, Farmacist, BBIFMAC, AgriTech Solutions, NQ Dry Tropics and DAF Queensland.

"They are all working on good projects that help us as farmers, but also help the industry tell a positive story about the things that we are doing." ■

sugarcane SOIL

For more information on soil health, including a video with Frank, visit the soil health toolbox pages on the SRA website sugarresearch.com.au

CUTTING THE LOSSES

For Craig Emmerson, getting the most sugar out of the paddock is about a whole range of factors working together, adding up to significant outcomes at the end of each day. *By Brad Pfeffer*

When it comes to improving harvesting efficiency, Craig Emmerson reckons it is about making all of the little things all add up.

In partnership with his cousin, David, Craig cuts up to about 200,000 tonnes annually in the Proserpine district, using two 2019 Case IH 8810s.

One machine is factory-standard, and the other machine has been heavily modified with a range of after-market components in order to keep chasing all the little gains in the paddock.

For example, it has been fitted with after-market components throughout the feedtrain: fronts, basecutter blades, shark fins on the top rollers, and chopper drums. They have also lifted the primary extractor, lifting it by 100mm, and have optimised the entire feedtrain. More recently, the machine, which is driven by Craig, has also been fitted-out with a yield loss monitor and a cane-loss monitor.

"With the new fronts, we were cutting some big plant cane last year between 170 and 200 tonnes per hectare, and we were struggling to get it to feed with standard fronts," Craig said. "So the new fronts were part of the process of getting the crop to feed.

"Along with our other changes to the feedtrain, we have stopped those big gulps of feeding through the machine, and have made things a lot more consistent.

"SRA have done a lot of work with contractors on optimising feedtrains over the years. For us, the optimisation has helped us see a difference even in standing cane, with the roller train just not fighting itself."

Craig said the modifications also go hand-in-hand with operating to the conditions and working proactively with growers in the group.

"Cane isn't making money for anyone if it is on the ground," he said. "We want to keep losses to a minimum, but we also want to make it cost effective as well.

"We know that cutting green, at some point you have to work out an acceptable level of loss. But with the investments we've made in the machine and the data we get through the loss monitor, we can have a benchmark for setting prices, and find the right balance."

Using eight blade choppers, Craig is aiming for billet length of about 20-22cm.

"We sacrifice a bit of bin weight for that, but we know that every cut is a loss," he said.

"We are also confident that we are gaining the tonnes. For example, the modified machine might do 10 x 8-tonne bins in an hour, while the other machine does 8 x 10-tonne bins in an hour.

"It is a good comparison with the two machines and we want to look at it more closely this season. On the modified machine, I have to fill more bins, but they are filled quicker as there is not as much cane being thrown out."

Craig has worked very closely with Bryan Granshaw from the Burdekin with a lot of his modifications, and ideas, and also to help track the impact of the changes.

"With Bryan's help we've been documenting all the changes, which I want to know for my own benefit. It is also good for talking with the growers in the group. It is rewarding to start seeing the results."

In this vein, SRA has recently commenced a project to deliver a digital tool for the Australian industry to help growers and contractors find the 'sweet spot' with harvesting, by bringing together recent research into harvesting and incorporating it with economic evidence.

The project is being led by Phil Patane from SRA with close collaboration with economists from the Queensland Department of Agriculture and Fisheries.

"The tool is at an advanced draft stage and will start to be tested in the field this season," Phil said. "Our aim is to make the tool more widely available for the 2022 season and ultimately deliver a tool that packages previous SRA research and allows growers and contractors to share the benefits equitably.

"There is a huge opportunity to create industry value by finding the sweet spot with harvesting practices.

"One of our overall goals for the project is helping the industry to capture about 4.9 tonnes of cane per hectare and 700kg of sugar per hectare per year, with an estimated industry net benefit of $69 million by 2030."

Back in Proserpine, and Craig Emmerson said he was keen to have a look at the tool as it was rolled out, because putting facts and numbers together could help growers and contractors continue to work together.

Beyond economics, he also said that another key component of improving harvesting efficiency was getting things right in the paddock.

A lot of the cane Craig cuts is on either 1.8 rows as dual row, or 2m rows as dual row.

He grows about 15,000 tonne of his own near Kelsey Creek, and in the last 12 months has shifted his farm from 1.65m rows to 1.8m dual rows.

"I've been wanting to make the change for a while but was worried about getting the interrow shaded in. We've now gone to a dual row planter, which will help with that."

He said it created big opportunities for efficiency with harvesting.

"At 1.65m you are hooking along to get across the country, but with 1.8m you can go a bit slower to get the job done, do a better ground job, and still cover the same area.

"It's also a big difference with compaction and moisture retention, which is important because my farm is dryland." ■

(Left) *Proserpine grower and harvesting contractor, Craig Emmerson, has made a number of modifications to his 8810 to improve efficiency.*

Queensland Government

SRA acknowledges the funding contribution from the Queensland Department of Agriculture and Fisheries towards this research activity to develop the harvesting predictive tool.

(Right) Water quality monitoring equipment set up on the Pilla farm.

(Top right) SRA Project Officer, Gracie White, was integral to running Cane to Creek 2.0 in the Burdekin, along with support from other local partners such as BPS and BBIFMAC.

(Bottom right) Burdekin grower Steve Pilla says being involved in the Cane to Creek 2.0 project has provided useful information to improve farming practices.

