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2024
RESEARCH, DEVELOPMENT AND EXTENSION (RD&E) COMMUNIQUÉS

JULY 2024

PREFACE

SASRI has commenced planning the 2025/2026 Programme of Work for research, technology development and knowledge exchange. The first step in the process was the hosting of five regional Research, Development and Extension (RD&E) workshops during February and March 2024. The purpose of the workshops was to engage with small- and large-scale growers, including miller-*cum*-planters (MCPs), on their technical needs and priorities, around which the SASRI Programme of Work is to be structured.

SASRI is grateful to growers, MCPs and other industry role-players who gave so freely of their time to participate in this RD&E process.

Following the workshops, the topics raised by growers were subjected to intense discussion by SASRI specialists to identify interventions that would be appropriate to address the needs expressed. The following actions are planned.

- *New projects*

  In instances where knowledge gaps were identified, new projects have been proposed for 2025/2026 (Table 1).

Table 1

New projects proposed for 2025/2026 arising out of the 2024 RD&E process

Project Title	**Project Category**	**Project Proposer** (click on links to email Proposer for further details)
Developing a workflow for YSA data capture, visualization and creating a central database	Technology Development	Ms Ingrid Thompson (click here to email Ingrid)
Verge control management and its role in yellow sugarcane aphid infestations in sugarcane	Technology Development	Dr Iona Basdew (click here to email Iona)
YSA and Soil Management Practices	Research	Dr Tracey Campbell (click here to email Tracey)
Assessing the efficacy and sustainability of commercial biological products versus traditional soil health management in sugarcane production	Knowledge Exchange	Dr Dimpho Elephant (click here to email Dimpho)

- *Communication plans*

  In many instances, knowledge was found to exist on some of the topics raise by growers and in these cases, SASRI will develop plans to share this information. Consequently, several Communication Plans covering these topics have been prepared for 2025/2026, some of which may already be implemented in 2024/2025. The plans describe various activities (e.g. grower days, newsletters, articles in *The Link* or *Ingede*) that will be undertaken to ensure effective communication and information sharing.

  For further information on the Communication Plans, please contact Michelle Binedell, the SASRI Knowledge Manager (click here to email Michelle).

- *Communiqués*

  This document provides communiqués on all the topics raised by growers during the workshop, outlining a SASRI response and any activities planned by SASRI in response to the topics.

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2024 RD&E WORKSHOPS

a) Dates and venues

Five regional RD&E workshops were hosted by SASRI in February and March 2024 (Table1).

Table 1

Regional RD&E Workshops: Region, venue and date

REGION	VENUE	DATE
Mpumalanga Lowveld	Malelane Golf Club	27 February 2024
Pongola	AgriHub	15 February 2024
Zululand/Umfolozi	Mtunzini Country Club	13 March 2024
North Coast/Midlands North	Umhlali Country Club	20 March 2024
South Coast/Midlands South	Sezela Country Club	8 February 2024

b) Participation

The workshops were attended by 131 participants (Table 2).

Table 2

Number of participants in RD&E Workshops per region

	LOWVELD	PONGOLA	ZULULAND/ UMFOLOZI	NORTH COAST/ MIDLANDS NORTH	SOUTH COAST/ MIDLANDS SOUTH	TOTAL
Large-scale Growers	15	11	8	8	4	46
Small-scale Growers	9	0	17	14	7	47
Miller-*cum*-Planters	7	0	2	8	0	17
Grower Associations	4	1	0	3	2	10
Government	4	0	3	0	0	7
Other	3	0	0	0	1	4
TOTAL	42	12	30	34	13	131

c) Evaluation

Workshop participants were requested to evaluate the workshop in a post-workshop questionnaire (Figure 1).

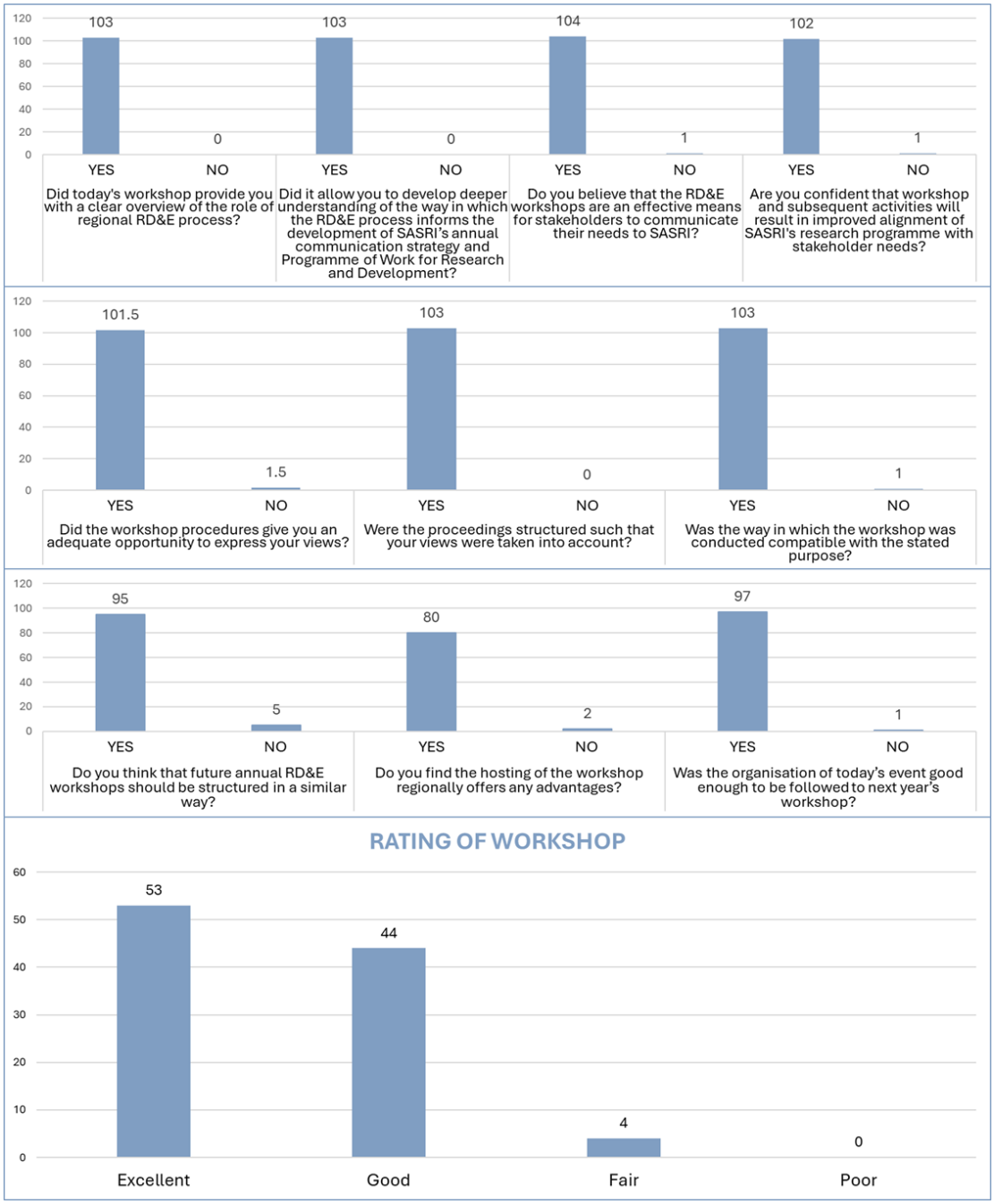

Figure 1

Participant rating of RD&E Workshops across all regions

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CROP MANAGEMENT AND DIGITAL AGRICULTURE

Revisiting SMS scheduling advice for SSGs (RD&E Topic Reference Code: CMDA4)

Background

Topic raised in **Lowveld** workshop.

- Irrigation scheduling advice based on crop stress monitoring (SSGs).

Feedback

Scheduling irrigation is a complex operation requiring precise knowledge of the soil water balance, and the current stage of the growing sugarcane crop. Currently, many growers use soil water probes, and a service provider, to schedule irrigation more precisely. SASRI itself does not monitor growers soil water balances and cannot offer direct scheduling instructions to growers. We also do not have dedicated staff to do this, like the service providers. The decision to irrigate is at a grower's discretion and may be undertaken in conjunction with a dedicated service provider that specialises in this kind of service, and with soil water probe monitoring.

Nevertheless, SASRI is currently developing a real-time weather-data mobile application, for Android and iOS, by means of which growers will be able to see the weather for today and yesterday measured at a nearby SASRI weather station. This station can be chosen by the user, or grower, from a google map on the first screen. The app is simple and only has two screens. Extension will be able to share and teach the use of the application to the growers, as needed.

There are crop-stress monitoring service providers working in Mpumalanga already in collaboration with RCL. Growers can contact the mill regarding such services. SASRI cannot offer this service nor dedicate staff to this, though as a research facility we are currently researching new techniques in making use of satellite imagery and remote sensing to assist growers in monitoring crop stresses.

The MyCanesim scheduling service was not efficient since the on the ground information was not available after the initial project. Grower actions such as irrigation or no irrigation, changes in crop stages, early harvests and split fields/crops, could not be adequately calculated by modelling, which the MyCanesim system made used of.

SASRI can provide SMS services that provide weather data, with values such as rainfall and potential evapotranspiration, although the mobile application mentioned above will be a good means of sharing real-time weather data.

For further information, please contact Aresti Paraskevopoulos (Scientific Programmer)

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WeatherWeb use (RD&E Topic Reference Code: CMDA4)

Background

Topic raised in **Lowveld** workshop.

Growers require assistance to use WeatherWeb more meaningfully.

Feedback

The WeatherWeb mobile application currently under development by SASRI will help growers to see the current and previous day's weather data. Release of the app is expected sometime in 2024. The application has just two screens with just a few clicks and is easy to learn and use. The application can be taught to growers after release via extension. A new website with a more modern look is also currently under development.

For further information, please contact Phil Sithole (Agrometeorologist)

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Drought Irrigation Program (DRIP) (RD&E Topic Reference Code: CMDA4)

Background

Topic raised in **Lowveld** workshop.

Update on DRIP for the management of irrigation according to growth stage.

Feedback

Work on the DRIP application is currently on hold due to capacity bottleneck in SASRI scientific programming capacity. With regards to irrigation per growth stage, the Irrigation Information Sheets (5.1 - 5.20), in particular Irrigation Information Sheet 5.2 (Irrigation strategies during water limiting periods) are useful for providing information about where growers can hold back on water, and which stages are more crucial. Information Sheet 5.3, in particular, discusses irrigation as per crop water demand, and ways to determine the demand based on canopy and crop stage.

For further information, please contact Aresti Paraskevopoulos (Scientific Programmer)

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Digital Agriculture for anomaly detection (RD&E Topic Reference Code: CMDA5)

Background

Topic raised in **South Coast/Midlands South**, and **Zululand/Umfolozi** workshops.

Growers are unsure what Digital Agriculture is and consequently, posed the following questions:

- Will an App be developed which indicates growth/ yield/ pest determination (Similar to PurEst®)?
- Can Digital Agriculture be used to highlight problems from a bird's eye view, so that growers can be notified that there is a patch in field that is not growing as per requirements?
- Can Normalized Difference Vegetation Index (NDVI) be used to monitor YSA and Eldana infestation in the field?

Feedback

An overview of Digital Agriculture was provided in the May 2024 edition of *The Link*, which growers may find informative.

- SASRI is engaging with prospective commercial partners regarding app development.
- Remote sensing via satellites, aircraft, and drones provides a synoptic view of the earth's surface; each at different spatial resolutions and scale. Satellites provide imagery for a given location on a regular interval (e.g. every 10 days). Satellite imagery (such a Sentinel-2, which is freely available) can thus be used for monitoring of fields, i.e. detection of anomalies that can be further investigated. Indices such as the NDVI, derived from satellite imagery, will be key for anomaly detection. Foundational research is, however, required to develop tools necessary for detection of pests & disease, nutrition deficiency, water stress, and other stresses.
- Additionally, an existing Project 22TD05 "A P&D risk model as a precursor to development of an early warning system (EWS)" seeks to model YSA risk using biophysical and climate data. This stage gate project serves as a precursor to the development of an early warning system for YSA, using remotely sensed satellite data.
- The NDVI is a vegetation index that employs the reflectance in the red and near infrared bands to provide an indication of plant vigour/greenness. The formula is (RNIR-RRed)/(RNIR+RRed) with values ranging from -1 to +1. Values between 0 and 0.33 are indicative of stressed plants, whereas values above 0.33 are indicative of healthy plants. Values close to +1 are typical of very healthy and/or dense vegetation. Values below zero indicate dead plants/bare soil/barren land. Changes in the NDVI of healthy vegetation may be interpreted as a change in the health status of the plant. Thus, NDVI alone cannot serve as an indicator of YSA- and/or Eldana-induced stress. NDVI can be used with other vegetation indexes and ancillary data such as climate and biophysical data to monitor YSA, Eldana, and other pests and diseases.

Increased knowledge exchange and Digital Agriculture awareness will be achieved through a **Communication Plan** that SASRI has developed, which will include further grower days and *The Link* articles.

For further information, please contact Dr Nitesh Poona (Digital Agriculture Specialist)

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Mobile app for identification of varieties, pests and diseases with management advice (RD&E Topic Reference Code: CMDA6)

Background

Topic raised in **Lowveld** workshop.

The following queries were raised.

- App for P&D ID / Variety Management needs to include recommendation on management/thresholds for management implementation. Can include variety information ID.
- A request for a cellphone and/or website application with photographic recognition for disease identification and variety type identification. Such a tool would provide instant diagnostics and real-time information on disease and variety management at hand in the field. This request seems to have arisen from growers' desire for more accessible packaging of multi-disciplinary information. Desire to have instantaneous access to (interdisciplinary) SASRI information at hand in the field. This includes information about (i) Variety identification, (ii) P&D identification & management, and (iii) Crop management.

Feedback

- Project 22TD04 “Disease detection in sugarcane using computer vision” (currently on hold) is aimed at developing models and a web application for identifying P&D using images captured using a mobile phone. Unfortunately, the work has been unable to proceed due the resignation of the Scientific Programmer driving the research and subsequent recruitment challenges.
- SASRI will engage with commercial partners regarding development of a mobile app that provides information on varieties, P&D, and crop management.

For further information, please contact Dr Nitesh Poona (Digital Agriculture Specialist)

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Cane quality estimate discrepancies (RD&E Topic Reference Code: CMDA9)

Background

Topic raised in **Zululand and Umfolozi** workshop.

Growers enquired why there is a difference between the cane quality estimates provided with refractometers (through the PurEst® application) compared to the data collected by the millers. These growers are also asking if there are alternative methods available for on-farm estimation of cane quality.

Feedback

Currently, two methods exist for estimating cane quality parameters on the farm. The most precise method is analytical testing of cane stalks (12 – 16 stalks per field) submitted to a cane testing laboratory at the local mill (CTS) or at the SASRI Research Stations in Pongola or Mount Edgecombe. This method is often not logistically possible due to distance from the laboratory or during the off-season when the CTS laboratories at the mills are not operational.

Hence, SASRI developed an alternative method that allows estimating cane quality on the farm with a portable refractometer in combination with the smartphone application PurEst®. For this method a minimum of 3 stalks per field must be used. The main benefit of the PurEst® method is that crop suitability for chemical ripening can be quickly assessed on the farm from about 3 months prior to harvesting. In addition, closer to harvesting the PurEst® method allows for comparisons between fields to identify those with the highest relative maturity for harvesting.

It is very common for the cane quality estimates obtained through both the analytical and PurEst® on-farm testing methods to differ from the data provided by CTS for cane consignments delivered to the mill. Usually the on-farm test values of RV% and juice purity are higher than the CTS test values. Both these on-farm methods estimate the quality parameters in unburned stalks, stripped of all leaf material and topped at the natural breaking point. As such, these on-farm methods cannot account for changes in cane quality that occur because of burning, variable topping height, presence of leaf residue, stalk desiccation, presence of extraneous matter (e.g. soil) and burn to crush delays. In essence, these on-farm test values represent the best-case scenario cane quality status of a particular field before harvesting processes, that reduces cane quality, come into effect.

Both the analytical and PurEst® on-farm testing methods are there to assist growers in chemical ripening and harvest decision-making and cannot replace the accredited analytical testing provided by CTS on cane consignments delivered to the mill.

SASRI is currently doing a research project where the ability to estimate cane quality parameters on a much wider scale, from imagery obtained with drone-mounted multi-spectral cameras, is being investigated. Such a method could widen the scope for on-farm testing of cane quality, but because of the reasons discussed

above, these estimates could easily also differ from the CTS data for cane consignments delivered to the mill.

For further information, please contact Dr Riekert van Heerden (Senior Scientist: Crop Physiology; and Manager of the Crop Performance and Management Research Programme)

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Progress in Digital Agriculture research (RD&E Topic Reference Code: CMDA10)

Background

Topic raised in **Lowveld** workshop.

Growers requested clarification on research project progress for digital agriculture as a whole, and the availability of remote sensing (RS) products and services to growers.

Feedback

During the Lowveld RD&E workshop, it was noted that SASRI has several Digital Agriculture research projects in all four SASRI research programs, i.e. Crop Performance and Management, Crop Protection, Systems Design and Optimization, and Variety Improvement. All research projects are stage-gate projects that serve to demonstrate proof of concept. Consequently, the research is not currently at the stage of operationalisation/commercialization. If proof of concept is obtained, further testing and evaluation will be required. Commercial partners can then be sought to operationalise the developed models/applications thereby providing a service to growers. Progress will be shared during regional events at the discretion of the relevant extension specialists.

For further information, please contact Dr Nitesh Poona (Digital Agriculture Specialist)

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Adoption and engagement with SUSFARMS® (RD&E Topic Reference Code: CMDA11)

Background

Topic raised in **North Coast/Midlands North** and **Zululand/Umfolozi** workshops.

Growers noted the following.

- Not much uptake in Darnall within the context of sustainable aviation fuels initiative.
- Driven by mills / need THS buy-in in Zululand/Umfolozi
- Perception by growers that it is laborious.
- Currently no strict control and until this in place there will be no movement.
- Currently it is on THS's radar.
- Needs to be top/down / technology 'pull'.
- There is resistance to the adoption of the Sustainable Sugarcane Farm Management System (SUSFARMS®) in some areas.
- Where are we with SUSFARMS® for SSGs?
- What is SASRI's role in supporting growers (SSG included) who wish to use this sustainability tool?
- How are growers going to be encouraged to adopt SUSFARMS®?

- Adoption of SUSFARMS®, especially among small scale growers, needs to be considered in terms of pulls and pushes towards adoption. There is a possible role for SASRI to help small scale growers in the initial year of reporting to SUSFARMS® (subsequent years are typically easier to do)"
- Is smart farming going to be working with SUSFARMS®? How are we going to encourage growers to get onto the SUSFARMS®, SASRI or Millers? Our role is to support not to enforce. Want a wider rollout. Illovo mill is enforcing customers, due to export demand (pull).

Feedback

The Sustainable Sugarcane Farm Management System (SUSFARMS®) is the South African Sugar Industry's sustainability system designed to help sugarcane farmers implement and monitor sustainable practices.

- It provides guidelines for better management practices (BMPs) that consider the environment, social responsibility, and economic factors.
- Farmers can use the system to evaluate their current practices and identify areas for improvement.
- SUSFARMS® offers a self-assessment Progress Tracker tool to track progress towards sustainability goals.

Overall, SUSFARMS® helps the sugar industry by reducing the environmental impact of sugarcane production, promoting fair treatment of workers and engagement with local communities; whilst ensuring farms are profitable in the long term.

Many customers of sugarcane products require sustainability certification**,** which address ethical and environmental concerns in sugarcane production. Currently, SUSFARMS® is being used in some mill areas to meet sugar customer demands for sustainable supply of the product. In these areas, engagement with the SUSFARMS® system is greater than in areas where it is not a mandatory requirement to complete a farm assessment. However, it is likely that certification will become a more widespread requirement when the industry diversifies into alternative products such as sustainable aviation fuel.

Whilst one of the benefits of certification include market access, adoption of better management practices within a farming system may lead to greater profitability on-farm. It is within this area that SASRI's Extension Specialists engage with growers – both large-scale and small-scale. SASRI provides the technical know-how and guidance for implementing better management practices, encouraging farmers to apply more regenerative approaches and long-term farm sustainability practices.

Whilst adoption of better management practices has its own challenges, it is the self-assessment aspect of SUSFARMS® that many growers find laborious. It is seen as an administrative burden and therefore engagement with the actual content of the system is low. In mill areas where there is no current requirement for certification, growers feel there is no incentive to engage with the system. This represents a lost opportunity in that growers are denied the opportunity to gain insight into labour requirements, practices to increase yield and so many more useful and sustainable operations.

Apart from market advantage, sugarcane growers can reap several benefits by implementing SUSFARMS®:

- Sustainability**:** SUSFARMS® promotes practices that minimize environmental impact, such as water conservation and soil health. This ensures long-term viability of the land and reduces regulatory risks.
- Profitability: Better management practices often lead to increased yields and efficiency. SUSFARMS® helps growers optimize resource use and potentially reduce costs.
- Compliance: SUSFARMS® keeps growers up to date on relevant regulations and helps them comply with legal requirements, avoiding potential fines or penalties.
- Self-Assessment & Improvement: The SUSFARMS® self-assessment tool allows growers to identify areas for improvement and track their progress towards sustainability goals.

By adopting SUSFARMS®, growers can become more responsible stewards of the environment, improve their bottom line, and position themselves for success in a demanding marketplace.

For further information, please contact Michelle Binedell (Knowledge Manager)

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Cane quality management of rainfed sugarcane crops during El Niño (dry) climatic conditions (RD&E Topic Reference Code: CMDA12)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers requested recommendations on cane quality management of rainfed sugarcane crops during El Niño (dry) climatic conditions

Feedback

Probably the most important consideration when planning to spray any of the registered products for chemical ripening is crop growth vigour and associated crop maturity at the time of spraying. It is of paramount importance that spraying takes place when the cane is growing vigorously, and crop maturity is sufficiently low. As the dry conditions associated with the El Nino phenomenon intensify there will be fewer and fewer rainfed sugarcane fields that meet the suitability criteria for ripener spraying. The main reason for this is that drought stress will rapidly reduce plant growth rate, and hence, accelerate sucrose storage (crop maturity) through a process called natural ripening.

Because natural ripening increases whole-stalk juice purity, the ability to estimate this quality parameter in sugarcane fields on the farm greatly enables ripening decision-making. This is particularly important in dry years where different soil and variety combinations could lead to uncertainties and inconsistencies regarding suitability for chemical ripening.

To assist growers in this regard SASRI developed a method that allows estimating whole-stalk juice purity on the farm with a portable refractometer in combination with the smartphone application PurEst®. The main benefit of the PurEst® method is that crop suitability for chemical ripening can be quickly assessed on the farm from about 3 months prior to harvesting. In addition, closer to harvesting the PurEst® method allows for comparisons between fields to identify those with the highest relative maturity for harvesting.

During dry spells growers are advised to intensify maturity assessment of their fields with PurEst® before deciding to apply ripeners. This will allow for objective assessment of chemical ripening needs that could be linked to the known juice purity thresholds of the different chemical ripeners (refer to SASRI Information Sheets 4.8 – 4.10).

The visual appearance of the crop during dry spells is also very important. If the leaf canopy is stressed with only a few mature green leaves (typically less than seven) remaining, it would be best not to apply chemical ripeners, even if crop maturity is relatively low. The reason is that chemical ripeners could add an additional stress burden on the crop, which could trigger unwanted consequences such as severe stalk desiccation, sour rot and eldana infestation. Eldana-infested cane (>5e/100) should also not be treated with ripeners, so during dry seasons proactive scouting for the pest and implementation of an eldana spray programme are important pre-requisites when considering chemical ripening.

For further information, please contact Dr Riekert van Heerden (Senior Scientist: Crop Physiology; and Manager of the Crop Performance and Management Research Programme)

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Aerial methods for agrochemical application (RD&E Topic Reference Code: CMDA13)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers expressed an interest in discussing and understanding the merits of applying agrochemicals with different aerial application methods (fixed-wing, helicopters, microlights and drones). They indicated that there was widespread use of drones due to higher accuracy of agrochemical application as compared to other aerial application methods, with similar costs involved for both methods. However, the drawback is that multiple drones are needed to cover large areas. The following questions were raised.

- Is there a difference in chemical efficacy between different service providers?
- Are there differences in efficacy in spray methods?
- Growers are using drones more regularly, and have been advised not to use them for fertiliser and herbicide application, is there potential for SASRI to look at addressing this?
- What are the possibilities for drones for other aspects of crop management? How can it be used as a management tool for farming in general?

Feedback

Chemical efficacy is thoroughly investigated by agrochemical companies prior to product registration. As long as a chemical product is registered for aerial application, and the service provider correctly adheres to the application instructions stipulated on the product label, good chemical efficacy can be expected, regardless of aerial application method. Growers should consult with local service providers based on their individual needs for coverage, precision and operation scale in order to make an informed decision regarding the most suitable aerial application method. Chemical application operations should comply with legal requirements, adhering to all relevant safety standards and operational guidelines, as per South African Civil Aviation Authority (CAA) regulations.

Furthermore, an agrochemical product can only be applied with a manned (e.g. fixed wing / helicopter / microlight) / unmanned (e.g. drone) aerial vehicle, if it has been registered for aerial application. Such registrations are funded solely by individual agrochemical companies and not through research conducted by SASRI (i.e. industry-funded).

In a more general capacity, drones offer numerous possibilities for enhancing crop management. Drones equipped with high-resolution cameras and multispectral sensors can be used for monitoring crop health, detecting issues such as nutrient deficiencies, and pest and disease infestations. They can also be used for irrigation management and identifying areas of water stress. Drone surveys can be used to track crop development and growth stages, and predict biomass and yield, allowing for more effective harvest planning. By integrating drones into their operations, farmers can make data-driven decisions, optimize resource use, and improve overall farm productivity.

For further information, please contact Dr Natalie Hoffman (Crop Physiologist)

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Digital and smart agriculture tools for small-scale growers (RD&E Topic Reference Code: CMDA15)

Background

Topic raised in **North Coast/Midlands North** workshop.

The following comments from growers were noted.

- Commercial service providers are expensive. Can SASRI do anything to deliver cost-effective tools?
- In a more digital world, how do we ensure digital solutions are accessible and affordable to all farmers?
- Access to smart farming tools by SSGs? Demonstration of these tools to SSGs?
- Digital software for management and record keeping tools are needed by smaller and medium growers who may not be able to afford CanePro or PlanAhead?
- We need to bridge the gap for SSG and introduce the technology to SSGs.
- Drones were provided by government to SSG a few years ago but due to a lack of understanding they haven't been used. How will SASRI ensure the transition from research to implementation to SSG?

Feedback

SASRI is not involved in software development. Consequently, growers will need to engage with SAFDA/SACGA regarding budgeting tools and management/record keeping software.

SASRI is aware that not all SSGs have smart phones that are required to run mobile apps. Consequently, SASRI will investigate alternatives to deliver technology-based solutions to SSG. SASRI will provide/arrange training for all digital tools.

For further information, please contact Dr Nitesh Poona (Digital Agriculture Specialist)

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CROP NUTRITION AND SOIL HEALTH

FAS: Understanding reports, micronutrients and liming recommendations (RD&E Topic Reference Codes: CNS1 and CNS6)

Background

Topic raised in **Lowveld** (FAS reports), **North Coast/Midlands North** (liming recommendations), **Zululand/Umfolozi** (micronutrients) workshops.

Growers expressed lack of understanding of the FAS report. Growers requested guidance on understanding FAS recommendations and interpretation of the results. Additionally, growers requested the understanding of nutrient interactions e.g applying P according to recommendations but not seeing increase in leaf – why? The growers want to monitor all elements in the soils than few elements. Growers highlighted that in most cases the recommendations are on NPK but there are other elements that have interactions with the availability of NPK, they required SASRI scientist to explain. Additionally, growers indicated the main challenge for small-scale growers is monoculture planting with no fallow periods, what other ways are there to look at other nutrients than NKP to add back to the soil. Growers asked why FAS not give micronutrients recommendations on the FAS report and could that be added going forward. Interest has also been expressed by growers for FAS report to include various options for liming. Currently, FAS report present options for liming to 20% acid saturation. Growers are requesting that in addition to presenting for liming to 20% acid saturation there should be options for liming to 10% and 5% acid saturation as well.

Feedback

The response has two parts, namely understanding FAS reports and liming to various acid saturation

Understanding FAS report

Understanding a soil, leaf and water report involves interpretation of various metrics related to physical and chemical soil properties. The information and the insights in an FAS report help you to improve your nutrient efficiency, nutrient management, soil health, diagnose in season crop deficiencies and prevent unnecessary yield losses. In the standard FAS soil test report, both macronutrients and micronutrients are included as elements tested. For topsoil, fertility and liming recommendations are made for the 0-20 cm soil depth while for subsoil lime/gypsum recommendations are made from the 20-80 cm depths.

The soil report includes analysis of elements/parameters that were measured in the sample submitted for analysis. Depending on the element tested, the unit of the element could be given in mass of an element per litre (mg/L); charge concentration of a molecule per litre of soil (cmol/L) and (%) which describes a proportion contribution of that element out of a possible total of 100%. Furthermore, the reports give threshold values for the elements and this threshold determines the adequacy of a nutrient or a potential limitation. In all the elements tested there is a relationship with either one or the other elements. For an example if your soil has low pH less than 4.5, you are mostly likely to get lime recommendation, but this recommendation is not only dependent on the value of soil pH but also at your acid saturation levels.

It is advisable to undertake leaf sampling where soil test values indicate deficiencies, and this is because the calibration between soil and micronutrient levels and crop response tends to be poor. The leaf analysis report gives guidance on whether the tested values are within the predetermined sufficiency range. Macronutrient units are reported as a percentage (%) element or gram element per 100-gram dry leaf. The micronutrients in the leaf analysis report are reported as parts per million (ppm). In the report, the sample value refers to the actual test result measured for the sample. The report also includes the leaf criteria which defines the threshold values that are used to decide if a nutrient is low, sufficient or high. The parameters measured each have a specific role that they play in the crop growth. An example, the nitrogen elements

tested in leaf analysis is essential for protein and chlorophyll production, phosphorus is key for the plants energy supply chain and establishment of a healthy root system.

Visit the SASRI e-Library to download more information sheets.

Liming to various acid saturation

FAS reports are meant to be simple and easy to interpret. They should ideally fit in one page per sample to simplify viewing the reports. Considering this, it may not be suitable to provide a report with three options for liming in addition to other presentation on fertiliser options. Notwithstanding, liming to very low acid saturation, particularly for a plant crop, is understood. Consequently, SASRI soil scientists are considering creating a macro enabled excel spreadsheet compatible with FAS soil test reports. This spreadsheet would allow growers to copy and paste FAS reports and then compute lime requirements for 10, 5, and 1% acid saturation. The macro-enabled spreadsheet could be made available on request from extension.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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FAS services and recommendations (RD&E Topic Reference Codes: CNS2 and CNS5)

Background

Topic raised in **Pongola** (recommendations) and **Lowveld** (FAS services) workshops.

There has been low support of FAS from the lowveld, and most of the growers send their soil samples overseas. They would get different results than those from FAS because different tests are used. Growers are also sending samples to be tested according to Albrecht system. The reasons for sending samples overseas have to do with personal preference and possibly some distrust of results from FAS. Growers have indicated that they would send two soil samples that were taken from the same field on the same day but get different results.

Feedback

The feedback is divided into the following sections.

- Tests and recommendations from FAS and the Albrecht system
- Soil variability
- Quality control measures from FAS

Tests and recommendations from FAS and the Albrecht system

FAS recommendations are based on many decades of research and are aimed at recommending optimal nutrient application rates for optimal crop growth for the sample test values and agronomic information supplied with the sample. They are also continually being examined to identify needs and gaps in the recommendations with the aim of ensuring optimal use of fertilisers.

Recommendations are extrapolated from calibration studies. In calibration studies, soils with varying soil test values, textures, and other properties are treated with increasing nutrient of interest and the response, in terms of yield, is measured. The relationship between the soil test value and the yields is then established which allows formulation of recommendations. Inarguably, the recommendations are specific to the soil test used for calibration and cannot be extended to a different soil test. Consequently, soil scientists at SASRI

cannot formulate recommendations for soils tested elsewhere using a different test than that used in FAS. In addition, the reliability of recommendations made without calibration studies cannot be confirmed.

In relation to Albrecht system, no calibration studies have been conducted at SASRI mainly because there is numerous evidence in literature that the system does not work. There are three things often mentioned by the proponents of the Albrecht system, namely: soil chemistry, soil physics, and soil biology. They often say that the system was designed to address all three components. These are the core of soil science and are not dependent on Albrecht system and could be addressed without following the system. A soil fertility test will alert a grower on chemical imbalances which will address the soil chemistry. A soil salinity-sodicity test will alert the grower if there any risks in terms of soil physics. And finally, adhering to SASRI's best management practices (BMPs) will improve the soil biology. Furthermore, 'Albrecht' based recommendations, frequently induce deficiencies of the metal micronutrients which will short-change growers. This article in the Farmers' Weekly may assist growers wishing to read further.

Soil variability

Soils are in their nature heterogeneous. This results in large variability of soil properties in one field. This is the reason why a composite sample consists of numerous sampling points and the final sample that gets sent to FAS needs to be mixed well. Several researchers have indicated that large errors are often associated with sampling rather than the testing in the laboratory. Thus, it is possible for soil samples taken from the sample field to give different values. But, if done according to the soil sampling guidelines, those differences should be minimal. This will apply even if the soil samples are not sent to FAS but to other soil testing laboratories.

