

South African Sugar Technologists' Association



Abstracts of the 76th Congress

30 July - 2 August 2002

PROGRAMME

OPENING & AGRICULTURAL SESSIONS

Tuesday 30 July Holiday Inn Durban Elangeni, Snell Parade, Durban

07h30-15h30 **REGISTRATION**

09h00-10h30 **OPENING** *Chairman: TJ Murray*

TJ Murray (SASTA President). *Welcome.*

K Michael (Managing Director: KM&A – Aids Management Services).
Impact of HIV/AIDS on the private sector in South Africa.

BG Dunlop (Chairman, South African Sugar Association and Patron
of SASTA).

TJ Murray (SASTA President). *President's address.*

10h30-11h00 **TEA**

11h00-13h00 **Session 1: PLENARY 1** *Chairman: MS Greenfield*

Launch of the *Manual of Standards and Guidelines for Conservation and
Environmental Management in the South African Sugar Industry.*

ES Wallis. *Research and development for the Australian sugar industry.*

SB Davis. *Seventy-seventh annual review of the milling season in southern
Africa (2000-2001).*

13h00-14h00 **LUNCH**

14h00-15h00 **Session 2: PLENARY 2** *Chairman: PH Hewitt*

PW Rein. *Aspects of the Louisiana sugar industry of interest to South
African technologists.*

RC Loubser. *Model for estimating the effects of harvesting practices on
factory output.*

15h00-16h30 **ANNUAL GENERAL MEETING** (Includes Prize Giving
& Innovation Awards).

18h00-20h00 **RECEPTION & COCKTAIL PARTY** *Holiday Inn Durban Elangeni*
(by invitation).

Wednesday 31 July Kwa-Shukela, Mount Edgecombe

08h30-10h30 **Session 3: SOILS & NUTRITION 1** *Chairman: JH Meyer*

BM Dee et al. *Sugar mill wastes can be important soil amendments.*

PE Turner et al. *Field evaluation of concentrated molasses stillage as a
nutrient source for sugarcane in Swaziland.*

A Wynne & JH Meyer. *An economic assessment of using molasses and
condensed molasses solids as a fertiliser in the South African sugar indus-
try.*

BL Schroeder et al. *An integrated approach to nutrient management in the Australian sugar industry.*

10h30-11h00 **TEA**

11h00-13h00 **Session 4: GENERAL** *Chairman: BA Sugden*

PY Le Gal & E Requis. *The management of cane harvest at the small-scale grower level: A South African case study.*

A Singels & MA Smit. *The effect of row spacing on an irrigated plant crop of sugarcane variety NCo376.*

RA Donaldson. *Changes in the components of sugarcane stalks from ripening with Fusilade Super.*

JM Gosnell & JH Engelke. *Development of a sugarcane industry in the Ord, Western Australia.*

13h00-14h00 **LUNCH**

14h00-15h30 **Session 5: AGRICULTURAL ENGINEERING** *Chairman: EJ Schmidt*
(Sponsored by Bell Equipment)

E Meyer & N Govender. *Trials comparing semi-mechanised and chopper harvesting methods over three seasons in Swaziland.*

OE Magwenzi. *A decision support tool for assessing the economics of irrigation in sugarcane.*

D Erasmus et al. *Project plan for an integrated mapping and information system in the South African sugar industry.*

15h30-16h00 **TEA**

16h00-17h00 **Session 6: NEMATOLOGY** *Chairman: VW Spaull*

P Cadet et al. *Distribution of nematodes, soil factors and within-field variation in sugarcane growth.*

P Cadet et al. *Termites and plant parasitic nematodes in sugarcane in KwaZulu-Natal.*

17h00-18h30 **SOCIAL GATHERING Kwa-Shukela** (informal)

Thursday 1 August Kwa-Shukela, Mount Edgecombe

08h30-10h30 **Session 7: SOILS & NUTRITION 2** *Chairman: RJ Haynes*

DWF Butler et al. *Assessing nitrogen fertigation strategies for drip irrigated sugarcane in southern Africa.*

DN Rietz & RJ Haynes. *Effect of irrigation-induced salinity and sodicity on sugarcane yield.*

MH Graham et al. *Size and activity of the soil microbial biomass in the row and interrow area of a sugarcane field under burning and green cane harvesting.*

NW Mazibuko et al. *The effect of different furrow irrigation regimes on infiltration and sugar yield at Ubombo.*