TRIAL DATA HELPS PINPOINT ON-FARM OPPORTUNITIES

Through involvement in a project called Cane to Creek 2.0, Steve Pilla has made adjustments to help improve irrigation efficiency. *By Brad Pfeffer*

For Burdekin cane grower Steve Pilla, the little things can add together to make quite a difference when it comes to running a profitable and sustainable farm.

This year, for instance, his costs are significantly down due to the wet summer and autumn experienced in the region, particularly for the northern parts of the region where Steve farms, not far from Giru.

"From Christmas until mid-April, we had basically two irrigations across the 240 hectares that I manage as part of a family share-farming operation," Steve said. "Normally through that time we could be non-stop, every five or six days."

The weather, of course, is out of his control and a nice little bonus that helps reduce electricity bills and the usage component of water bills.

There are other small things that Steve and the family are adjusting to help make improvements to their farming operation to improve productivity and reduce costs.

"Electricity is one of our main costs and we are facing a change in tariff at the end of June, so we are looking for any way possible to save. We are going through the process of looking at our pumps, possible tariffs and usage, and using external advice to help us.

"We are looking at other things. For example, on one farm we have recycled water and gravity-fed, so we use that gravity feed as much as possible to save costs."

Steve added that another critical factor with irrigation efficiency was looking closely at issues such as potential deep drainage and flow rates through the furrows.

"Small things like furrow shape are also important to look at."

For example, through work with a range of trials and projects over the years, Steve learnt that he had too much lateral movement of water across his drills because the furrows were a bit too shallow. This was causing inconsistent flow times in different furrows within each set.

A simple process of reshaping the furrows has reduced crossover of water between drills and furrows, simply by making a slightly bigger hill.

Some of this information was gathered through a project called Cane to Creek 2.0, led in the Burdekin by SRA and operating with support from groups such as Burdekin Productivity Services (BPS) and BBIFMAC.

Before the trial, Steve thought the cause of his inconsistent flows through his irrigation sets was due to deep drainage.

"I was approached by BPS to be involved in the project and I was keen to be involved as I'd participated in similar work before," he said. "We looked at a new block within the Cane to Creek project and saw that the losses to deep drainage were minor. I'm pleased to say that in two years of involvement we've made some improvements to furrow type and lateral movement of water."

The trials also looked at other issues such as fertiliser placement as Steve is keen to look for new ways to improve efficiency through nutrient management.

In recent years, Steve was also involved in a major project in the Burdekin known as RP20, which looked at the SIX EASY STEPS in commercial conditions on several farms.

"The RP20 project really opened our eyes to the potential to target our fertiliser usage to the recommendations – and also that we would still maintain production," he explained. "We were expecting we could see massive loses to production by reducing rates – but the trials showed that didn't happen.

"We also learnt that SIX EASY steps is the baseline for us as farmers. When we combine it with other factors in the farming system and get them right, things work well. As long as the crop has its nutrient requirements, the rest is up to us."

He added that these type of trials were helpful for individual growers, for local districts, and the industry as a whole.

"The communication through Cane to Creek was brilliant, and when we see the results, it gives growers a positive motivation to move forward. It shows us that the improvements that we have been making are having an impact, and it also shows us that we can also continue to improve in small areas."

Steve's main varieties include Q240$^{\Phi}$, Q200$^{\Phi}$, KQ228$^{\Phi}$, Q208$^{\Phi}$ as well as some Q253$^{\Phi}$ and some SRA17 in his seed plot for planting out this year.

He manages ratoons based on performance rather than a strict cycle, and normally grows between four and five ratoons, although will push this longer if particular blocks are maintaining performance.

When it comes to variety selection, he talks to BPS, other growers and sources information from SRA variety guides, and then looks at his own soil types and conditions before making a decision. ■

Cane to Creek 2.0 is funded by a partnership between the Australian Government's Reef Trust, the Great Barrier Reef Foundation with support from SRA.

YELLOW CANOPY SYNDROME (YCS) INDUSTRY UPDATE

By Gerard Scalia

Through SRA's investment, more than 30 scientists and support staff worked on the YCS issue on five distinct projects, with an overall estimated investment to date of $10.2 million.

YCS remains a priority and will continue to the subject of investment in the future but SRA is reducing from the high-level of funding that was committed to YCS in recent years. *Although the integrated research program structure has ceased, SRA will continue to invest in YCS to achieve practical solutions and balance our investments with the many other requirements of the industry.*

(Over top right) *YCS symptoms in the field.*
(Below) YCS in the lab at SRA Indooroopilly.

The YCS integrated research program has completed a major report into its progress. Key findings from the research are as follows.

YCS SYMPTOMS, IDENTIFICATION, CROP AGE AND SEASON

YCS is a condition of the mid-canopy (leaf +3 to +6), affects all varieties and has been confirmed as far south as Maryborough. It presents as a golden-yellow colour of the leaf blade and usually expresses after good rain following a dry or high stress period. YCS can occur in both rainfed and irrigated crops. YCS is a form of induced leaf aging (senescence) and is therefore best detected early in development to reduce misdiagnosis. Starch iodine staining of the midrib prior to 8am, together with key visual YCS characteristics (canopy position and colour) is a quick method of diagnosis in the field. A YCS identification test kit was developed by SRA to assist industry service providers.