Quality control measures from FAS

FAS has several control measures in place to ensure that they produce high quality results. These include internal control, accreditation with SANAS, participation in national and international proficiency schemes. The internal control measures include reviewing of results by a soil scientist before they are released and analysis of quality control samples with all the batches. In this instance, soil samples that have been analysed several times by different technicians gets included in the batch and the results are compared against previous results. If the results of the control samples are not comparable to previous results, then the whole batch is repeated, and an investigation is initiated. The investigation and repetition of analysis is inline with the SANAS standards. In addition, SANAS also requires the laboratory to conduct internal and external audits, all to ensure quality of results.

FAS is also a member of AGRILASA and WEPAL which are national and international proficiency schemes, respectively. AGRILASA is mainly for soils, leaves, and fertilisers while WEPAL is only for leaf analysis. Over the years, FAS has performed well in these proficiency schemes.

In summary, FAS recommendations are based on calibration studies and using sound scientific basis, and the tests are reliable and backed by several quality control measures.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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FAS methods of testing (CNS 3 and 9)

Background

Topic raised in **Lowveld** workshop.

Growers questioned the method of testing phosphorus used by FAS, *viz*. the Bray 2 method. Growers requested that FAS should offer a choice to growers to use different P methods e.g. Grade 1 (acidic soils) or 2 (trace metal – alkaline soils) or both.

Feedback

Phosphorus recommendations in sugarcane are based on soil testing, where calibration between soil test values (extractable phosphorus) and crop response are established. Where soil levels are sub-optimal, then phosphorus application is advised to raise the soil test value to the threshold value where no further crop response is expected. However, due to the complex chemistry of phosphorus in the soil and the multitude of extraction procedures to estimate plant available phosphorus for different soils and crops, it can be difficult to find a single, reliable, extraction method for use in routine analysis for advisory purposes. Because of the complexity around phosphorus extractions, it is always advantageous to use a single multi-element extraction for routine fertility assessments hence FAS uses resin P.

The extraction method is suitable for all soil types and accommodates a wider soil pH range. There are many more other methods for measuring phosphorus in soils such as bray 1, bray 2, Olsen and Mehlich 3. In soil analysis of phosphorus, two types are distinguished: 1) total analysis and 2) extractable analysis. It is important to note that many laboratories choose a method of extracting phosphorus that is able to define what can be considered as plant available phosphorus. Soil pH is an important function in determination of phosphorus. FAS uses a method that accommodates a wider range of soil pH. FAS is part of the Agri-Laboratory Association of Southern Africa (AgriLASA) that aims to provide a forum to promote analytical accuracy, encourage diversity and provide network opportunities between experts.

Participation of FAS in AgriLASA helps FAS in keeping up with mostly used test methods by other laboratories in the country. A new method being tested by most laboratories in the country is Mehlich 3. FAS is also testing this method (Mehlich 3) under project 22CM01. The method has become a popular phosphorus method amongst many other laboratories worldwide. The method is a multi-element extraction method used in routine agriculture laboratories. The method has several advantages in that it is reported to work well across a range of soil conditions, correlate well to crop responses, has a short extraction time and is a cost-effective method that can simultaneously extract all commonly measured soil nutrients currently requiring several different extractants. The project has the following aims

- To compare the extraction efficiency of several common phosphorus (including multi-element) extraction methods on a range of soil types from the South African sugar growing regions.
- To determine phosphorus response thresholds values for each of the tested methods where sugarcane crop response is likely (initially using pot trials).
- Revise phosphorus application recommendations based on P application rates, crop responses and amounts of phosphorus extracted for each of the test methods.Examine the amount of phosphorus that each method extracts as a proportion of non-labile and total phosphorus forms (to permit assessment of potential long-term supply).

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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Fertiliser recommendations for yield targets plus incremental targets (RD&E Topic Reference Code: CNS4)

Background

Topic raised in **Lowveld**, **Pongola** and **South Coast/Midlands South** workshops.

Growers would like to increase their yields and would like FAS to give recommendations for target yield and for options such as target yield plus 5%. They are of the view that the given recommendations are under ambitious and do not enable cane to reach full potential. Growers also want to know how the method and results from FAS compare to other soil testing laboratories.

Ideally, growers would like fertiliser recommendations according to yield target but then also a range of incremental targets e.g. target, target + 5%, target + 10%, etc. In addition, growers want a tool to determine whether it is economically viable to try and improve yields say from 120 t/ ha to 150 t/ ha.

Feedback

The issues raised have two components. One has to do with the quality of results from FAS and this has been addressed for topics CNS 2 and 5. The other issue has to do with the recommendations. The discussion on recommendations will include the approach used to formulate recommendations and then highlight the importance of monitor plots in exploring the potential yields.

Fertiliser recommendations are formulated using two sources of information, one supplied by the grower when submitting the soil samples and other is obtained from the laboratory through soil testing. The information supplied by the grower includes target yield, management practices, and the variety. The target yield is important in formulating the recommendations because, using that information, it could be estimated how much nutrient will from the soils. And, using the soil test value, it could be estimated how much is needed to achieve the target yield. The deficit from the soil is supplied through fertiliser and other inputs that are related to management. This is the reason why the FAS form would ask whether residues are being retained and which green manure crops are used. The link between the soil test value, management practices, and target yield is backed by decades of research and should remain inviolable.

There are several site-specific factors that influence yields beyond the soil test value and the inputs applied, which could be determined by a soil testing laboratory. There are risks associated with excessive application of fertiliser and recommending without sufficient information to guide such decision. For instance, excessive supply of nitrogen could cause crops to be susceptible to lodging and other pests and may delay maturity of the crop. So, if FAS were to recommend more fertilisers to try and achieve higher yields without knowing the limitations of the land then that would cause other problems leading to declining yields and loss of profits. It is thus not possible for FAS to make recommendations for target yields and plus other options that would explore potential yields without assuming the said risks.

Does this mean that the grower should settle for what would be mediocre yields when something better is possible? Not at all. But determining yield potential could be done by the grower with assistance from the extension specialist and not FAS. Reason being that the soil test value is not indicative of the potential yield, and it is not a good practice to guess whether the target yield is closer to the potential or not. So, if that is the case, how would a grower determine the potential yields? One way to do that is to use monitor plots where deviations from FAS recommendations are applied on a small piece of the farm and the obtained yields are compared with the rest of the fields. Several readings are available on monitor plots, and they listed below. Sometimes, the monitor plot is referred to as ‘indicator plot’.

1. Information sheet 7.3: Nitrogen management: N-Monitor plots
2. The Link, January 2022: Managing carry-over cane this season
3. The Link, May 2018: Be wise, don’t over-fertilise
4. The Link, September 2022: Foliar feeding of nutrients

With the information from the monitor plot a decision could be made regarding the potential yield of a particular piece of land. This information could then be used when filling in the FAS form and, consequently,

when formulating fertiliser recommendations. In this way, the risk is mitigated, and the potential yields were not left unexplored.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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Copper rods (RD&E Topic Reference Code: CNS7)

Background

Topic raised in **Zululand/Umfolozi** workshop.

Growers expressed an interest in the use of copper rod for crop productivity. Copper rods implanted in the ground are reported to improve crop quality and productivity by supplementing soil nutrition; investigating whether this method effectively enhances crop quality remains essential.

Feedback

Sugarcane requirements for copper (Cu) are very low with the crop removing only about 1 to 2 grams per ton of cane harvested (a typical 100 t/ha sugarcane crop removes about 0.1 to 0.2 kg Cu/ha). Copper is important for the production of chlorophyll and for photosynthesis. It is also involved in protein and carbohydrate processes in the plant. Copper is taken up by the plant as the Cu2+ cation or as organic chelates. Due to the very low crop requirement, deficiencies are rarely reported as most soils have sufficient supply. Use of copper rods as a way to supplement Cu in soils could cause greater harm than providing solution. Excessive Cu in the soil can lead to toxicity, negatively impacting plant growth and soil microbial health. Additionally, Cu can accumulate in the soil over time, especially in soils with low pH, leading to long-term negative effects.

There is limited scientific research and evidence supporting the widespread use of Cu rods for soil health improvement. Most benefits are theoretical or anecdotal at this stage. Furthermore, the use of any material such as rods in agriculture is subject to regulatory oversight to ensure safety for the environment and human health. Introduction of Cu rods into the soil would need to comply with agricultural and environmental regulations and implementing Cu rods in large-scale agricultural operations could be impractical and costly compared to traditional soil amendment and fertilisation methods. Growers are advised to make use of copper sulphate (mono or penta-hydrate, 25-35% Cu) or a suitable copper fortified fertiliser mixture. Information sheet on “Copper management” (available from the SASRI E-library).

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Testing for boron (RD&E Topic Reference Code: CNS8)

Background

Topic raised in **Lowveld** workshop.

Growers would like to know whether it would be possible for FAS to test for boron.

Feedback

SASRI recognises the importance of boron in sugarcane production. Nevertheless, challenges in analysing boron in soils and plants have led to this nutrient being offered only as a supplementary for leaf analysis. Leaf analysis for total boron is by acid-digestion of the leaf material. Currently FAS analyses leaf material using X-Ray fluorescence spectroscopy, but this technique is not sensitive to certain elements, including boron. This is why boron is offered as a supplementary analysis by FAS as it requires a different method to determine.

With respect to soil analyses for boron, the accepted standard method for soil boron availability is the “hot water” soluble extraction method. However, the method can result in highly variable results and is prone to several interferences that affect the reliability of the extraction. This reduces the usefulness of the method to accurately predict soil levels. There are also no sound calibrations in terms of the actual soil-test value, boron-fertiliser application rates and crop response.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist)

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Fertiliser application (RD&E Topic Reference Code: CNS10)

Background

Topic raised in **South Coast/Midlands South** workshop.

Growers expressed interest in knowing whether SASRI has done trials on best methods for the application of fertiliser (banding/broadcasting).

Growers suggested a flow chart or Excel/app whereby a tick list could generate an answer.

Feedback

Fertiliser application is indispensable in current agricultural farming for maintaining soil fertility, enhancing crop yield and quality. While fertilisers are beneficial, it is crucial to apply them judiciously and in a balanced manner to avoid potential environmental issues such as nutrient runoff and soil degradation. By integrating proper fertilisation practices with sustainable agriculture techniques, growers can achieve long-term productivity and environmental health. To optimise fertiliser use requires a management approach that regularly evaluates the current soil and crop status then adapts to changes and requirements. There are three main steps in developing your nutrient management programme.

Step 1: Developing baseline knowledge

Knowledge of your soil is the cornerstone to managing nutrient supply. Knowledge of soils in different areas across your farm will enable you to adapt your management to best suit the characteristics of those soils. Some understanding of how nutrients behave in soil goes hand-in-hand with understanding your soil. Certain conditions will affect whether a nutrient is plant available, whether it can be converted to non-available forms, or worse, be permanently lost from the rooting zone. Consideration of climate and weather are also useful, as this affects your cropping cycles and the best time to apply nutrients. Recognising the impact of your landscape (e.g. slopes, valleys) on equipment access, risk of erosion or waterlogging also impacts your decision on the 4Rs of nutrient management.

Step 2: Determining the crop requirement

Soil testing is critical in determining nutrient applications as nutrient levels change over time. This is due to uptake by the crop, the amount and type of fertiliser and other ameliorants you have applied, rainfall and soil processes all of which can affect the amount and availability of a nutrient in the soil. Regular soil sampling (if done correctly) and analysis by a reputable laboratory, are essential steps for optimal nutrient management. After soil sampling, it is important to follow the nutrient application recommendations that have been advised, as these are based on many years of research to develop optimal practices and strategies. It is important to remember that under-application of nutrients can lead to yield and quality losses, thus lowering net returns. On the other hand, over-application increases fertiliser expense without any advantage in yield and can sometimes lead to a crop quality decline and also contribute to environmental pollution. Ensure that application considers the right type, rate, timing and placement of nutrients.

Step 3: Evaluating for site-specific adjustments

The soil environment is dynamic so it's impossible to guarantee that your crop will take up the nutrients applied. The best way to check that the crop is adequately supplied with nutrients is to assess the crop, most typically by leaf analysis. In the longer term, to properly adjust and adapt your nutrient management programme to crop uptake and yield response, it is essential that you maintain good records of soil and leaf analyses per field. It is also necessary to record the fertiliser and other management inputs and crop yields. Records of climate should also be kept, especially given the importance of crop water supply. Over time, these records will help identify site-specific adjustments to your nutrient applications, so you get the best from your fertiliser investment.

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Fertiliser decision support: split application (RD&E Topic Reference Code: CNS11)

Background

Topic raised in **Lowveld** and **Zululand/Umfolozi** workshops.

Growers have requested an app which will help to advise on fertiliser splitting, as well as the costs associated with different fertilisers. The potential exists to include this function in the current OptiFert tool.

Feedback

A fertiliser app, SASRI OptiFert, has been developed and is available to growers. This app finds the best fitting and lowest-cost fertiliser options for a given NPK requirement. A few simple inputs are required, and choices can be changed easily, allowing seamless evaluation of multiple types of fertilisers to find the best possible options. Researchers, extension specialists and now crop nutrition consultants and individual growers, have been exposed to the app and have given their feedback. While the current version is user-friendly and useful, regular updates will be made to allow for the inclusion of requests for, amongst other things, advice on nutrient splitting, along with multi-field capability, whereby nutrient recommendations for entire farms or estates will be taken into account and fertiliser needs streamlined. It is planned that FAS soil reports will be able to be uploaded into the app, so that more soil information can be taken into account in the final recommendations given.

For further information, please contact Dr Ruth Rhodes (Extension Specialist: Zululand North), Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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Soil categories and decision support tool (RD&E Topic Reference Code: CNS12)

Background

Topic raised in **Zululand/Umfolozi** workshop.

Soils are broken down into categories. Growers need to understand what the different categories mean and whether a description could be included in FAS report. They would also want to know if further categories for splitting fertiliser applications could be made possible. There is also a need for an app where growers can select soil type, selection of blends and then advised on whether to split once or twice, and timing between splits. Growers would also like to know if they could top-up nitrogen on carryover cane.

Growers wish to better understand the N categories from the FAS report and have access to a decision support tool where they can select soil type, selection of blends and then advised on split application of nitrogen fertiliser.

Feedback

The discussion on the decision support tool has been covered under CNS11. So, here the discussion will be explaining the N categories.

The soil N categories in FAS report are used for formulation of nitrogen fertiliser recommendations. They are derived from clay and organic matter contents of soils. Organic matter contains nitrogen which could be mineralized into inorganic-N that is taken up by sugarcane. In this instance, application of nitrogen fertiliser should be reduced to account for nitrogen coming from soil organic matter. Thus, the concept of soil N categories was developed to quantify and categorize the N supplying capacity of soils. Where soils with low organic matter will have low N supplying capacity while those with high organic matter will have a higher capacity. It can be understood then that the soil N categories do not influence the splitting of nitrogen fertiliser but rather the amount that is recommended. The reading on N management listed below will provide further clarity.

Information sheet 7.2: Nitrogen management

It is worth noting that the soil scientists are exploring using audio visuals that will assist in understanding the FAS report and what is the meaning of each parameter that is reported. This is also related to CNS1 where a query about FAS report was made.

In relation to the top-up of carryover cane, the above reading can provide some insights. A brief extract from the information is provided here. An additional application of nitrogen may be necessary in these conditions and growing season where long cycle cane is planted or cane is carried over. Ideally, apply the fertiliser over the row area if the cane stand is accessible, otherwise broadcast. This top-dressing should coincide with the first spring rains with adequate soil moisture and active plant growth of the second growing season. Other options include taking of leaf samples and determining if nitrogen is deficient and using monitor plots as described for CNS 4. In this instance, a ‘top up’ of 50 kg/ha N can be applied to a small area of the field. If growing conditions are good, a difference will be noticed within a few days if the crop is short of N; the grower can then opt to apply a top-up of N to the entire field.

For further information, please contact Dr Ruth Rhodes (Extension Specialist: Zululand North), Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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SSG soil analysis for yield potential estimates (RD&E Topic Reference Code: CNS14, CNS20, CNS26)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers requested feedback on Small-Scale Grower samples that were collected in North Coast region. Grower stated that soil samples were taken and submitted for analysis however no feedback has been given to the growers.

Feedback

SASRI project 18TD08 titled “Capacitating Small Scale extension in estimating yield potential in SSG regions using simple soil data” is an SSG project that started in 2021 with the aim of addressing issues around soil classification for SSGs in the sugar industry. The aims of the project are:

- To enable extension personnel to use soil data to estimate yield potential in the SSG regions
- Develop and maintain soil database for SSG for future use.

Since its inception, the project has been successfully completed in Midlands North, Felixton, Midlands South. Currently the project is continuing in three regions, North Coast, Pongola and South Coast. Feedback to growers is given on completion of the survey that is done on that region. For all the regions where the project has been successfully completed, feedback to the growers has been given while for those regions where the project continues, the feedback will be given when the project has been completed successfully.

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Green manure crops (RD&E Topic Reference Code: CNS15 and CNS16)

Background

Topic raised in **Lowveld** and **Zululand/Umfolozi** workshops.

Background

Green manure crops are important for breaking up monocropping and improving soil health. SASRI has a green manuring manual to assist growers with choosing a green manure crop depending on the goal they have in mind. However, growers feel that the manual is too broad and would also like to know the best green manure crop to break monocropping and whether a weed fallow is okay.

Growers require advice from SASRI about green manure crops

Response

Australian research has shown a well-managed fallow to be more beneficial than a weed fallow. There are a number of reasons for this, but the two biggest are, a) weed pressure (a well-managed green manure fallow will allow minimal weed encroachment, and therefore reduce weed seed pressure following the green manure fallow, compared to a weed fallow); and b) Specific benefits: green manure crop species are specifically chosen with certain objectives in mind. They may be legumes (to add N); flowering plants (to attract bees and other beneficial insects); high-biomass crops (to add maximum organic matter); compaction-alleviators (crops with fleshy roots or tubers); or nematode-manipulators (crops which either kill or starve the harmful nematode species that build up in sugarcane soil, or which encourage beneficial nematode species). These factors, amongst others, have been combined into an economic calculator in a SASTA paper (Rhodes, Ferrer & Gillitt, SASTA 2012), which found that well-managed green manure fallows gave more economic benefit than either no fallow or weed fallows in the South African sugarcane landscape. If a green manure fallow is not, for some reason, achievable, a weed fallow is second best, and no fallow, the least desirable option.

The 'best' green manure crop depends on the specific 'task' that you would like it to do. The various green manure crops have different benefits, and your choice will depend on what you would like to happen in your field. These benefits include N fixation (legumes), nematode control, weed control, biomass (organic matter), attraction of beneficial insects, alleviation of compaction etc. To achieve these goals, one or a mix of green manures may be chosen towards this end. However, for a general soil health 'kick', choose a green manure which will give the most organic matter (grown in the correct season), to boost the soil's stocks of fresh carbon. Again, this can be achieved by use of one or multiple (mixed) green manures.

SASRI is also exploring whether it is time to update the current green manure manual or the information in the current manual is up to date with the recent trends and literature on the subject.

References

- Rhodes R, Ferrer SRD and Gillitt CG (2012). The economics of green manuring in the South African sugar industry. Proc S Afr Sug Technol Ass 85: 80-85.
- Rhodes R, Jones MR, Edmonds A, Gillitt CG, Wilkinson D (2014). Potential economic impact of a long fallow and changing plough-out dates in the Kwazulu-Natal midlands. Proc S Afr Sug Technol Ass 87: 486-492.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Ruth Rhodes (Extension Specialist Zululand North)

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Application of lime and gypsum (RD&E Topic Reference Code: CNS17)

Background

Topic raised in **Zululand/Umfolozi** workshop.

Growers expressed concerns about applying lime on ratoons, asking whether it worth putting lime down or rather wait for replanting.

Feedback

Soil acidity is characterised by aluminium toxicity and associated calcium and magnesium deficiencies. These limiting factors can be addressed by application of lime and gypsum. Lime may require deep incorporation to reduce subsoil acidity, due to its limited solubility and mobility (Farina et al., 2000). There are concerns that gypsum, which has relatively high solubility and mobility, can leach potassium, magnesium, and aluminium into the subsoil, causing depletion of potassium and magnesium in the topsoil (Ernani et al., 2006; Farina and Channon, 1988; Shainberg et al., 1989; Sumner, 1970). Literature reports

suggest that a combination of lime and gypsum incorporated into the topsoil is an effective means of ameliorating subsoil acidity (Sumner, 2012). However, the rate at which these materials react and their efficacy when surface-applied without soil incorporation remain uncertain. SASRI project 18CM01 title "Understanding how soil acidity related processes affect management practices used in sugarcane: A review" will address some of the issues raised by the growers around application of lime and gypsum.

References

- Ernani PR, Miquelluti DJ, Fontoura SM, Kaminski J and Almeida JA (2006). Downward movement of soil cations in highly weathered soils caused by addition of gypsum. Comm Soil Sci Plant Anal 37:571-586.
- Farina MPW and Channon P (1988). Acid-subsoil amelioration: II. Gypsum effects on growth and subsoil chemical properties. Soil Sci Soc Am J 52:175-180.
- Farina MPW, Channon P and Thibaud GR (2000). A comparison of strategies for ameliorating subsoil acidity II. Long-term soil effects. Soil Sci Soc Am J 64:652-658.
- Shainberg I, Sumner ME, Miller WP, Farina MPW, Pavan MA, and Fey MV (1989). Use of gypsum on soils: A review. Adv Soil Sci. 9:1-111.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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Silicon (RD&E Topic Reference Code: CNS18)

Background

Topic raised in **Zululand/Umfolozi** workshop.

- Is there an answer on the advantages of applying silicon? Feedback needed.
- Silicon: better way of applying? Many years of hearing about the benefits but no product available.
- Si issue – what has happened since earlier research was done? Is there a better product and what about issue of uptake?

Feedback

The effects of silicon (Si) nutrition on eldana in South African sugarcane varieties have been well documented in the literature. However, over and above this benefit, provision of Si as silicate slags has other soil health benefits, including strong liming capacity (equivalent to dolomitic lime), and provision of calcium (Ca) and magnesium (Mg). The use of silicate slags should therefore be targeted at the appropriate soils, namely those with low plant-available soil Si levels (<10 mg/L), high acid saturation (>20%, preferably higher to maximise solubilization of the slag and release Si), and marginal or low concentrations of Ca (<150 mg/L) and Mg (<50 mg/L), to maximise benefits of their application. In this regard, extensive soil surveys across the sugar industry have shown that while Si deficiency is common in sugarcane grown on the weathered (desilicated) soils of the Coastal and Midlands regions, where the clays (such as kaolinites and sesquioxides) have been leached of plant-available Si, the soils in the Irrigated North (with clays such feldspars, vermiculites, and smectites) have abundant endogenous plant-available Si and leaf Si levels often exceed 1.0%. Application of Si-bearing materials to the latter soils is therefore unnecessary. It should be borne in mind that Si can be considered a macronutrient in sugarcane, given the crop's potential as a Si-accumulator to take up >300 kg Si/ha/annum in Si-rich soils. Therefore, in Si-depleted soils, studies have shown that Si-rich amendments are necessary to raise available soil Si levels and plant Si concentrations to optimise yields. In all instances, application of slag should always be considered as a replacement for lime (on a ton for ton basis) and should only be applied where SASRI's Fertiliser Advisory Service (FAS) soil analysis provides a recommendation for the correction of soil acidity. Use of alternative sources of Si, such as liquid foliar or root-drench Si, have not proven effective in field crops such as rice and sugarcane

and are prohibitively expensive. Slags have thus remained the international standard for Si supply in Si-accumulator field crops.

Field practices that may enhance the solubilisation of slag and availability of Si from this source are currently being investigated in field trials on the North Coast in low-Si, acidic, sandy and humic soils, and over several crop cycles. These practices include broadcast and in-furrow application of slag, in combination with organic matter. Local studies have found that leaf Si concentrations are positively associated with soil organic matter. In all instances, slag materials should be thoroughly incorporated before planting to ensure no solidification of slag on the soil surface and to increase Si availability to roots in and around the furrow. Very acidic soils are frequently associated with higher eldana infestations due to the toxic effects of aluminium (Al) on roots and consequent plant stress (reduced water and nutrient uptake). Therefore, attention to soil health through appropriate liming is an important aspect of integrated pest management for eldana. The same appears to be true for yellow sugarcane aphid (YSA), where high acid saturation levels and consequent crop stress may be associated with YSA infestations and damage.

Ultimately, it is envisaged that the current field trials examining practices that enhance soil Si availability and uptake will provide recommendations on application rates for slag and best implementation practices to ensure the maximum benefits of slag application in terms of yield improvement and pest (eldana, YSA) resistance.

For further information, please contact Dr Malcolm Keeping (Senior Entomologist)

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Timing and frequency of leaf and soil sampling (RD&E Topic Reference Code: CNS19)

Background

Topic raised in **Lowveld** workshop.

The growers questioned the need for annual soil sampling and asked whether is it necessary to take samples every year or might it be sufficient to skip a year or two before sampling again?

Feedback

Soil sampling

Soil samples can be taken at any time of the year. It is essential to allow enough time for sample analysis so that fertilisers can be purchased and applied at the correct time. Sampling for a replant and ratoon cycles should be done as soon as possible after harvest. This is particularly important where amendments such as lime might also be needed, as these can take time to be delivered and also require enough time to react in the soil before replanting occurs. If accessible, soils can also be sampled before the last ratoon crop is harvested. It is advised to sample before the planting of green manure crops so that issues such as acidity can be addressed sooner and improve the performance of that green manure crop.

Ideally, samples should be collected after every harvest. This allows for more accurate recommendations to be made for each crop. However, it is recognised that some growers may not have the capacity to undertake sampling at this intensity. In these cases, the maximum period between sampling events should be limited to sampling after every third harvest (e.g. if sampled for planting, then next sampling must take place at the end of the second ratoon harvest).

Selecting an area to sample

The sampling unit must be representative of the field or management unit (i.e. an area that will be treated similarly with respect to fertilisation, liming and green manuring). This may vary from less than a hectare to several. In general, it is advised that a sample not represent any area larger than 5 ha, while smaller areas may be better where there is high variability in soils and management practices. Regardless of the size, the area to be sampled should be relatively homogenous (similar) with respect to soil properties. Avoid sampling anomalous areas that don't represent the general field conditions. This includes features such as ant hills, old roads, loading decks and loading or handling areas for organic amendments, fertiliser, lime and gypsum. Where there are underperforming areas in a field, sample these separately from the remainder of the field.

Topsoil sampling

For routine topsoil fertility assessment, soils must be sampled to 0 to 20 cm depth. Sampling to this depth is most conveniently done using the Beater auger (bicycle handle auger) with a 20 cm coring bit attached. This sampling tool ensures a consistent depth and volume of soil is collected. When collecting soil samples one needs to move in a zig zag pattern, this ensures that the whole area intended for sampling is covered. Collect about 30-40 subsamples from the field and mix to make a composite sample.

Subsoil sampling

Besides topsoil sampling, there is also a need to sample the subsoil as sugarcane roots are not restricted to the top 20 cm of soil but may penetrate to a depth of about a metre or more. However, subsoil acidity can be problematic mainly in the rainfed areas of the industry and limits deep root growth. Subsoil acidity sampling is done in 20 cm increments to a depth of at least 80 cm (i.e. 20 to 40, 40 to 60, and 60 to 80 cm; 80 to 100 optional). Sampling to shallower depth than 80 cm severely limits the value of the analysis as corrective recommendations will be incomplete. If sampling depth restrictions are present at shallower depths, then collect to the maximum possible. An open bucket (dutch) auger is used. The shaft can be appropriately marked to aid sampling.

In the irrigated regions, profile sampling is done mainly to evaluate soil salinity and sodicity problems. For salinity and sodicity assessment, samples are collected at 0 to 30, 30 to 60 and 60 to 90 cm depth. It is advised to collect samples to the maximum depth indicated, unless a soil depth restriction exists (in which case collect to that depth). Use an open bucket auger (Dutch auger). Since subsoil tends to be less variable than the topsoil (and subsoil sampling is laborious), the process only needs to be done on four to six randomly selected sites across the field. Where there are specific problem patches these should be sampled as above, but separately from the better areas or remainder of the field.

Leaf sampling

Representative leaf samples must be properly collected to obtain reliable analyses and interpretations. To ensure that good samples are taken and properly handled, particular attention should be paid to organization and preparation before heading to the field to sample leaves. Assemble all the materials necessary for the sampling event and establish a sampling label protocol that will be easily tracked in the field and laboratory. The following materials are recommended for leaf sampling: pre-labelled grocery-sized paper bags to collect whole leaves in the field.

Timing of leaf sampling

It is important that leaf samples are collected when the crop is actively growing

The ideal leaf sampling times for different regions within the sugar industry:

- Midlands: 4-9 months
- Coastal lowlands: 4-7 months
- Northern Irrigated: 3-5 months

Procedure for leaf sampling

- Select leaves from the stalks of average height, but not from young shoots or unusually tall stalks.
- Select the third fully expanded leaf. The first leaf is the leaf that is at least half unrolled.
- Collect about 30-40 such leaves randomly from the various spots throughout the field. A zig zag pattern is useful to ensure coverage of the field.
- Do not collect leaves from the edges of the field as dust contamination and variable growth affect analysis results.
- If the field consist of areas of good and poor growth, a separate sample should be taken from each portion, even if the field has been fertilised as one unit.
- Hold the leaves in a bundle, chop off the tops and bottoms, leaving a central portion roughly 30 cm long.
- Strip out and discard the midrib from this central portion, using a knife or simple by tearing.
- Spread the leaf sample on a clean sheet and leave to dry in a well-ventilated area.
- Where samples cannot be spread out to dry, store them in brown paper bags (not plastic bags), ideally with the top open.

NB: do not use fertiliser bags for storing leaf samples as this may contaminate the sample.

Information sheet on Soil Sampling Procedure; Sugarcane Leaf Sampling and Soil testing: A key to reducing inputs cost (available from the SASRI E-library).

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Mycorrhizae and soil health (RD&E Topic Reference Code: CNS21)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers have been approached by agrochemical sales representatives who are selling products that are said to improve soil health. These products contain various organisms such as mycorrhizal fungi and bacteria which are meant to improve nutrient acquisition. They would like to know if any research has been conducted at SASRI and if not, then if SASRI could conduct a literature survey on the subject. Growers would value advice from SASRI regarding products containing various organisms to improve nutrient acquisition.

Feedback

A **proposal** for a knowledge exchange project has been submitted. The research will focus on a systematic review of literature on the use of various organisms in sugarcane production. The outcomes of the review will be communicated to growers.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist)

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Fertiliser combinations and liquid fertilisers (RD&E Topic Reference Code: CNS22)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers have raised several issues regarding fertiliser application and its integration with other treatments such as liquid fertiliser and solid fertilisers, has there been studies done and if so, what are the results? What are the pros and cons of liquid versus solid fertilisers? The growers wanted to know the effect of combination of liquid fertiliser and herbicide, has it been done? Growers indicated that information would be valuable.

Feedback

Combining liquid and solid fertilisers provides a balanced nutrient supply, enhancing crop health and yield by ensuring both immediate and long-term nutrient availability. Liquid fertilisers offer quick-release nutrients for the growth of a crop at critical stages and can be applied directly to the root zone or as foliar sprays, improving nutrient uptake efficiency. The solid fertilisers, particularly slow-release types, provide sustained nutrient support and improve soil structure. This combination allows for flexible and customizable fertilisation programs, reducing overall fertiliser use and minimizing environmental impact. By integrating both fertiliser types, growers could optimize resource use, while enhancing soil health, and achieve higher productivity and better-quality crops.

There are also several risks linked with combination of liquid fertiliser with solid fertiliser. Combining certain liquid and solid fertilisers can cause chemical reactions that reduce the effectiveness of both products and create compounds that can harm crops. Precipitation or separation in the mixture can clog equipment and result in uneven application. Over application of both liquid and solid fertilisers can lead to nutrient imbalances in soils, which can harm the crop and reduce crop yields. Excessive nutrients can also cause toxicity. Improper application of both liquid and solid fertilisers could result in nutrients leaching and contaminating water bodies and causing environmental issues such as eutrophication. The optimal application timing for liquid and solid fertilisers may differ, complicating the fertilisation schedule and potentially leading to sub optimal nutrient availability for the crop.

Combination of liquid fertiliser with herbicides comes with potential challenges. There are compatibility issues with combination of liquid fertiliser with herbicides where not all herbicides are not chemically compatible. Mixing incompatible products can result in precipitation, reduced effectiveness and or phytotoxicity. Some of the combinations may form unstable mixture that separate or degrade quickly thereby reducing their effectiveness. Herbicides and fertilisers often have different optimal application timings, where there could be application timing conflicts. Herbicides are typically applied when weeds are actively growing, while fertilisers may need to be applied at different growth stages of the crop. Adding to that young plants may be sensitive to certain herbicides and combining them with fertilisers might exacerbate potential damage. The efficacy of herbicides could be reduced by the mixing of the two incompatible products. Regulatory compliance must also be considered to avoid legal penalties.

Due to potential risks to the crop and environment, SASRI does not investigate combinations of liquid fertilisers and herbicides. When one applies such chemicals, it is paramount that one adheres strictly to the label instructions of both fertilisers and herbicides to ensure that correct dosages and mixing procedures are adhered to.

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Managing carryover crops and mulching of standing cane (RD&E Topic Reference Code: CNS23)

Background

Topic raised in **North Coast/Midlands North** workshop.

SASRI Extension Specialists from the Midlands North raised a question about carryover cane giving an example of the situation of growers from the Midlands North involved in mulching of whole standing carryover cane. Is it worth doing research on these fields (no fertiliser or herbicide). Hopefully carryover won't be persistent in the industry, is there any science behind recommendation. He added that research and literature is required for recommendation made regarding mulching older cane especially for the Midlands area. It has been recommended to mulch the whole crop (carry over cane) and not apply fertiliser and herbicide treatments. Is it worth it to do further research on mulching and determine if one should apply fertiliser/ herbicide? Growers from the Midlands are faced with problems of carryover cane forcing growers to mulch crops at high biomass.