10h30-11h00 **TEA**

- 11h00-13h00 **Session 8: VARIETIES & BREEDING** *Chairman: RC Parfitt*
 MM Isyagi & MW Whitbread. *Yield performance of South African sugarcane varieties in plant cane variety trials at Nchalo sugar estate, Malawi.*
 D Marion et al. *The establishment of a sugarcane variety evaluation network for western and central African countries.*
 KA Redshaw et al. *Investigating two statistical techniques used in the analysis of sugarcane variety trials.*
- 13h00-14h00 **LUNCH**
- 14h00-15h30 **Session 9: BIOTECHNOLOGY** *Chairman: BAM Potier*
 DL Carson et al. *Gene discovery and expression analysis in sugarcane: The story so far.*
 D Watt. *Enhancing sucrose accumulation: Identifying gene targets for manipulation.*
 S Hack et al. *Application of microsatellite analysis to the screening of putative parents of the sugarcane cross AA40.*
- 15h30-16h00 **TEA**
- 16h00-17h00 **Session 10: POSTERS** *Chairman: KM Hurly*
 S Chetty et al. *Caustic recovery via membrane microfiltration.*
 S Berry et al. *Development of new methods for diagnosing yellow leaf syndrome.*
 MG Keeping & N Govender. *Update on methodology used in screening for resistance to Eldana saccharina in potted sugarcane.*
 P Dana & P Cadet. *Field variation of abiotic factors and their relationship with nematode communities in sugarcane.*
 R van Antwerpen & JH Meyer. *The effect of burning and trashing on sugarcane leaf analysis.*
 CN Bezuidenhout & C Gers. *Homogenous climate zones for the South African sugar industry: Preliminary boundaries.*
- 14h00-15h30 **Session 11: SYSTEMS AGRONOMY** *Chairman: A Singels*
 (Concurrent)
 CN Bezuidenhout et al. *Whole farm/harvesting strategy optimisation using the CANEGRO model: A case study for irrigated and rainfed sugarcane.*
 PJ Thorburn et al. *The impact of trash management on soil carbon and nitrogen I : Modelling long term experimental results in the South African sugar industry.*
 R van Antwerpen et al. *The impact of trash management on soil carbon and nitrogen II : Implications for sugarcane production in South Africa.*
- 15h30-16h00 **TEA**

- 15h30-17h30 **Session 11 (continued): SYSTEMS AGRONOMY** *Chairman: A Singels*
NG Inman-Bamber et al. *Aspects of dry matter partitioning in sugarcane.*
A Singels & NG Inman-Bamber. *The response of sugarcane to water stress.*
MG McGlinchey & NG Inman-Bamber. *Robust estimates of evaporation for sugarcane.*
- 19h30 **AUTHORS' DINNER - Holiday Inn Durban Elangeni** (by invitation)
(Sponsored by Techserve CC)

Friday 2 August Kwa-Shukela, Mount Edgecombe

- 08h30-10h30 **Session 12: PATHOLOGY** *Chairman: RS Rutherford*
SA McFarlane. *The relationship between extent of colonisation by Leifsonia xyli subsp xyli and yield loss in different sugarcane varieties.*
K McFarlane & SA McFarlane. *Improvements in the sugarcane smut screening programme at the Pongola research station.*
RS Rutherford et al. *Promoting plant health: Potential for the use of plant-associated micro-organisms in the biological control of pathogens and pests in sugarcane.*
T van Antwerpen et al. *Assessment of sugarcane endophytic bacteria and rhizospheric Burkholderia species as antifungal agents.*
JL Vogel et al. *Isolation and characterisation of sugarcane rhizobacteria and their effect on nematodes.*
- 10h30-11h00 **TEA**
- 11h00-12h30 **Session 13: PESTS** *Chairman: MG Keeping*
DE Conlong & R Goebel. *Biological control of Chilo sacchariphagus (Lepidoptera: Crambidae) in Mozambique: The first steps.*
H King et al. *Genetic differentiation in Eldana saccharina (Lepidoptera: Pyralidae): Evidence for the mitochondrial cytochrome oxidase I and II genes.*
MK Butterfield. *Genetic models to assess the development of counter-resistance in insect pests exposed to Bt-sugarcane.*
GW Leslie. *Treatment of sugarcane setts for the suppression of the pyralid borer Eldana saccharina.*

CLOSING *TJ Murray (SASTA President)*

PROGRAMME

FACTORY SESSIONS

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Wednesday 31 July Kwa-Shukela, Mount Edgecombe

08h00-10h30 **Session 3: BOILERS AND ENERGY** *Chairman: DG Coates*

(Sponsored by PGBI)