YCS development and expression occurs during the peak growing period of December to March with highest severity typically noted in mid-February. This coincides with the time of accelerated growth rate due to high light intensity and temperature and a longer day length. Symptoms exhibit in the mid-canopy of crops of different ages at the same time and severity is strongly correlated with growth rate. Hence, younger and more

actively growing crops typically display higher levels of YCS severity than more mature crops.

Crops do recover from a YCS event with yellowing usually subsiding from April and no longer visible by May.

PATHOGENS

Molecular screening for the presence of pathogenic organisms (phytoplasmas, bacteria, viruses, fungi and protozoa) in soil, plant tissue and sap was unable to consistently identify the presence of such agents prior to, and during, the development and expression of YCS. Samples were collected from fields, glasshouses and quarantine facilities, representing the main commercial varieties grown widely throughout Queensland.

Transmission studies using leaf tissue, juice and setts from YCS affected cane show that YCS is not caused by the transfer of an agent through these sources.

Evidently, no biotic agent is consistently present during YCS development and expression. This suggests the primary cause of high sucrose accumulation in the source leaves of the mid-canopy is not due to a pathogen disrupting sugar transport. YCS is not a disease.

INSECTS AND MITES

Under experimental field conditions, a high concentration of a broad-spectrum insecticide promoted an increase

in internode growth and effectively suppressed YCS expression by preventing the accumulation of high levels of sucrose in the leaf. As pathology studies have been unable to consistently identify any potential insect-vectored phloem blocking pathogen, it can be concluded that insects are impacting growth directly.

While insect involvement in YCS development has been confirmed in trials, the direct impact of a specific insect (or mite) in YCS development has not yet been determined. Therefore, it is likely the broad-scale removal of insect and mites reduces stress on the crop, redirecting resources from defence to stalk growth.

However, as environmental triggers influence the abundance of insect and mite species at any one time, this type of biotic stress impact on growth rate will vary within and between seasons. Therefore, the consistent use of a non-specific broad-spectrum insecticide or miticide is not a sustainable or viable option to manage YCS.

The outcome of 1ha strip trials conducted under commercial conditions in three districts in 2019–2020 showed the efficacy of a broad-spectrum insecticide to be inconclusive.

NUTRIENTS AND HEAVY METALS

Nutrient testing of soil and plant tissue confirmed YCS is not caused by nutrient deficiencies, heavy metal toxicities, or compromised nutrient mobilisation within the plant. However, elevated levels of silicon and reduced magnesium content were detected in all YCS samples across all leaves. Increased silicon uptake is typical of plants under stress. Once accumulated, silicon is no longer mobile within the plant. However, magnesium levels returned to normal after recovery, implying the previously recorded reduction was due to mobilisation of resources out of a leaf that was prematurely aging. Intensive field trial monitoring of leaf numbers shows induced senescence causes YCS stalks to always have two fewer attached leaves than green counterparts. The addition of magnesium to either the soil or as a foliar spray had no impact on YCS incidence or severity.

CROP STRESS

Crop age and growth regulator trials together with physiological studies identified growth rate to be the key driver of YCS. Research showed that YCS-like symptoms can be induced or mitigated by manipulation of stalk/internode growth (sink strength). Either abiotic or biotic stress can cause growth rate impediment and sink limitation, leading to the development of YCS. Therefore, any stress factor that impacts upon plant resources that would otherwise be used for growth is the cause of YCS.

Environmental stress response expressed through gene expression, products of metabolism and protein levels is consistently represented across all samples sets.

Stress shield chemicals induce a temporary stay-green effect and offer no long-term protection against the development and expression of YCS.

PLANT PHYSIOLOGY

YCS is a physiological disorder in response to reduced export of sugar from the source leaf (supply) to the stalk and roots (demand). In YCS this disruption may be caused by a limitation to internode size or a possible partial physical restriction in the sucrose transport system.

YCS SYMPTOM PROGRESSION

An imbalance between supply and demand will cause sugars to accumulate in the leaf and this is exacerbated when sucrose production is highest during the peak photosynthesis and growth period of November to March.

Several physiological changes such as decreased photosynthetic rate and internal leaf CO^2 (Ci), reduced stomatal conductance, uncoupling of the photosynthetic electron transport chain, changes in carbon partitioning, reduced translocation in vascular bundles and disruption to cell membrane integrity already occur in the leaf tissue before visible yellowing. Reduced translocation of assimilates out of the leaf results in sucrose accumulation and downregulation of the photosynthetic genes. Accumulation of sucrose above an upper tolerance threshold leads to under-utilisation of incoming solar radiation, major disruption to the photosynthetic machinery, photooxidation, destruction of chloroplasts (contain green pigment) and leaf yellowing.

Gene expression data and protein levels support a general impact on leaf metabolism which is consistent with changes to source leaf metabolism. Therefore, leaf yellowing is a response to, and not the cause of impeded growth rate. As symptoms progress the leaf undergoes premature aging in response to the metabolic disruptions caused by growth disruption.