Desired outcomes include: (a) Research and literature required for recommendation made regarding mulching older cane; (b) guidance on whether fertiliser should be applied in this event or is research required; and (c) whether further research is needed on mulching and to determine whether or when to apply fertiliser/ herbicides.

Feedback

The issue on mulching whole standing crop due to carryover needs to be thoroughly investigated and well thought through. The growers that have had this issue particularly the Midlands North growers will be visited to get more information on how they have mulched the whole standing crop due to carryover cane.

For further information, please contact Dr Dimpho Elephant (Senior Soil Scientist) and Dr Thandile Mdlambuzi (Soil Scientist)

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Carbon: burning of cane (RD&E Topic Reference Code: CNS24)

Background

Topic raised in **North Coast/Midlands North** workshop.

The growers expressed concerns about how much carbon is lost when cane is burnt. The growers wanted to know if is there any way to determine/measure carbon levels following the burning of cane? Does burning of sugarcane depletes carbon levels? Effect of burning on Soil C vs mulching.

Feedback

Burning sugarcane fields is a common practice in many sugarcane producing regions. This method facilitates harvestings efficiently. However, burning has significant implications for soil carbon content and overall soil health. There are immediate carbon losses that occur during the burning of sugarcane, and this results in the immediate loss of organic matter as carbon dioxide and other gases. When cane is burnt it reduces the soil organic carbon content in the soil, which is critical for maintaining soil health and fertility. The loss of soil organic matter negatively affects soil structure, leading to compaction, reduced porosity, and decreased water infiltration and retention. Furthermore, soil organic matter in the soil supports microbial

life, which plays a crucial role in nutrient cycling and soil fertility. Burning reduces the microbial biomass and diversity, impacting soil health. Adding to that there are also long-term impact of burning sugarcane. Repeated burning over time can lead to a significant depletion of organic matter, diminishing the soil's ability to retain moisture and nutrients. There are several ways in which carbon can be measured after burning of sugarcane.

- Soil Sampling: Collect soil samples from different depths and locations within the burned area to ensure a representative assessment. Samples should be taken both before and after burning for comparison.
- Mid-Infrared Reflectance Spectroscopy (MIR): Uses mid-infrared light, which can provide more detailed information about the types of organic compounds present in the soil.
- Near-Infrared Reflectance Spectroscopy (NIR): This method uses near-infrared light to estimate soil carbon content based on the absorption characteristics of organic matter.
- Wet Combustion Method (Walkley-Black Method): A chemical oxidation method where soil organic matter is oxidized, and the amount of carbon is estimated. This method is less accurate than dry combustion but widely used due to its simplicity.
- CO_2 Flux Measurement: Measuring the rate of carbon dioxide (CO_2) released from the soil can provide indirect information about soil organic matter decomposition and microbial activity. This is done using soil respiration chambers or CO_2 sensors placed on the soil surface.
- Remote Sensing: Satellite or aerial imagery combined with ground-truthing (actual soil sampling) can help estimate soil carbon levels over larger areas. Vegetation indices and soil reflectance data are used to infer soil carbon content.

Research shows that burning of sugarcane fields significantly depletes soil carbon levels. Burning sugarcane results in the combustion of organic matter, releasing carbon stored in plant residues as CO_2 and other gases into the atmosphere. This process significantly reduces the amount of organic carbon returned to the soil. Furthermore, when sugarcane residues are burnt, the carbon that would have been incorporated into the soil as organic matter through decomposition is lost, this leads to a decrease in soil organic carbon levels. It is important to note that soil organic matter is a key food source for soil microorganisms. Burning of sugarcane and its residues reduces the amount of organic material available for these microbes, leading to a decline in microbial activity and diversity. This negatively impacts nutrient cycling and soil fertility.

Effects on soil carbon vs mulching

Comparing the effects of burning versus mulching on soil carbon reveals significant differences in how these practices impact soil health and carbon levels. Mulching involves spreading crop residues on the soil surface. These residues gradually decompose, adding organic matter to the soil and maintaining or increasing soil organic carbon levels. The mulch provides a habitat and food source for soil microorganisms, promoting microbial diversity and activity. This enhances nutrient cycling and improves soil biological health. While burning of sugarcane provides immediate benefits to harvesting, it also leads to significant soil carbon loss, soil degradation, and reduced long-term soil fertility. It also has negative environmental impacts such as air pollution and greenhouse gas emissions.

Mulching, on the other hand, promotes soil health by conserving organic matter, enhancing soil structure, supporting microbial activity, and improving nutrient availability. It mitigates erosion, reduces weed pressure, and fosters sustainable soil management practices. One of the longest trials in the world, the Burning and Mulching Trial (BT1) at SASRI, that seeks to promote soil management practices such as conservation and accumulation of organic matter has been used to test the effect of burning vs mulching on soil carbon. Preliminary analyses from this trial indicated that the highest amount of carbon was extracted from the mulch (M) treatment from both fertilised and not fertilised plots (Figure 1) while the lowest amounts of fresh carbon were extracted for treatments where no organic matter was returned following harvesting (Bto). There were no differences (values similar) for the burnt cane with residue retained treatment (Bt) for both fertilised and not fertilised plots. Mulch with fertilisation resulted in the highest fresh carbon. The burnt with tops retained management option yielded significantly less carbon at a depth of 0 - 5 cm compared to the no burning option with all residue retained.

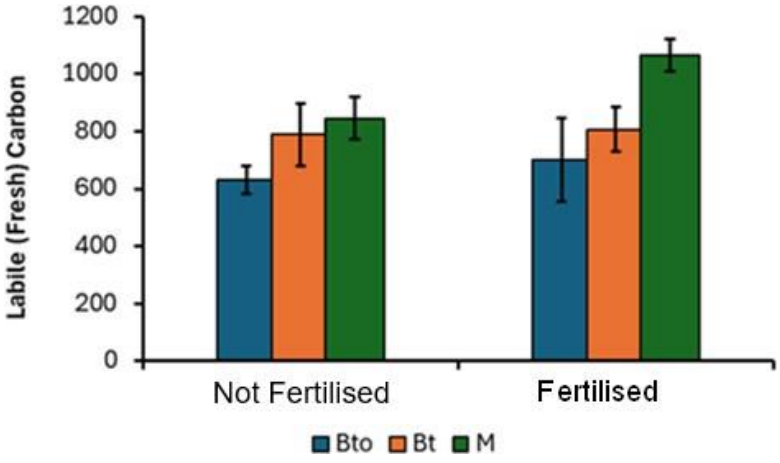

Figure 1

Effect of management practices on soil fresh carbon at 0 - 5 cm depth

For further information, please contact Dr Thandile Mdlambuzi (Soil Scientist)

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Smart Agriculture to enhance crop nutrition and soil health (RD&E Topic Reference Code: CNS25)

Background

Topic raised in **North Coast/Midlands North** workshop.

Growers queried how smart agriculture techniques could be used to enhance crop nutrition and soil health. The following points were raised.

- What innovation technologies can be used to enhance crop nutrition and soil health?
- Can remote sensing technologies (such as drones or satellites) be used to improve crop nutrition, such as through the detection of leaf N levels, or to inform the best time and amount to apply via split applications? What research / innovation is being done in this area?

Feedback

The new SASRI developed app, OptiFert, is an example of technology innovation that may be useful to growers, allowing the user to calculate the rate and cost per hectare of various fertiliser options. SASRI is investigating the potential for expanding the application to include splitting options and estate-wide nutrient management.

SASRI is also currently undertaking several projects aimed at demonstrating that remote sensing can be used to improve crop nutrition. Project 21CM01 seeks to model leaf nitrogen content using in situ hyperspectral data. This may serve as the foundation for the development of prediction models that can be upscaled to drone and/or satellite sensors, to enable growers to monitor and proactively manage crop nutrition through the growing season. Additionally, Project 22VI03 aims to model N, P and K through drone imagery in breeding populations, which could serve as proof of concept that remote sensing technologies could be used to enhance the management of crop nutrition. The findings of these projects could be used

in future follow-on research to directly address the second key point raised above. There is currently no research investigating soil health using remote sensing technologies.

For further information, please contact Dr Natalie Hoffman (Crop Physiologist) and Dr Nitesh Poona (Digital Agriculture Specialist)

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CROP PROTECTION

Alternative eldana management options (RD&E Topic Reference Code: CP1)

Background

Raised in the South Coast/Midlands South and Zululand/Umfolozi workshops.

- What are the challenges with biocontrol of Eldana? Why is it not working and how practical is it?
- Burning. Why do growers revert to chemicals?
- Refresher needed on what's been done with Push-Pull.
- Growers are interested in non- chemical management options for Eldana - update (i.e., GM Bt cane and SIT).

Feedback

Biocontrol

SASRI began rearing eldana in numbers during the early 1980s originally for the mass production of egg parasitoids (four species of *Trichogramma* and *Telenomus*) and their inundative field release. However, because of the cryptic oviposition habit of eldana, egg parasitoids were not successful. Eldana lays eggs between two surfaces and it was found that only the eggs on the edges of egg batches would be parasitised, if any. These eggs were highly likely to be consumed by eldana larvae emerging from unparasitized eggs.

Attention then turned to larval (*Goniozus* and *Paratheresia*) and pupal (*Xanthopimpla*) parasitoids. However, in extensive surveys, negligible parasitism of eldana larvae was recorded in sugarcane, even when the crop was planted adjacent to infested indigenous host plants with abundant eldana parasitoids present. Mass reared larval parasitoids also failed to establish in the sugarcane environment despite repeated release in the same fields.

The failure of biocontrol in sugarcane could have more than one cause.

Firstly, volatile chemical cues are important in host-parasitoid and host-predator interactions. The parasitoid *Goniozus* is attracted to eldana feeding on its natural host papyrus but is not attracted to eldana feeding on sugarcane. However, parasitoids can respond to chilo and sesamia damage because sugarcane produces SOS volatile signals in response to their damage. Chilo and sesamia are top borers that damage younger tissue and leaves which are the main source of SOS volatiles.

The vast majority of eldana damage is to mature stalk and it appears that there is no systemic signal (from damaged mature stalk to leaves) that elicits SOS volatile signalling. Eldana is associated with the fungus *Fusarium* which is beneficial to it. This fungus colonises the sugarcane tissue around the boring and often causes much more damage than the borer itself. It is possible that *Fusarium* suppresses SOS signalling, or it may camouflage the presence of eldana such that the plant does not respond.

Secondly, to become established parasitoids require a relatively stable environment where their hosts are continuously available, e.g., in a papyrus stand. The practices of burning and clear-cutting large areas of sugarcane at harvest mitigate against the success of biocontrol.

Push-Pull

Eldana moths prefer wetland sedges (*Cyperus dives* and *Cyperus papyrus*) to sugarcane for egg-laying. Eldana is controlled in sedges by its natural enemies (e.g., *Goniozus*). Natural hosts serve as a reservoir of parasitoids.

For sugarcane a ‘Push-Pull’ system has been designed that makes use of melinis (molasses grass) (Figure 1) as a repellent ‘push’ plant and combines it with natural hosts of eldana as ‘pull’ plants. Melinis is unusual in that it produces SOS volatiles even though undamaged. SOS volatiles serve to attract parasitoids and predators but also repel the host (so that the hosts offspring are more likely to escape parasitism and predation) (Figure 2).

Figure 1

Melinis grass is highly repellent to eldana moths

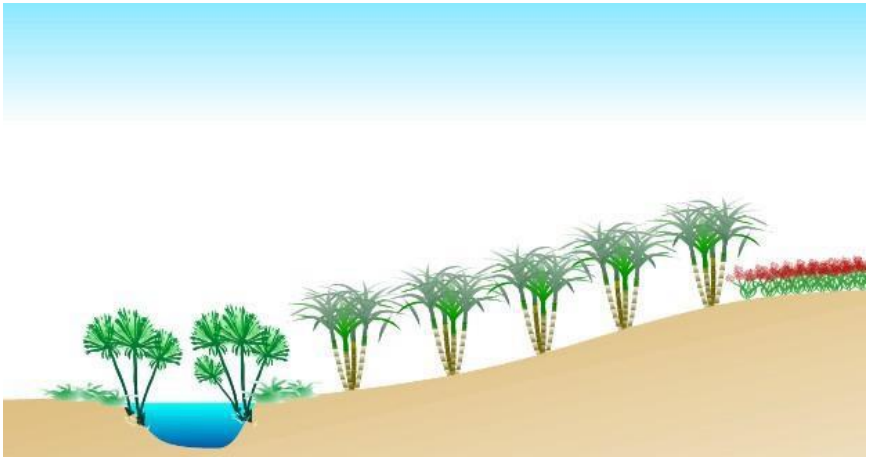

Figure 2

Combining attractive natural host plants and repellent melinis grass in a ‘push-pull’ system. Habitat Management can create a refuge and ‘source’ of parasitoid and predator species.

Field trials in the Midlands and growers’ experiences have shown that cane adjacent to sedges growing in wet areas have lower infestations of eldana than cane that is not adjacent to sedges.

Furthermore, the feasibility of using push-pull for management of eldana in coastal KZN was tested using large-scale on-farm field trials conducted on five model farms. On each farm, wetland habitats were rehabilitated with pull plants (*Cyperus dives* and *C. papyrus*) and fields were intercropped with the repellent grass melinis. Eldana damage and infestation levels were recorded to assess the efficacy of push-pull, using a multiple before-after-control-impact (mBACI) design. Push-pull treatment sites showed a significant reduction in mean percentage stalk damage and eldana abundance relative to control sites. Furthermore, stemborer surveys in wetland habitats revealed higher numbers of eldana within *Cyperus* stands. Pull plants effectively attracted eldana away from sugarcane.

Adoption of this technology has been slow, despite its benefits. A study conducted in the Midlands showed that large-scale growers have a good knowledge of eldana, IPM and push-pull but that they needed more practical knowledge for implementation of the strategy. Despite demonstrating a positive attitude towards push-pull, growers perceived it to be a 'hassle' and this appears to be the biggest barrier to its adoption.

However, with suitable learning opportunities for growers and good support for planting inputs, implementation of push-pull is likely to succeed. SASRI Extension and Biosecurity can be contacted for assistance by growers interested in implementing push-pull.

Other components of IPM

Integrated pest management (IPM) is a broad-based approach that integrates practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level or economic threshold (ET). The UN's Food and Agriculture Organisation defines IPM as "the careful consideration of all available pest control techniques and subsequent integration of measures that discourage the development of pest populations and keep pesticide interventions to levels that are economically justified and reduce or minimize risks to human health and the environment".

IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. However, it does not exclude the use of pesticides.

The SASRI publications "An Integrated Pest Management (IPM) approach for the control of the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae)" and "Controlling eldana in the South African sugarcane industry" describe and explain how best management practices can be integrated into an IPM programme for eldana control. When applied as an entire package, in an area-wide approach, eldana damage can be reduced to such an extent that longer cropping cycles become possible.

GM-Bt

Genetically modified (GM) sugarcane expressing the bacterial *Bacillus thuringiensis* (Bt) lepidopteran-specific insecticidal proteins, CRY 1 and CRY 2, has the potential to control eldana and related borer pests (e.g. *Sesamia calamistis* and *Chilo sacchariphagus*) in South Africa. SASRI has embarked on the development of GM sugarcane and several promising GM events in cultivars N71, N80 and 10K0222 (a pre-release rainfed variety) have been produced in the SASRI Biotechnology laboratory. They are being tested in eldana bioassays and characterised on a molecular level. Agronomic field performance will be conducted on the most promising 5-10 events in the next few years. The aim is to commercialise one GM sugarcane event in the early 2030's if all the regulatory-associated processes are accomplished. Deployment of Bt sugarcane will reduce the need for the application of insecticides.

SIT

Sterile Insect Technique (SIT) research on pest control has been ongoing for the past 20 years. As a species-specific and environmentally friendly control method, SIT depends on the area-wide release of sterile insects. The research involves mass-rearing and release of first-generation eldana offspring. The significant progress that has been made includes (i) the development of a diet for larvae, (ii) the mating behaviour and release of irradiated moths, (iii) the lifecycle of the sterile population, and (iv) the effect of long-distance transportation on the fitness of irradiated moths.

Currently, SASRI is conducting studies on releasing sterile F1 moths in the field and under controlled conditions, the effects of gamma and X-ray irradiation on the physiological and reproductive fitness of eldana, as well as to examine the impact of combining SIT with GM sugarcane on the management of eldana. With a successful proof of concept, the SIT programme could be a viable control measure for this pest in sugarcane production.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme), Dr Sandy Snyman (Principal Scientist: Biotechnology; and Manger of the Variety Improvement Research Programme) and Dr Lawrence Malinga (Entomologist)

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Mosaic in Pongola (RD&E Topic Reference Code: CP2)

Background

Raised in the Pongola workshop.

Mosaic has been detected on N57 and N36 and a strategy is needed to deal with this with

Feedback

The Pongola Biosecurity Inspectorate identified mosaic in fields of N36 and N57 (both have an intermediate mosaic rating) in Pongola in February 2024 (Table 1). Mosaic is rare in Pongola – the last time it was observed was in 1997 on the susceptible variety N19. The permissible limit for mosaic in this P&D Control Area is zero.

Table 1

Mosaic-infected fields in Pongola

Date	Field	Ha	Variety	Crop	Class	Age months	% MOSAIC
08/02/2024	12A	2,26	N36	4	C	2	0,06
08/02/2024	11C2(B)	1,25	N57	6	C	3	0,55
14/02/2024	12D	1,25	N36	5	C	3	0,41
14/02/2024	11C2(A)	1,25	N57	6	C	3	0,19
14/02/2024	11C2(B)	1,25	N57	6	C	3	2,15

Approach

1. Leaf samples were collected from the N57 fields, and the presence of *Sugarcane mosaic virus* (SCMV) was confirmed using molecular methods.

2. No SCMV was detected in the symptomatic maize and grass samples collected from the informal vegetable plot and verges in the vicinity of the fields using SCMV-specific and general potyviridae primer pairs.

3. The grower was issued with crop eradication orders for the infected fields and he has agreed to spray out the fields after harvest.

    3.1. The crops will be destroyed by 1 November 2024 and an inspection of the fields has been scheduled for 5 November 2024.

    3.2. Thereafter, the grower is required to inspect the fields every month and destroy all volunteers before the start of a fallow period (free from any living sugarcane) of at least 6 months.

    3.3. This process will be monitored by the Extension Specialist and Biosecurity Inspectorate.

    3.4. A low growing, broad leaf cover crop may be planted during the fallow period.

        - Avoid cover crops in the Poaceae family (grasses) as these may harbour mosaic.

- Avoid tall crops such as sunnhemp that will make volunteer identification difficult.

4. The fields surrounding the infected fields will be monitored for mosaic for at least 3 seasons from spring 2024.

5. The Biosecurity Inspectorate will receive follow-up training on identifying mosaic in the field in September 2024 to ensure that all staff members are familiar with the symptoms.

6. Further samples will be collected from potential alternate hosts of the virus in the surrounding area to test for SCMV in July 2024 if the vegetation is still green, and through spring.

7. All molecular tests will be redone, using the current RNA extracts, and newly synthesized Oligo 1n and Oligo 2n primers and results will be compared. The CIRAD potyviridae diagnostic protocol, which uses the Qiagen one-step RT-PCR kit for their Potyviridae diagnostics and incorporates an Rnase inhibitor will be investigated and optimised. Additionally alternate universal primers will be tested, looking at a different conserved region (NIb rather than CP). NIb2F and NIb3R were developed based on two conserved sites in the NIb region of the potyvirus genome (Zheng *et al*. 2010). This may help in targeting a wider range of potyviridae species.

Reference

Zheng L, Rodoni BC, Gibbs MJ, Gibbs AJ (2010). A novel pair of universal primers for the detection of potyviruses. *Plant Pathology* 59: 211-220.

For further information, please contact Sharon McFarlane (Senior Pathologist)

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Crop protection thresholds (RD&E Topic Reference Code: CP4)

Background

Topic raised in Lowveld workshop.

- A request for information on threshold values for disease or pest levels on the crop and when should a farmer respond to such levels. A decision tree of what to do should be built into the advice to indicate when and how to do targeted interventions. Suggest that this request be included in the P&D notes of the workshop.
- Thrips - how do you determine what the limit for insecticide application is in a season?
- Chemicals have a “sweet spot” – growers require knowledge on how many times they can apply insecticide and at what application rate not to over or under apply.

Feedback

Eldana

Growers should refer to the recommendations provided in the manual “Controlling Eldana in the South African Sugar Industry” (published April 2020) available on the SASRI website together with the information sheet on “Insecticidal control of eldana”..

There are two approaches to eldana control using insecticides: preventative and corrective (curative). In all cases, a preventative approach is preferred over corrective and should include the adoption of other pest management options, such as appropriate variety choice, knowledge of soils on the farm to identify fields

where cane may become stressed, conducting eldana surveys to determine the eldana risk in different-aged fields, and thereafter deciding on which fields (if any) need to be treated with a registered insecticide. The latter decision may also depend on whether a field is going to be carried over to the next milling season. Knowledge of current and historical levels of eldana (as E/100) and eldana damage (as percentage internodes bored or percentage stalk red) in different fields is essential in deciding whether application of insecticides is necessary.

While cane in the Lowveld region is generally not aged beyond 12 months and water stress should not be a concern where there is reliable irrigation or no over-irrigation, cognisance should still be given to the possibility of a drought or El Nino conditions, which may affect irrigation supply. This should be done in conjunction with information on how much rainfall has been received over the growth period of a crop.
Economic damage is the amount of crop damage (or yield loss) that equates to and justifies the cost of carrying out control measures for a pest. For eldana in sugarcane, economic damage of 7% internodes bored (IB) at harvest is approximately equal to the cost of a spray programme to prevent this damage. The economic threshold (ET) is that point at which an insecticide control programme should be implemented to prevent this level of damage at harvest. Eldana damage in late August, which coincides with the second moth-emergence peak during the year (from September to November), can be used to predict damage in cane carried over to the following April. ET levels of 1% IB, 2% IB and 3% IB have been estimated for susceptible, intermediate, and resistant varieties respectively, based on August damage estimates. The triggering of a spray programme at the end of August using these ET levels has prevented economic damage in the crop at harvest the following year. Surveys should also be carried out in late February to coincide with the start of the second moth-emergence peak from March to May, applying the same principles as above. During warm dry winters an additional moth peak may occur in July, necessitating eldana surveys during June to determine whether insecticide application is required. At all times, registered insecticides should be used, adhering to the product label.

When fields are being considered for carry-over, careful assessments are essential regarding variety eldana ratings (https://sasri.org.za/download/158/3-varieties/30760/all-variety-pest-ratings.pdf), current eldana levels in potential carry-over fields, likelihood of water stress (drought/shallow soils or waterlogging), and rainfall received over summer. Where reliability of irrigation is not a concern (in the irrigated regions), it is nonetheless preferable to carry over only varieties rated as resistant or intermediate-resistant to eldana, with careful attention paid to the other factors mentioned above. In rainfed regions, where water stress is a significantly greater risk factor, especially on shallow soils, the eldana resistance of varieties and the application of an IRAC compliant insecticide programme to carry-over fields are of particular concern. Note that resistant varieties can incur severe infestations when water stressed.

Preventative insecticide programmes can also be applied to young cane, which is less damaging to predators and a much easier operation than in older cane. Eldana damage to young cane typically results from high below-ground infestation of stools in the previous crop and is common during droughts. Insecticide application to young cane mainly targets moths that develop and emerge from these below-ground infestations. Treating the crop during early stalk elongation in affected cane, especially during the March to May or September to November moth peaks, will reduce subsequent eldana infestation levels.

The decision tree depicted in Figure 1 should assist in making decisions on whether to apply a preventative insecticide programme. In all cases, insecticides should be applied using the methods and rates specified in the product label.

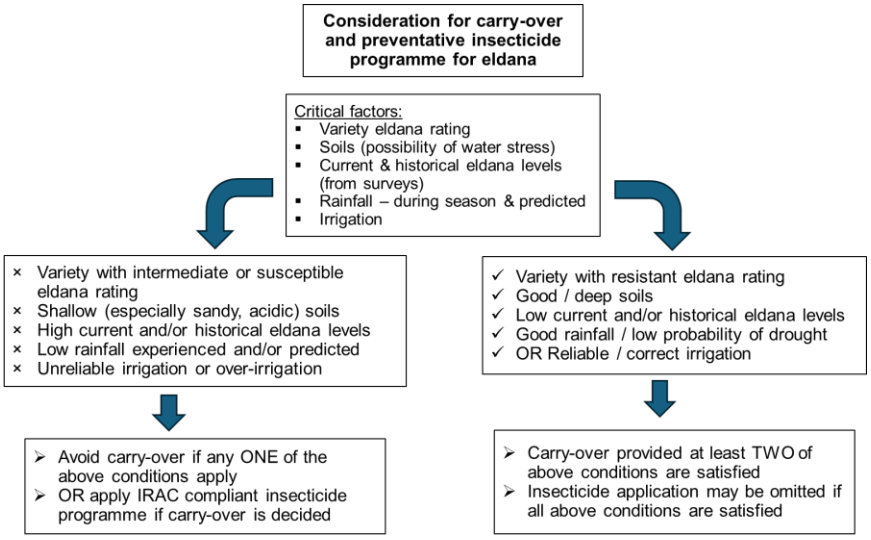

Figure 1

A decision tree for implementation of a preventative insecticide programme

Corrective insecticide applications are required under very different and specific circumstances, as dictated by the Local Pest, Disease and Variety Control Committee (LPD&VCC) rules. Under these rules, remedial operations involving either harvest or treatments of infested fields with an IRAC compliant insecticides programme, are enforced according to region-specific eldana hazard levels based on grower-conducted or LPD&VCC team surveys. In these cases, growers should consult with their local Biosecurity and Extension Specialist.

Yellow sugarcane aphid (YSA) and thrips

Growers should refer to the following SASRI publications for full details on management options for thrips and YSA, including scouting, chemical control, and treatment thresholds.

- Thrips and YSA Control Manual
- Thrips information sheet
- YSA information sheet

The above publications give detailed information on preventative and corrective (reactive) insecticide products and their application for control of thrips and YSA in sugarcane. As for eldana, preventative control using systemic insecticides is preferable to corrective control and less environmentally harmful, especially for natural enemies of these pests. There are no thresholds for preventative application, which must be guided by previous experience of the pests on a farm or field and growers' perceived threat of severe infestations based on this experience. Thresholds for YSA corrective applications following scouting are provided in the control manual and information sheet. Insecticide treatments to fields with obvious visible (and especially large) areas of damage are generally too late, with aphids having often already moved out of these areas.

Key to effective and early control is scouting for thrips and YSA in young cane before visible leaf damage becomes evident, and especially during early summer before populations build up. Early scouting in fields (or for YSA patches within fields) with a history of infestation is also important, as their presence in such fields serves as an early warning of potentially severe infestations. Target more susceptible varieties for scouting (see the Variety Pest Ratings information sheet. Verges, cane breaks, and grasses alongside fields should also be scouted, as they may harbour aphids that later move into the cane. When aphids are found in small patches in young cane, pre-emptive spot spraying with an appropriate foliar insecticide is feasible, which will be less costly than blanket spraying of the entire field and will help to reduce impacts on natural

enemies. In this instance, scouts and personnel handling spraying equipment could work co-operatively to reduce the time and effort required.

In all cases, attention should be to an integrated approach to management of these pests, rather than depending only on chemical control. Other options include encouraging natural enemies of the pests by diversifying the natural environment around cane fields, reducing crop stress by improving soil biological and physical characteristics, planting less susceptible varieties, and adjusting planting dates. These approaches are detailed in the Thrips and YSA Control Manual.

Smut and mosaic

In terms of clauses 77 and 78 of the Sugar Industry Agreement, the LPD&VCCs must monitor sugarcane in their Control Areas for specific diseases (e.g. smut, mosaic), and with the approval of SASA, specify and publish permissible levels and remedial operations for these diseases. The Biosecurity Inspectorate inspect selected young commercial fields throughout the industry for smut and mosaic each year. While the Inspectorate aim to visit each farm in their respective P&D Areas, they are unable to inspect every field. Growers should ensure that their fields are scouted regularly for diseases. Early detection allows for swift intervention, potentially preventing the disease from spreading further and exceeding the stipulated permissible levels for the area (refer to the Local Pest, Disease and Variety Control Committee Rules, published in 2015 and amended in 2018 and 2020).

Sugarcane rusts

A number of fungicides are currently registered for treating rust on sugarcane in South Africa (Refer to SASRI Information Sheet 9.4: Sugarcane rust). Timely applications when severity is low is usually most effective in managing rust, rather than applying fungicides according to a set regime (Staier et al., 2003). Thresholds of 5% and below 10% leaf area infected have been used as a guide for the timing of fungicide applications in Australia (Staier et al., 2003) and Florida (Raid and Comstock, 2013; Chaulagain et al., 2019a) respectively. Applying fungicides before these thresholds were reached resulted in the lowest rust progress values and biggest yield improvements. Applications in the mid or late epidemic stages were less effective, but still provided partial control. Spray intervals are important for acceptable chemical control of rust. Two applications of a strobilurin-triazole fungicide with a spray interval of 3-4 weeks were effective in treating brown rust with subsequent yield improvements if applied early in the outbreak (Rutherford et al., 2013; Chaulagain et al., 2019b), while three applications provided the best control for orange rust (Chaulagain et al., 2019a). Forecasting systems based on mathematical models can be used to predict rust outbreaks and identify areas of high risk. These systems can potentially reduce the number of fungicide sprays or improve efficiency of control through better timing of fungicide applications. A brown rust risk model is being used in the SA industry to advise the Extension Specialists when conditions are favourable for brown rust infection. This model has also been shown to effectively predict the onset of tawny rust.

References

- Chaulagain B, Raid RN, Dufault N, van Santen E, and Rott PC (2019a). Application timing of fungicides for the management of sugarcane orange rust. Crop Protect 119: 141–146.
- Chaulagain B, Raid RN and Rott PC (2019b). Timing and frequency of fungicide applications for the management of sugarcane brown rust. Crop Protect 124: 104826.
- Raid RN and Comstock JC (2013). A review of fungicide evaluations for the control of orange rust on sugarcane in Florida. Proc Int Society Sugar Cane Technol 28: 1211–1219.
- Rutherford RS, Mhora T, Martin LA and McFarlane SA (2013). Aspects of sugarcane rust research in South Africa. Proc. Int. Soc. Sugar Cane Technol 28: 307-310.
- Staier T, Magarey R, Willcox TG (2003). Control of orange rust in sugarcane with fungicides. Proc Aust Soc Sugar Cane Technol 25: 14.

For further information, please contact Sharon McFarlane (Senior Pathologist) and Dr Malcolm Keeping (Senior Entomologist)

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Relationships between silicon and eldana and YSA (RD&E Topic Reference Code: CP5)

Background

Topic raised in Lowveld workshop.

- Relationship amongst N and Si established.
- Has the same been established for YSA?
- Eldana - growers require more information on what can be done for Eldana (and YSA) control.

Feedback

The effects of silicon (Si) and nitrogen (N) nutrition on eldana in South African sugarcane varieties have been well documented in the literature, with Si increasing stalk resistance to the borer and N increasing susceptibility (damage and infestation), especially in eldana-susceptible varieties subject to water stress. The effects of increased plant Si concentration in reducing eldana survival and damage are much reduced in eldana-resistant varieties, where the endogenous resistance of such varieties masks the effect of increased plant Si levels. Therefore, application of Si-rich amendments (such as calcium silicate slags) specifically for eldana management in resistant varieties is unlikely to as be beneficial as for susceptible (stress-prone) varieties. However, over and above their provision of Si, silicate slags have other soil health benefits, including strong liming capacity (equivalent to dolomitic lime), and provision of calcium (Ca) and magnesium (Mg). Their use should therefore be targeted at the appropriate soils, namely those with low plant-available soil Si levels (<10 mg/L), high acid saturation (>20%, preferably higher to maximise solubilization of the slag and release Si), and marginal or low concentrations of Ca (<150 mg/L) and Mg (<50 mg/L), to maximise benefits of their application. In this regard, extensive soil surveys across the sugar industry have shown that while Si deficiency is common in sugarcane grown on the weathered (desilicated) soils of the Coastal and Midlands regions, where the clays (such as kaolinites and sesquioxides) have been leached of plant-available Si, the soils in the Irrigated North (with clays such feldspars, vermiculites, and smectites) have abundant endogenous plant-available Si and leaf Si levels often exceed 1.0%. Application of Si-bearing materials to the latter soils is therefore unnecessary. It should be borne in mind that Si can be considered a macronutrient in sugarcane, given the crop's potential as a Si-accumulator to take up >300 kg Si/ha/annum in Si-rich soils. Therefore, in Si-depleted soils, studies have shown that Si-rich amendments are necessary to raise available soil Si levels and plant Si concentrations to optimise yields. In all instances, application of slag should always be considered as a replacement for lime (on a ton for ton basis) and should only be applied where SASRI's Fertiliser Advisory Service (FAS) soil analysis provides a recommendation for the correction of soil acidity. Use of alternative sources, such as liquid foliar or root-drench Si, have not proven effective in field crops such as rice and sugarcane and are prohibitively expensive. Slags have thus remained the international standard for Si supply in Si-accumulator field crops.