A Wiense & MA Gooch. *Mill settings and reabsorption*

E Kaliika, R Renton, J Groenewald & G Wenham. *Feeding bagasse to multiple boilers with a "Smart – Feed" bagasse fuel conveyance and distribution system, incorporating "Renton Ploughs".*

K McIntyre. *A review of the common causes of boiler failure in the sugar industry.*

S Ndoro, J Groenewald & G Wenham. *The engineering, installation, integration and operation of a 20 MW co-generating turbine alternator at Hippo Valley Estates.*

AS Vawda. *The implementation of a steam transformer system.*

10h30-11h00 **TEA**

11h00-13h00 **Session 4: BOILING HOUSE OPERATIONS** *Chairman: GRE Lionnet*
(Sponsored by Bosch Projects)

DJ Love & DC Walthew. *A pilot scale batch pan.*

I Singh, H Jones & S Gayapersad. *Air cooling of A-crystallisers (SC).*

MJ Gibbon & B StC Moor. *A new compact vertical massecuite reheater.*

KCA Crane, SR Morris, PLM Vermeulen & AW Phillips. *Stainless Steel laser-drilled screens for continuous centrifugals.*

13h00-14h00 **LUNCH**

14h00-15h30 **Session 5: CLARIFICATION** *Chairman: SS Munsamy*

(Sponsored by Illovo Sugar Limited)

P Sahadeo, GRE Lionnet & SB Davis. *Mixed juice clarification revisited.*

S Chetty, SB Davis, A Raghunandan & S Maharaj. *A successful modification to the Dorr 444 clarifier (SC).*

PG Morel du Boil & S Wienese. *Enzymic reduction of dextran in process - laboratory evaluation of dextranases.*

15h30-16h00 **TEA**

16h00-17h30 **Session 6: MODELLING AND INSTRUMENTATION**

Chairman: SB Davis

SD Peacock. *The use of Simulink for process modelling in the sugar industry.*

GRE Lionnet & MA Gooch. *The analysis of ethanol in shredder gases (SC).*

AZ Mhlongo & MJ Alport. *Application of artificial neural network techniques for measuring grain sizes during sugar crystallisation.*

17h00 **SOCIAL GATHERING Kwa-Shukela** (informal)

Thursday 1 August Kwa-Shukela, Mount Edgecombe

08h00-10h30 **Session 7: REFINING** *Chairman: DM Meadows*

(Sponsored by Elgin Engineering)

M Moodley, PM Schorn, DC Walthew & P Masinga. *Optimising the carbonatation process.*

PB Devnarain, DR Arnold & SB Davis. *Production of activated carbon from South African sugarcane bagasse.*

B Barker & SB Davis. *Colour removal with the SPARAC process- Preliminary results (SC).*

L Smith. *Mechanical redesign of ion exchange resin vessel bottoms at Hulett Refinery.*

DC Walthew & CRC Jensen. *Towards a new process to produce white sugar directly from cane juice.*

10h30-11h00 **TEA**

11h00-13h00 **Session 8: ANALYTICAL AND FACTORY CONTROL**

Chairman: J FitzGerald

(Sponsored by Western States Machines)

SN Walford. *Improving productivity in an analytical environment implementation of a LIMS.*

DJ Love. *Estimating dry solids and true purity from brix and apparent purity.*

GRE Lionnet. *A modified constant pressure filterability test for raw sugar.*

SD Peacock & PM Schorn. *Crystal recovery efficiency as an overall measure of sugar mill performance.*

13h00-14h00 **LUNCH**

14h00-15h30 **Session 9: GENERAL** *Chairman: BS Purchase*

DCM Keir. *Brown sugar bagging and storage - new advances in technology.*

GB Deshpande. *Overview of continuous alcohol fermentation and multi-pressure distillation technology.*

15h30-15h45 **TEA**

16h00-17h30 **Session 10: POSTERS** *Chairman: KM Hurly*

S Chetty et al. *Caustic recovery via membrane microfiltration.*

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P Dana & P Cadet. *Field variation of abiotic factors and their relationship with nematode communities in sugarcane.*

CN Bezuidenhout & C Gers. *Homogenous climate zones for the South African sugar industry: Preliminary boundaries.*

JOINT SESSION

RESEARCH AND DEVELOPMENT FOR THE AUSTRALIAN SUGAR INDUSTRY

ES WALLIS

*Bureau of Sugar Experiment Stations
PO Box 86, Indooroopilly Qld 4068, Australia*

Abstract

Since I last addressed the SASTA Conference (June 1995) significant changes have occurred in the delivery of R&D to the Australian industry. This paper outlines the most significant changes including the loss of a compulsory levy to BSES; the downturn in industry profitability related to the impact of pests and diseases and R&D's response; the refocussing of BSES as an industry owned entity; and the recognition by all industry participants that a reliable and increasing cane supply is the driving force for industry prosperity. Data will be presented that updates the 1995 paper on the benefit/cost of R&D and how these data assist in keeping the R&D agenda as an important part of industry discussion.