SOIL BIOLOGY AND ROOT HEALTH

Soil treatment studies of soil biology show that YCS is not caused by a soil borne agent. Root examinations also show YCS does not cause poor root health or changes to root system structure. However, it is evident from pot trials that restricted root growth increased the prevalence and severity of YCS. As the root system is a major carbon sink, any limitations on root growth should therefore be removed or managed to reduce the risk of YCS development. *(It should be noted that YCS affected crops are primarily influenced by a limitation to internode growth in the zone below the symptomatic source leaf of the mid-canopy – the proximity of this sink limitation causes a more immediate source leaf response).*

VARIETY ASSESSMENT

Sampling and leaf sugar content analysis across all commercial varieties showed similar upper tolerance levels of sucrose accumulation. Assessment trial studies attributed variations in YCS expression to differences in canopy cover and shading of the mid-canopy. However, variation is also influenced by environmental and climatic conditions which heavily influenced water availability, sink strength (demand), photosynthetic rate and radiation use efficiency (supply).

The collective data does not support a genetic predisposition for YCS in commercial varieties throughout the regions.

YCS DISTRIBUTION AND INCIDENCE

YCS has been confirmed from the North Queensland Wet Tropics to Maryborough in the South East. However, the incidence of YCS within a region, and between regions and districts, will vary seasonally and from year-to-year due to the episodic nature of YCS. Robust data of prevalence and distribution is unlikely to be obtained without a unique diagnostic test

to distinguish YCS from the many other forms of sugarcane leaf yellowing. Such a diagnostic is likely unachievable given that YCS is a physiological disorder linked to more than one growth-limiting causal agent.

CANE YIELD AND CCS

Irrespective of the field trial investigation or analytical method employed, biomass studies showed no correlation between YCS and yield or CCS.

YCS is driven by reduced growth. Therefore, yield loss precedes YCS development and expression. It is this period of impeded growth that influences the magnitude of any yield (TCH) penalty. Thus, it is the intensity, duration and scale of the growth stressor, be it biotic or abiotic, that is the cause of crop yield loss and not YCS per se. Photosynthetic data suggests an approximate 2% yield loss directly attributed to YCS yellowing.

MANAGING YCS

Preventing the slowdown of growth by reducing stress (abiotic and biotic) on the crop prior to and during the peak growing season will lower the risk of YCS development and expression and is therefore key to managing YCS. Site-specific crop assessment to identify growth limiting factors (above and below ground) sits at the centre of any YCS management program. Therefore, whichever farming practice removes or reduces the most dominant stressor/s impacting crop growth will be the best management option to prevent or mitigate YCS development.

YCS AND CLIMATE

The emergence of YCS in Queensland during the summer of 2012/2013 is aligned with a significant and consistent increase to mean temperature as identified by the Australian Bureau of Meteorology. This change has endured for almost a decade and has seen an increase of approximately 0.5°C during this period, contributing to increased incidence of severe weather events, rainfall variability and stress on crops throughout Australia. This increased environmental stress in addition to other stressors (abiotic and biotic) linked to a changing climate may be associated with impacts on crop growth and the physiological response exhibiting as YCS. It is not possible to rule out the appearance of some other unknown factor around 2012/2013 that has induced this physiological response. ■

(Top right) *Stress-induced yellowing, part of the YCS exploratory work that was conducted at the SRA Burdekin Station.*

(Right) *Dr Frikkie Botha and Davey Olsen (both former SRA staff) discussing YCS diagnosis in the field in the Burdekin.*

Queensland Government

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

ON-FARM DEMONSTRATIONS HELP DELIVER OUTCOMES AT PROSERPINE

Over the last three years, a project at Proserpine has been working with growers to target sustainability and profitability outcomes in an important sub-catchment within the district.

Called *Pathways to Water Quality Improvement in the Myrtle Creek Sub-catchment*, this project was delivered by SRA and Sugar Services Proserpine, funded by the Queensland Government's Reef Water Quality Program.

The project worked with growers on a series of demonstration sites looking at various farm practices, and then carefully examined the environmental and productivity outcomes in order to match these dual goals.

Sam Orr was one of the growers involved in the project and had a trial on the family farm in 2020. This included a collaboration with the Department of Agriculture and Fisheries (DAF) coastal farming systems team to look at various herbicides through a dual-herbicide sprayer.

"We became involved to learn about the impacts of our current farming practices and it was also a chance to look at different techniques that we could implement in the future," Sam said.

Through the trials, growers such as Sam learnt information about the potential for lowering the rates of pre-emergent in the interrow.

"We are currently looking at whether we invest in a new sprayer. If we do that, we will investigate the reduction of sprays in the interspace, and hopefully achieve the same control as what we were doing traditionally. The result is we will be more cost-effective and have better overall outcomes for the environment," Sam explained.

The project was led by Molly O'Dea, who until recently was the SRA Adoption Officer at Proserpine. Molly explained that with the help of DAF, the trial at Sam's farm was replicated and involved weed counts and extensive collection of growth data, including cane height and stalks per metre.

"Thanks to the help of Allan Blair at DAF (Senior Development Extension Officer), we were really able to have a look at the potential for the dual herbicide sprayer locally," Molly said.

The dual-herbicide sprayer is fairly well known through the industry due to the potential it offers by using two spray tanks – one for chemical over the top of the cane and a different one for the inter-row.

"This allows growers to put pre-emergent over the cane and a knockdown between the rows, which is cheaper and has less of an environmental impact," Molly said.

As well as a control treatment with no chemical, at Sam's farm they looked at options that used Bobcat i-MAXX as the pre-emergent, but with different knockdown options including glyphosate(Round up); ammonium glufosinate (Basta); and paraquat/diquat (Spray.Seed 250).