Field practices that may enhance the solubilisation of slag and availability of Si from this source are currently being investigated in field trials on the North Coast in low-Si, acidic, sandy and humic soils, and over several crop cycles. These practices include broadcast and in-furrow application of slag, in combination with organic matter. Local studies have found that leaf Si concentrations are positively associated with soil organic matter. In all instances, slag materials should be thoroughly incorporated before planting to ensure no solidification of slag on the soil surface and to increase Si availability to roots in and around the furrow. Very acidic soils are frequently associated with higher eldana infestations due to the toxic effects of aluminium (Al) on roots and consequent plant stress (reduced water and nutrient uptake). Therefore, attention to soil health through appropriate liming is an important aspect of integrated pest management for eldana. The same appears to be true for YSA, where high acid saturation levels and consequently crop stress were associated with YSA infestations and damage.

The effects of Si and N on yellow sugarcane aphid (YSA) have not been established in sugarcane. However, most studies in other crops and on other aphid species have found that Si can reduce aphid feeding and performance; hence there is a reasonable possibility that it may have the same effect on YSA in sugarcane.

YSA also feeds predominantly on the lower, older leaves in sugarcane, which have significantly higher concentrations of Si in their tissues than young leaves towards the top of the plant. The absence of any effect of Si on sugarcane thrips may be a result of low concentrations of tissue Si in the top-most (spindle) leaves of the plant where thrips feed. Of interest, it has been shown that high plant N increases infestation by sugarcane thrips. Two grower-led fields trials to assess the effects of a Si-rich steel slag on YSA infestation and damage are underway on the North Coast. However, due to the absence of YSA infestation across the trials to date, no conclusions can be drawn at this stage. There has also been no evidence of Si uptake from the slag, which is a slow-release source that has so far not been tested in sugarcane and may only show evidence of uptake when the cane is older.

Regarding other macronutrients, including N, published research has clearly demonstrated the effects of crop nutritional status on aphid population densities and reproduction. Aphids and other sap-feeding insects are particularly sensitive to changes in plant macronutrients such as N. In most cases studied, increasing plant N promotes aphid feeding, growth, and reproduction. Such effects on aphid performance have been shown for YSA in kikuyu grass fertilised at higher N rates, due either to greater aphid feeding preference or to increased reproduction at high leaf N. Plant stress and senescence also mobilizes leaf N (protein) in the form of amino acids, which the plant then redistributes to and concentrates in the stalk and younger tissues. The resultant availability of soluble amino acids in the leaves would benefit YSA, making severe infestations more likely in stressed sugarcane.

A large imbalance in N and potassium (K) fertilisation (low K plus high N) produces greater damage in kikuyu by YSA. Macronutrient ratios are therefore important in determining effects of plant nutritional status on insect herbivores, making careful attention to crop nutrition a critical component in pest management (in addition to optimising yields and avoiding wasteful over-fertilising), and should be deployed by growers as an integral part of their fertilising programme according to FAS recommendations. Currently, there is no information available on effects (if any) of micronutrients on YSA or other pests infesting sugarcane; growers are best advised to ensure that micronutrient deficiencies are corrected by fertilising with the appropriate commercially available products. Further detailed information regarding management of crop nutrition and plant stress in relation to YSA and thrips infestation, including considerations around splitting N applications, is presented in the Thrips and YSA Control Manual.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme), Dr Malcolm Keeping (Senior Entomologist) and Dr Iona Basdew (Biosecurity Scientist)

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Orange rust (RD&E Topic Reference Code: CP6)

Background

Topic raised in Lowveld workshop.

Growers require more information on orange rust, which varieties are affected etc.

Feeback

Growers are referred to Information Sheet 9.4 Sugarcane rust SASRI eLibrary - Information Sheets and the charts that are available to assist with identification: SASRI elibrary - Illustrative Guides

A project on orange rust (22CP05) is in progress. Key focus areas include the following.

Varietal susceptibility

Varieties are being screened for orange rust at Mount Edgecombe and Eston. Preliminary ratings for most commercial varieties will be available by December 2024 and new releases will be routinely screened going forward. The Plant Breeding trials are also being assessed.

Yield loss trials

Large plot yield loss trials have been established in Umfolozi where severe orange rust is common. In the first trial, a 19% reduction in RV (tc/ha) was recorded in N60 with moderate to severe symptoms in the early and mid-stages of growth. A second trial is in progress.

Conditions favouring infection

Laboratory experiments to determine the temperature range most conducive for the germination of orange rust spores is in progress. Brown and orange rust monitoring plots have been established adjacent to an automatic weather station at Mount Edgecombe. Rust severity and disease progress is assessed on a weekly basis and will be linked to temperature, relative humidity and leaf wetness. Anecdotal evidence provided by the Extension Specialists and Biosecurity Officers, along with hourly weather data is also being used to identify the most favourable conditions for orange rust infection. This information will be used to develop an orange rust risk model.

For further information, please contact Sharon McFarlane (Senior Pathologist)

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Rusts (RD&E Topic Reference Code: CP7/V20)

Background

Topic raised in Zululand/Umfolozi workshop.

Growers raised the following questions.

- What is the effect of climate on rust?
- Does rust spread through irrigation systems?
- What is the effect of rust on varieties (N70, N76)
- How does rust spread?

Effect of climate on rust

The development of rust is influenced by host resistance, environmental conditions (temperature, leaf wetness and relative humidity) and inoculum load (Comstock and Ferreira 1986; Sanjel et al., 2019; Chaulagain et al., 2019 a, b). Infection and severity is strongly influenced by the duration of conducive climatic conditions. While dew, mist and light rainfall promote leaf wetness, heavy rainfall is not favourable for rust development as it tends to wash spores off the leaves onto the soil (Comstock and Ferreira, 1986). These spores are then unable to germinate and cause infection. Sugarcane that is stressed due to factors such as drought or frost are less favourable for rust development (Sanjel et al., 2019).

Brown rust

- Most commonly observed in spring and autumn
- Most favourable temperatures for infection: 16-22°C (field-based observations)

Tawny rust

- Most commonly observed in spring and autumn
- Most favourable temperatures for infection: 18-22°C (laboratory-based tests)

Orange rust

- Observed to infect from January through May
- Most favourable temperatures for infection: 20-25°C (field-based observations)

Rusts require a minimum leaf wetness period of 6-9 hours for infection to occur and temperatures exceeding 30°C limit infection.

Does rust spread through irrigation systems?

Rust spores will not spread through irrigation systems and during an irrigation event - most spores will be washed to the ground and will not cause infection, similar to a heavy rainfall event. However, if the irrigation finishes in the late afternoon, early evening, the leaf wetness requirement for infection may be met through the night. Irrigation will also increase the humidity in the field, making conditions more conducive for rust.

Effect of rust on varieties (N70, N76)

Reductions in green leaf area and leaf net photosynthetic rate associated with rust infections can affect plant growth and contribute to yield losses (Carretero et al., 2011; Dijoux et al., 2023). In addition, damage to the epidermis of the leaf after the pustules rupture affects the water use efficiency of the plant, contributing to yield loss (Grimmer et al., 2012). Yield loss tends to be greatest when epidemics persist and lower when fungicides are applied in the early stages of the epidemic (Hoy and Hollier, 2009; Chaulagain et al., 2019b).

Expected yield loss for the three rusts:

- Brown rust: 10-40%
- Orange rust: 15-40%
- Tawny rust: 10%, but losses will be higher when infections are severe

N70 and N76 are susceptible to orange rust, but these varieties have not as yet been assessed in yield loss trials. RV yields of N60 were 19% lower in unsprayed sections of a large plot trial conducted in Umfolozi in 2023.

How does rust spread?

- Through wind-blown and water-splashed spores.
- Rust is not spread by planting seedcane with symptoms.

References

- Carretero R, Bancal MO and Miralles DJ (2011). Effect of leaf rust (Puccinia triticina) on photosynthesis and related processes of leaves in wheat crops grown at two contrasting sites and with different nitrogen levels, European J Agron 35(4): 237-246.
- Chaulagain B, Raid RN, Dufault N, van Santen E, and Rott PC (2019a). Application timing of fungicides for the management of sugarcane orange rust. Crop Protect 119: 141–146.
- Chaulagain B, Raid RN and Rott PC (2019b). Timing and frequency of fungicide applications for the management of sugarcane brown rust. Crop Protect 124: 104826.
- Comstock JC and Ferreira SA (1986). Sugarcane rust: Factors affecting infection and symptom development. Proc Int Soc Sugar Cane Technol 19: 402-410.
- Dijoux J, Dumont T, Paysan M et al. Effects of orange rust on sugarcane yield traits in a multi-environment breeding program. Euphytica 219: 49.

- Grimmer MK, John Foulkes M and Paveley ND (2012). Foliar pathogenesis and plant water relations: a review. J Exp Bot 63:4321–4331.
- Hoy J and Hollier C (2009). Effect of Brown Rust on Yield of Sugarcane in Louisiana. Plant Dis 93: 1171-1174.
- Sanjel S, Chaulagain B, Small IM, Comstock JC, Hincapie M, Raid RN, Rott P (2019). Comparison of progress of brown rust and orange rust and conditions conducive for severe epidemic development during the sugarcane crop season in Florida. Plant Dis 103(5):825-831.

For further information, please contact Sharon McFarlane (Senior Pathologist)

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Longhorn beetle (RD&E Topic Reference Code: CP8)

Background

Topic raised in Zululand/Umfolozi workshop.

What options are available to growers who have had to have a three-year fallow, as they have suffered losses? Abandoned fields and would like to reuse them, how? Is there an insecticide that can be applied to stool straight after harvesting where you can see the affected stalk?

Feedback

eNtumeni: The first LHB damage was identified, and grubs were collected in October 2015. Adult beetles were first observed in two previously infested fields during February and March 2018 and several new positive fields were identified. By January 2020 the destruction of LHB-infested and buffer fields was completed on all affected farms. However, in February 2020 and November 2021 two new positive fields were identified and destroyed. Recently, in August and September 2023, four more infested fields were harvested and destroyed, to be left fallow for three years or planted to alternative crops.

Melmoth: Two LHB positive fields were found November and December 2023 on two farms in close proximity to each other. Both fields were harvested (December 2023) and eradicated. Three additional fields were detected in 2024 (one field before harvest during a routine eldana survey and the other two, during harvest having stubble holes and visible larvae). These are in the process of eradication.

eNtumeni and Melmoth growers have been compensated for loss of income during the three-year fallow period, and during this time may plant the area to any crop they choose if it does not pose a risk as a potential host of the pest (fields do not need to be abandoned). Once the three-year fallow has elapsed growers may plant cane again, but at the risk that if the pest recurs then there will be no compensation and the cane will have to be eradicated at the growers' expense.

The insect has a two-year life cycle. In September-November, large larvae are present that are around 18 months old. These cause the most visible damage in standing cane due to a weakened stalk and root system that leads to stress symptoms and lodging (Figures 1 and 2).

Figure 1

Late instar (L6) LHB lava within a stool; large hole in stubble indicative of larval presence

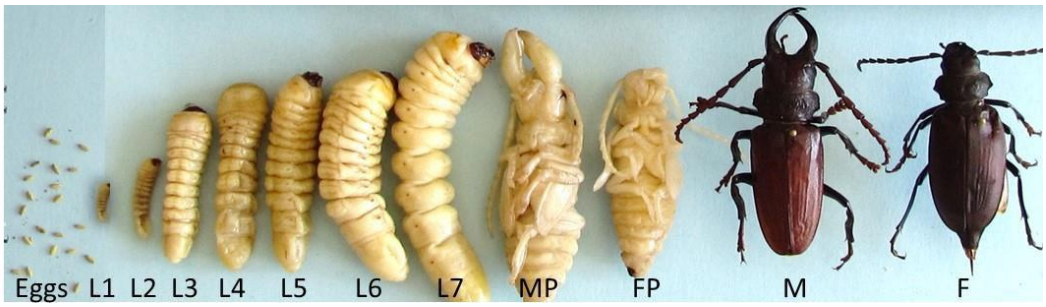

Figure 2

Life stages of the longhorn beetle

In an intensive survey conducted at eNtumeni in September 2016 larvae from L1 to L6 were found. L1 larvae likely arose from eggs laid in March 2016 while L6 larvae would have arisen from eggs laid during January-March 2015.

In November-December late instar larvae pupate directly under the stool in chambers that they construct from soil and organic matter (Figure 3). Beetles emerge beginning in December but mainly January through March, to mate and lay eggs.

Figure 3

Pupa stage found under cane stool in pupal chamber: Female beetle emerging from hole in sandy soil

When cane is harvested, the presence of large holes in the stubble indicates that larger larvae are or have been present as these tunnel up into stalks above ground. Most larvae were collected post-harvest by

digging up stools with stubble holes. Consequently, most of the larvae collected by SASRI were late instar (medium-sized to large).

Investigating insecticide efficacy involved a combination of pot trials (at eNtumeni and SASRI) and field trials (at eNtumeni), which included, in total, 11 different active ingredients.

Among the 11 potential insecticides tested (plus some combinations thereof) in pot and/or field trials, the use of ethylene-dibromide (EDB – this chemical has now been removed from the market) as a soil fumigant to destroy larvae within the stools showed significant promise in large-pot trials, but was not successful in the field due to difficulties surrounding its application (via a stool splitter) and limited movement of the fumigant beneath the soil into the root zone where larvae are present. Other insecticides, including Emma® and Bandito®, showed little or no efficacy against the medium-sized to large larvae used in pot trials.

Emamectin benzoate has been registered by Arysta-UPL (Emma®) for LHB control in stubble. In cane harvested in April 2024 (Melmoth), SASRI applied Emma® during May at a per stool calculated rate based on product label instructions. The whole dose was applied into the large holes created by late instar larvae. Stools were dug up one week later. Unfortunately, no dead larvae were found while live larvae were found in other parts of the stools. This may be because late instar larvae quickly move away from exposed holes or insecticides, or that they had already pupated in November-December 2023. Remaining younger larvae would have avoided the insecticide by being within other parts of the stool.

Eradication and fallow remain the best method for dealing with infested fields. Although it appears that registered insecticides (Bandito® and Emma®) have minor effects on medium and large instar larvae, an effect on much smaller first and second instars is much more likely. Effective targeting of these would require application to cane harvested April onwards, after egg laying, and may be best applied to fields surrounding the eradication zone which may be newly infested, but that infestation will not be detectable for another 12-18 months.

If possible, when eldana surveys conducted in August detect LHB, fields should be harvested, ratooned, killed and finally ploughed out in November. Mechanical tillage in November will disrupt the delicate pupal phase which is below the stool.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Termites (RD&E Topic Reference Code: CP9)

Background

Topic raised in Zululand/Umfolozi workshop.

Growers noted the following.

- Empangeni is a hot, dry area, and these is an emerging termite problem How do we deal with this?
- Termites have become a problem under very dry conditions and difficult to manage at depth.

Feedback

Several generic products containing fipronil are registered for termite control in row crops when applied as baits. Insecticidal activity relies on the termites moving the bait from the surface into their nests.

Preparation of bait for harvester termite control

- As bait carriers coarse lucerne and cut veld grasses are suitable. Carriers must be dry (i.e. not green) when used. The carrier must be cut into lengths of no more than 25mm. This provides bait lengths preferred by the termites.
- Weigh the bait carrier into 10 kg lots. Spread the 10 kg lots into 2 m x 2 m piles on a clean, dry, even surface. It is important that the surface be clean (i.e. not contaminated with oil, other pesticides etc.) as the termites are very sensitive to foreign odours and will reject any contaminated bait.
- The bait carrier piles are then treated with 12,5 ml FarmAg Fipronil 200 / 5 lt water / 10 kg bait carrier pile. The bait carrier piles can be treated with a knapsack sprayer.
- During treatment the piles must constantly be turned with pitchforks to ensure an even coverage of the bait carrier with the spray mixture. Leave the bait piles to dry, occasionally turning with pitchforks to hasten the drying process. When dry, bag the bait in clean (i.e. unused) bags.
- Mark bags clearly to indicate that the content is poisonous. Use clean gloves when handling the bait during cutting and bagging. The bait is then ready to be applied.

NB: It is important not to contaminate the bait during bait preparation with any foreign substances. This will cause the termites to reject the bait. Overdosing of bait will also cause the termites to reject the bait. Applications to the bait carrier must be made accurately to prevent overdosing.

Field application

- Scatter 10 kg prepared bait evenly over 1 hectare (1 g bait/m²). Termite nests are usually present over a large area, and it is therefore necessary to treat the entire infested area.
- Scatter prepared bait when termites become active and start to forage for dry grass. This is usually in April, at the beginning of winter but can be earlier under dry conditions. Also scatter the bait from mid-morning when the termites are active.
- When active foraging holes are noticed after the initial treatment, apply spot treatments at 1 gram bait per m².

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Nematodes (RD&E Topic Reference Code: CP10)

Background

Topic raised in Zululand/Umfolozi workshop.

Dokodweni SSGs in and around eMacambini: Poor soils < 5% clay - nematode problem, 3-4 ratoons and need to replant. Need strip trials for nematicides to demonstrate value; need training; posters; demonstration plots to raise awareness and to improve sustainability

Feedback

A nematicide should routinely be used to treat cane on poor sandy soils, i.e. where the clay content is less than about 6%. Response to nematicide decreases as the clay percentage increases. Generally, response to nematicide is 10% or more on soils with 20% clay or less.

Where there is any doubt as to what the cause of poor growth may be, particularly on less sandy soils, it is advisable to first assess the value of using a nematicide. This may be done by applying the nematicide to a few rows immediately after harvest. If nematodes are the main factor limiting growth, then a clear growth response will be observed in the treated strips within eight weeks. The remainder of the field should then be

treated without delay. When cane is harvested and treated in winter the response to treatment may take longer than eight weeks to be discernible.

1. Choose a place in a field where the soil and cane growth are uniformly poor.

2. A treated strip must be at least 5 m away from the field edge (Figure 1).

3. Treat a strip of at least five rows wide and a minimum of 10 m long.

3. Distinguish your treated rows with some visible marking e.g. wooden pegs, stones; anything to remind you where the treatment begins and ends.

4. Explain to your staff, and induna, where the strip is and what special precautions to take, if any.

5. Monitor the treated strip and adjacent untreated cane (away from the field edge) for visible differences in crop vigour, colour, and stalk height and numbers.

Figure 1

Configuration of treated and untreated field panels for a strip trial to test nematicides

As an alternative to nematicides at planting, sett roots of plant cane can be shielded from plant parasitic nematodes by encasing the planted sugarcane setts in an envelope of organic matter applied at approximately 100 tons/ha in the furrow (Figure 2). This provides protection for sufficient time to ensure that the young shoots are well grown before the roots are attacked. When using organic matter in this way, a nematicide should not be applied. The effect of the organic matter can persist through to the following crop.

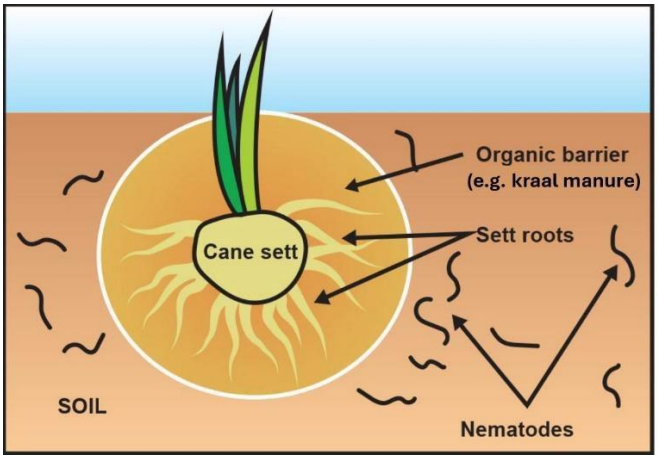

Figure 2

Sett roots of plant cane shielded from plant parasitic nematodes by enclosing setts in an envelope of organic matter

Small scale grower extension (Thulani Masondo; Sifiso Hlela – ZN & ZS) will be incorporating the provision of training and the raising of awareness regarding nematodes into their programme of work.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Ratoon Stunt (RSD) (RD&E Topic Reference Code: CP11)

Background

Topic raised in Pongola, South Coast/Midlands South and Zululand/Umfolozi workshops.

Growers noted the following.

- Importance of field hygiene.
- Does RSD survive in the soil?
- Are there alternate hosts?
- Feedback on progress with lateral flow device.

Feedback

Importance of field hygiene.

Refer Information Sheet 9.1 Ratoon stunt (RSD) SASRI eLibrary - Information Sheets

Does RSD survive in the soil?

The RSD bacterium is a nutritionally fastidious, slow-growing, xylem-dwelling bacterium in sugarcane stalks (Monteiro-Vitorello et al., 2009; Castro-Moretti et al., 2021). The bacterium was shown to survive for at up to 3 months after eradication of a crop that was severely infected with RSD (Bailey and Tough, 1992), most likely in moribund plant material.

Alternate hosts

Sugarcane (*Saccharum* spp. and *Saccharum* interspecific hybrids) is the only known natural host of the RSD bacterium (Young, 2016). Although certain grasses have been experimentally infected with the pathogen, titres within the plants remained low (Zavaglia et al., 2016).

Progress with lateral flow device

Project 16TD03 aimed at developing a lateral flow device (LFD) for the detection of the RSD bacterium closed out in March 2024. The Technology Innovation Agency is currently working on a protype with other service providers. Once this is available, SASRI will assess the accuracy and sensitivity of the LFD in the laboratory and field. Alternative near-to-field diagnostic methods continue to be explored (see attached project pre-proposal)

References

- Bailey RA, Tough SA (1992) Ratoon stunting disease: survival of Clavibacter xyli subsp xyli, in field soil and its spread to newly planted sugarcane. *Proc S Afr Sug Technol Ass* 66: 75–77.
- Castro-Moretti FR, Cocuron JC, Cia MC, Cataldi TR, Labate CA, Alonso AP, Camargo LEA (2021). Targeted metabolic profiles of the leaves and xylem sap of two sugarcane genotypes infected with the vascular bacterial pathogen *Leifsonia xyli* subsp. *xyli*. *Metabolites* 11(4): 234.

- Monteiro-Vitorello CB, Zerillo MM, Van Sluys MA, Camargo LEA (2009). Genome sequence-based insights into the biology of the sugarcane pathogen *Leifsonia xyli* subsp. *xyli*. In: Jackson R., editor. *Plant Pathogenic Bacteria—Genomics and Molecular Biology*. Caister Academic Press; Cambridge, MA, USA: pp. 135–146.
- Young AJ (2016). Possible origin of ratoon stunting disease following interspecific hybridization of Saccharum species. *Plant Pathology* 65(9):1403-10.
- Zavaglia, A.C., Cia, M.C., Popin, R. *et al.* (2016). No alternative hosts of the sugarcane pathogen *Leifsonia xyli* subsp. *xyli* were identified among grass and non-grass species using novel PCR primers. *Trop Plant Pathol.* 41: 336–339.

For further information, please contact Sharon McFarlane (Senior Pathologist)

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Eldana and emamectin (RD&E Topic Reference Code: CP12)

Background

Topic raised in North Coast/Midlands North workshop.

Eldana incidence increasing and how does Emma® affect this? When to apply emamectin for optimal efficiency? – uptake in the area is increasing. Anything further on it?

Feedback

An eldana infestation is measured by sampling, stalk splitting and expressing the level of infestation in terms of eldana numbers per 100 stalks (E/100). However, a proportion of the larval population is found below base cutting height (approximately 10%) which remains after harvest. When infestations are heavy, these larvae indicate their presence by producing frass “volcanoes” and dead hearts. Larvae will eventually develop into adults increasing the overall infestation area-wide.

Area wide integrated pest management (AW-IPM) programmes against eldana ideally consider moth movement between fields and farms. Emamectin benzoate has been registered by Arysta-UPL (Emma®) for eldana control in stubble with the aim of preventing moths from spreading to adjacent fields and farms. In their registration trials they showed increases in viable tillers (reduction in dead hearts) (Figure 1).

Figure 1

Emma® registration trials (Arysta-UPL) showing increased viable tillers (reduction in dead hearts)

Independently, SASRI included Emma® in two research trials. In these trials Emma® applied to stubble directly after harvest decreased early damage (total dead-hearts and frass eruption counts) (Table 1).

Table 1

Effect of stubble treatment containing emamectin benzoate on subsequent total stubble frass eruptions, dead-hearts (recorded during the first three and five months of the ratoon respectively) and yield (T sucrose/ha), quality (Pol%) and eldana damage (%IB) at harvest (18 mo).

Trial 1

Treatments	D/heart Counts	Frass Counts	Pol %cane	Ts/ha	%IB
Control	2019	150	8,4	5,1	36,1
Emamectin 15g /ha	**1124**	**88**	8,8	5,6	34,2

Trial 2

Treatments	D/heart Counts	Frass Counts	Pol %cane	Ts/ha	%IB
Control	456	62	13,9	7,9	10,1
Emamectin 10g /ha	**175**	**9**	14,7	6,5	11,3
Emamectin 20g /ha	**152**	**3**	14,6	8,3	10,4

However, this did not translate into decreased damage at the following harvest 18 months later (non-significant differences in %IB).

The absence of an effect on harvest %IB could be because adult moths emerging from stubble and dead-hearts in young ratoons do not remain in the same field due to the absence of egg-laying sites and stalk for infestation at that time. They may migrate to more suitable fields nearby. Alternatively, it may be due to a trial artefact. Higher moth numbers emerging from the control plots might 'randomly' distribute across the whole trial infesting new stalks in all treatments evenly (as the effects of the treatments wore off), each generation behaving similarly.

Emma® clearly has a place in reducing overall eldana pressure area wide and in many cases, treatment will result in an improved tiller count, a more complete canopy and reduced weed pressure due to better shading. To determine whether the use of Emma® might be beneficial an eldana survey at harvest should be carried out. As a rule of thumb, if E/100 is greater than 10, then Emma® should be applied.

It is important to observe recommendations for use detailed in the Emma® label so that efficacy is not compromised:

- Use of adjuvant as per label is essential to ensure penetration into the stubble. Do not use any other adjuvant other than what is specified on the label.
- Thorough wetting is essential. Use high water volumes of 750-1000L/ha.
- For optimum effect, the cut ends of the stubble must not be dried out.
- Apply directly to stubble up to 5 days after cutting with 300 g Emma® per hectare + 1,5ml Silhouette per L water.
- The target area must be free of excessive trash to ensure that the spray mixture comes into direct contact with the cut stumps.
- The spray must be directed onto the row and application can be applied by knapsack applicator or by tractor (Figure 2).

Figure 2

During Emma® application, the spray must be directed onto the row and application can be applied by tractor (left) or knapsack (right).

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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White grub management (RD&E Topic Reference Code: CP13)

Background

Topic raised in North Coast/Midlands North workshop.

Feedback

A communication plan on white grub management has been prepared by Drs Lawrence Malinga and Iona Basdew for implementation in 2025. A series of knowledge exchange interventions have been designed to engage with growers on options for managing this pest.

For further information, please contact Dr Lawrence Malinga (Entomologist) and Dr Iona Basdew (Biosecurity Scientist)

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Insecticides for thrips and YSA management (RD&E Topic Reference Code: CP14)

Background

Topic raised in Lowveld, North Coast/Midlands North and Zululand/Umfolozi workshops.

- How to mitigate YSA-induced yield loss through spraying?
- How many times can one spray without causing problems with quality / insect resistance development. What is the latest you can apply chemicals (insecticide) regarding impact on stalk length etc.
- How do you determine what the limit for insecticide application is in a season?
- Need general advice on YSA management according to agrochemical labels.

- Over reliance on agrochemicals leading to resurgence in x (grasshoppers in Swaziland?) possibly a result of agrochemical over use (neonicotinoids).
- How long does it take for a sugarcane plant to take up insecticide (e.g., Bandit to the leaves), particularly through drip?
- The growers are looking for more insecticides than currently available to manage YSA specifically for ratoon crops.

Feedback

Research in the United States indicates that yield reductions due to YSA feeding damage are usually as a result of infestations during the early plant growth stages. Anecdotal evidence from Umfolosi also suggests that early infestations can cause severe yield loss. A field of YSA susceptible N19 failed to canopy for most of a summer due to YSA infestation. Early and repeated infestations field-wide on susceptible varieties are more likely to result in significant yield loss. A patchier infestation pattern as is often seen on the North Coast will reduce yield in those patches and loss may be less significant on a field scale.

Given that early YSA infestation is likely to have the greatest negative effect on cane growth, especially as a population explosion at this stage fuels repeated infestation, pre-emptive control should be considered. Bandit®, Kohinor®, Apache® and Actara® (Group 4A) and Bandito® (Groups 1A+4A) are registered for pre-emptive application to soil and/or stubble and their use should take into consideration varietal susceptibility and field history of infestation. Insecticides that are effective against YSA are generally also effective against thrips and vice-versa, although they may not be registered for both (Tables 1 and 2).

The soil applied neonicotinoids (group 4A) and oxamyl (1A - as a component of Bandito®) are highly systemic when taken up from the soil in the transpiration stream. Uptake will be almost immediate during summer periods of high evapotranspiration provided there is adequate soil moisture. The neonicotinoids move in the xylem stream primarily to fully emerged leaves which are transpiring the most. Neonicotinoids accumulate in leaves and are eventually broken down and metabolised by the plant.

Foliar applications are limited to members of these same groups (1A – carbamates and 4A – neonicotinoids) plus the group 28 diamide cyantraniliprole and the group 3 pyrethroid l-cyhalothrin (the latter as a component of Ampligo® - also contains the diamide chlorantraniliprole which is ineffective against aphids and thrips).

To help prevent or delay the incidence of resistance, the Insecticide Resistance Action Committee (IRAC) promotes the use of a Mode of Action (MoA) classification of insecticides in effective and sustainable IRM strategies. Available insecticides are allocated to specific groups, based on their target site within the insects' physiology. By using sequences or alternations of insecticides from different MoA groups, where possible, resistance is less likely to occur.

Unfortunately, of all the MoA groups effective against aphids and thrips (Table 1) only four of ten are registered against YSA and/or sugarcane thrips. Limited possible alternations are illustrated below consisting of furrow and/or soil-stubble application of Bandito®, Actara®, Bandit®, Apache® or Kohinor® followed by foliar applications of Vydate®, Apache®, Allice®, Wonderland®, Maintain®, Ampligo® or Benevia® (Figures 1 and 3).

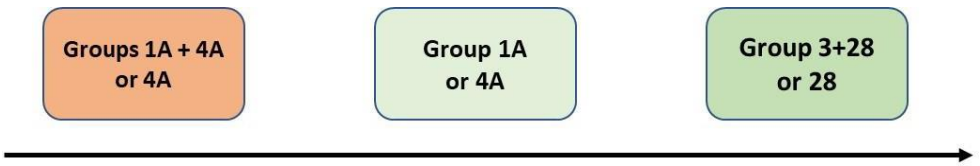

Figure 1

Example of a sequence of insect Mode of Action groups registered for YSA and thrips control

Table 1

Modes of action effective against aphids. Compounds must only be used according to the label instructions: # = registered for sugarcane thrips control; and * registered for YSA control

IRAC Group	Modes of action effective against aphids in general	Sub-group	Example active ingredients
1	Acetylcholinesterase inhibitors	A B	Oxamyl*# Malathion
2	GABA-gated Cl- channel blockers	A	Endosulfan
3	Sodium channel modulators (pyrethroids)	A	l-cyhalothrin*
4	nAChRagonists (neonicotinoids)	A C D	Imidacloprid*#, Thiamethoxam*, Acetamiprid*# Sulfoxaflor Flupyradifurone
7	Juvenoids	A	Pyriproxyfen
9	Effectors of chordotonal organs	B D	Pymetrozine Afidopyropen
12	mitochondrial ATP synthase inhibitor	A	Diafenthiuron
23	Inhibitors of acetyl-CoA carboxylase	None	Spirotetramat
28	Ryanodine receptor modulators	None	Cyantraniliprole*
29	Effectors of chordotonal organs	None	Flonicamid

Over reliance on insecticides can be avoided by following guidelines contained in the SASRI publication "Thrips & YSA Control Manual".

The 'SLOW DOWN - SPEED UP' Strategy for Pest Management

For effective control, some elements in the system need to be speeded up, and others slowed down.

Many natural enemies of pests need support from the environment in the form of pollen, nectar, resting places, or (alternate) prey availability. Manage a diversity of plantings on the farm to 'speed up' natural biocontrol. SASRIs' Biosecurity Scientist can assist you in the establishment of on farm biodiversity.

Varieties with some pest resistance 'slow down' pest development while slower developing natural enemies catch up.

Unstressed plants defend themselves better. Reduce plant stress by managing soil physical and biological health.

Plants with optimal nutrition 'slow down' pest development. Avoid overapplication of N. Avoid underapplication of P and K.

Pests are stressed when they feed on unstressed resistant plants and become more susceptible to insecticides than those that feed on susceptible plants.

Optimal use of insecticides will 'slow down' pest development while minimising negative effects on natural enemies that suppress pests. Oxamyl, imidacloprid and thiamethoxam are applied pre-emptively at a time when both pest and natural enemies are absent. Acetamiprid and cyantraniliprole can be applied to the foliage and are less damaging to natural enemies (Figure 2).

The above measures increase predator to prey ratios.