SEVENTY-SEVENTH ANNUAL REVIEW OF THE MILLING SEASON IN SOUTHERN AFRICA (2001-2002)

SB DAVIS

Sugar Milling Research Institute, University of Natal, Durban, 4041

Abstract

Performance, throughput and other relevant aspects of the sugar industries in Southern Africa are presented and discussed. Data from sugar mills in South Africa, Swaziland, Zimbabwe and Malawi are included. The cane crop and factory performance are discussed, with RV trends particularly mentioned. There was a significant improvement in RV % cane in the Midlands, while elsewhere trends were mixed. The season started very well but climatic conditions resulted in a smaller crop than forecast. Lost time % available has improved steadily to an average of 5,35%.

ASPECTS OF THE LOUISIANA SUGAR INDUSTRY OF INTEREST TO SOUTH AFRICAN TECHNOLOGISTS

PW REIN

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Louisiana State University AgCenter
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USA*

Abstract

A broad overview of the Louisiana cane sugar industry is presented, and significant differences by comparison with the South African industry are highlighted. Cane quality and harvesting systems are different and their consequences are described in terms of the effect on recovery of sugar and sugar quality. Challenges to the Louisiana industry to reduce cost of production are identified. The effects of different approaches to some aspects of factory processing are identified. Some details of interest to millers are presented which could be considered for use in the South African industry.

Keywords: Sugar, Louisiana, industry, quality, processing, payment

MODEL FOR ESTIMATING EFFECTS OF HARVESTING PRACTICES ON FACTORY OUTPUT

R C LOUBSER

Sugar Milling Research Institute, Durban

Abstract

Sugar technologists have proposed many models to predict and optimise particular plant and processes used in the production of sugar. This has led to the sub-optimisation of activities. This paper is intended to take the process one step further, that is, models for each activity have been combined into a single model to indicate the interaction between the stages. Various models were evaluated and the most appropriate option chosen to model each of the aspects. Losses associated with burn to crush delays depend on the ambient temperature and the duration of the delay. Initially models for the generation of ethanol were adapted to estimate deterioration losses. A direct correlation model expressing change in purity as a function of temperature and time, that was published more recently, was used in place of the ethanol model. Factory performance and molasses losses were calculated using a model that could predict response to small deviations from a known operating condition. The sub-models have been combined to give a single spreadsheet model to predict how changes in operation can change profitability.

AGRICULTURAL SESSIONS

SUGAR MILL WASTES CAN BE IMPORTANT SOIL AMENDMENTS

BM DEE¹, R.J.HAYNES¹ and JH MEYER²

¹Discipline of Soil Science, School of Applied Environmental Sciences, University of Natal, Pietermaritzburg, Private Bag X01, Scottsville, 3209.

²South African Sugar Experiment Station, Private Bag X02, Mount Edgecombe, 4300.

Abstract

The effects of additions of three wastes from sugar mills on the properties of an acid soil were investigated. The wastes used were boiler ash and filter cake from a conventional milling operation and fly ash from a new milling process, where filter cake is burnt in the boilers. Additions of each of the wastes at two sites raised soil pH and increased maize yields in a pot experiment; the effect being greater at the higher rate. Concentrations of exchangeable Al and total and monomeric Al in soil solution were reduced by additions of each of the wastes. Thus, the increase in pH caused precipitation of potentially phytotoxic soluble and exchangeable Al as hydroxy-Al polymers. Waste additions increased the basal respiration rate and the activities of the soil enzymes arylsulphatase and acid phosphatase. Additions of filter cake increased the organic C content of the soil and the amount of N mineralised during incubation. It was concluded that all of the waste materials had a liming effect and at high rates they increased the microbial activity in the soil. In particular, filter cake was found to be a valuable organic amendment that should be recycled back onto sugarcane fields to increase their fertility and organic matter status.