"Of course, where we used less pre-emergent chemical, less came off and the amount of knockdown chemicals we were picking up in the run-off was really low," Molly said.

"We haven't harvested the site yet, but so far we aren't seeing a difference in the growth of the cane for using less pre-emergent.

"That's a really positive thing for the growers, helping them with more local information on reducing chemical costs, maintaining cane yield, while improving environmental impact."

"It is important to note that the overall project is about demonstration sites and local information to look at water quality at the farm scale and compare different practices. The project didn't conduct statistically analysed research trials."

Overall, the project provided local specific information that supports previous research and demonstration results linking practices such as:

- timing application to avoid run-off for at least the first 20 days after application
- incorporation of herbicides and nutrients with irrigation can assist in improving water quality
- less on, less off.

All up, there are about 55 growers in the Myrtle Creek sub-catchment, which covers a significant part of the district to the north of the town and running into the Proserpine River.

Over the course of the project, it has looked at demonstrations such as mill mud, enhanced efficiency fertilisers, and chemicals, with each trial looking at both water quality issues and productivity information.

As well as the field demonstration sites, the project has involved extensive water sampling and collection from paddocks and creek samples, during the wet season.

"Growers have been really interested in finding out what is happening locally. It has given us a good idea of where we are at and what we need to work on," Molly said.

"There's always room to improve, but a lot of our numbers were really positive. This project has been about being more profitable and helping the environment, which often go hand-in-hand."

Along with regular shed meetings and demonstrations, the project produced a range of information sheets, which have been published on the SRA website. These include wet season results, usage constraints for the district, and tips for herbicide usage for the district. ■

(Top left) *Molly O'Dea, who has now finished with SRA and is completing further studies, with Proserpine grower Sam Orr.*

(Below) *Growers at a recent shed-meeting hearing outcomes of 2020/21 wet season monitoring.*

The project was delivered in partnership with Sugar Services Proserpine and funded by the Queensland Government's Reef Water Quality Program.

SRA also acknowledges the support from Incitec Pivot, Farm HQ, and DAF.

Mark Vass is improving soil health and farm profitability through rotational crops.

ROTATIONAL CROPS
LIFTING SOIL HEALTH

By Brad Pfeffer, SRA

Mark Vass has sugarcane farming in his blood, but he is also quick to admit that he is still learning about ways to improve his farming operation.

Farming not far from Home Hill in the Burdekin, Mark returned to the family farm about six years ago, after moving away to work in mining and construction and starting his first business.

"But the farm was always a bit of a magnet and my partner and I reached the stage where we wanted to come back," he said. "I started by leasing the farm and then bought it, and I'm absolutely loving farming.

"It's harder work than anything else I've ever done, but you really appreciate working on the business and making improvements and seeing things grow."

Mark, 34, and his young family are now farming about 185 hectares. Since getting back to farming, he has been keen to learn as much as he can, look for improvements, hear from other growers in the district, and maximise profitability and efficiency.

In recent years, this has led to a growing interest in improving soil health and growing cash crops in a way that boosts overall farm revenue while also complementing cane production.

This includes crops such as soybeans, maize and mungbeans usually in a pattern of legume-grass-legume, with Mark emphasising the importance of the legumes in the rotation to improve soil health.

He is the first to admit that it comes with plenty of challenges and more pressure, but he is seeing results in terms of improved cane production.

"My aim at the end of this process, as I refine things, is to be 20 tonnes of cane per hectare better off across the crop cycle, aiming for the farm to produce around 18–19,000 tonnes of cane," he said.

Mark first started with legumes about four years ago and said that the change came with a few mistakes and lessons, one of the biggest of which was the time-demand that came with rotational crops given there is "more room for error" with sugarcane.

"Cane is a great crop, but in saying that, if you want the tonnes you've got to be a good farmer. With legumes, you can't give or take a day. If you've got an insect that needs attention, you can't just wait a few days to spray it; you've got to time everything right and get the right support."

Mark said that when he first started farming, he was keen to attend as many workshops and shed meetings as possible, but he added that it was important to carefully assess each piece of information and consider how to apply it to his own situation.

"The soil health movement can be very passionate and there's a lot of different paths and ideas out there. It's really important to sort out the facts from the opinions and look at what will work for you, especially as a young farmer when you are looking for new ideas," he said.

"An idea might be excellent in theory, but it has to work in practice for you. You also need to keep an eye on the fundamental things like crop nutrition and weed control. Weed control is an ongoing issue. I feel I've come a long way in the last five years, but seeds can last in the ground for seven years, so it's an ongoing battle."

Mark is also passionate about precision agriculture and using various tools that can assist with decision making.

As well as running the whole farm on GPS, for example, he also uses the IrrigWeb program, which was originally developed in South Africa and commonly used in the Burdekin to assist with irrigation scheduling.

The program brings in information such as rainfall and soil type and is established with the assistance of Burdekin Productivity Services (BPS), who look at parameters such as crop growth rates.

"I don't necessarily use IrrigWeb during peak watering season for scheduling, I just use it for my record keeping as I am trying to get around the farm, possibly in five days," he said. "It is a great tool when the cane is small. I am also trying to avoid the topsoil cracking, as on my farm when that happens we just can't put enough water on and it runs straight down."