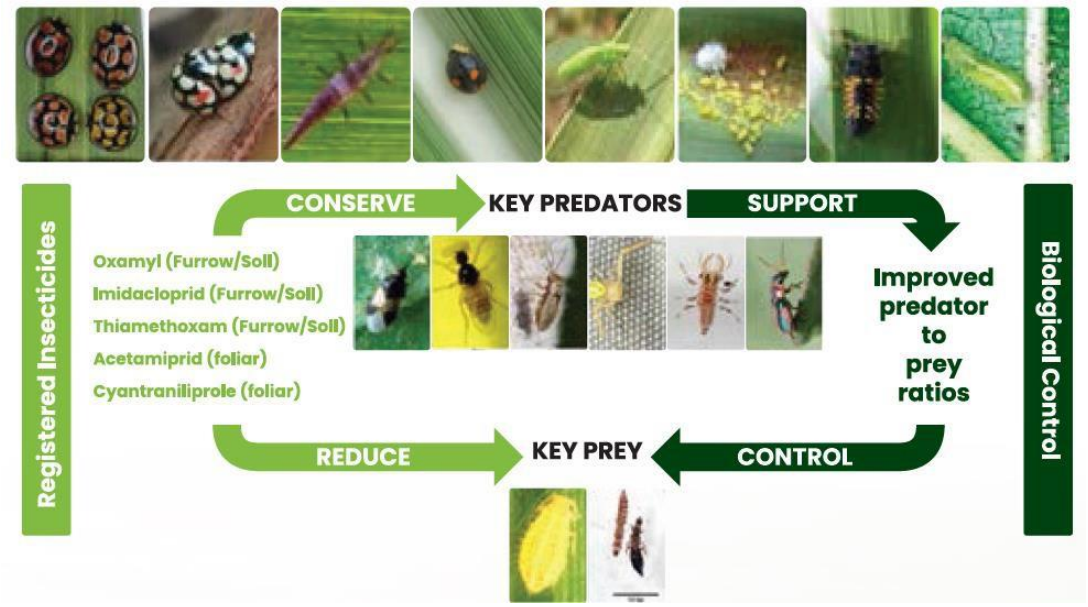

Figure 2

When used optimally, negative effects of insecticides on natural enemies can be minimised.

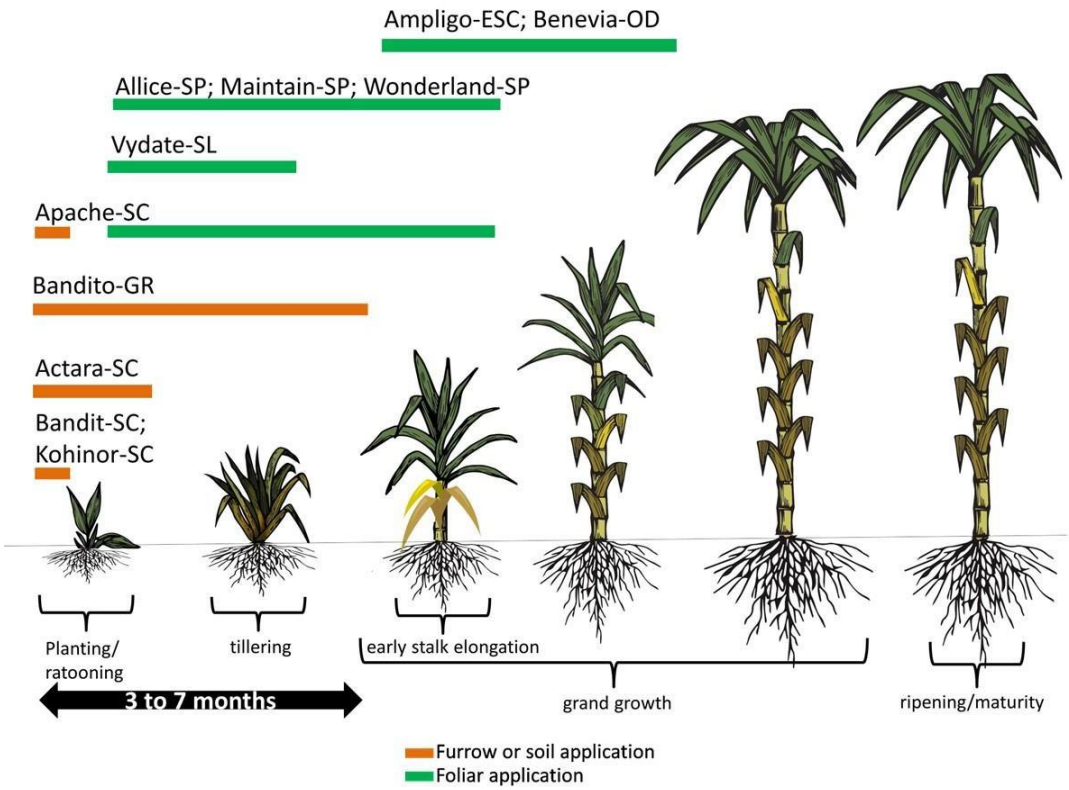

Figure 3

Suggested timing of use for registered products in accordance with product labels.

Table 2

Use of registered insecticides.

Registered product(s)	Active ingredient(s): IRAC code	Application	Registered for control of:	Notes
Bandit SC & Kohinor SC	Imidacloprid: 4A	**Plant cane furrow only:** Single application only (September to November). Apply to the furrow in 200 to 300 ℓ water/ha, using a flat fan nozzle.	Thrips	If applied for thrips control, will also control YSA. Likely to have a plant physiological stress alleviating effect.
Actara SC	Thiamethoxam: 4A	Apply once only, in 200 - 300 ℓ water / ha: **Plant cane furrow**: Apply as a single in-furrow band application (30 to 50 cm wide), at planting, after placement of the seed cane, as the last operation before closing. **Ratoon cane:** Apply between 7 and 30 days after harvesting. For bee safety, ensure that stubble is dry before applying the product. Apply as a broad band application over the cane rows.	YSA	If applied for YSA control will also control thrips. Likely to have a plant physiological stress alleviating effect.
Bandito GR	Oxamyl & Imidacloprid: 1A+4A	**Plant cane furrow:** Apply granules with the use of a mechanical granular applicator only after the planting sets have been placed in the furrow. Cover setts and granules with soil. **Ratoon cane soil:** Apply to moist soils in the rainy season. Band apply on the soil surface on both sides of, or over, the plant rows.	Thrips, YSA & nematodes	Likely to have a plant physiological stress alleviating effect.
Apache SC	Imidacloprid: 4A	**Plant cane furrow:** Apply a single application only from September to November. Apply directly into the furrow using 200 - 300 ℓ water/ha. Use a flat fan nozzle. **Foliar application:** Apply in at least 250 ℓ water/ha as soon as the pest is noticed between October and November. Apply when at least 3 – 4 green leaves are present. Sugarcane planted earlier in the season (September) should receive 3 applications at 14-day intervals. October plantings need only 2 applications, also at 14-day intervals. Direct spray at the centre of the developing tillers using a flat fan nozzle. Good coverage is essential.	Thrips	If applied for thrips control, will also control YSA. Likely to have a plant physiological stress alleviating effect.
Vydate SL	Oxamyl: 1A	**Foliar application:** Apply as an early corrective application at first signs of thrips infestation or mottling between the 2-leaf but not later than the 6-leaf stage (at maximum plant height of 0,5m) of the crop. Application timing is critical for the effective control of thrips. VYDATE applied before the 2-leaf and later than the 8-leaf stage of the crop is less effective against thrips. A follow-up application may be required 21 – 28 days after the first application based on scouting of live thrips under conditions of continued thrip re-infestation.	Thrips & nematodes	If applied for thrips and/or nematode control, will also control YSA.
Allice SP	Acetamiprid: 4A	**Foliar ground application:** Apply in at least 250 ℓ water/ha as soon as pest is noticed. Use a flat fan nozzle and direct the spray to the centre of the developing tillers for thrips or the lower leaves for YSA. **Aerial application (thrips only):** Apply in at least 30 ℓ water per ha. (Use Silhouette at 200 mℓ per ha.)	Thrips & YSA	Of the neonicotinoids, acetamiprid is least damaging to natural enemies.

Registered product(s)	Active ingredient(s): IRAC code	Application	Registered for control of:	Notes
Maintain SP	Acetamiprid: 4A	**Foliar ground application:** Apply treatment when at least 6 to 8 green leaves are present. Apply in a minimum volume of 250 litres water per hectare as soon as pest is noticed. The use of a twin flat fan type nozzle is recommended. Direct the spray to the centre of the developing tillers. **Aerial application:** Apply in at least 30 litres water per hectare. The addition of a registered drift retardant adjuvant, to minimize spray drift to any area not under treatment, is strongly recommended.	Thrips	Of the neonicotinoids, acetamiprid is least damaging to natural enemies.
Wonderland SP	Acetamiprid: 4A	**Foliar ground application:** Apply in at least 250 ℓ water/ha as soon as pest is noticed. Use a flat fan nozzle and the spray must be directed to the lower leaves.	YSA	Of the neonicotinoids, acetamiprid is least damaging to natural enemies.
Ampligo ESC	l-cyhalothrin & Chlorantraniliprole: 3+28	**Foliar ground application:** Apply at the first sign of infestation. For aphids, direct the spray towards the lower parts of the cane where the pest is present. The action for aphids is short-term contact only.	YSA & eldana	l-cyhalothrin has a short-term knock-down effect on YSA. It is damaging to natural enemies. Chlorantraniliprole is not effective against YSA.
Benevia OD	Cyantraniliprole: 28	**Foliar application:** Apply in at least 250 ℓ of water / hectare. Good coverage of all foliage is essential. Apply as soon as the pest is first noticed. For aphids, direct the spray towards the lower leaves of the cane where the pest is present. A second application should be made 7 days later. A maximum of 2 consecutive applications should be made to the crop. Further application(s) must be with an effective product with a different mode of action (non-Group 28 insecticide). The use of Trend 90 or H & R Crop Oil as prescribed under DIRECTION FOR USE table can offer enhanced pest control when added to BENEVIA® 100 OD.	YSA & eldana	If applied for YSA and/or eldana control, may also control thrips. Is least damaging to natural enemies.

ESC - Encapsulated Suspension Concentrate; GR – Granular; OD – Oil Dispersion; SC – Suspension Concentrate; SL – Soluble Liquid; SP – Soluble Powder.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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YSA / Thrips / Biological control / Field hygiene / Farmscaping (RD&E Topic Reference Code: CP15)

Questions / Problems / Challenges

- Management: Biological control through habitat management / natures enemies.
- Are there any observation studies on farms using ladybirds and natural predators for YSA, and the effects of insecticides on the natural predators?
- Verge management hygiene - possible role in maintenance of biodiversity / habitat - not cutting verges - a possible way to keep YSA out of cane?
- Best practises in terms of insecticide applications (the tendency to use Allice in tank mix on non-crop verges – illegal).

1. Biodiversity Management

Farmscaping is a potential remedial practise that could be implemented in-field to enhance biodiversity within the sugarcane landscape. Farmscaping involves an integrated, whole-farm approach to the biological control of pests through laying out of the farm to include flowering hedges, natural insectary plantings, cover crops, water and other features to attract and sustain beneficial organisms that are primarily predators of insects pests. Beneficial organisms include insects, birds, bats, arthropods and microorganisms. With specific reference to sugarcane, predatory insects such as ladybirds, lacewings, soldier beetles, pirate beetles, hover flies, mantids, and certain species of wasp prey on the major pests currently affecting the industry particularly, yellow sugarcane aphid, Eldana and thrips (Table 1).

Table 1. Major predators of yellow sugarcane aphid prevalent on South African sugarcane

Order: Family	Species
Coleoptera: Coccinellidae	*Nephus kamburovi* Mulsant (1846) *Cheilomenes propinqua vicina* *Exochomus flavipes* Thunberg (1781) *Cheilomenes lunata* Fabricius (1775) *Harmonia axyridis* Pallas (exotic) *Hippodamia variegata* Goeze
Diptera: Syrphidae	*Asarkina Africana* Bezzi (1908) *Toxomerus floralis* Fabricius (1798)
Neuroptera: Hemerobiidae Neuroptera: Chrysopidae	*Micromus africanus* Weele (1910) *Chrysopa congrua* Walker (1853)

Beneficial insects require food and shelter if they are to control pests. The planting of flowering plants will increase the likelihood that predators and parasitoids will remain in an area and assist with pest management – natural insectaries. In the absence of the specific pest during the off-seasons, these predatory insects still have the capacity to feed on pollen and nectar. These insectary plantings can consist of an area reserved entirely for beneficials or, as would be most applicable for sugarcane agriculture, it can be made up of small, planted areas of indigenous flora that will serve as reservoirs for the natural enemies. In order for such a system to work, it requires selection of the right plants, in appropriate areas of the farm (water courses, slopes, etc), in order to attract the right predators.

Four primary **SAFE** criteria need to be met to encourage beneficials:

1. **Shelter** which should be areas protected from insecticides, intensive tillage, or other practises such as burning, that provide habitat to sustain beneficials. Cultivation schemes that may be compatible specifically with sugarcane and/or multicropping systems of sugarcane + macadamias/bananas/avocado include a strip (or more if resources allow) of permanent vegetation bordering a field or between two fields, e.g., between sugarcane and macadamias. A border such as this can be planted to attract beneficials throughout the cropping season if the proper plants are used. These are ideally perennials.
1. **Alternative Food Source** outside of the pests that we are aiming to manage. Pests are generally present over a short duration of the crop growing cycle. However, this is not the case with yellow sugarcane aphid and Eldana that are present all year around but with fluctuations in population density. Food can be provided for yellow sugarcane aphid and Eldana predators during pest population dips by provision of other plants with nectar and pollen.
2. **Flower-rich Habitat** as pollen and nectar are essential food for parasitic wasps, hoverflies and lacewing adults. Pollen and nectar also provide an alternative food source to ladybirds, pirate bugs, soldier beetles, lacewing larvae, predatory flies. Annual and perennial flowering plants can supply this pollen and nectar.
3. **Environment** that is rich with floral diversity and with minimal exposure to insecticides, e.g. field margins, contours, waterways, or indigenous bush zones.

A successful insectary has the following characteristics:

1. Indigenous perennial and annual plants that provide flowers throughout the year; usually 5-6 types of plant.
2. Plants of varying size and height to provide shelter for insects in different niches.
3. Is a long term and permanent feature of the area being landscaped
4. Provides small flowers for parasitoids (insect parasites), hover flies, wasps and robber flies.

5. Provides large and long flowers for butterflies, bees and flies.
6. Provides sturdy herbaceous shrubs for mantids to lay their egg casings against.
7. Ideal species: *Aloe* spp., *Lavandula* spp., *Salvia* spp., *Ocimum* spp., *Anthericum* spp., *Allium* spp., *Leonotis leonorus*, *Tulbaghia* spp., *Crocosmia* spp.

Going Forward: Major steps to consider before implementation:

1. Analyse records of where, when and what pests occur and relative abundance/severity of infestation.
2. Know the pest and the targeted predators: biology, ecology.
3. Select the right plants for your particular agro-climatic region.
4. Select the zones that you would like to diversify.
5. Start SMALL and SIMPLE!

Remember:

1. Not a quick, “silver bullet” system.
2. Some maintenance will be required in the first few seasons: trimming and weeding.
3. Seed/seedlings will need to be sourced.
4. Manpower will be required for planting.
5. The system will most likely require fine tuning such as adding, removing or varying the plants.
6. Plants ideally planted in rows of alternating species, e.g., flowering annuals alongside flowering perennials, or strong aromatics alongside softer pollen and nectar producers.

2. YSA + Ladybird + Plant Interactions

There are limited studies on the use of ladybirds to manage aphid infestations in sugarcane. Notable studies conducted in the United States (Akbar et al. 2009) and Brazil (Auad et al. 2013) showed promise for the biological control of YSA using various ladybird species. However, confounding results were reported in Japan (Kindlmann et al. 2015) which cautioned the interpretation of results in experiments investigating the use of a long-lived predator (ladybirds) to manage a short-lived herbivore (aphids).

The effects of insecticides is a further factor that requires investigation. While the insecticides regsitered for use againts YSA are able to suppress pest populations if applied appropriately, they also adversely impact the natural predator populations that concurrently develop in response to aphid infestations. Previous studies by Jalali et al. (2009) have shown that the neonicotinoid insecticides diminished fecundity in *Adalia bipunctata* (Linneaus 1758) which lead to reduced reproductive ability in adult ladybirds and induced a reduction in the size and robustness of the ladybird larvae. This translates to reduced predatory capacity of both the larvae and the adults. Although some ladybird species can tolerate exposure to, and indirect digestion of neonicotinoids, some species are completely suspectible, along with major lacewing species (larvae and adults) (Jansen 2012; Dai et al. 2021). However, pyrethroid based insecticides are completely toxic to all insects, hence ladybird and most other natural predator populations are killed along with the aphids (Benelli et al. 2015; Thornham et al. 2008).

YSA demonstrates cryptic biology and behavioural patterns, one of which is the theorised suppression of the plants’ defence signalling network when under attack by the pest (different from other aphid species) (White 1990; Akbar et al. 2010; Koch et al. 2020). This inhibition of the plant defence system allows YSA populations to feed for prolonged periods, while simultaneously being undetected by predators. This is exacerbated by the erratic retention periods of YSA colonies on leaves which does not allow sufficient time for predators to locate, establish and feed on the pests (observational). Studies have shown that aphids are manipulators of the plant’s chemical defence systems. In plants, the jasmonic acid (JA) pathway activates resistance against herbivores (especially chewing herbivores), while the salicylic acid (SA) pathway is involved in resistance against pathogens (Erb et al. 2012). In the evolutionary arms race, herbivores have evolved to produce effectors (e.g., orally secreted proteins) that modulate plant defensive pathways and may suppress or manipulate the plants defences. Aphids are particularly successful in this regard, often producing multiple effectors in their saliva (Johnston & Zust 2018). Because of their unique mode of feeding, aphids mostly trigger SA-mediated responses in their host plant, even though JA-mediated defences would often be more effective against them (Johnson & Zust 2018).

Under the current conditions, recommendations for the management of YSA includes a combination of factors from variety choices, to the judicious use of insecticides, plus soil health aspects. However, a common concern that has arisen amongst growers in terms of YSA management is the role that field verges might play in either harboring, or, providing an alternative food source for the pest. The current

SASRI recommendation to assist with the management of YSA (plus thrips) is to keep grasses on verges and cane breaks short and to ensure that there is a baresoil gap between the grass and sugarcane.

A verge typically refers to an area on the edges of, or flanking cane fields, and is either planted to grass and kept trimmed, or left to nature in which case it is often crowded with weeds. Traditional management of verges has relied almost exclusively on mowing and keeping these zones well manicured and weed-free. Encroaching weeds are usually treated with registered herbicides, or in some cases removed through mechanical mowing. This was thought to confer both aesthetic appeal and possibly repel insects that might otherwise feed on the adjacent cane. Growers have now requested further information on the role played by both verges and cane breaks during YSA infestations.

In light of this, a project was proposed and accepted that will comprise a one-year survey to investigate the effects of trimmed verges and trimmed cane breaks versus untrimmed verges and untrimmed cane breaks and their respective effects on YSA infestation in surrounding cane, and the diversity of insects residing in those zones. The survey will be conducted in the North Coast, Zululand, South Coast, Pongola and Komatipoort. Possible benefits associated with untrimmed verges and untrimmed cane breaks include a greater diversity of predatory insects, higher numbers of pollinators (applicable for growers with dual biosystems), and downstream benefits in terms of reduced insecticide applications.

Should the results derived from the survey show an increase in both number and diversity of predatory insects, coupled with a decrease in YSA infestation in surrounding cane in VT- sites compared to VT+ sites, it would be beneficial for growers to leave their verges and cane breaks to nature, rather than maintain them through regular trimming and herbicide applications. However, current SASRI recommendations are for verges to generally be kept short for weed and disease management (mosaic, rust – *Miscanthidium capense* is thought to be the native host of tawny rust). Considering this, the findings of the proposed study are meant to provide a recommendation where YSA is severe, and the grower is not necessarily experiencing serious mosaic or rust pressure. If mosaic or rust pressure is high, the grower would have to reevaluate whether to leave his verges untrimmed or not. Going forward, SASRI research- and extension specialists would be able to support growers in making an informed decision about adopting a change in verge management.

3. Insecticides

From the perspective of chemical management, there are several chemicals registered for application against YSA on cane (Table 2). It is essential that these chemicals are applied as per label specifications to optimise efficacy, e.g., do not use a spray application where the label recommendation is a drench treatment. Do not use three consecutive cycles of the same active ingredient in one insect generation, e.g., do not use Allice three times in a row, in the same field, to control a single infestation. Always alternate active ingredients at least after two applications. As a cautionary measure, where growers have multicropping systems and require the work of pollinators (bees specifically), the timing of these insecticide applications is crucial to minimize impacts on bee populations as all of the listed chemicals are toxic to bees.

4. Surveying

Surveying remains the crucial first step to detect the pest before infestation becomes severe. Key factors to be on the lookout for include:

- Purple-red discolouration of grasses on verges – colour change is a reaction to YSA feeding on the grass.
- The YSA will usually move from the grass to the closest cane. If no YSA can be found on discoloured verge grasses, check the cane closest to the grass.
- Early infestation appears as yellow patches. Old infestation turns brown as the leaves dry.
- Infestation can either be patchy and unevenly distributed in the field or infestation can be uniform. Check underside of leaves as YSA are UV sensitive and do not like direct sunlight.
- Leaves of some cane varieties also exhibit a colour change from green to purple when infested with YSA. In particular, N12, N16, N37, N59.
- Cane is most susceptible up to 6mo, however infestation has been recorded in old cane (12-14mo).
- Plant and ratoon cane are both susceptible.

- Stressed soils, such as those with an excessive accumulation of nitrogen, or those that are sandy are particularly prone to infestation.

Table 2. Insecticides registered for YSA on sugarcane in South Africa

Registered Insecticide	Active ingredient & Field application rate	Effect on Natural Predators
Actara (Syngenta)	Thiamethoxam (neonicotinoid); 900ml/ha; (Gr 4A); soil drench application; systemic action from soil to upward parts of plant.	**Moderately Toxic** – reduced fecundity and size of ladybird larvae and adults
Allice (Arysta)	Acetamiprid (neonicotinoid), (Gr 4A); 1,5kg/ha; spray treatment; Acropetal so will not move from sprayed leaves to new leaves.	**Moderately Toxic** – reduced fecundity and size of ladybird larvae and adults
Ampligo (Syngenta)	Chlorantraniliprole (Gr 3) and λ-cyhalothrin (pyrethroid) (Gr 28); 150-300ml/ha; spray treatment; contact and systemic	**TOXIC** to ladybird larvae and adults
Bandito (Arysta) nematicide + insecticide	Imidacloprid (neonicotinoid) 25g/kg – insect; (Gr 4A) Oxamyl (carbamate) 100g/kg – nematode; (Gr 1A) Granular application in furrow at planting, on row or banded in ratoons (the latter after stubble has dried out and best applied in spring/early summer. Use applicator. Use on soils with <15% clay; systemic action (soil to upwards parts of plant).	Imidacloprid – **Sub-lethal** effects on ladybirds
Benevia (FMC Ag ZA) (registered in Dec '22)	Cyantraniliprole (anthranilic diamide) 100g/l (Gr 28); spray application; Acropetal so will not move from sprayed leaves to new leaves.	**TOXIC** to bees, **Moderately Toxic** to ladybirds
Wonderland (Farm Ag)	Acetamiprid (neonicotinoid) 1kg/ha (plus wetter 0.05%). **Ground application** Apply in at least 250 ℓ water/ha as soon as pest is noticed. Use a flat fan nozzle and the spray must be directed to the lower leaves.	**Moderately Toxic** – reduced fecundity and size of ladybird larvae and adults

Potential Research Studies Going Forward:

a. The effects of YSA- registered insecticides against the major predators of YSA on sugarcane.
b. Quantifying the feeding effect of ladybirds on YSA populations on sugarcane.
c. The feasibility of commercial resistance inducers to enhance sugarcane tolerance to YSA infestations.

References:

Akbar, W., Carlton, C., Reagan, T.E. (2009). Life cycle and larval morphology of *Diomus* terminatus (Coleoptera: Coccinellidae) and its potential as a biological control agent of *Melanaphis sacchari* (Hemiptera: Aphididae). Ann. Entomol. Soc. Am. 102:1, pp 96-103.

Akbar W, Showler AT, Reagan TE, White WH. 2010. Categorizing sugarcane cultivar resistance to the sugarcane aphid and yellow sugarcane aphid (Hemiptera: Aphididae). Journal of Economic Entomology 103(4):1431-1437. doi: 10.1603/ec09336.

Auad, A.M., Fonseca, M.G., Monteiro, P.H., Resenda, T.T., Santos, D.R. (2013). Aspects of the biology of the lady beetle *Diomus seminulus* (Coleoptera: Coccinellidae): A potential biocontrol agent against the yellow sugarcane aphid in Brazil. Ann. Entomol. Soc. Am. 106:2, 243-248.

Benelli M, Leather SR, Francati S, Marchetti E, Dindo ML. 2015. Effect of two temperatures on biological traits and susceptibility to a pyrethroid insecticide in an exotic and native coccinellid species. Bulletin of Insectology 68(1): 23-29. https://www.researchgate.net/publication/281653811.

Dai C, Ricupero M, Wang Z, Desneux N, Biondi A, Lu Y. 2021. Transgenerational effects of a neonicotinoid and a novel sulfoximine insecticide on the harlequin ladybird. Insects 12:681. doi: 10.3390/insects12080681.

Erb M, Meldau S, Howe GA. 2012. Role of phytohormones in insect- specific plant reactions. Trends Plant Science 17(5):250–259. doi: 10.1016/j.tplants.2012.01.003.

Jalali MA, Van Leeuwen T, Tirry L, De Clercq P. 2009. Toxicity of selected insecticides to the two-spot ladybird *Adalia bipunctata*. Phytoparasitica 37(4):323-326. doi: 10.1007/s12600-009-0051-6.

Jansen J-P. 2012. Toxicity of two neonicotinoid insecticides via the food chain for larvae of the two spot ladybrid *Adalia bipunctata*. Pesticides and Beneficial Organisms, IOBC-WPRS Bulletin, 82:19-26.

Johnson SN, Zust T. 2018. Climate change and insect pests: Resistance is not futile? Trends in Plant Science 23(5):367-369. doi: 10.1016/j.tplants.2018.03.001.

Kindlmann, P., Yasuda, H., Kajita, Y., Sato, S., Dixon, A.F.G. (2015). Predator efficiency reconsidered for a ladybird-aphid system. Front. Ecol. Evol. 3:27.

Koch KG, Palmer NA, Donze-Reiner T, Scully ED, Seravalli J, Amundsen K, Twigg P, Louis J, Bradshaw JD, Heng-Moss TM, Sarath G. 2020. Aphid-responsive defense networks in hyrbid switchgrass. Frontiers in Plant Science 11(1145). doi: 10.3389/fpls.2020.01145.

Thornham DG, Blackwell A, Evans KA, Wakefield M, Walters KFA. 2008. Locomotory behaviour of the seven-spotted ladybird, *Coccinella septempunctata* in response to five commonly used insecticides. Annals of Applied Biology 152(3):349-359. https://doi.org/10.1111/j.1744-7348.2008.00224.x.

White WH. 1990. Yellow sugarcane aphid (Homoptera: Aphididae) resistance mechanisms in selected sugarcane cultivars. Journal of Economic Entomology 83(5):2111-2114. https://doi.org/10.1093/jee/83.5.2111.

YSA and crop nutrition (RD&E Topic Reference Code: CP16)

Background

Topic raised in North Coast/Midlands North and Zululand/Umfolozi workshops.

- YSA problem on the farm – is there something they could do for the soils since they go into the soils, apply to the soil, systemic resistance. Silicon application and uptake likely, high/excess nitrogen

promotes aphids and plant stress. Soil health in general needs to be looked at. Unpredictability of YSA is a problem for trials.

- Can anything be applied to the soil to ameliorate severe
- YSA. Is there anything that can be applied to the soil? Chemical or soil ameliorant? Systemic? Effect of Si?
- Are there ways to treat soil to reduce or control YSA?
- YSA is a major problem this year and getting onto many fields.
- YSA varietal information and effects of acid saturation on YSA infestation – a WhatsApp group with knowledge exchange via growers and SASRI.
- The sporadic nature of YSA in-field and could this be related to soil variances?

Feedback

A project to uncover possible interactions between YSA and crop nutrition is to be initiated under the leadership of Dr Tracey Campbell, the SASRI Extension Specialist for the North Coast (SASRI Project Reference: 24CP03).

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme), Dr Malcolm Keeping (Senior Entomologist) and Dr Tracey Campbell (Extension Specialist: North Coast)

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YSA yield loss (RD&E Topic Reference Code: CP17)

Background

Topic raised in Zululand/Umfolozi workshop.

Growers enquired about estimated yield and economic losses associated with YSA infestations.

Feedback

Research in the United States indicates that yield reductions due to YSA feeding damage are usually because of infestations during the early plant growth stages. Infestation within the first three months of growth and with two out of six leaves below the Top Visible Dewlap (TVD) having >50% damage, was enough to reduce yield at harvest by up to 6%, while more extensive damage with all six out of the six leaves below the TVD with >50% damage early in the season, reduced yields by 19% (Figure 1).

Anecdotal evidence from Umfolozi also suggests that early infestations can cause severe yield loss. A field of YSA susceptible N19 failed to canopy for most of a summer due to YSA infestation.

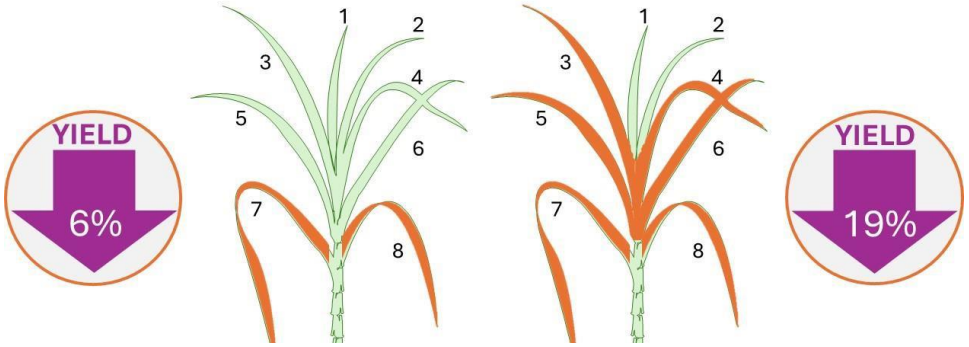

Figure 1

Estimated yield loss associated with extent of leaf damage by YSA

There is no definitive quantitative field information on the effect of YSA on sugarcane yield elsewhere, or in South Africa. Difficulties were experienced in determining yield loss in field trials established in the Pongola and Gingindlovu areas. These trials gave poor results due to the insects' patchy, unpredictable infestations. The 'heat-map' in Figure 2 illustrates the positioning of YSA infested patches within a field that was intensely surveyed at two-week intervals. Aphid movement probably depends on population density (overcrowding), plant decline as a source of nutrition and predator build-up.

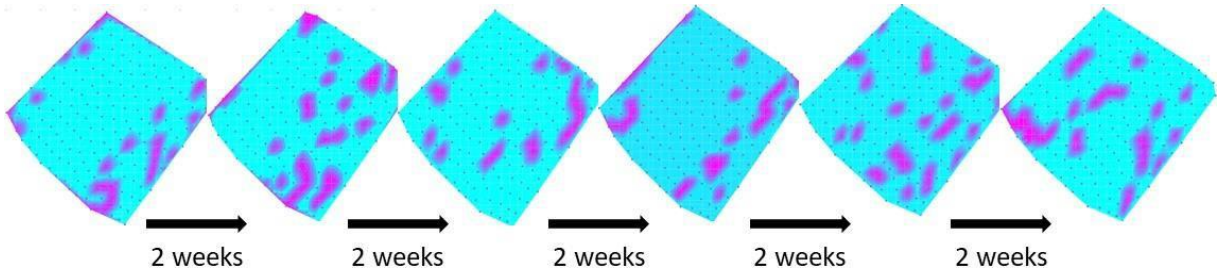

Figure 2

A 'heat-map' illustrating the positioning of YSA infested patches within a field that was intensely surveyed at two-week intervals

Pot trials have also been used to estimate yield loss. Biomass accumulation in the presence of caged aphids is compared with that of aphid free plants. In the USA, the height of the primary shoot of young plants infested with an average of 100 aphids was reduced by 36%, and in biomass by just over 70%, compared with uninfested plants after a three-week period of exposure to YSA. The regeneration of shoots of infested plants after harvest was only 35%, compared to the 94% regeneration of uninfested plants. At SASRI biomass yield was reduced by around 50% in infested plants, compared with uninfested plants.

Losses of 50 – 70% in caged pot trials represent very intense aphid pressure on young plants since the aphids cannot move away from a nutritionally declining host plant to a new one as they do in the field. Also, predators are excluded in caged pot trials.

Yield loss due to YSA is therefore highly context specific. Early and repeated infestations field-wide on susceptible varieties are more likely to result in significant yield loss. A patchier infestation pattern as is often seen on the North Coast will reduce yield in those patches and loss may be less significant on a field scale. Indeed, it is likely that there is already undetected yield loss in these patches due to underlying soil factors that could be driving YSA infestation. SASRI will be conducting a new project that will explore a probable link between certain soil factors and YSA infestation.

Given that early infestation is likely to have the greatest negative effect on cane growth, especially as a population explosion at this stage fuels repeated infestation, pre-emptive control should be considered. Actara® and Bandito® are registered for pre-emptive control and their use should take into consideration varietal susceptibility and field history of infestation.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Yellow Sugarcane Aphid (YSA) Infestation Tracking (RD&E Topic Reference Code: CP18)

Background

Topic raised in **North Coast and Midlands North** workshop

- Growers require clarity on the release and functionality of the YSA App that was previously developed by SASRI to track YSA infestations.
- It was noted that it would be useful for the App to allow for information sharing amongst growers and with SASRI whilst providing clarity on the susceptibility of certain sugarcane varieties and the impact of soil characteristics.

Feedback

The GIS office at SASRI, together with the SASRI Management Team, designed an App in ArcGIS Survey 123 for surveying YSA, primarily for use by growers but also for the Biosecurity Teams, SASRI researchers and extension specialists. The App can be used to capture the severity of YSA presence and damage symptoms infield whilst simultaneously recording field data such as variety and soil type. The App can record the device's accuracy based on satellite triangulation at the time of recording the incident. The data is sent to the ArcGIS Portal where it is computed to a dashboard, in real-time.