FIELD EVALUATION OF CONCENTRATED MOLASSES STILLAGE AS A NUTRIENT SOURCE FOR SUGARCANE IN SWAZILAND

PE TURNER¹, JH MEYER² AC KING³

¹ *Sugarcane Research Services, Cluster Box 1443, Forest Hills 3610*

² *SASA Experiment Station, Private Bag X02, Mount Edgecombe, 4300*

³ *Royal Swazi Sugar Corporation, Simunye, Swaziland*

Abstract

Stillage or vinasse, which is a byproduct of ethanol production, is produced from the fermentation of molasses and is used as a source of potassium on cane fields at Simunye-Royal Swaziland Sugar Corporation. Due concern regarding its high salt content and Chemical Oxygen Demand (COD), a trial was established on an S set soil (Mayo form) to study the effect of increasing levels of concentrated molasses stillage (CMS) on cane and sucrose yield, recovery of ash in the mill and the impact of CMS on soil quality and the environment. The results of two crop harvests indicated no significant differences in cane and sugar yields when the K source was either muriate of potash or CMS, provided the recommended amount of K was adhered to. The low CMS treatment of 3t/ha banded on the row initially produced the highest sucrose yield and this provided approximately 160kg/ha K. Doubling the CMS rate to 6t/ha impacted negatively on cane growth and sucrose yield but no evidence of salt accumulation or pH change was found. The results suggested that the application of CMS at the recommended rate to supply K, would maintain sugar productivity and soil fertility and cause no environmental contamination.

Keywords: Alcoholic slops, vinasse, potassium, environment.

AN ECONOMIC ASSESSMENT OF USING MOLASSES AND CONDENSED MOLASSES SOLIDS AS A FERTILISER IN THE SOUTH AFRICAN SUGAR INDUSTRY

AT WYNNE¹ and J MEYER²

*¹ South African Cane Growers Association, PO Box 88
Mount Edgecombe 4300*

*² South African Sugar Association Experiment Station, P/Bag X02,
Mount Edgecombe 4300*

Abstract

The value of molasses as a fertiliser has become topical in recent times with the rapid devaluation of the Rand and the reliance of South African agriculture, including the Sugar Industry, on mainly imported N and K fertiliser. Molasses is used primarily as a source of K but it has other significant advantages such as increasing the amount of organic matter in the soil and microbial activity associated with nitrification. Molasses also contains secondary elements in small quantities such as phosphorus, sulphur, calcium and magnesium, as well numerous trace elements. The application of molasses also improves soil aggregation and reduces surface crusting in hard-setting soils. However, there are disadvantages to the use of molasses on farm such as the risk of ground water pollution if incorrectly applied and variable nutrient composition, which creates difficulties in applying it evenly infield. Its viscosity also makes it difficult to handle and its large volume creates application difficulties on steeper lands. Molasses also needs to be collected rateably from the mill whereas its best application is not necessarily rateable resulting in storage implications. This paper attempts to consider all these factors and quantify the economic value of molasses compared to inorganic fertiliser to help growers make an informed and cost effective decision regarding molasses use on farm. In addition, the demand for industrial alcohol and ethanol is increasing which uses molasses as a feedstock in their production process. A by-product of alcohol and ethanol production is vinasse or in a concentrated form Condensed Molasses Solids (CMS), which also has value mainly as a source of K fertiliser. This paper also briefly considers the economic value of CMS.

Keywords: Molasses, potassium, fertiliser, economics, vinasse, stillage, inorganic

AN INTEGRATED APPROACH TO NUTRIENT MANAGEMENT IN THE AUSTRALIAN SUGAR INDUSTRY

BL SCHROEDER^{1,3} and AW WOOD^{2,3}

¹*Bureau of Sugar Experiment Stations, Bundaberg;* ²*CSR Sugar, Macknade;*

³*CRC for Sustainable Sugar Production*

Abstract

On-farm nutrient management in the Australian sugar industry has historically been based on general recommendations for use across regions and soils. This approach, although simple to use, does not reflect the large diversity of conditions and soils that exist in the industry. Re-evaluation of past data together with the results from recent investigations, improved access to soil survey data, the availability of leaf analysis results from four distinct regions in the sugar industry, reports of progress on a number of related fronts and an education program aimed at industry advisors and agribusiness, have substantially added to existing knowledge. This has enabled the formulation of an integrated approach to nutrient management. It combines a number of useful 'tools' for adapting general fertiliser recommendations and inputs into a set of soil and site-specific nutrient management strategies. Recognition of soil type in the field, based on easy to recognise properties (colour, texture and position in the landscape), will be used as the initial framework for varying rates of nutrients applied within the integrated approach. Soil analysis results and expert knowledge of soil properties and processes will be utilised to further modify recommended nutrient application rates, fertiliser form and application strategies. Adjustments will also be made according to previous cropping history (actual or modelled) and intended practices and/or past experience on-farm. Leaf analysis will be used to check on the adequacy of fertiliser recommendations and inputs, and monitor nutrient trends at the block, farm and regional levels. Ultimately, it is envisaged that the results of juice analysis from the mill could be used to further modify nutrient inputs in the following crop. This system will be sufficiently flexible to cover the range of on-farm management styles that exist in the industry and will allow for future modifications to be introduced as further information becomes available. Not only will implementation of this system improve productivity on-farm, but it will also signal the on-going willingness of the sugar industry to be environmentally responsible.