Mark also has strong relationships with other local farmers which allows them to learn together, assist with contracting, and sharing machinery.

"Cane is a hard crop to beat, when you strip it back to its input costs. It is also such a resilient crop, so it will always have a strong future in this district. As an industry, we need to continue to look at ways of making more money from the crop." ■

For more information on soil health, visit the soil health pages of the SRA website.

NUTRIENT MANAGEMENT PLANNING DELIVERS PRACTICAL BENEFITS

By Will Higham, Farmacist

The Arcidiacono family has been farming at Sandy Creek near Gordonvale for more than 50 years. Brothers John and Joe Arcidiacono are partners in the farming business which includes contract cane planting and cane harvesting. It is a family business with John's wife Anita driving cane haulouts (among other things) and their son Matt taking responsibility for driving the billet planter and looking after the GPS and fertiliser rate controllers.

John became involved with the RP161 Cairns and Babinda Complete Nutrient Management Project early in 2020. This project provides cane farmers with high quality nutrient management plans and tailored advice from independent agronomists Charissa Rixon (TRAP Services) and Will Higham (Farmacist).

John explains the history of nutrient planning on their farm: "We started doing our first Nutrient Management Plan (NMP) with the Canegrowers Wet Tropics Sugar Industry Partnership program a few years ago. This was a good steppingstone from our old school methods that were drummed into me by my father. It's fair to say that before we started, our nitrogen fertiliser rates were up there. Last year we joined the RP161 project and worked with Charissa to use the new nitrogen (N) and phosphorus (P) budget approach to nutrient management and it is definitely the way to go – its magic."

They said there were many practical benefits of the RP161 project and the nutrient plans for their farm:

- The N and P budget has allowed them to smooth out and simplify the fertiliser products and rates across their farm and meet the regulations.
- The fertiliser application maps are simple and easy to follow. There are summaries for each farm as well as the whole business.
- They kept a copy of the fertiliser application maps in the fertiliser tractor and this simplified record keeping.
- All the fertiliser information is in one place. They kept a second copy of the plan in the ute so they could organise things such as ordering fertiliser in between doing other jobs.
- Accounting for the nitrogen from the previous legume fallow saved them time by reducing jobs in the plant cane. Charissa worked out the fertiliser rates and products so they could put all the fertiliser required on at planting. Reducing jobs and saving time is a huge advantage because they are busy in the planting and harvesting season.

The planning process involves several meetings with an agronomist to collect farm information and soil tests and prepare the draft and final nutrient management plans for the year. The agronomists tailor the nutrient plan to the individual business and are on call to work on any issues that arise throughout the year.

John encouraged Matt to be involved in all the meetings and decision-making with Charissa.

"I think it is good for both of us to understand more about nutrients and why fertiliser products need to change between paddocks."

"One way or another we are going to stick with Charissa to do these plans in the future."

What's included in the RP161 Cairns and Babinda Complete Nutrient Management Project?

- *tailored, spatially mapped whole farm nutrient plan in line with Queensland Government's reef protection regulations*
- *nutrient application data recorded in line with reef protection regulations*
- *agronomic advice on call for the year*
- *all historical soil sampling data spatially allocated*
- *crop plans with variety and class analysis*
- *assistance with fertiliser box calibration*
- *Google Earth training.*

For more information please contact:

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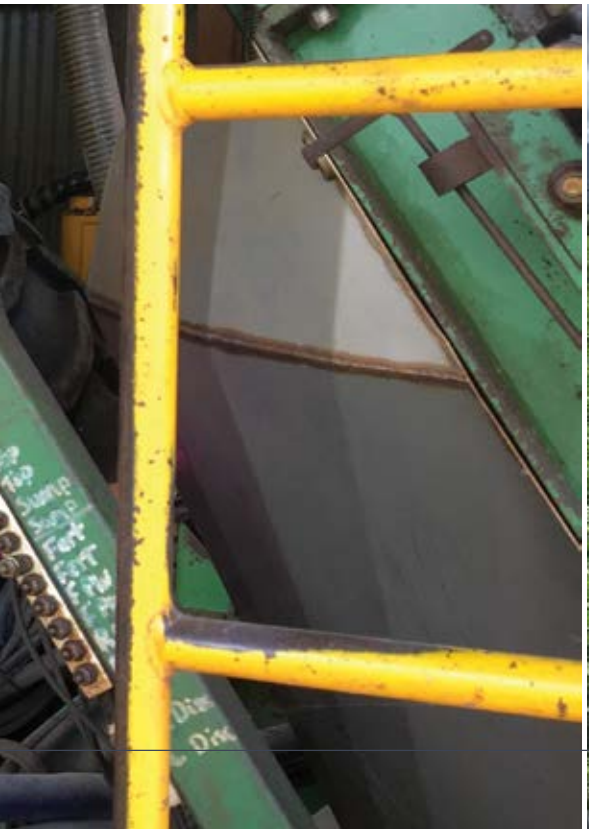
(Bottom left) *Grower John Arcidiacono and agronomist, Charissa Rixon, looking at the fertiliser rate controllers on the cane billet planter.*

(Bottom right) *John Arcidiacono accounting for nitrogen from the previous legume fallow has saved time by reducing jobs in the plant cane.*

The RP161 Cairns and Babinda Complete Nutrient Management Project is funded by the Queensland Government's Reef Water Quality Program and the Australian Government's Reef Trust.