To date, the App has been underutilized, however, a number of updates and improvements to functionality have been made during 2024. The App is currently being retested infield and tweaked to ensure efficiency and reliability as a result of the updates and minor changes made.

In addition, Dashboards to download and visualise the data collected by growers and other interested stakeholders are being developed. There will be two Dashboards, one for SASRI staff where grower details will be visible, and a WebApp for growers that will show infestations, and the levels thereof but not provide grower details. The SASRI dashboard will allow Extensions Specialists to monitor pest numbers closely and send out alerts to their growers via WhatsApp or other suitable means. The Grower WebApp will be a mobile dashboard so that growers can see the proximity of recorded incidents to where their farm is based. Both Dashboards will provide a valuable tool for tracking and monitoring the presence of YSA in local or more large-scale sugarcane growing regions by all relevant stakeholders.

The URLs for both Dashboards will be QR-coded. Read-me documents are also being created as mini manuals on how to install the Apps and these will be available for distribution to relevant parties.

It is anticipated that the Grower App and Dashboards will be available for release at the end of October 2024. Extension specialists will be involved in promoting the App in their respective regions and encouraging grower use. The more real time data that is recorded and available, the better-informed growers can be to implement timeous interventions to manage and control this problematic pest.

For further information, please contact **Ingrid Thompson** (Digital Agriculture Scientist) and **Tracey Campbell** (Extension Specialist)

YSA (RD&E Topic Reference Code: CP19)

Data were collected in 7 trials from 2018-2022. There was significant genotype by environment interaction for YSA scores. The results showed presence of up to 34 % and average of 16 % resistant genotypes indicating presence of moderate to high levels of resistance in South African sugarcane populations. A subset data from cultivars was subjected to BLUP analysis to evaluate levels of YSA damage and potential resistance. Cultivar N71 ($P < 0.01$), N49 ($P < 0.05$), N36 ($P < 0.10$) produced significantly lower damage from YSA and can be classified as resistant. Cultivars N57 ($P < 0.01$), NCo376 ($P < 0.05$), N73, N60 ($P < 0.10$) produced significantly higher damage from YSA and can be classified as susceptible. Evaluating cultivars included in these trials showed that N36, N49, and N71 had resistance to YSA out of 13 cultivars, indicating the presence of resistance in cultivars not exposed to YSA during development. The presence of resistance in cultivars indicates potential to mitigate the effect of YSA in commercial crops by planting more area under the resistant cultivars. Further, these resistant cultivars must be established during the peak YSA period to minimise yield losses. Increasing area planted to resistant cultivars will also reduce the need as well as the area sprayed with chemicals to control YSA. The results indicate that active breeding will increase YSA resistance.

Reference:
Zhou, MM (2024). Genetic and breeding parameters for Yellow Sugarcane Aphid (*Sipha flava*) damage in advanced South African sugarcane breeding populations. *South African Journal of Plant and Soil (In Press)*

Giant Barbi grass management (RD&E Topic Reference Code: CP21)

Background

Topic raised in South Coast/Midlands South workshop.

Feedback

In the South Coast and Midlands South KwaZulu-Natal regions, the problematic weed was identified as giant *Panicum maximum*. *Panicum maximum* also referred to as Guinea grass, Barbi grass or uBabe, is a prominent weed in sugarcane agriculture, and it is a coloniser of disturbed sites, including roadsides, and particularly untended areas. It is characterized as a perennial tufted grass with a strong and vigorous root system. Common *P. maximum* shares the same genus and species with the giant *P. maximum*, yet they are phenotypically larger in size.

Controlling giant *P. maximum* can be a challenging task, as it is a fast-growing, hardy grass species, which grows between sugarcane rows and is as tall as the sugarcane. The most used method for weed management in sugarcane agriculture is the application of herbicide in pre-emergence conditions. It ensures a prolonged residual effect and control effectiveness during the critical period of competition with the crop. An article was published in The Link in September 2021 detailing active ingredients register for the control on *P. maximum,* an updated article will be published in the Link.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Replacement chemistries for weed management (RD&E Topic Reference Code: CP22)

Background

Topic raised in the South Coast/Midlands South and Zululand/Umfolozi workshops.

Growers enquired about: (a) the implications of the possible phasing-out of certain chemicals for weeds (e.g. Paraquat, Glyphosate); and (b) availability of alternatives to glyphosate for cane eradication before replant and volunteer management that are perceived less negatively.

Feedback

In March 2021, the Registrar of Act No. 36 of 1947 published his intention to phase out agricultural remedies that have been shown, to meet the criteria of carcinogenicity, mutagenicity, or reproductive toxicity (CMR) category 1A or 1B. To date as of the June 1, 2024, The Registrar may not approve applications for registration of agricultural remedies or renew existing registrations if the active ingredient or formulation of the agricultural remedy meets the criteria of a CMR category 1A or 1B.

The potential impact on a grower's ability to control pests were assessed by the CropLife SA CMR working group, agricultural remedy registration holders and grower associations including SASRI. Currently, certain agricultural remedies registration holders have indicated that they intend to defend their registration and have sought for a temporary one-year extension to use their product beginning mid-2024.

The active ingredients glufosinate-ammonium and halosulfuron-methyl will no longer be available from mid-2025. Alternative chemistries exist for these.

Glyphosate is not categorised as CMR 1A or 1B and will remain available. However, in terms of cane eradication prior to replant and for volunteer control, imazapyr and fluazifop-butyl are registered alternatives.

Likewise, paraquat is not categorised as CMR 1A or 1B. However, on the 27 February 2024, the Registrar announced his intention to ban paraquat due to deaths by poisonings, but this is yet to be gazetted at which time the public will be invited to comment.

A communication plan has been developed to improve knowledge exchange between SASRI and growers on this topic. The SASRI Herbicide Selector is updated annually, removing de-registered chemistries and adding the latest available for the sugarcane industry.

See: https://laeveld.co.za/understanding-the-ghs-global-harmonised-system-label-changes-and-the-cmr-carcinogenic-mutagenic-reproductive-toxicity-products-phase-out/

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Weed management (RD&E Topic Reference Codes: CP23 and CP26)

Topic raised in the Lowveld and Zululand/Umfolozi workshops.

Growers noted the following.

- An explanation is required about what happened with respect to SASRI weed research.
- Growers require recommendations for the control of grasses and weeds in cane fields.
- Biggest issue cynodon (Kweek), progress with management. Link to soils.
- Kweek - big issue, progress with management options.
- Weeds are a major issue - how do we deal with it?

Leading up to the 2018/2019 season, the industry had been seriously affected by drought, imposition of the Health Promotion Levy by government and inadequate government tariff protection to discourage deep sea sugar imports, which all negatively impacted on the financial wellbeing of the industry. Consequently, strong downward pressure was applied by the industry on the SASRI budget and SASRI management were instructed to make significant budget cuts, the quantum of which could not be met by conventional cost-savings and efficiency improvements. Facing these difficult decisions, SASRI management proposed budget cuts to the industry in areas which could be met by other entities and service providers e.g. national and provincial departments of agriculture, consultants. As a result, dedicated research in weed science and nematology was curtailed and replaced with a new consolidated

agrochemicals research and advisory function within SASRI. This rationalisation resulted in the improved efficiencies that enabled the cost savings by SASRI that were demanded by the industry.

In the Zululand and Umfolozi region, the problematic weed was identified as Cynodon. A booklet was previously published by SASRI titled: Integrated weed management of creeping grasses in sugarcane. This booklet describes sixteen control tactics for creeping grasses, with a description of the circumstance where each tactic is suitable. The booklet's online version can be found in the Books and Manuals section of the SASRI E-library.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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Rottboellia management (RD&E Topic Reference Code: CP25)

Background

Topic raised in North Coast/Midlands North workshop.

Feedback

Rottboellia, a weed that causes problems in sugarcane and other crops, is also referred to as Guinea-fowl grass. *Rottboellia cochinchinensis* is its scientific name, and it is a member of the Poaceae family of grasses. It is an erect annual weed species that may grow up to 3 meters tall. If uncontrolled, it can drastically lower the yield of crops. It is particularly difficult to manage because of its aggressive growth habit, abundant seed production, and ability to quickly colonize disturbed areas.

Integrated weed management approaches are typically used to control Rottboellia in sugarcane fields. Regular monitoring of sugarcane fields for Rottboellia infestations and timely intervention are crucial for successful weed control and preventing seed development. Practices such as crop rotation, optimizing planting density, proper irrigation and fertilisation to maintain a healthy crop can help suppress Rottboellia infestations. Cultural and mechanical methods including hand weeding, mowing, and tillage can be effective for removing Rottboellia from fields, especially in smaller infested areas. Moreover, herbicides are frequently employed to control Rottboellia; table 1 below lists the active ingredients registered for Rottboellia management in sugarcane. The SASRI Herbicide Selector is updated annually with the latest chemistries available for the sugarcane industry. This document can be located on the SASRI E- library under the folder Decision support tools.

Table 1

A list of active ingredients registered for Rottboellia management in sugarcane

Active ingredients registered for Rottboellia
Pendimethalin + Amicarbazone
Pendimethalin + Diuron

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme)

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VARIETIES AND BIOTECHNOLOGY

Carryover cane (RD&E Topic Reference Code: V1)

Background

Topic raised South Coast/Midlands South workshop.

- New varieties that are similar to N12 / 'self-ripening' and do not deteriorate during unplanned carryover. Perhaps need to right-size crop to avoid future massive carryover.
- Carryover challenges may not persist but will be good to have a new variety that will be suitable for carryover beyond 18 - 24 months up to 30 months to avoid mill rejections.
- Challenges with ageing N12 beyond 24 months include sour rot. Will be good to have a new variety similar to N12 but is more resistant to sour rot. "
- Challenge: Growers are harvesting 32-month-old cane. Growers require a variety that can be grown for longer periods, especially when growers need to carry over cane.
- A variety similar to N12 has been suggested as N12 which carries over better.
- Newer varieties grown longer than the prescribed period results in cane quality reduction, which is not ideal when the grower needs to carry over.

Feedback

Observation: Growers want new varieties that are similar to N12/self-ripening and do not deteriorate during unplanned carry-overs. While unplanned carry-over may not persist, it will be good to have a variety that will be suitable for carryover beyond 18-24 months and up to 30 months to avoid mill rejections. Current issue with N12 is sour rot when aged beyond 24 months.

Having carry-over cane is a seasonal management factor that largely depends on the mill performance. However, its impacts cannot be overlooked when there's a sudden change in the standard harvest age of different varieties and the pest and disease pressure increase. A variety such as N58 on the coast is ideal for carry-over, as it produces high yields and has good eldana resistance. In the Midlands, new varieties N66, N69, N74, N75 and N78 are all suitable for carry-over, producing better yields than N12 and showing good eldana resistance. All SASRI varieties have unique agronomic characteristics that allow for broad adaptability in different environments and recommendations are given based on their suitability for carry-over. Variety N12 has been in the industry since 1979 and it was bred for the 15-18 months harvest cycle. It has unique characteristics, like being a slow germinator, and to achieve best yields, one needs to age it beyond 18 months in the midlands, it also has good ratooning ability and other characteristics. These unique characteristics of different varieties are summarised in the Variety Guide, a Decision support tool for varieties, and the recently updated variety information sheets.

The Variety Guide is a grower decision support tool that is available on the SASRI website. The tool provides concise information on different varieties in a format that allows growers to compare varieties and select the correct variety based on the grower's search criteria. Planting varieties in correct environments and spreading the risk on the farm is one of the strategies that growers can use combat the impact of carry-over when it happens. Based on the preliminary data from the midlands variety evaluation (VE) trials, not all the newly released varieties from the midlands region are fast maturing varieties. Variety N66 needs to be aged beyond 18 months to get the best yields in humic soils. The unique characteristics of different varieties are currently available in the SASRI Variety Guide, which is easy and simple to use.

The SASRI Variety Guide uses a simple drop-down menu and command buttons that the user can select. The user can select the region they are from, preferred cutting cycle and the soil potential (Figure

1a). All the varieties that are recommended for those growing conditions will be displayed. The displayed varieties can also be filtered even further when a user selects a specific planting scenario (Figure 1b). Varieties that are recommended for the selected scenario are then displayed in a simple tabular format (using words and colours indicating their suitability or highlighting the limitations of different varieties - Figure 2). The varieties are ranked according to their relative tonRV/ha and soil potential. All the data used in the Variety Guide is based on all analysed current and historical datasets from Plant Breeding and VE trials. This is a useful tool to compare varieties and their suitability for carry-over.

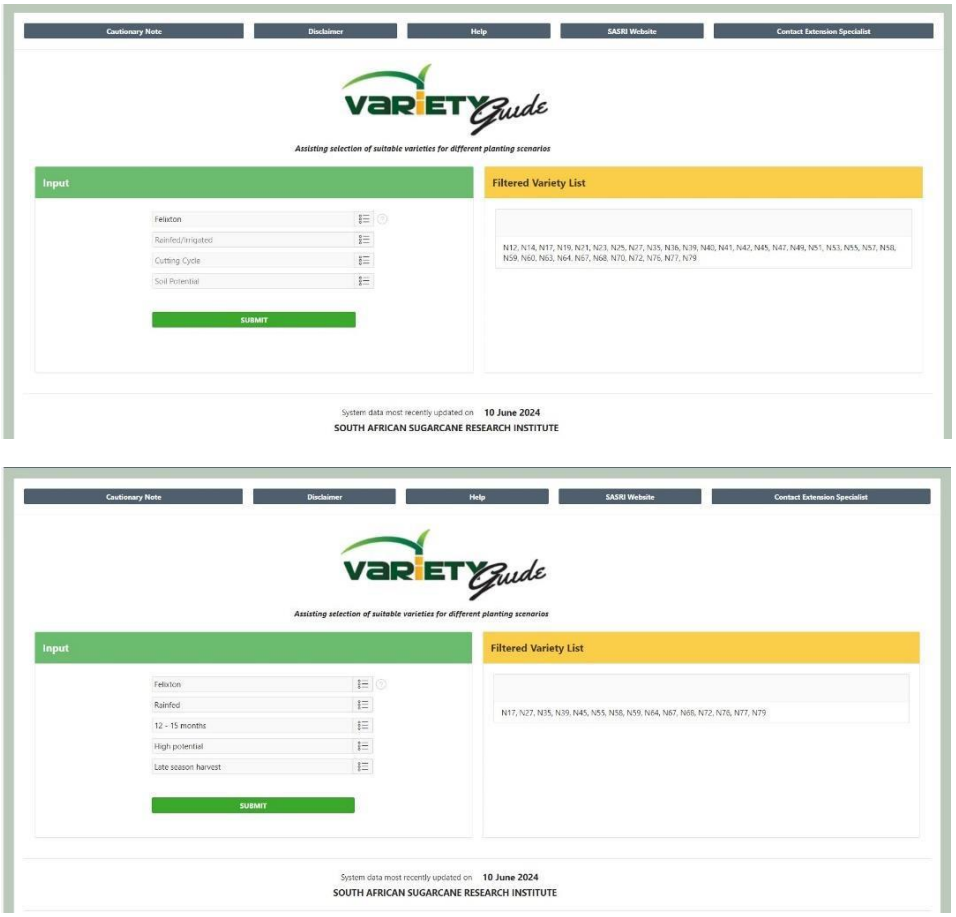
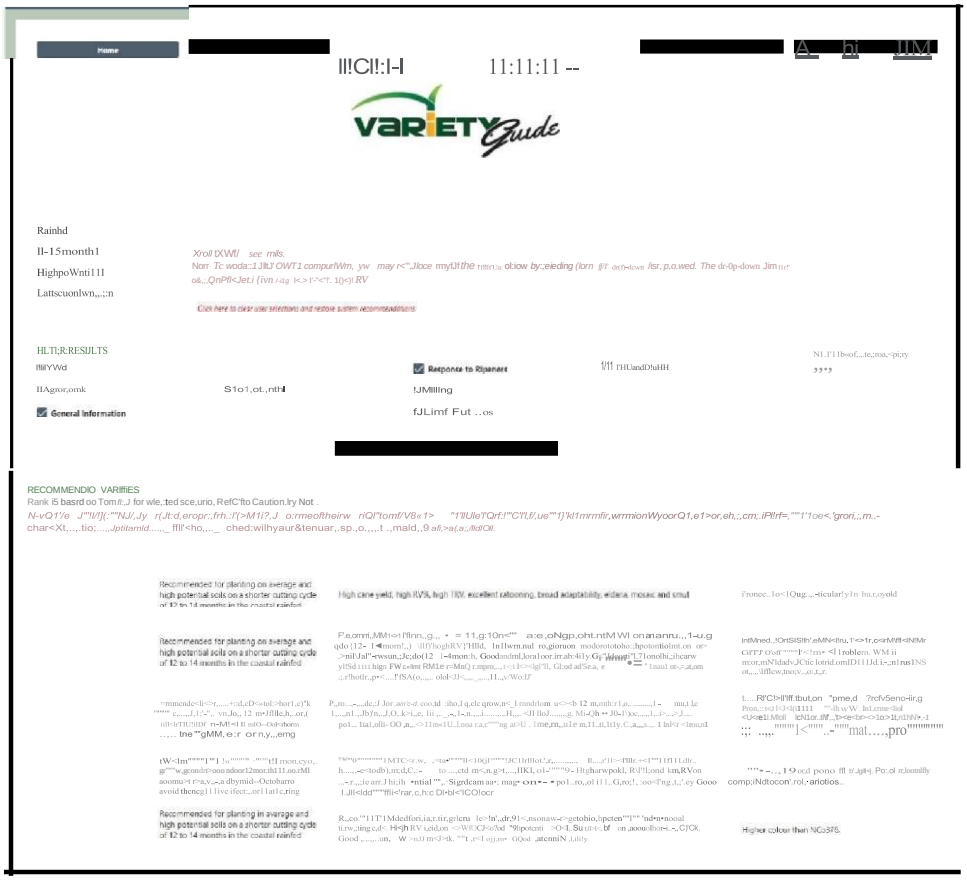
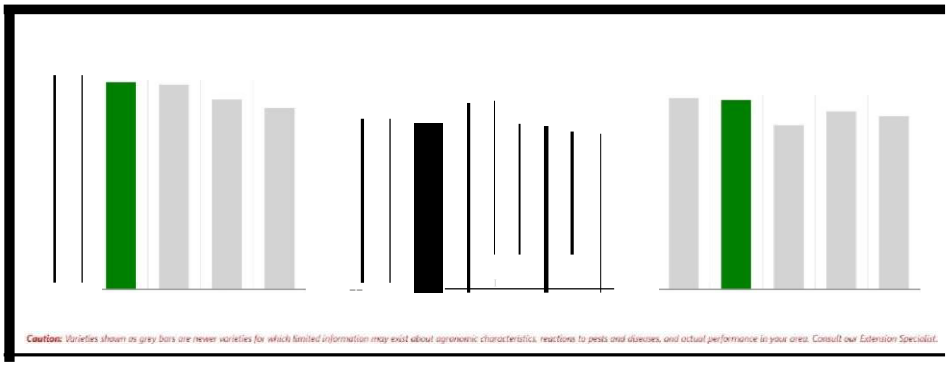


Figure 1a

A screenshot from the Variety Guide showing the input tabs with the filtered list of varieties recommended for planting in Felixton area (top) and filtered list of varieties based on the harvesting scenario (bottom).


Home
VARIETY Guide
Rainhd
HighpoWnti111
Lattscuonlwn,,,::n
HLTI;R:RESIJLTS
Reqponse to Rjoenert
fJLimf Fut ..os
RECOMMENDIO VARIfiES
Recommended for planting on average and high potential soils on a shorter cutting cycle of 12 to 14 months in the coastal rainfed
High cane yield, high RVI's, high TRV, excellent ratooning, broad adaptability, eldena, mosaic and smut
Recommended for planting on average and high potential soils on a shorter cutting cycle of 12 to 14 months in the coastal rainfed
Recommended for planting on average and high potential soils on a shorter cutting cycle of 12 to 14 months in the coastal rainfed
Higher colour than NCo376.


Caution: Varieties shown as grey bars are newer varieties for which limited information may exist about agronomic characteristics, reactions to pests and diseases, and actual performance in your area. Consult our Extension Specialist.


MANAGEMENT PKTQ
Suitable for frost pockets
SOIL POTENTIAL ¥
N78
N67
N76
N77
N72
Low potential
Average potential
High potential


IUSTIONSE TO R.I N(°5 ††
Response to Combo Ethephon + Fusila
Response to Moddus
Response to Combo Moddus + Fusilad
Unknown
Unknown
Unknown

Figure 2

A Screenshot from the Variety Guide of the outputs, showing the planting scenario, recommended top 5 varieties and filtered results.

For further information, please contact Ms Thobile Nxumalo (Variety Scientist)

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Cutting cycle options (RD&E Topic Reference Code: V2)

Background

Topic raised in Zululand/Umfolozi workshop.

Grower observation: newer varieties are mainly suitable for a long cycle and there are limited short cycle varieties. SASRI should look at more short cycle varieties.

Feedback

N72, N67, N79 on short cycle are performing very well and as well as short cycle varieties

Cutting cycle for different varieties varies on the variety characteristics, environmental conditions and management practices. Varieties are then selected and released to the industry based on their yield potential, pest and diseases resistance and suitability to local growing conditions. They are further tested in different environments and cutting cycles in the variety evaluation (VE) trials. Performances of

varieties in different environments is continuously updated through Extension specialists, grower days, information sheets and different SASRI communication platforms.

Variety choice is one of the essential components of sugarcane farming and it is usually influenced by a range of factors. It is essential that growers consider the differing cutting cycle that is associated with different variety characteristics and growing conditions. SASRI has released six new varieties N64, N67, N72, N76, N77 and N79 for the coastal short cycle (12-15 months) growing conditions. Some of the dominant varieties in the coastal region such as varieties N55, N58 and N59 were bred for the coastal long cutting cycle (15-18 months). However, over the years they've shown adaptability under the short cutting cycle in different areas along the coast. Recent variety evaluation (VE) trials established in Empangeni at UVS farms aim to test a range of coastal varieties under different cutting cycles. Data from these trials will be communicated through Extension newsletters, at Variety Grower days and local grower meetings to further unpack the issue of cutting cycles.

For further information, please contact Ms Thobile Nxumalo (Variety Scientist)

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Breeding for alternative uses (RD&E Topic Reference Code: V3)

Background

Topic raised in Zululand/Umfolozi workshop.

- Varieties for alternate uses e.g. co-gen - does SASRI breed specifically for these?
- Is it true that we are currently breeding for co-generation and fibre?

Feedback

The SASRI breeding programme has not been given the mandate to breed for alternative uses of sugarcane. Alternative uses in other countries include biomass for second generation ethanol or high fibre for co-generation. In Brazil, ethanol is produced for blending with petrol for fuelling cars. In Zimbabwe, the Green Fuel company was established to produce ethanol for blending with petrol. Green Fuel has imported SASRI varieties under Variety Licence Agreement and they are producing ethanol from SASRI varieties. The Zimbabwe government has mandated up to 20% petrol blending with ethanol. In Brazil, they are vehicles that operate using 100% ethanol. Our current varieties may well be suitable for alternate uses, depending on how the industry decides to move forward in this area.

In the past 20 years, several F1 crosses (commercial type x *Saccharum spontaneum*) and BC1 (commercial type x F1 progenies) have been produced. The progenies from F1 and BC1 crosses produce high cane yield and low sucrose content making the genotypes suitable for biomass production. In 2017, SASRI was approached by Nocks international (a new company) for high biomass varieties for second generation ethanol production to be established in the Eastern Cape. As a result of the request, 25 genotypes derived from F1 and BC1 populations that were evaluated in Single Lines trials planted at Empangeni and Pongola Research Stations were selected for further testing in a biomass trial planted at Empangeni Research Station. The trial will be harvested in the fourth ratoon crop in 2024. However, Nocks international stopped further contact with SASRI with regards to the request for high biomass varieties.

In 2023, SAPPI (a South African forestry, pulp and paper company) approached SASRI with regards to using sugarcane as a potential source of raw material for paper production during periods when their regular supply of raw material is off-season. This provided a potential source of utilising sugarcane high biomass varieties for other alternative uses and providing opportunities for further revenue sources for SASRI. Results from the biomass trial indicated three genotypes (13T3840, 13T3843, 13T3857)(Table 1) produced high biomass and will be tested by SAPPI to determine suitability as input in their product development. The results of these tests will determine the most suitable of the three genotypes as well guide the development of genotypes for future exploitation in paper production. These genotypes are expected to grow and produce high biomass in marginal soils and growing conditions offering potential to expand the sugarcane growing areas.

From the trial, combined data analysis of plant, first, second and third ratoon crops showed 13T3840 produced 15% higher stalk yield, 13T1843 (19% higher stalk yield) and 13T3857 (21% higher stalk yield) than control commercial varieties. The high biomass genotypes produced 26 – 42% lower RV%, 15 – 27% lower TRV, 6 – 15% lower Purities, 67 – 167% more stalks that similar in height but 18 – 35% thinner stalks than N41. The stalks were 9 – 15% less likely to lodge, with 59 – 75% less bored internodes and 57 to 71% less bored stalks than N41. No smut whips were recorded from these varieties. The results suggest these varieties can be harvested beyond 12 months with less risk of lodging and eldana damage which provides greater flexibility for time of harvesting. Future targeted development of biomass varieties is expected to increase biomass yields.

Table 1

Summary table showing characteristics of high biomass genotypes compared with commercial cultivars

Genotype	TCH	RV%	TRV	Fibre	Purity	Stalks	Height	Diameter	Flower	Lodging	PBI	PBS	Stools	Whips
13T3840	109.1	9.4	10.2	16.5	81.9	324.3	188.3	15.5	0	2.4	1.4	12.9	0	0
13T3843	113.7	7.4	8.8	16.5	74.3	285.1	174.3	17.7	55	2.3	2.3	17.5	0	0
13T3857	114.9	8.6	9.9	16.7	80.1	196.2	189.2	19.6	17	2.5	2.1	19.2	0	0
N41	95.2	12.8	12.1	13.7	87.3	117.6	188.7	23.9	0	2.8	5.6	45.0	0	0
N64	82.3	13.1	10.7	14.4	87.8	124.9	178.3	22.4	1	3.4	4.9	43.3	0	0
N65	85.5	13.5	11.5	14.4	89.1	121.7	178.1	23.6	52	4.4	3.6	33.8	0	0
N67	80.3	12.3	10.0	12.5	85.7	104.8	167.9	25.9	22	3.0	10.2	65.4	0	0
N68	81.6	12.0	9.7	12.8	85.4	115.6	170.9	25.1	0	3.9	5.0	44.2	0	0
NCo376	91.8	10.9	9.9	13.5	84.5	143.3	165.3	23.1	0	2.8	12.3	66.3	2.0	10.3
Mean	89.4	10.1	9.0	14.4	82.2	148.0	184.5	22.8	25	3.5	8.8	49.7	1.2	5.3
RSq	0.94	0.86	0.90	0.89	0.84	0.94	0.79	0.91	0.85	0.86	0.92	0.88	0.86	0.87
CV%	9.0	12.5	15.3	8.0	4.0	15.6	10.3	7.1	136.3	20.6	39.3	26.2	181.4	204.9

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager)

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Breeding process (RD&E Topic Reference Code: V4 and V5)

Background

Topic raised in Lowveld and Zululand/Umfolozi workshops.

Lowveld

- What are the breeders doing with the old varieties, we keep making new varieties, are we improving from the older varieties?
- Breeding process of the varieties, what genes are used and the new varieties which genes?
- Can we do bigger trials before a variety is released to the industry to predict the commercial potential?"
- Site visits to the trials.
- Older varieties sometimes succumb to P&D pressures and are degazetted.
- Pedigrees? Are new varieties ""incremental"" or are they based on novel genealogies?
- Is SASRI releasing varieties prematurely i.e. without sufficient testing?
- Varieties with flaws are costing the industry a lot of money.

Zululand and Umfolozi

- Balance between RV and biomass yield. Are the breeders getting this right e.g. N52 high biomass but disappointing RV yields?
- Cost / Benefit: Keeping varieties in the breeding system to extend testing period for P&D resistance. Does SASRI do a cost/benefit analysis of the advantages of keeping varieties longer in the testing programme?
- Degazetting varieties due to P&D issues, especially for SSGs - can be a challenge.

Feedback

The variety development process at SASRI is designed for simultaneous breeding of multiple traits (Zhou 2018a, 2018b). Simultaneous breeding for cane yield and RV% is a central objective across regional breeding programs. There is established negative genetic correlation between cane yield and RV% which means an increase in cane yield will result in a decrease in RV% among populations. However, despite the negative correlation, the plant breeding strategies developed from 2010 have been used for overcoming this. The strategy involves research into genetic control of cane yield and RV%. The research showed that among SASRI populations, cane yield is controlled by non-additive genes (Zhou 2019b, 2020a, 2020b, 2023) while RV% is controlled by additive genes (Mishasha et al. 2022). The implications are that cane yield is increased by exploiting heterosis or hybrid vigour among cross combination while RV% is increased by exploiting additive genes through recurrent breeding and selection among parent genotypes. Genotypes with high breeding values for cane yield are crossed with compatible parents to produce high heterosis for cane yield thereby generating populations with both high cane yield and high RV%. This part of the strategy is implemented during parent selection and crossing.

The next part of the strategy is to develop objective and accurate methods for increasing simultaneous selection of progenies with the best combinations of cane yield and RV%. The strategy is supported by extensive research done using SASRI populations (Zhou 2018a, 2018b). Research using logistic regression models enables efficient and accurate optimum selection of multiple traits. Results showed that genotypes with best combinations of traits can be identified using logistic regression models. As a result of this approach, several cultivars with combinations of high cane yield, high RV% and other important commercial traits such as N53, N55, N58, N65, N76, N79, N80 have been released.

To ensure better characterisation of varieties before release, all on and off-station testing sites across regional breeding programs are continuously evaluated to ensure they are representative of the agro-ecological regions the varieties will be released. The midlands and coastal regions sites are all representative. The irrigated regions testing sites were deficient and a review done in 2018 (Zhou 2019a) and 2022 resulted in implementation of new sites and testing for seasonal adaptability. New sites were established in Pongola, Malelane and Eswatini to provide representative testing of genotypes. The new off-station site in Pongola is on an average cane yield potential environment while the new site in

Malelane is on sandy soils. The sites in Eswatini established at Ubombo (moderate to high potential) and Simunye (high potential) complements other sites to provide comprehensive testing of varieties before recommendation for release. Further, any promising genotypes are planted in new trials to further test for broad adaptability. All the trials are harvested in the plant, first, second, third and in a few trials, fourth ratoon crops providing adequate evaluation for ratooning ability. At all the sites, trials are planted in the early and late season to test for adaptability to early and late season harvesting. The result is that each irrigated genotype is tested in 12 trials harvested in plant plus three crops making a total of 48 crops before recommendation for release.

The recently released irrigated variety N80 has all round and all year adaptability. All-rounded released varieties are N55, N58, N79 (Coastal regions) and N69, N78 for Midlands regions. Research to increase the development of all year and broadly adapted varieties (Zhou, 2018a, 2018b) has increased the efficiency of SASRI variety development. Further studies on genotype by environment (GXE) interactions (Zhou 2019, 2021, 2022) highlighted the key variables that determine broad adaptability of variety traits.

References

- Mishasha T, Zhou MM, Van der Merwe R. (2022). Evaluating additive and non-additive genetic effects for Brix in sugarcane breeding populations. SASTA 2022: 56-60
- Zhou, M.M. (2018a). Using logistic regression models to determine optimum combination of yield components among sugarcane breeding populations. *South African Journal of Plant and Soil 2018: 1-9*.
- Zhou, M.M. (2018b). Simultaneous selection for multiple traits in Sugarcane breeding populations using logistic regression models. *South African Journal of Plant and Soil* 165-171.
- Zhou, M.M. (2019a). Location and seasonal effects on irrigated sugarcane breeding for yield and sucrose content in South Africa. *Crop Science* Vol 59: 2077-2086.
- Zhou, M.M. (2019b). Potential of exploiting additive and non-additive genetic effects in sugarcane breeding. *Proceeding of the International Society of Sugar Cane Technologists* 30: 482 – 488.
- Zhou, M.M. (2020a). General and specific combining ability effects for sugarcane yield among South African breeding populations. *South African Journal of Plant and Soil* 37(4): 300–307.
- Zhou, M.M. (2020b). General and specific combining ability for cane yield and implications for sugarcane breeding. *Crop Science* DOI:10.1002/csc2.20356.
- Zhou, M.M. (2021). Genotype and environmental effects on sugarcane flowering in South Africa. *Sugar Tech*. https://doi.org/10.1007/s12355-021-01025-y
- Zhou, M.M. (2022). Location and seasonal effects on sugarcane smut (*Sporisorium scitamimeum)* and implications on breeding for resistance in South Africa. *South African Journal of Plant and Soil* https://doi.org/10.1080/02571862.2021.1969692.
- Zhou, M.M. (2023). Exploiting heterosis in breeding for sugarcane yield. *Proceeding of the International Society of Sugar Cane Technologists* 31: in press

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager)

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Using a mixture of varieties to improve resilience (RD&E Topic Reference Code: V6 and V14)

Background

Topic raised in the Zululand/Umfolozi workshop.

- Has SASRI done research on planting multiple varieties in a line. Benefit of both in one field. Comment - Shaun Berry did this specific for Nematodes, could look at these results.
- Mixing varieties in a field to improve overall resilience of the system.
- Does SASRI have an idea on how to design a trial with a single line and comparing several varieties – UVS Q at Empangeni- revisit Shaun Berry's work.