THE MANAGEMENT OF CANE HARVEST AT THE SMALL-SCALE GROWER LEVEL: A SOUTH AFRICAN CASE STUDY

P-YLEGAL and EREQUIS

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Abstract

The South African sugar industry relies for a significant part of its production on a large number of small-scale growers. Placed today in a context of liberalism and international competitiveness it needs to improve the efficiency of this group of farmers. In that respect the management of the cane harvest and supply to the mill represents a key-issue regarding both the reduction of burn to crush delays, the regularity of deliveries and the reduction of production costs. A study conducted in 1998 in two sub-committees supplying the Amatikulu mill analyses the impacts of the decisions made both by small-scale contractors, sub-committees and small-scale growers in terms of harvest management. It highlights the irregularity of small-scale contractors' performances and the low profitability of their business. It also stresses the difficulties encountered by the sub-committees in co-ordinating the relationship between contractors and growers. Some kinds of improvement are proposed with regard to both the management of contractors' business and the role of the sub committees. Keywords: harvest, management, small-scale grower, contractor, performance, South Africa.

THE EFFECT OF ROW SPACING ON AN IRRIGATED PLANT CROP OF SUGARCANE VARIETY NCO376

A SINGELS and MA SMIT

*S.A. Sugar Experiment Station, Private Bag X02,
Mount Edgecombe, 4300
South Africa*

Abstract

The effect of five row spacings (RS) on source/sink processes in a plant crop of NCo376 was investigated at Mount Edgecombe. Tiller population (TPOP), fractional light interception (FI), intercepted radiation (RADI), cane and sucrose yields were recorded over the duration of growth. The crop was fully drip irrigated in order to avoid water stress conditions. Differences in FI_{PAR} between the treatments were most pronounced early in the growing season. It took 135, 175 and 221 days after emergence (DAE) to reach $0.8 FI_{PAR}$ at 0.73m, 1.69m and 2.66m RS, respectively. The rate of canopy closure had a direct linear relationship with RS and increased by $26\% m^{-1}$ reduction in RS. The total accumulated incident global radiation from day of planting until final harvest was $5772 MJm^{-2}$, giving a seasonal fraction of radiation intercepted of 0.49, 0.37 and 0.26 for 0.73m, 1.69m and 2.66m RS respectively. The rate of increase in TPOP was directly related to the amount of seed cane planted, and the timing of peak TPOP (or onset of tiller senescence) did not relate to FI for the different RS treatments. These results confirm previous observations that the light environment within the stool zone, rather than in the inter-row zone, dictates tiller phenology prior to peak TPOP. Final TPOP demonstrated a linear increase of 5.30 tillers m^{-1} with decrease in RS ($R^2=0.86$). Radiation use efficiency (RUE) ranged from 1.25, 1.35 and $1.72gMJ^{-1}$ for 0.73, 1.69 and 2.66m RS respectively. In addition to achieving higher RUE, wider rows partitioned a higher fraction of aerial dry mass to stalks. At twelve months there was an average response of 13% increase in stalk dry mass per meter decrease in RS. This relates well to previous South African studies.

Keywords: Sugarcane, Row spacing, Fractional interception, Tiller population, Radiation use efficiency, NCo376

CHANGES IN THE COMPONENTS OF SUGARCANE STALKS FROM RIPENING WITH FUSILADE SUPER

RADONALDSON

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Abstract

The effects of the chemical ripener, Fusilade Super, were evaluated over time in order to characterise the response curves of sucrose, fibre and non-sucrose content. This was done to provide a comparison between the responses in terms of sucrose mass and ERC (estimated recoverable crystal) mass. The ERC formula is used as a surrogate for RV (relative value) so that the benefits from Fusilade Super could be quantified in terms of the RV payment system. The raw data of sucrose, fibre and non-sucrose from a single experiment at Pongola on stress-free NCo376 were normalised and responses were constituted as the difference between treated and control values expressed as a percentage of control. A second set of data from 13 experiments were collectively analysed in the same manner for sucrose mass responses. Response curves of sucrose mass were related to radiation Rad, thermal time TT10 and evapotranspiration ET_{ref} accumulated after spraying as a means of producing a base for developing more appropriate time intervals between spraying and harvesting. Data from the experiment at Pongola showed that the fibre and non-sucrose content were reduced by about 10% while sucrose content increased by 15% on a dry matter basis, 58 days after spraying Fusilade Super. The changes in the partitioning of stalk components resulted in an increase of 27% in sucrose mass and 30% ERC (estimated recoverable crystal) mass. Peak response occurred when accumulated TT10 = 500 °C days, ET_{ref} = 165 mm and Rad = 820 MJm⁻². These values were different for the extended data set.