BETTER UNDERSTANDING THE TRUE EXTENT OF RSD

By Dr Anthony Young, University of Queensland

There's a good chance you've heard more about ratoon stunting disease (RSD) in the past few years than you ever have before.

RSD is easily spread through both diseased planting material and via contaminated cutting equipment and can hit yields without showing clear symptoms. Over the past 10 years there has been significant industry debate about how best to manage RSD, and in particular the role of varietal resistance. But when assessing whether current strategies have worked, and determining the costs of new methods, the sticking point has always been: how much RSD is out there, and is it worth the while?

For many years the conventional wisdom was that less than 5% of Australia's canefields were infected. At the recent 2021 Congress of the Australian Society of Sugar Cane Technologists, Dr Rob Magarey (SRA) and colleagues presented a paper that revealed a much greater prevalence of RSD. While three areas had reasonable RSD control, it was found that the disease was potentially spreading.

The University of Queensland's Dr Anthony Young has had a long association with RSD research in Australia and abroad. "The problem with RSD is that you can't see it and, even with the most sophisticated tests available, it's easier to miss than it is to find."

Following the coronavirus pandemic, Australians and the rest of the world have never been so familiar with diagnostic tests and contact tracing, and the same applies to RSD. "It's no good having a country say they have little to no coronavirus but not conducting any organised testing," says Dr Young.

Since the original surveys that confirmed the presence of RSD throughout the Australian industry in the late 1940s and early 50s, until now there has never been an industry-wide survey for RSD.

Instead, the sugar industry has relied on Plant Source Inspection (PSI) results. But this is problematic. Firstly, seedbeds are a biased sample as they are typically the best quality cane available on a farm. Secondly, only 16 stalks are sampled per field. In recent years, there have also been significant advances in the sensitivity of detecting the bacteria that cause RSD.

With the deployment of molecular methods such as qPCR, whether applied to pumped xylem sap or leaf sheath biopsy (LSB) samples, RSD has been found to be having a much greater impact than previously thought.

(Above images) *Implementation of the three pillars of RSD management (disease-free seed-cane, equipment sanitation and planting into fallow ground devoid of volunteers) are essential to minimise RSD incidence.*

Dr Magarey's estimate is $25 million annually, while Dr Young believes it is closer to $100 million. Dr Young explains: "These are just estimates of direct losses but don't take into account the impact of premature ploughout of infected fields, soil damage and management costs associated with the disease."

All of this leads us back to the broader question of what to do now. In the short term, farmers are urged to ensure they purchase clean seed, and make sure it's the first thing that gets planted on their farm each year.

Ploughout-replant should be avoided at all costs, and volunteers removed from fallows, as this further spreads the disease. All seedbeds should be RSD-tested before planted out. Harvesters and planters should be sterilised between varieties and blocks.

No sugarcane varieties are resistant to RSD: they can all become infected, suffer yield losses, and further spread the disease.

Some varieties are more sensitive to RSD and carry significantly higher levels of the bacteria. In situations where RSD is a high risk and hygiene measures are not guaranteed, it may be appropriate to avoid varieties such as KQ228$^{\phi}$, Q253$^{\phi}$, SRA1$^{\phi}$ and SRA3$^{\phi}$.

Work is continuing at SRA to test the reaction of international varieties and clones to RSD in the hope of finding genuine resistance.

For now, the disease can only be managed through clean seed and good farm hygiene. ■

If you have queries about RSD, please contact your nearest SRA office, your local productivity services organisation, or the following industry researchers:

Dr Rob Magarey
rmagarey@sugarresearch.com.au

Dr Anthony Young
anthony.young@uq.edu.au.

You can read recent research papers on RSD, presented to the Australian Society of Sugarcane Technologists conference, at SRA elibrary. Hover your smart phone's camera over the QR code to visit the elibrary.