Feedback

Using mixed varieties is not a recommendation for improving resilience and is not recommended as a SASRI best practice. The reason mixed varieties are not recommended is because varieties have different growing conditions which could lead to the those with slower growth to be shaded out by the vigorous ones resulting in lower yield in the slower variety and overall lower cane yield. Also, varieties mature at different times resulting in different RV%. Therefore, delivering mixed varieties to the mill could lower RV to the level of the lower RV variety. The slower variety shaded by the vigorous variety will mature much later further lowering RV% of the crop.

Varieties succumb to different pests and diseases, in mixtures, the more prone variety will spread pests and diseases to the other increasing disease pressure. Control measures for pests and diseases are variety specific confounding recommendations in mixed varieties. Varieties often have different adaptabilities to soils, seasons and harvest age. Therefore, mixing will confound the optimising of soils, seasons and harvest age required to maximise crop yield. The best approach to increase resilience is to match variety to soils, seasons, harvest age, pest and disease prevalence and agro-ecological zones.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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Cold/frost tolerance (RD&E Topic Reference Code: V7)

Background

Topic raised in the South Coast/Midlands South workshop.

Growers noted the following.

- N54 greens up (new growth) rapidly after cold snaps and frost. Ripened N66 only greened up in December. Is N66, because of this feature, suitable for certain sites? (e.g. hill tops)
- 'Real-world' trials would be useful to assess best sites for growing particular varieties.
- Might it be useful to determine how long it takes for varieties to recover ('green-up') after frost events? "
- Newer varieties appear to take longer to “green up” following frost (depending on the degree of frost).
- N54, is an example of a variety that “greens up” fast and is more adaptable for cold climates.
- What is the strategy for growing cane in frost areas?
- Do the current frost trials investigate if the cane is killed by the frost?

Feedback

Frost occurs frequently in the Midlands sugarcane areas. Areas that experience frost, known as frost pockets, experience frost events more frequently. In extreme cases, frost causes extensive damage to the crop requiring immediate harvesting before cane deterioration starts reducing RV%. The SASRI Midlands breeding programs are not designed to breed for frost but however do cater for cold tolerance and adaptability. Cold adaptability means that Midlands varieties will grow faster during persistent periods of low temperature than varieties from Coastal and Irrigated breeding programs highlighting the benefits from selecting for cold tolerance.

Two of SASRI testing sites, one near Cool Air in Dalton and another near Fawn Leas experience regular frost events. The Fawn Leas site experiences more frequent frost events over the years. Every year, after frost events, the plots are assessed and scored for frost damage followed by evaluation of recovery from frost damage. The data is used to determine and produce recommendations of sensitivity to frost damage among Midlands varieties. However, because of the variable frost events, some varieties may be tested in years with no frost events. A potential strategy would be to plant a set of varieties in a frost site for more accurate and comprehensive evaluation.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager), David Wilkinson (Extension Specialist: Midlands North) and Paul Botha (Extension Specialist: Midlands North)

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Drought tolerance (RD&E Topic Reference Code: V8a)

Background

Topic raised in the North Coast/Midlands North workshop.

- Innovations in cane breeding to accommodate climate change: increased temperatures, droughts, high eldana, high smut.
- Drought tolerant varieties.
- Likely to have increased P&D levels - breeding for improved resistance.

Feedback

Rain-fed sugarcane production in South Africa accounts for 70% of the cultivated crop. As extreme weather events become more common, improving drought tolerance of South African cultivars has become imperative. *Note that drought tolerance does not mean that plants will survive without water.*

Sugarcane requires a certain minimum amount of water to develop into mature millable stalks and produce an economic yield. It is recognised as a crop that requires water to grow to maturity largely because of its origin in tropical regions of the world where high rainfall occurs throughout the year. True drought tolerance as in other crops such as sorghum is not present in sugarcane. The SASRI breeding program's testing sites are designed to evaluate genotypes in environments with low rainfall or in shallow or sandy soils providing limited potential to evaluate and compare tolerance to low moisture during growth as well as yield under low moisture growing conditions. For example, the Cool Air site near Dalton (sandy soils), the G2 site near Gingindlovu (shallow/rocky soils), and the Pambili site near Malelane are all prone to frequent moisture stress where genotypes are assessed for tolerance to moisture. Using these assessments varieties such as N58 have been observed to tolerate higher moisture stress and to produce higher cane yield under drought conditions compared with other varieties. These assessments will be intensified as a strategy to identify varieties with higher tolerance to drought in order to mitigate yield losses from the expected frequent droughts. Further, SASRI biotechnology is developing drought tolerant lines using mutagenesis that can be used for breeding in order to incorporate drought tolerance in breeding populations providing sustained breeding for drought resistance.

Drought tolerance has been investigated via mutagenic breeding using:

(1) chemical mutagenesis using ethyl methanesulfonate (Masoabi et al. 2023); and

(2) a novel protocol for inducing epigenetic mutations under stress-induced selection pressure. These

mutations confer heritable changes in gene expression that are not due to changes in the underlying sequence of the DNA but, nevertheless, are aimed at conferring improved stress tolerance. Epimutagenesis using the demethylating agent, 5-azacytdinine, and remethylation in the presence of a poly ADP ribose polymerase (PARP) enzyme inhibitor with selection under heat (40°C) and osmotic pressure [26% polyethylene glycol (PEG)] followed by several rounds of chimera dissolution under stress is the most promising technology (Koetle et al. 2022; 2023).

Drought tolerance was assessed for plants derived from the processes described above. Four-month-old potted plants were subjected to water deficit stress by withholding water for 14-21 days. During the stress treatment and subsequent alleviation by watering, morpho-physiological traits were monitored, including relative water content of leaves, green leaf area, plant height, stomatal conductance, chlorophyll content (as measured by SPAD), chlorophyll fluorescence (Fv/Fm), oxidative damage and anti-oxidant accumulation. A significant finding is that near-infrared spectral measurements can offer a more rapid means of assessment compared with the above multiple evaluations in the future.

One epiline of N41, 'Dry 8', has been determined to be the best performer under drought stress, using a Stress Tolerance Trait Index that considers seven traits (Table 1). The best performing seven epilines are currently under evaluation for drought stress tolerance in the Mount Edgecombe campus rain-shelter facility (Figure 1).

Table 1
Chlorophyll content (SPAD), Relative Water Content (RWC) and a stress index (STTI) as percentages of non-stressed (NS) N41 determined in glasshouse pot trials after 14 days of stress (Koetle et al. 2022; 2023) for epilines SP5, MP2 and GP2 and four Dry lines. N41 S=stressed.

Line	SPAD (%)	RWC (%)	STTI (%)
Dry 8	78.8	81.8	80.3
Dry 5	71.4	71.3	71.4
Dry 10	69.4	67.9	68.7
Dry 1	64.8	70.3	67.6
SP5	66.6	62.1	64.4
MP2	68.4	58.8	63.6
GP2	59.6	59.9	59.8
N41 S	69.5	49.4	59.5

Figure 1
Sugarcane lines produced via an epimutagenic protocol are being assessed for drought tolerance in the SASRI rain-shelter trial site.

References

- Koetle MJ, Snyman SJ, Rutherford RS (2023) Rapid identification of drought tolerant sugarcane epimutants via in vitro chimera dissolution and near infrared screening ex vitro. *Plant Stress* https://doi.org/10.1016/j.stress.2023.100200
- Koetle MJ, Snyman SJ, Rutherford RS (2022). Ex vitro morpho-physiological screening of drought tolerant sugarcane epimutants generated via 5-Azacytidine and imidacloprid treatments. *Tropical Plant Biology* 15:288-300. https://doi.org/10.1007/s12042-022-09323-9
- Masoabi M, Snyman SJ, Van der Vyver C (2023) Characterization of an ethyl methanesulfonate-derived drought tolerant sugarcane mutant line. *Annals of Applied Biology* 182(3):343-360. https://doi.org/10.1111/aab.12823

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager); Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme) and Dr Sandy Snyman (Principal Scientist: Biotechnology; and Manager of the Variety Improvement Research Programme)

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Self-trashing variety trait (RD&E Topic Reference Code: V8b)

Background

Topic raised in the North Coast/Midlands North workshop.

- Self-trashing midlands varieties to reduce trash in cane at harvesting, on breeding populations, effect of burn to crush, tops for cattle feed, other benefits, weed control of trash, green cane harvesting, easy of hand cutting.
- Self -trashing varieties. Midlands grower – mechanised green cane harvesting on long cycle – self trashing. Any research on this or looking into this?
- Self-trashing would be useful for SSGs. Help with weed control and moisture control and Eldana. Also, beneficial for manual harvesting efficiency.
- Midlands - long-cycle varieties - possible move to green cane harvesting may need some form of self-trashing varieties. These would help manage the high leaf biomass in varieties developed and a 29-month cycle.

Feedback

Self-trashing is a variety trait where dead leaves detach from the stalk and fall off, producing clean stalks. After self-trashing, the stalks are easier to hand cut and deliver clean stalks to the sugar mills. Self-trashing varieties are easier to harvest as green cane or unburnt cane because the lower leaves would have fallen off while remining green leaves are easier to remove because the leaf sheath is loosely attached to the stalks. Planting more self-trashing varieties will increase the adoption of green cane harvesting, a practice known to preserve the natural enemies of pest in the sugarcane canopy. Further, the trash left behind will act as a mulch protecting the soil against erosion, conserve moisture after rains and smother weeds before the young crop canopy develops.

After self-trashing, the stalk is exposed thereby reducing oviposition sites for the eldana moth. Any eggs laid on the old leaves will be exposed as the leaf detaches from the stalk and falls off, increasing predation on emerging larvae. Further, the rind of the exposed stalk hardens making it difficult for the hatching eldana larvae to bore into the stalk. All these factors reduce the levels of eldana damage,

further reducing yield loss. Our research shows significant reduction in eldana damage with increase in levels of self-trashing. Family and genotype genetic differences for self-trashing indicate effective selection for higher self-trashing. Therefore, self-trashing is a trait that can be used for indirect breeding for lower eldana damage. Preliminary research showed independence between fibre % and self-trashing traits, indicating that simultaneous selection for fibre % and self-trashing will result in additive increase in eldana resistance (Nxumalo and Zhou 2017, 2018, 2019).

Currently, most released SASRI cultivars, for example N55, N58, N63, N68 show high eldana resistance linked to high fibre content. Including self-trashing as an additional trait for eldana resistance breeding will diversify eldana resistance among SASRI populations resulting in more stable resistance among genotypes with high fibre and self-trashing.

Self-trashing information will be indicated on Variety Information Sheets.

References

- Nxumalo PD and Zhou MM (2019). Phenotypic correlations of leaf-shedding and fibre content with yield and quality traits in sugarcane genotypes. *Proceedings of South African Sugarcane Technologists Association* 92: 167-170.
- Nxumalo, P.D. and Zhou, M.M. (2018). The effect of fibre content and self-trashing traits on *Eldana saccharina* (Lepidoptera: Pyralidae) stalk borer damage in sugarcane and implications for resistance breeding. *Proceedings of South African Sugarcane Technologists Association* 91: 177-180.
- Nxumalo, P.D. and Zhou, M.M. (2017). The relationship between the self-trashing trait and *Eldana saccharina* (Lepidoptera: Pyralidae) damage in sugarcane and implications for resistance breeding. *Proceedings of South African Sugarcane Technologists Association* 90: 152-155.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager)

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Variety eldana resistance (RD&E Topic Reference Code: V9)

Background

Topic raised in Zululand/Umfolozi workshop.

Good eldana resistance is needed, even through difficult carryover years.

Feedback

Conventional breeding

Eldana resistance is a core breeding strategy across all regional breeding programs. Eldana is endemic in the coastal regions where yield losses are high. Eldana has since spread to the midlands and irrigated regions where damage is increasing. The breeding strategy includes determining the genetic control of eldana damage to guide breeding approaches. Crosses are designed to produce progenies that combine eldana resistance and other commercial traits.

Across all population evaluation stages (Mini-Lines, Single Lines, Variety Trials) data for eldana damage is collected and analyzed to guide family and progeny selection. Progenies are selected from low eldana damaged families and further tested in Single Lines. In Single Lines, each genotype is evaluated in replicated plots for eldana damage by sampling 10 stalks per plot in the plant and first ratoon crops.

Only genotypes with less eldana damage than a resistant control cultivar are advanced for further testing in advanced variety trials.

Variety trials are planted at multiple locations, where data for eldana damage is collected in each plot. In each plot, 20 stalks are split to count the number of eldana bored internodes (an index of yield loss). The data is analyzed across sites to determine genetic differences among genotypes as well stability of resistance across varying growing conditions. Only genotypes with lower eldana damage than a resistant control cultivar are recommended for commercial release.

To date several highly resistant cultivars such as N55, N58, N63, N68 and many others have been released to the industry. Further, populations across all breeding programs show lower eldana damage over time highlighting the improvement in eldana resistance. Newer varieties released in the last 20 year have higher eldana resistance than those released in prior years. All varieties released in coastal areas where eldana is endemic are exposed to high natural selection for eldana damage. Varieties such as N55, N58, N63, N68 showed exceptionally high eldana resistance with N58 showing very little damage even under high levels of infestation. Table 1 shows the high levels of resistance among coastal varieties compared with those in the Midlands and Irrigated regions. Further, the latest released coastal varieties (N58, N63, N65) have high levels of resistance than the earlier varieties (N39, N41, N55, N56) showing progress in eldana resistance breeding.

Table 1

Eldana damage of Coastal, Irrigated and Midlands varieties from eldana field screening trials at the Gingindlovu Research Station.

Variety	Region	% Bored Internodes
N39	Coastal	13.6
N41	Coastal	14.6
N55	Coastal	12.1
N56	Coastal	18.3
N58	Coastal	9.0
N63	Coastal	5.8
N65	Coastal	5.3
N71	Irrigated	20.1
N61	Midlands	19.3
N62	Midlands	25.9
N66	Midlands	15.6
N69	Midlands	19.9
N74	Midlands	14.4
N75	Midlands	16.9
N78	Midlands	14.1
Average	Coastal	11.3
	Midlands	18.0
	Irrigated	20.1

All varieties selected from breeding programs located in areas with low levels of eldana damage (Irrigated, Midlands) are tested in eldana field screening established at Gingindlovu research station

where eldana is endemic. These varieties are evaluated for eldana damage by splitting 50 stalks per plot in trials with three replicates. The data is collected in plant and 2 to 3 ratoon crops to provide comprehensive data to quantify eldana resistance. The data will also be used to evaluate progress in eldana resistance breeding over time and to develop effective breeding strategies.

Genetic modification (GM) technology

The sugarcane stem borer *Eldana saccharina* (eldana) causes losses to the South African sugar industry in excess of R 1 billion annually if not adequately controlled. Genetically modified (GM) sugarcane expressing the bacterial *Bacillus thuringiensis* (Bt) lepidopteran-specific insecticidal proteins, CRY 1 and CRY 2, has the potential to control eldana and related borer pests (e.g. *Sesamia calamistis* and *Chilo sacchariphagus*) in South Africa. SASRI has embarked on the development of GM sugarcane that is both insect resistant and herbicide tolerant (*refer to V10 Communique*).

Transgenic events expressing different versions of the transgenes Bt *Cry1A* (*Cry1New* or *Cry1Old*) and *Cry2A*, were included to determine construct efficiency by assessing eldana mortality of 5-month-old plants. GM event selection was based on CRY protein presence in a lateral flow strip test and screening plantlets in an *in vitro* eldana bioassay (Jacob et al. 2023). GM events were planted in rectangular plastic trays in a replicated, randomised plot design at the Entomology shade houses. Each stalk was inoculated with 40 eldana eggs and the trial was harvested after 600-degree days. The presence of live/dead larvae or pupae and % internode damage was recorded for each event. Table 2 indicates the lines selected for Bioassay #4. Multiple varieties were evaluated to investigate inserted gene functionality in different background sugarcane germplasm.

Table 2

Varieties tested in the eldana pot-based Bioassay #4.

Recipient variety	**No. transgenic events tested**	***Bt Cry* gene**
N71 (irrigated)	3	*Cry1New*
10K0222 (rainfed)	6	*Cry1Old; Cry1New*
N67 (rainfed)	5	***Cry2***
N73 (irrigated)	15	*Cry1New;* ***Cry2***
06K2331(rainfed)	9	*Cry1New*
88H0019 (control eldana susceptible line)	2	*Cry1New; Cry1Old*

Expression of *Cry1New* in all events tested (N73, N71, 88H0019, 10K0222 and 06K2331) conferred significant resistance to eldana feeding when compared with the unmodified parent (Figure 1). Of the *Cry1New*-expressing events tested, 60% showed no damage by eldana larvae (Figure 1) and all except one event (Figure 1; see 062331 results) showed resistance levels comparable to or better than N21 (one of the most eldana-resistant varieties in the SA industry; see Figure 1; 5% internodes damaged).

Seven of the eight events expressing only the sugarcane-optimised *Cry2A* gene showed a statistically significant increase in eldana resistance compared with the relevant wildtype variety (Figure 1; see N67 and N73 results). Expression conferred resistance levels similar to that of N21 (less than 5% internodes damaged) to N73 events (N73 wildtype showed approximately 20% internodes damaged). These results illustrate this version of the *Cry2A* gene is effective against eldana when expressed in sugarcane. Because the CRY1 and CRY2 proteins have different modes of action, a transgenic sugarcane event containing both will decrease the incidence of insect resistance build-up to CRY proteins.

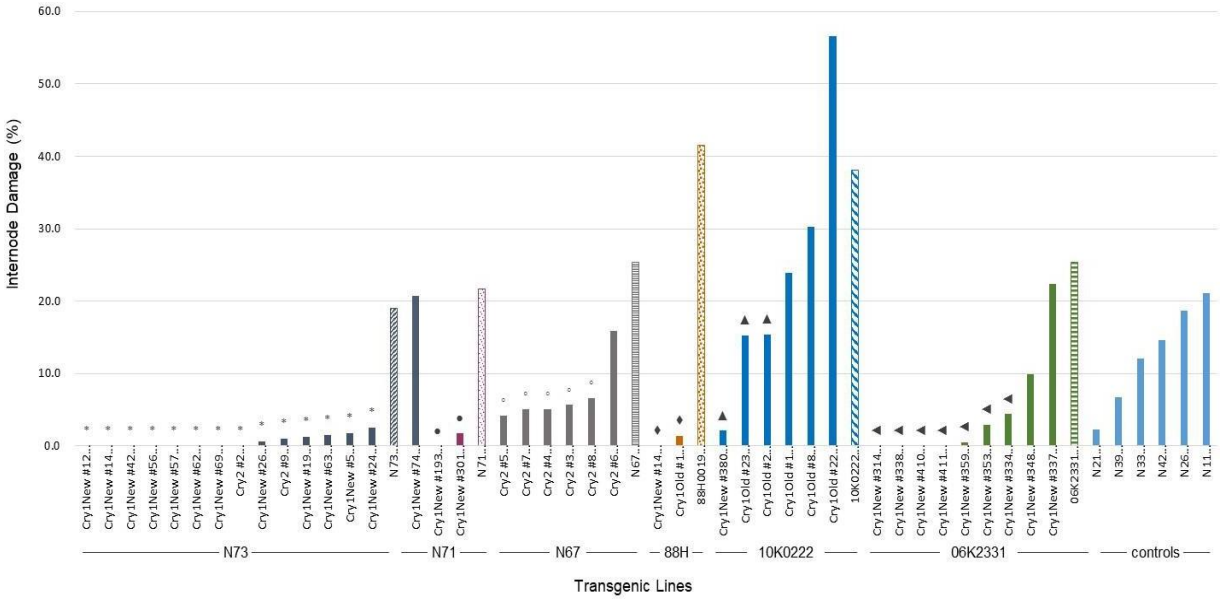

Figure 1

Internode damage of transgenic events expressing *Cry1A* and *Cry2A* in in the Entomology shade house trials on 5-month-old sugarcane. Symbols above a bar indicate statistical difference from the relevant non-GM parental variety.

In the future, it is anticipated that the GM Bt events will be used in commercial breeding to incorporate the Bt gene into breeding populations so that more commercial varieties will contain the Bt gene to enhance eldana control. Utilizing the Bt gene will also diversify genetic basis of eldana resistance breeding.

Reference

Jacob RM, Ligege RW, Meyer GM and Snyman SJ (2023) Screening transgenic sugarcane plants for resistance to eldana larvae. *Proc S Afr Sug Technol Ass* 95: 186.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Dr Sandy Snyman (Principal Scientist: Biotechnology; and Manager of the Variety Improvement Research Programme)

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Methods for estimating yield (RD&E Topic Reference Code: V9a)

Background

Topic raised in the North Coast/Midlands North workshops.

Growers noted the following.

- Estimating cane yield of new varieties difficult. Are there any tools for estimating yield of new varieties. Researching tools for estimating cane yield in commercial fields? Developing a tool using stalk traits to estimate cane yield??
- In the past, estimating yields for N12 and NCo376 was possible. It's very hard to estimate the new varieties based on height. New varieties tall but getting lower yield, thin stalks.

Feedback

There are a number of methods used in the industry to estimate yield. According to SASRI Extension Specialists, the majority of growers use the method of height divided by two (2). Others rely on experience and field records of performance in previous years, adjusting their estimates based on visual appearance, rainfall distribution and sunlight days.

There are, however, other known methods of estimating crop yield. In situations where no experience or no field records exist, reasonable estimates can be made by calculating the stalk population per hectare (number of stalks per metre of row x length of row per hectare), then multiplying this by the average mass of selected representative stalks.

Computer applications, namely StalkGro and MyCanesim Lite, are available applications that can be used to estimate crop yield based on inputs related to a crop's irrigation status, TAM of soils, crop cycle and harvest month.

A new information sheet will be drawn up summarising all methods available for yield estimation.

For further information, please contact Michelle Binedell (Knowledge Manager)

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Lodging (RD&E Topic Reference Code: V9b)

Background

Topic raised in the North Coast/Midlands North workshops.

Growers noted the following.

- Growers have observed that new varieties lodge. Is there a way to get around lodging in new varieties? Need to collect more information on lodging and the conditions.
- Common in high yielding new varieties. What can be done?
- Lodging of the newer varieties... can SASRI advise on that? (Small-scale growers)

Feedback

All varieties planted in Plant Breeding trials are scored for lodging and straightness at time of harvest to collect data for providing recommendations. Lodged cane is difficult to hand cut and therefore reduces productivity of cane cutters increasing harvesting costs. When cane is lodged, payloads are lower increasing transport cost to the mill particularly for growers located long distances from the mills. The increase in harvesting and transport costs must be offset by the high cane and sugar yields per hectare. All released varieties have a lodging score and this is reflected on the variety information sheets. Variety N80, released in 2023 has shown very little to no lodging making it ideal for irrigated growers located long distances from the mills.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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Variety recommendations (RD&E Topic Reference Code: V9b and V18)

Background

Topic raised in the Lowveld and North Coast/Midlands North workshops.

Lowveld

- Perception of SASRI unwillingness to provide precise unequivocal recommendations and guidance on varieties.
- Recommendations need to be context specific and be done through extension.
- Large number of varieties – variety choice – variety optimization of niche environments – targeted variety recommendations – variety guide optimisation

North Coast and Midlands North

- The number of varieties available, so many, get to know the variety on a small scale and then adopt on a large scale on your own farm.
- Would be useful for grower to test new varieties in small trials on their farms as varieties perform differently under different varieties / conditions.
- Demonstration plots have been useful for SSGs in this regard.

Feedback

Variety recommendations for planting are determined by several factors such as age at harvest, soil type, yield potential, season of harvest, pest and diseases resistance and other agronomic interventions such as ripening or crop aging. Growth and development of varieties is different with some producing optimum RV% earlier than others as well as at different crop ages. Choosing early or later maturing varieties is key and must be matched with the expected age and time of harvest. Varieties to be harvested at the opening of mills, such as in March, must be early maturing and achieving high RV% during this period of active cane growth (Zhou 2017). Mid-season maturing varieties are suitable for harvest from June to August when natural ripening produces high RV% in all varieties. Late maturing varieties may also be suitable for aging when they have high eldana resistance because they can keep growing and increasing cane yield.

Soil type is a major consideration for variety recommendations. Most varieties will produce high cane yield in rich soils but very few varieties produce high cane yield in sandy, shallow and poor soils (Zhou and Gwata 2015). Choosing varieties that excel in producing high cane yield in poor growing conditions will guarantee high cane and sugar yield as well maintain longer ratooning cycles. Varieties not adapted to harsh growing conditions tend to have very few profitable ratoons in these growing conditions.

Age at harvest is an import consideration when recommending varieties for commercial planting. Generally, in poor growing conditions, age at harvest can be increased with associated benefits of increasing cane yield while in good growing conditions higher crop ages can result in heavily lodged crops, side shooting, bull shoots and other undesirable effects all of which will reduce cane yield and RV% cane.

Targeted yield potential is another consideration for variety recommendation. When high yield is expected, it is imperative to choose high yield potential varieties to attain this objective. Low yield potential environments associated with either poor growing conditions or low input levels must choose hardy varieties that will produce a sustainable yield under difficult conditions. A variety such as N58 is

an example for the coastal regions: N58 produces high cane yield in poor, sandy soils and during periods of drought.

Season of harvest is another consideration which applies for 12 month harvested cane where early, mid and late seasons are distinct (Zhou 2019). Early season adapted varieties must be early maturing producing high sucrose content when growing conditions are unfavourable for sucrose accumulation. Most varieties are adapted to mid-season where the cool and dry weather forces natural sucrose accumulation/ ripening. Late season is a challenging environment where peak stalk elongation coincides with cold weather and therefore adapted varieties must have fast growth to accumulate economic yield during this period of low temperature and slower growth. When chemical ripeners form part of crop management, low RV% varieties can be recommended for early season.

Pest and diseases are key to variety recommendations where high eldana resistance determines recommendations for the Coastal environment while smut resistant must be considered for Irrigated areas where smut infection is high. It is for this reason that Midlands varieties are not recommended in Irrigated areas. Midlands breeding programs are located cooler areas where smut levels are very low, thus no natural selection occurs. However, with climate change and global warming, higher temperatures are expected resulting in higher smut infection.

SASRI Plant Breeding has conducted extensive and intensive studies (Ramburan et al. 2011, 2012; Zhou et al. 2012; Zhou and Gwata, 2016; Sengwayo et al. 2018; Zhou 2019) on genotype by environment interaction (GxE) to understand variables underlying variety adaptability across diverse environments. The results highlighted the key components of GxE among the regional breeding programs. These findings guided the development of breeding strategies as well as determined breeding programs where exchange of varieties would produce similar results in adaptation and guide variety recommendations.

In 2024, Plant Breeding grower days will be held at Bruyns Hill Research Station (Midlands) on Wednesday 31 July 2024, Gingindlovu Research Station (Coastal long cycle) on Wednesday 3 July, 2024, Empangeni Research Station (Coastal short cycle) on Wednesday 24 June, 2024, Pongola Research Station (Irrigated) on Wednesday 28 August 2024 and Mpumalanga Research Station (Irrigated north) on Wednesday 18 September, 2024. These will be used to describe and present the Plant Breeding process and strategy designed to develop varieties suited to the agro-ecological regions as well as get feedback from growers on the variety adaptability needs in the various regions. The grower days will also be used to highlight progress made by SASRI variety development (Zhou and Gwata 2016; Zhou 2017, 2023) over the years to get feedback on deficiencies of currently released varieties in order to advise the development of future breeding strategies to increase development of better and more adaptable varieties. The grower days will also be used to highlight challenges faced by the Plant Breeding programs with the objective of getting growers to help with some of these challenges such as providing suitable testing sites and logistics for establishing on-farm plant breeding trials.

References

- Ramburan, S., Zhou, M.M. and Labuschagne, M. (2011). Interpretation of genotype x environment interactions of sugarcane: Identifying significant environmental factors. *Field Crops Research* 124: 392–399.
- Ramburan, S., Zhou, M.M., and Labuschagne, M. (2012a). Integrating empirical and analytical approaches to investigate genotype x environment interactions in sugarcane. *Crop Science* 52(5): 2153–2165.
- Ramburan, S., Zhou, M.M. and Labuschagne, M. (2012b). Investigating test site similarity, trait relations and causes of genotype by environment interactions in the Midlands region of South Africa. *Field Crops Research* 129: 71–80.
- Zhou, M.M., Joshi, S.V. and Maritz, T. (2012). Trends and implications of genotype by environment interaction in South African sugarcane breeding. *Journal of Crop Improvement* 26: 1–14.
- Zhou, M.M. and Gwata, E.C.T. (2015). Location effects and their implications on breeding for sugarcane yield and quality in the Midlands region of South Africa. *Crop Science* 55: number 6: 2628-2638.
- Zhou, M.M. and Gwata E.C.T. (2016). Quantifying Sugarcane Cultivar Genetic Gains in the Midlands region of South Africa. *Agronomy Journal* 108: 342-348.

- Zhou, M.M. (2017). Cultivar genetics gains from 50 years of irrigated sugarcane breeding in South Africa. *South African Journal of Plant and Soil 34: 167-174*.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018a). Trends in broad sense heritability and predicted selection gains for yield, quality and agronomic traits among coastal short cycle populations. *South African Journal of Plant and Soil* 89-99.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018b). Location and crop-year effects for yield, quality and agronomic traits among coastal short cycle breeding programmes in South Africa. *South African Journal of Plant and Soil* 2017: 79-87.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018c). Trends in variance components for yield, quality and agronomic traits among coastal short cycle breeding population. *South African Journal of Plant and Soil*. 2017: 41-50.
- Zhou, M.M. (2019). Location and seasonal effects on irrigated sugarcane breeding for yield and sucrose content in South Africa. *Crop Science* Vol 59: 2077-2086.
- Zhou M.M. (2023). Cultivar genetic gains for coastal agro-ecological regions of South Africa. *South African Journal of Plant and Soil*

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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Genetically modified varieties (RD&E Topic Reference Code: V10)

Background

Topic raised in Pongola, North Coast/Midlands North and Zululand/Umfolozi workshops.

Growers requested an update on progress in developing genetically modified (GM) varieties.

Feedback

The sugarcane stem *borer* Eldana saccharina (eldana) causes losses to the South African sugar industry in excess of R 1 billion annually if not adequately controlled. Genetically modified (GM) sugarcane expressing the bacterial *Bacillus thuringiensis* (Bt) lepidopteran-specific insecticidal proteins, CRY 1 and CRY 2, has the potential to control eldana and related borer pests (e.g. *Sesamia calamistis* and *Chilo sacchariphagus*) in South Africa. SASRI has embarked on the development of GM sugarcane that is both insect resistant and herbicide tolerant. The latter trait is conferred by a mutated form of the sugarcane acetolactate synthase enzyme (mALS) against imazapyr, the active ingredient of Arsenal® GEN 2 (BASF) and is effective at controlling creeping grasses. Having imazapyr-tolerant cane will mean that growers can overcome the long soil residual period of 4 months and 600 mm of rain prior to planting in treated fields.

Several promising GM events in cultivars N71, N80 and 10K0222 (a pre-release rainfed variety) have been produced in the Biotechnology laboratory; they are being tested in eldana bioassays and characterised on a molecular level. Agronomic field performance will be conducted on the most promising 5-10 events in the next few years. The aim is to commercialise one GM sugarcane event in the early 2030's if all the regulatory-associated processes are accomplished. To that end, preparatory environmental biosafety work is underway.

- We have established that there will be no gene flow from commercial sugarcane hybrids to wild relatives, *Miscanthidium junceus* and *M. capense*.
- Effect of the Bt GM cane on non-target insects will need to be assessed in field trials.
- Insect resistant management plans must focus on calculating the proportion of non-GM refuge plantings. Mathematical models considered differently shaped and sized refuge areas were investigated using simulation experiments and a refuge size of between 10% and 30% was recommended.

A series of booklets and videos have been created to increase awareness amongst growers of the technology being developed.

Note that glyphosate tolerance (i.e. Roundup Ready) was not supported by growers as a trait for introduction to sugarcane via GM technology as it was desirable to retain the herbicide efficacy to kill off cane during minimum tillage practices.

For further information, please contact Dr Sandy Snyman (Principal Scientist: Biotechnology; and Manager of the Variety Improvement Research Programme)

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Hot water treatments: variety sensitivity and improving germination (RD&E Topic Reference Code: V12)

Background

Topic raised in Lowveld workshop.

- Hot water treatment of varieties - what can be done to test the sensitivity of these varieties e.g. N36 has been shown to be sensitive to hot water treatment (HWT).
- Can anything be done to improve germination after HWT?

Feedback

Testing the sensitivity of varieties to HWT

Glasshouse experiments comparing the germination of varieties with and without HWT are conducted routinely. The results of these experiments have been combined and analysed statically. Some of the most sensitive varieties in these experiments were N42, N47, N50, N65 and N68, while the most tolerant were N23, N51, N54 and N80. There was a high degree of variability in the germination of N36, ranging from 17% lower to 42% higher in the HWT seedcane compared to the control.

Some of this information is in the SASRI Variety Guide but the results for the newer varieties will be discussed with the Extension Specialists before inclusion.

Improving germination after HWT

- Use a continuous flow HWT tank. By adding relatively small baskets at short intervals large water temperature fluctuations are avoided. With this system, the time to reach the required temperature is reduced and a fairly constant temperature is maintained during the process.
- Ensure that the water temperature in the tank does not exceed 50.5°C and the duration of treatment does not exceed 2 hours.
- Replace the water in the tank when it becomes contaminated and acidic as this can have a serious impact on germination.
- Loose dead leaf material should be removed before HWT but leave the leaf-sheath bases at the nodes. This provides some protection to the buds which become soft during hot water treatment.
- Seedcane should be handled carefully after HWT. Softened buds are easily damaged after removal from the tank, and this often results in poor germination.
- A fungicide soak after HWT cools the setts and will offer protection against soil-borne pathogens.
- Avoid planting HWT seedcane when conditions are not favourable for germination.