DEVELOPMENT OF A SUGARCANE INDUSTRY IN THE ORD, WESTERN AUSTRALIA

JM GOSNELL¹ and JH ENGELKE²

¹*PGBI Engineers and Constructors, PO Box 2668 Rivonia 2128*

²*Dept of Agriculture, Kununurra, Western Australia*

Abstract

The Ord River Irrigation Area is 3200 km NE of Perth on latitude 15° 30' S, at an altitude of less than 100m, with rainfall of 800 mm. Water is supplied from the vast Lake Argyle, soils utilised for agriculture are predominantly black montmorillonitic clays and topography is generally very flat. Growing conditions are superb for most tropical crops. Out of a total of 11,000 ha under irrigation, sugarcane is grown on 4000 ha to supply a mill producing around 55,000 tons sugar/annum. The factory was initially constructed on a low-cost new technology basis, unfortunately it gave serious problems and required major modifications. In contrast, the cane harvesting and transport system is highly efficient. Land forming is carried out on all fields to a very high standard and all cane is furrow irrigated. Twenty growers, with an average cane area of 200 ha, focus on highly efficient sugarcane production with low labour input. Average yields of 128 tch at 14 pol % cane were attained during the period 1996-2001. The first outbreak of sugarcane smut in Australia was recorded in the Ord in 1998 and resulted in the elimination of the two most promising varieties, Q117 and NCo310. A detailed feasibility study was carried out to develop over 30,000 additional ha and construct a new sugar mill with a capacity of 400,000 tons sugar/annum, but these proposals have recently been abandoned primarily due to low prospective world sugar prices. However, the existing mill is planning to double its current crushing capacity which will require a further 4000-5000 hectares of land to be planted to sugarcane.

Keywords: Ord, sugarcane, montmorillonitic clays, land forming, smut, furrow irrigation

TRIALS COMPARING SEMI-MECHANISED AND CHOPPER HARVESTING METHODS OVER THREE SEASONS IN SWAZILAND

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Abstract

The South African Sugar Association Experiment Station, Agricultural Engineering Department conducted a series of semi-mechanised versus fully mechanised harvesting trials on a large commercial estate in Swaziland over the 1998/1999, 2000/2001 and 2001/2002 seasons. During the trials machinery performance was measured, differences in the quality of cane delivered to the factory were determined, and associated infield cane losses were estimated. The results of all three trials showed that infield cane losses were statistically significantly lower where the cane was manually cut and mechanically loaded, compared with cane harvested by combine harvester. Two out of the three trials showed that the quality of cane delivered to the factory by the combine harvester treatments was not statistically significantly different to that delivered by the manually harvested and mechanically loaded treatments. Mechanical loader and combine harvester performance varied considerably depending on the type of machine, cane yield, and crop and field conditions.

Keywords: manual harvesting, mechanical harvesting, cane quality and cane losses

A DECISION SUPPORT TOOL FOR ASSESSING ECONOMICS OF IRRIGATION IN SUGARCANE

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Abstract

In 1997, the Swaziland Sugar Association Technical Services initiated a programme to improve water use efficiency by providing information on appropriate irrigation methods, crop water use, irrigation scheduling, system design, water measurement and irrigation system performance. Maximizing irrigation efficiency was considered to be a first step towards the goal of increasing sucrose yield per unit of water. Results from the programme, highlighted the need for assessing economics of irrigation to ensure that technical efficiency was not pursued at the expense of economic efficiency. This paper reports on the development of a decision support tool to help growers make economically sound decisions in an irrigated sugarcane production system. Irrigation decisions are becoming more complex with changes in markets, water legislation, wider choice of irrigation systems and development of more marginal water supply sites. Historically, growers often made irrigation decisions based on minimizing capital costs without taking in to account the long-term nature of irrigation investments. This approach often results in selection of systems that do not maximize profits and may not meet other production system requirements. The framework developed helps to evaluate the relative trade-offs between water, capital and running costs over the life of the system. Sugarcane production costs and economic data from Swaziland are used to demonstrate the utility of the principles used in the model.