RESEARCH PROJECT INVESTMENT

PROJECT IDENTIFIER	TITLE	CHIEF INVESTIGATOR	RESEARCH AGENCY	END DATE
Research Mission 1: Continuous improvement in farming and milling profitability				
2016/020	Reducing boiler maintenance costs and deferring capital expenditure through improved technology	Floren Plaza	QUT	1/06/2021
2017/002	Implementing and validating genomic selection in SRA breeding programs to accelerate improvements in yield, commercial cane sugar, and other key traits	Ben Hayes	UQ	1/07/2022
2017/007	Investigations to mitigate the effects of juice degradation in factory evaporators on sugar recovery and quality, corrosion and effluent organic loading	Darryn Rackemann	QUT	1/03/2022
2018/003	Implementation of root system diagnostics to deliver a field-based measure for root health.	Anne Rae	CSIRO	1/08/2021
2018/005	Genetic analysis and marker delivery for sugarcane breeding	Karen Aitken	CSIRO	30/06/2022
2018/009	Development of commercial molecular biological assays for improved sugarcane soil health and productivity	Rob Magarey	SRA	30/06/2020
2018/012	Pan design and operational changes to suit Australian pan stages operating on low pressure vapour	Ross Broadfoot	QUT	1/11/2022
2019/002	Validating high-throughput phenomics technologies for sugarcane clonal selection	Sijesh Natarajan	SRA	30/09/2022
2019/004	Harvester losses assessment by real-time Machine Vision Systems	Cheryl McCarthy	USQ	1/01/2022
2019/005	Strategies to minimise impacts of processing existing soft cane varieties, and industry cost/benefit analysis	Floren Plaza	QUT	1/05/2021
2019/007	Eliminating roll arcing	Geoff Kent	QUT	
2019/901	Smarter Irrigation for Profit Phase 2	Multiple	Multiple	30/06/2022
2019/903	Australian sugar industry soil health benchmarking in the Central region of Qld - increasing profit and transforming soil health practices through competitive industry research, extension and adoption.		SRA	31/10/2021
2019/904	Australian sugarcane industry soil health benchmarking in the Wet Tropics region of QLD - increasing profit and transforming soil health practices through cooperative industry research, extension and adoption	Marguerite White	SRA	31/10/2021
2020/003	Maximising cane recovery through the development of a harvesting decision-support tool	Phil Patane	SRA	1/06/2023
2020/201	Evaluating the suitability of two mud level sensing technologies for juice clarifiers	Robert Stobie	Wilmar/QUT/ Bundaberg Sugar	14/05/2021
2020/202	Improving pan stage performance by on-line monitoring of C seed grainings using the ITECA Crystobserver	Ashley Curran	Sunshine Sugar / QUT	1/05/2022
2020/203	Increased sugar recovery through improved mill sanitation and biocide application	Anthea Fernando	Bundaberg Sugar / QUT	30/06/2021
2020/204	Investigating the corrosivity of evaporator condensates and the contributing factors	Phil Woods	Isis Mill / QUT	30/06/2021
Research Mission 2: Position the industry to stay ahead of climate, environmental and biosecurity threats				
2017/809	Modern diagnostics for a safer Australian Sugar Industry	Nicole Thompson	SRA	1/06/2022
2018/010	Moth Borers – how are we going to manage them when they arrive?	Kevin Powell	SRA	1/08/2021
2019/905	Boosting Diagnostic Capacity for Plant Production Industries	Multiple	GRDC	4/08/2022
2020/002	Developing an integrated device for on-farm detection of sugarcane diseases	Muhammad Shiddiky	Griffith University	30/04/2023
2020/004	Beyond Imidacloprid - Chemical and Biorational Alternatives for Managing Canegrubs	Kevin Powell	SRA	1/02/2024
Research Mission 3: Capitalise on changing consumer preferences, and the growing bio and green economies to develop product diversification opportunities				
2019/902	Biorefineries for Profit - Phase 2 (RR&D4P Round 4)	Ian O'Hara	QUT	30/03/2021

PROJECT IDENTIFIER	TITLE	CHIEF INVESTIGATOR	RESEARCH AGENCY	END DATE
Research Mission 4: Position the Australian sugarcane industry as leaders in profitability, environmental sustainability and resource-use efficiency				
2017/004	SIX EASY STEPS - continuing perspectives in time and space	Bernard Schroeder	USQ	1/02/2022
2017/008	Keeping our chemicals in their place - in the field	Emilie Fillols	SRA	1/07/2021
2019/803	Nutrient Management Planning in the Russell Mulgrave	Gavin Rodman	SRA	30/12/2021
2020/001	Environmental Risk Assessment & Life Cycle Assessment of the Raw Sugar Manufacturing	Simon Carke	Integrity Ag	1/03/2023
2020/802	Mackay Whitsunday Cane to Creek	Matt Schembri	SRA	31/10/2023
2020/803	On ground testing and modelling of the effectiveness of Enhanced Efficiency Fertilisers in the Wet Tropics catchments of the Great Barrier Reef	Julian Connellan	SRA	30/06/2022
2020/804	Reducing herbicide usage on sugarcane farms in reef catchment areas with precise robotic weed control	Mostafa Rahimi Azghadi	JCU	31/08/2022

Research Mission 5: Support the development of an adaptable, professional, commercial and entrepreneurial industry and research community				
2017/101	Re-evaluating the biology of the sugarcane root system: new knowledge allows for assessment of production impacts and implications for yield decline	Anders Claasens	Southern Cross University	1/09/2021
2017/102	Microwave Sensors for Sugarcane Sugar Analysis	Scott Thomason	UQ	1/09/2021
2018/101	New Approaches to Quantifying Nitrogen Fluxes in Enhanced Efficiency Fertilisers in Australian Sugarcane Soils	Aiden Chin	UQ	1/06/2022
2018/102	Characterizing Nitrogen Use Efficiency in Sugarcane	Anoma Ranagalage	UQ	1/06/2022
2019/006	Australian Sugar Industry Training - Development of factory training modules - Phase 2	David Moller	QUT	30/06/2022
2019/102	Genetic solutions for determining fibre quality traits in sugarcane	Angela O'Keefe	UQ (QAAFI)	30/06/2023
2019/401	A new high throughput method for screening for root knot and root-lesion nematode resistance in sugarcane (RESEARCH AWARD)	Karen Aitken	CSIRO	1/03/2021
2019/402	Enhancing the resilience of sugar canes with photoactive carbon nanodots	Qin Li	Griffith University	1/01/2021
2020/101	Engineering bacterial enzyme secretion for cellulose utilisation	Madeline Smith	QUT	1/02/2023
2020/402	Early detection of sugarcane diseases via hyperspectral imaging and deep learning	Jun Zhou	Griffith University	1/02/2022

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