For further information, please contact Sharon McFarlane (Senior Pathologist)

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Managing N70: pithing (RD&E Topic Reference Code: V15)

Background

Topic raised in Lowveld workshop.

- When is the right time to harvest variety N70, they've observed lots of gaps on variety N70 and N36.
- Linking up to the N70- pithing what does the grower need to do with pithing?
- Time of harvest to lessen impacts of pithing.
- Pithing management: Pithiness on some varieties e.g. N70. Is there advice to manage this – strategies around timing, harvesting etc?
- Growers are experiencing pithing in some varieties e.g. N70. "

Feedback

N70 is recommended for a late season planting and growers can recoup high RV yields in late season cycle. However, N70 is known to flower profusely in good flowering season. As it is known that flowering can negatively affect cane yield and quality, but also reduces RV yield if harvesting is delayed for too long after flowering. Moreover, research by SASRI has shown that flowering increases RV yield provided the harvesting occurs before the end of September. It is recommended that N70 gets harvested between June and September. Please refer to N70 variety information sheet for further details.

Pithiness in sugarcane has not been widely researched, but it is highly correlated with flowering. The typical pithing symptoms due to flowering will be 'island' pithing, which starts at the top of the stalk and moves downwards. There will be a reduction in RV% due to pithing and it can also result in reduced sucrose extraction during milling. The best management of flowering cane will reduce the negative consequences associated with pithing. However, growers also need to be aware that high growth rates in response to very favourable growing conditions, can also cause pithing, even in the absence of flowering. Please refer to information sheet on flowering and pithing in sugarcane (Information Sheet 4.3), which details factors affecting flowering and pithing, and the best management practices to implement with flowered cane.

For further information, please contact Dr Shailesh Joshi (Plant Breeder)

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Ratoonabilty (RD&E Topic Reference Codes: V16 and V17)

Background

Topic raised in South Coast/Midlands South, Pongola and Zululand/Umfolozi workshops.

Growers raised the following topics.

- New varieties on slopes (N48, N54) have disappointing ratoonability (acknowledged that taking equipment onto slopes may be a contributing factor) (desire to keep vars for more than10 ratoons).
- Possibly test ratoonability of new varieties on south facing slopes and those that are subjected to mechanisation activity (e.g. Bell loaders).
- Growers would like a variety that can ratoon for many years i.e. 10 years.
- There is resistance to using new varieties (i.e. growers prefer N27 to N57 and N59) as there are perceptions that they don't ratoon well).
- Growers want the longevity in their varieties.
- NCo376 and N12 are ideal variety but there's been nothing since, plant to 10th ratoon and still happy to replant to same variety. Now looking for a different variety.
- Ratoonability remains an issue.
- Perceptions that newer high yielding varieties do not ratoon as well (small-scale growers).
- Ratooning ability of the newer varieties is not as good as the older varieties… Is this true?
- Within the SSG perceptions of lower ratoonability impedes variety adoption of the newer varieties.
- Need to explore management options to enhance ratoon longevity.

Feedback

The perception that new varieties have poor ratooning ability compared with older varieties has been raised by growers. One of the potential causes of perceived poor ratooning ability of new cultivars compared with older varieties could be caused by specific or niche adaptability. Older varieties were largely broadly adapted. New varieties are developed for high yield in specific environments or niche environments. When the new varieties are planted in environments for which they are not adapted, they will produce lower yield as well as show poor ratooning ability. However, there are new varieties that are broadly adapted and have shown good ratooning ability across environments.

The ratooning ability of new varieties are compared with that of older varieties that haves been shown to be good over the years. The comparison of new varieties is with three of the most widely planted varieties across the irrigated, coastal and midlands agro-ecological regions. Table 1 provides a summary of top three 'old' varieties and percent of cane produced viz. N36, N41 and N49 in the Irrigated area, N39, N41 and N12 for Coastal and N12 for Midlands. The other top Midlands variety is N54, a popular new variety.

Table 1

The top three old varieties for Irrigated, Coastal and Midlands areas

Irrigated		Coastal		Midlands	
Variety	**Percent**	**Variety**	**Percent**	**Variety**	**Percent**
N36	22.0	N39	16.2	N12	19.0
N41	12.3	N41	10.7		
N49	10.3	N12	9.4		

Irrigated Varieties

N80, the recently released irrigated variety produced consistently higher cane yield when compared with its ratoons, much like N41 but with higher yield levels, indicating better ratooning ability (Figure 1). N80 showed more consistent ratooning than N36. N80 and N41 are more broadly adapted than N36, explaining the up and down cane yield across ratoons, reflecting the effect of growing conditions.

N81 produced consistently high cane yield across ratoons and far higher than N36 and N41, highlighting high cane yield potential across ratoons (Figure 2). N81 cane yield was consistent from plant to third

ratoon, showing high yield stability across ratoons. A similar trend has been observed across sites indicating broad adaptability for yield.

N60 another broadly adapted irrigated varieties produced higher cane yield than N41 and N49 in the early and late season harvested crops (Figures 3, 4). The yield margin of N60 was higher in late season than N41 and N49 because N60 is broadly adapted and while N41 and N49 have poor adaptability to late season harvesting. In the early season, N60 had marginally higher cane yield than N41, because N41 is adapted to early season. The results (Figures 1, 2, 3, 4) showed that new varieties produced higher ratoon yields and had better ratooning ability than older varieties N41 and N49.

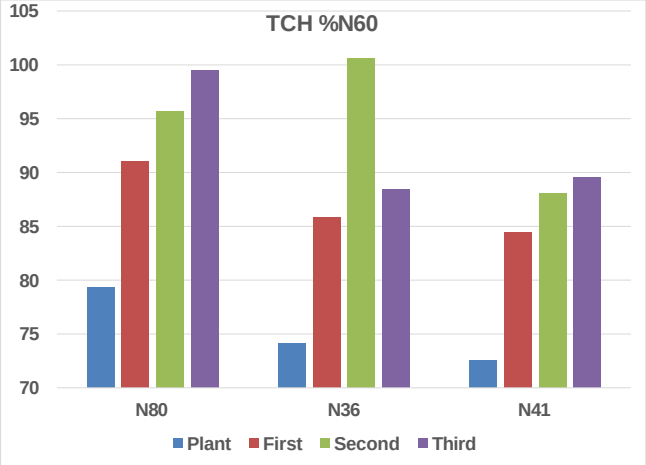

Figure 1

Tons cane per ha (TCH) across ratoons expressed as a percentage of N60 for N80 vs N36 and N41

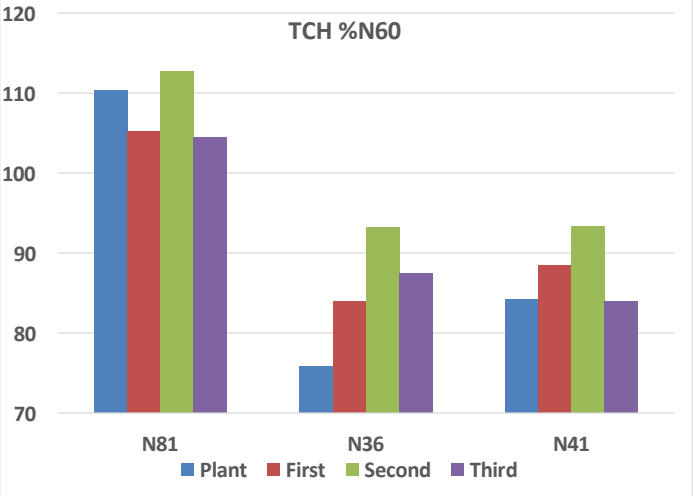

Figure 2

Tons cane per ha (TCH) across ratoons expressed as a percentage of N60 for N81 vs N36 and N41

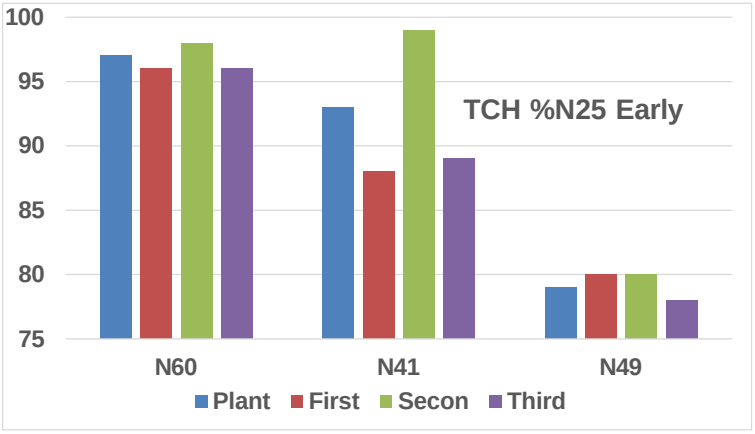

Figure 3

Tons cane per ha (TCH) across ratoons expressed as a percentage of N25 for N60 harvested in the early season vs N41 and N49

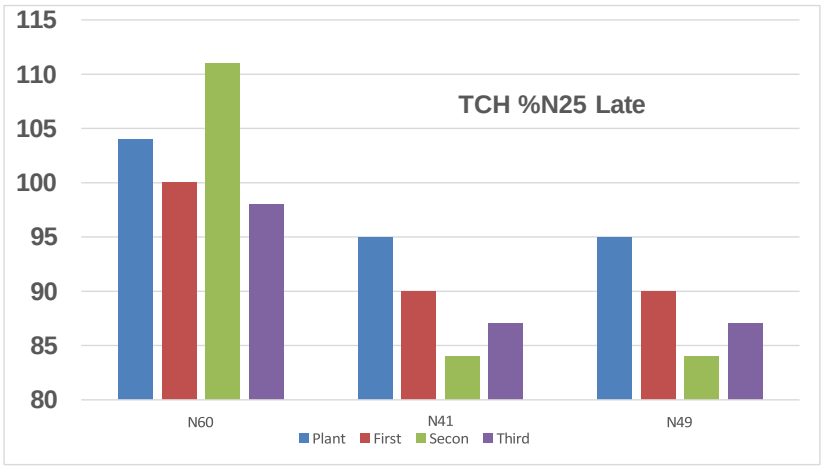

Figure 4

Tons cane per ha (TCH) across ratoons expressed as a percentage of N25 for N60 harvested in the late season vs N41 and N49

Coastal Varieties

N58 is a coastal variety with broad adaptability that grows well in poor soils and during periods of drought (Figure 5). N58 produced much higher cane yield than N39 and N41 across ratoon crops demonstrating superior ratooning ability.

N58 and N59 produced higher cane yield across ratoons than N12 and N41 (Figure 6). N58 produced consistently more stable and higher yield indicating broad adaptability. N59 produced higher yield with larger fluctuations indicating the narrow or niche adaptability. When planted in favourable conditions under good management, the yields are higher across ratoons but when growing conditions are unfavourable, the yields decrease and ratooning ability is poor.

The results show that newer varieties produced higher cane yield across ratoons than older varieties indicating better ratooning ability. N58, a broadly adapted variety will ratoon well across all growing conditions while N59 ratoons well in niche environments.

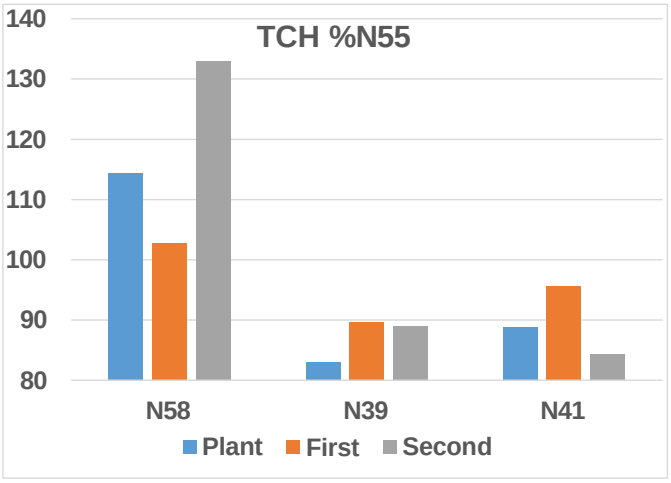

Figure 5

Tons cane per ha (TCH) across ratoons expressed as a percentage of N55 for N58 vs N39 and N41

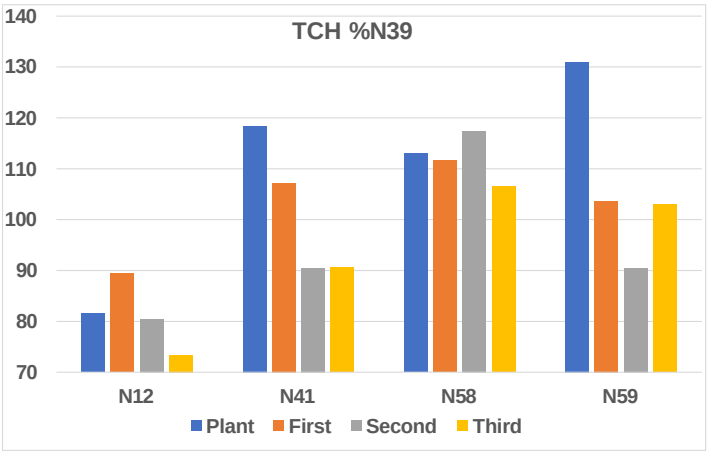

Figure 6

Tons cane per ha (TCH) across ratoons expressed as a percentage of N39 for N58 and N59 vs N12 and N41

Midlands Varieties

Midlands environments are categorised into humic and sandy soils. Humic soils have deep soils rich in organic matter and nutrients with high water and nutrient holding capacity. Sandy soils are shallow with very little organic matter, nutrients and low water holding capacity and therefore prone to frequent

N66 will ratoon poorly in sandy soils while varieties adapted to sandy soils tend to do well in humic soils.

Variety N78 is a broadly adapted midlands variety that can be grown in humic and sandy soils (Figure 7). N78 produced consistently higher cane yields than N12 across ratoons showing higher ratooning ability. N78 also produces higher sucrose content than N12 resulting in much higher RV yields.

Variety N69 is broadly adapted to both humic and sandy soils producing higher cane yields than N12 across ratoons (Figure 8, 9). Both N69 and N12 are broadly adapted with N69 being a higher yield variety.

Variety N62 produced consistently higher cane yield than N12 across ratoon crops (Figure 10). N62 is an exceptionally high cane yield variety with broad adaptability. The results indicated new SASRI varieties produce better or similar ratooning compared with older varieties at higher yield levels. Niche varieties must be planted in the environments they are best adapted to optimise yield and ratooning ability.

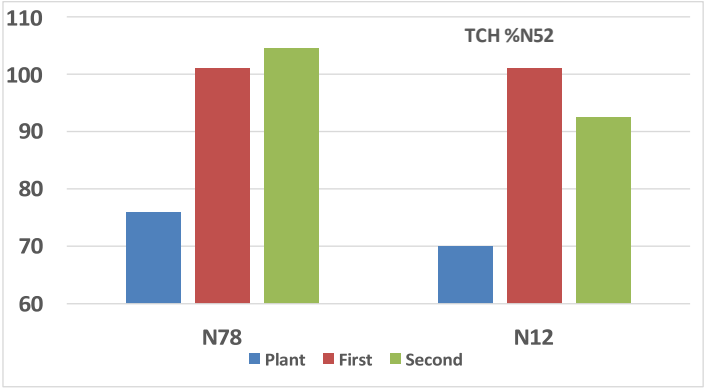

Figure 7

Tons cane per ha (TCH) across ratoons expressed as a percentage of N52 for N78 vs N12

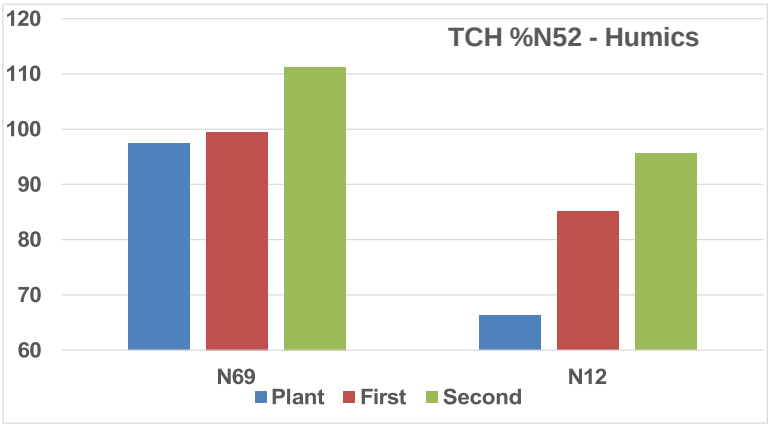

Figure 8

Tons cane per ha (TCH) across ratoons expressed as a percentage of N52 for N69 ratooning in humic soils vs N12

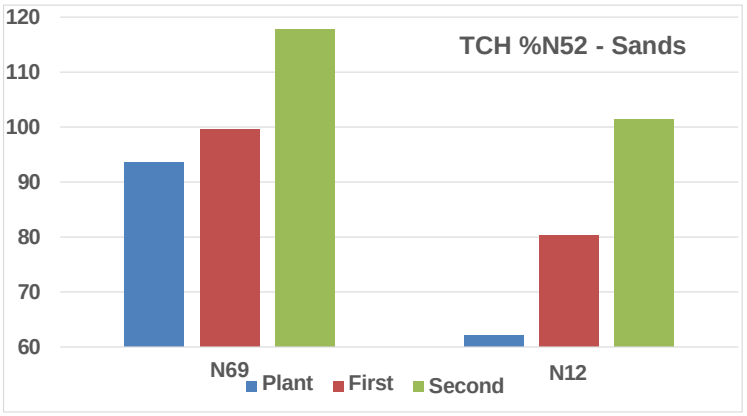

Figure 9

Tons cane per ha (TCH) across ratoons expressed as a percentage of N52 for N69 ratooning in sandy soils vs N12

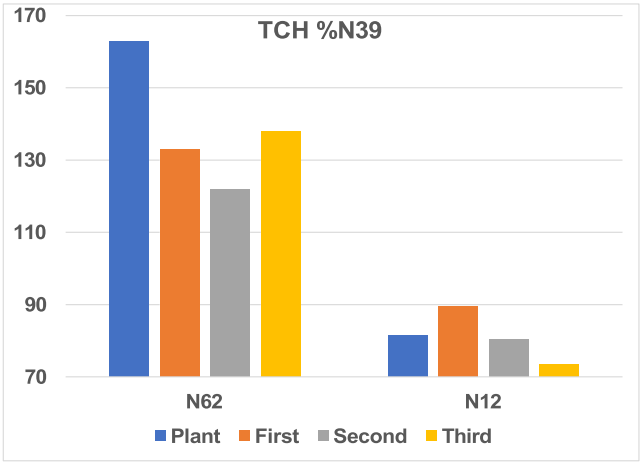

Figure 10

Tons cane per ha (TCH) across ratoons expressed as a percentage of N39 for N62 in the South Coast vs N12

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager)

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Varieties for sandy soils (RD&E Topic Reference Code: V21)

Background

Topic raised in Lowveld workshop.

- Suitable varieties for sandy soils?
- Can we give a guide on the Information Sheets on varieties recommended for planting in sandy soils.
- Trial site on sandy soil needed.
- Recommendations for varieties suitable to particular sites, e.g. sandy soils.

Feedback

The topic of varieties adapted to sandy soils has been raised repeatedly in recent years and in previous RD&E workshops. In the irrigated regions, this topic is particularly strong in Malelane areas where several farmers grow sugarcane on sandy soils. Sandy soils have low clay and organic matter content resulting in low water holding capacity. The low organic matter results in low water and nutrient holding capacity. Currently, a site was established at Pambili farm on highly sandy soils. At this site, the trials are planted in early and late seasons. The trials will be harvested in the plant and four ratoon crops to evaluate varieties for yield and ratooning in sandy soils. The Mpumalanga grower day (Wednesday 18 September, 2024) will highlight the sandy soils trials and how these trials can be used to enhance development of varieties for these difficult sugarcane growing environments. Genotype by environment (GxE) studies (Ramburan et al. 2011, 2012; Zhou et al. 2012; Zhou and Gwata 2016; Sengwayo et al. 2018; Zhou 2019) will be embarked upon with the data collected from the site to guide understanding of traits that control adaptability to sandy soils. The results will guide further strategies for breeding adaptability to sandy soils in early-stage breeding populations.

References

- Ramburan, S., Zhou, M.M. and Labuschagne, M. (2011). Interpretation of genotype x environment interactions of sugarcane: Identifying significant environmental factors. *Field Crops Research* 124: 392–399.
- Ramburan, S., Zhou, M.M., and Labuschagne, M. (2012a). Integrating empirical and analytical approaches to investigate genotype x environment interactions in sugarcane. *Crop Science* 52(5): 2153–2165.
- Ramburan, S., Zhou, M.M. and Labuschagne, M. (2012b). Investigating test site similarity, trait relations and causes of genotype by environment interactions in the Midlands region of South Africa. *Field Crops Research* 129: 71–80.
- Zhou, M.M., Joshi, S.V. and Maritz, T. (2012). Trends and implications of genotype by environment interaction in South African sugarcane breeding. *Journal of Crop Improvement* 26: 1–14.
- Zhou, M.M. and Gwata, E.C.T. (2015). Location effects and their implications on breeding for sugarcane yield and quality in the Midlands region of South Africa. *Crop Science* 55: number 6: 2628-2638.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018a). Location and crop-year effects for yield, quality and agronomic traits among coastal short cycle breeding programmes in South Africa. *South African Journal of Plant and Soil* 2017: 79-87.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018b). Trends in variance components for yield, quality and agronomic traits among coastal short cycle breeding population. *South African Journal of Plant and Soil*. 2017: 41-50.
- Sengwayo, S., Zhou, M.M., Labuschagne, M. (2018c). Trends in broad sense heritability and predicted selection gains for yield, quality and agronomic traits among coastal short cycle populations. *South African Journal of Plant and Soil* 89-99.
- Zhou, M.M. (2019). Location and seasonal effects on irrigated sugarcane breeding for yield and sucrose content in South Africa. *Crop Science* Vol 59: 2077-2086.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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Early and late season varieties for the Lowveld (RD&E Topic Reference Code: V24)

Background

Topic raised in Lowveld workshop.

- Speedlings that the Lowveld has been receiving only focuses on mid-late season harvesting - is there any focus on the early season varieties?
- Varieties recommended for early season harvesting - knowledge on early season varieties in terms of their yielding potential? (SSGs)
- Early and mid-season varieties are dominant in new releases. What is being done about late season? "
- Need information on when varieties will deliver highest RV yield i.e. early, mid, late-season.

Feedback

Early and late season trials are established at all irrigated Plant Breeding sites to evaluate for adaptability to early and late season harvesting. Currently, few varieties such as N49, N53, N60, and N80 show adaptability to both early and late season with N80 showing adaptability for all-year harvesting while N81 can be harvested all year if it responds to chemical ripeners in the early season. All previously released varieties have been categorised as either early or late season. Future varieties will be recommended with higher accuracy from the combined analysis of the data collected from current trial setup. Genotype by environment (GxE) studies (Zhou 2019; 2021; 2022) have shown that variables controlling early and late season adaptation were specific and these were used to develop breeding strategies and variety recommendations. The Mpumalanga grower day (Wednesday 18 September 2024) will highlight variables determining adaptability to early and late season as well as efforts to develop broadly adapted varieties. N80, released in 2023 for irrigated regions is broadly adapted to early and late season harvesting.

References

- Zhou, M.M. (2019). Location and seasonal effects on irrigated sugarcane breeding for yield and sucrose content in South Africa. Crop Science Vol 59: 2077-2086.
- Zhou, M.M. (2022). Location and seasonal effects on sugarcane smut (Sporisorium scitameum) and implications on breeding for resistance in South Africa. South African Journal of Plant and Soil https://doi.org/10.1080/02571862.2021. 1969692.
- Zhou, M.M. (2021). Genotype and environmental effects on sugarcane flowering in South Africa. Sugar Tech. https://doi.org/10.1007/s12355-021-01025-y

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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Integrated smut management and smut on N59 (RD&E Topic Reference Codes: V25 and CP3)

Background

Topic raised in Lowveld, Midlands North/North Coast and Zululand/Umfolozi workshops.

Integrated smut management (Lowveld, Umfolozi, Zululand, North Coast, Midlands North)

- Integrated management of smut.
- Chemicals for managing smut, no registered products, provide information on the use of Sporekill at planting.
- Chemical for smut after HWT

N59 and smut (Zululand and Umfolozi)

- N59 is a popular and valuable variety, good yields but getting a lot of smut in some areas. Need advice on how to deal with it - management / thresholds / degazetting
- NCo376 has been degazetted but is no getting much smut in the SSG areas where it is planted whereas N59 is getting smut but has not been degazetted.
- N59 at Umfolozi is only recommended on beach sands due to smut.

Feedback

The integrated management strategy for smut includes the following (Lowveld, Umfolozi, Zululand, North Coast and Midlands North).

Varietal resistance

Varietal resistance is the easiest and most economical way to manage smut. However, no variety is immune to the disease and under heavy inoculum pressure, and when conditions are highly favourable for infection, even the most resistant varieties (e.g. N40, N49) can become infected.

There is an inverse relationship between smut and eldana susceptibility (Heinze at al., 2001), and varieties with adequate resistance to eldana tend to have some susceptibility to smut infection. With the drive to improve eldana resistance in the industry in recent years, the release of smut resistant varieties is more of a challenge.

No more than 30% of a farm should be planted to one variety to reduce the risk of serious economic losses should a variety become affected by a pest or disease.

Targeting the pathogen

- *Seedcane health*
  Smut is spread by planting infected seedcane. It is essential to plant commercial fields with approved seedcane from a certified source. This implies that the seedcane has been intensively inspected for smut and other diseases.

- *Volunteer removal*

  Ensure that crop eradication is effective before fields are replanted so that smut does not persist in volunteers. Commercial fields should be fallowed for a minimum of three months after the last volunteer has been removed (6-9 months in total) before being replanted with healthy seedcane. It is advisable to plant a low-growing broadleaf cover crop during this break from cane.

- *Fungicides*

  Seedcane health is an important factor in the integrated management of smut. Fungicides can be effective in reducing the risk of infection at planting, particularly after hot water treatment to produce certified seedcane. Bayleton 25% WP is the only fungicide that is currently registered against smut on sugarcane in South Africa, but it is no longer available. Benlate (benomyl) can be used but it is not as effective. Research on replacement fungicides and / or alternative treatments is ongoing.

  Two fungicides (a.i. Flutriafol: Fluoxastrobin and Azoxystrobin: Tebuconazole: Prochloraz) have been shown to be effective against smut at planting when applied to setts as a 10-minute soak or in-furrow spray. No smut was observed 6 months after planting in the soak treatments. Smut incidence (shoots infected) was up to 98% lower in the soak treatments and 92% lower in the in-

furrow treatments 8 months after planting compared to the untreated control. In the 1R crop, incidence was up to 40% lower in the treated plots. Further efficacy data are required from trials with sufficient infection to allow a comparison between treatments before the chemical companies can submit a request for registration. SASRI is in communication with CropLife SA regarding the urgent requirement for registration of a product.

Fungicides applied to established cane with smut have not been effective in reducing incidence in field trials.

Sporekill® is being used at planting by some growers but this is a general quaternary ammonium compound disinfectant. It will kill smut spores present on the sett on contact but will not be effective in protecting the buds from infection once planted.

- *Alternative treatments for smut*

  Several agrochemicals with active ingredients classified as carcinogenic, mutagenic and reprotoxic (CMR) are due to be banned and other options for managing smut and other sugarcane diseases are being investigated (00CP04; 22TD03). Resistance inducers, unlike fungicides that act directly on target pathogens, activate natural defence mechanisms in the host plant (Choi et al., 2013). Commercially available resistance inducers such as the protein Harpin have been reported to suppress pathogens in vegetables and fruit trees, either on their own or in combination with biological control agents or reduced concentrations of fungicides (Sands et al., 2022; Reglinski et al., 2023). SASRI will be conducting a project that investigates various resistance inducers in combination with fungal and bacterial biological control agents (commercial and in-house) beginning in 2025.

- *Protection of NovaCane® plantlets against smut*

  To protect young NovaCane® plantlets from rust in bulking plots, a routine foliar application of a registered strobilurin: triazole fungicide has been introduced before releasing the plantlets from the hardening off facility. Fungicide application at this early stage of growth may offer protection against other fungal pathogens including smut. This is likely to improve the overall health of Certified Seedcane produced in the bulking plots. This is currently being investigated (SASRI Project 22TD03).

- *Roguing*

  Smut is spread by wind-blown and water-splashed spores that are produced on whips emerging from the top of stalks. Up to 1 billion spores can be released from a whip per day and whips continue to emerge for up to 3 weeks. It is important to remove this source of inoculum to limit spread to neighbouring stools, fields and surrounding farms. In most situations, smut can be contained by intensive roguing (SASRI Information Sheet 9.12: Roguing). If smut is identified in certified or approved seedcane fields, and incidence is below the permissible level for seedcane in the P&D Area, all these stools must be rogued out during the early stages of growth. Commercial fields should be inspected routinely for smut and infected stools should be rogued out timeously to maintain low levels. Time and motion studies indicated that chemical roguing (applying 10% glyphosate to smut-infected stools) was fourfold quicker than manual roguing (physical stool removal) (Project 18TD02). The amount of soil and plant material removed from the field during the chemical roguing operation was substantially lower than physically removing stools, saving time, and reducing costs associated with the disposal of the infected material. Based on grower surveys, chemical roguing is less popular than manual roguing. Growers are being encouraged to test chemical roguing on their farms as an alternative to manual roguing (17KE01).

- *Crop eradication*

  Eradicate severely infected fields and replant with a more resistant variety after a suitable fallow period. Crop eradication is a requirement when incidence exceeds the permissible level for the P&D Control Area.

Managing the environment

- *Planting dates*

  Where possible, avoid planting and harvesting smut-prone varieties in spring and early summer when the number of viable spores in the soil is likely to be high to reduce the risk of infection of germinating buds and new growth.

- *Marginal fields*

  Avoid planting smut-prone varieties in marginal soils where the cane is likely to become stressed as soon as growing conditions deteriorate. Stressed cane is more prone to infection and the impact of smut on yield will be greater.

- Pre-irrigation

  Smut spores can survive in dry soil for at least 6 months. Where possible, fields should be irrigated two weeks before replanting to encourage the germination of smut spores in the soil. In the absence of host plants, the young fungal growth will not survive.

Smut in N59 (Zululand, Umfolozi)

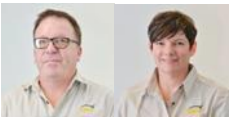
The decision to degazette NCo376 was made by the relevant LPD&VCC Committees with SSG representatives in attendance and was supported by SASA. Affected growers are being advised to hold back on planting N59 if the variety has developed high levels of smut on their farms.
It is likely that the high levels of smut observed in some newly planted fields is through planting infected seedcane. New certified seedcane nurseries of N59 should be established for growers who are still interested in the variety. Seedcane should be treated with Benlate before planting to offer some protection against infection.

N59 should not be planted in extremely sandy soil (“beach sand”) as the cane is likely to become stressed under dry conditions, which will favour infection, spread and exacerbate yield loss. Nematodes may also be an issue in these soils, stressing the cane further.

References

- Choi MS, Kim W, Lee C and Oh CS (2013). Harpins, multifunctional proteins secreted by gram-negative plant-pathogenic bacteria. Molecular plant-microbe interactions.26(10):1115-22.
- Heinze BS, Thokoane LN, Williams NJ, Barnes JM, Rutherford RS (2001). The smut-sugarcane interaction as a model system for the integration of marker discovery and gene isolation. Proc S Afr Sug Technol 75: 88-93.
- Reglinski T, Havis N, Rees HJ and de Jong H (2023). The Practical Role of Induced Resistance for Crop Protection. Phytopathology 113(4):719-731. doi: 10.1094/PHYTO-10-22-0400-IA.
- Sands LB, Cheek T, Reynolds J, Ma Y and Berkowitz GA (2022). Effects of Harpin and Flg22 on Growth Enhancement and Pathogen Defense in Cannabis sativa Seedlings. Plants (Basel). 11(9):1178. doi: 10.3390/plants11091178.

For further information, please contact Dr Stuart Rutherford (Principal Scientist: Integrated Pest and Disease Management; and Manger of the Crop Protection Programme) and Sharon McFarlane (Senior Pathologist)



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Varieties for Pongola (RD&E Topic Reference Code: V26)

Background

Topic raised in Pongola workshop.

- Becoming increasingly important for growers to get breeding outcomes quickly as they are under severe pressure.
- Growers are appreciative of the ongoing communication with Etienne and Marvellous, which has helped in getting results quicker on variety issues.
- On ratooning ability, growers wish to maintain the RVs and TRVs for 10-15 years.
- Growers want to be involved in decision making when it comes to varieties with high yielding ability but poor traits such as lodging, eldana, smut. They have P&D teams to manage P&D issues, if they fail to manage that can industry rules kick in. The growers would appreciate access to the information so that they can decide what to do with a particular variety.

Feedback

The Pongola growers expressed the need to consider release of varieties with some deficiencies that can be managed through other interventions. The examples include varieties that may show high lodging, low RV% (where ripeners can be used to increase RV%), relatively higher eldana damage (where chemical spraying can be used to limit crop loss) among other deficiencies. This is acknowledged as a temporary measure in consultation with Extension Specialists while the future focusses on development of well-rounded varieties with minor deficiencies.

For further information, please contact Dr Marvellous Zhou (Senior Breeder and Breeding Manager) and Ms Thobile Nxumalo (Variety Scientist)

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