PROJECT PLAN FOR AN INTEGRATED MAPPING AND INFORMATION SYSTEM IN THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

There are a number of current initiatives in the South African sugar industry investigating and implementing mapping programmes and information systems. These independent initiatives have raised concern over the lack of industrial standards and frameworks that are necessary to consolidate the mapping and industrial information for the benefit of the whole sugar industry. To address these issues the South African Sugar Association Experiment Station appointed private consultants to undertake a study of the mapping initiatives, industrial information systems and information requirements, common to all industrial stakeholders. The paper summarizes the project results and recommendations from the six project reports for the industrial study, completed in December 2001.

DISTRIBUTION OF NEMATODES, SOIL FACTORS AND WITHIN-FIELD VARIATION IN SUGARCANE GROWTH

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Abstract

A common feature of plant-parasitic nematodes on annual crops is that they have an uneven distribution within a field and the symptoms of damage, normally associated with high population densities, occur in patches (McSorley, 1998). Where a susceptible annual crop is replanted year after year the nematodes spread and the patches increase in size and eventually coalesce (Brown, 1987; Swarup and Sosa-Moss, 1990). Monocropping for decades, as is common in sugarcane agriculture, will enhance the horizontal spread of the common nematodes and lead to their more uniform distribution (Delaville *et al.*, 1996). One factor likely to interfere with the uniform spread of the nematodes is soil texture as this can influence their abundance and distribution (Cadet *et al.*, 1994; Norton, 1989; Upadhyay *et al.*, 1972). For example, species of *Meloidogyne* are frequently more numerous and more pathogenic in light textured soils, giving rise to greater symptom expression in the sandier areas within the field (Kincaid, 1946; Prot and van Gundy, 1981). If, after years of monocropping, patches of poor growth are seen in a field, these could reasonably be ascribed to soil differences. Thus when, in a sugarcane nematicide trial, an area of poor growth was observed that extended across both nematicide treated and untreated plots, it was initially assumed to be due to a difference in soil. However there were no obvious soil textural differences on the surface or at depth. Plant parasitic nematodes were numerous throughout the trial and were represented by the same species in the good and poor growth areas. Apart from the occasional white grub larvae (Coleoptera, Scarabaeidae), no insects were observed in the soil samples collected from the trial site. Similarly there were no widespread symptoms of disease within the trial area. Sugarcane had been grown in the field for 30 years, with a cropping system usually comprising a plant crop plus two ratoons and with a 2 to 3 month period between ploughing out the old crop and replanting. The three crops of cane on the trial site had been fertilised but

the amount applied was based on the average requirement for the field and not on the need of localised areas. The objective of this work was to identify the most likely cause or causes of the uneven growth of the sugarcane within the field trial – attention being given to the abiotic edaphic factors and the nematodes. Soil samples were collected from each of the plots within the trial to determine soil texture, pH, organic matter content and the levels of various soil chemical elements, as well as the numbers of the common and abundant plant parasitic nematodes. These were *Meloidogyne* sp, *Pratylenchus zaeae*, *Helicotylenchus dihystra*, *Xiphinema elongatum* and *Paratrichodorus* sp. To identify the factors associated with the areas of well grown and poorly grown sugarcane the soil and nematode data were subjected to principal component analysis (PCA). The yield data were centred and normalised separately for the treated and control plots and the values projected on the trial map to study spatial distribution. Plots with above-average yields, whether treated or untreated, occurred in the lower part of the trial site. The PCA factorial values were also projected onto the map of the trial. According to the first factor of the analysis of the abiotic soil characteristics in the 0-20 cm surface layer, the trial site could be divided into two areas, one on the left and one on the right. PCA

TERMITES AND PLANT PARASITIC NEMATODES IN SUGARCANE IN KWAZULU-NATAL

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Abstract

In the South African sugar industry, the occurrence of circular patches of exceptionally well-grown sugarcane is a common feature of sandy soils. Most of these patches correspond to termite mounds levelled by the ploughing of the field before planting. These mounds and the associated better grown cane are known locally as 'isiduli'. The soil of the mound contains more clay than the surrounding area – a consequence of the activity of the termite *Macrotermes natalensis*, that bring clay particles up from the deeper soil layers, and mix them with saliva to build their underground galleries and the walls of the nest. To study the influence that the termites have on the physical, chemical and biological properties of the soil, root and soil samples were collected at two depths every 70 cm along a 21 m transect along a sugarcane row which passed through an isiduli. The isiduli was situated in a ratoon field of NCo376 on the La Mercy Farm on the North Coast of KwaZulu-Natal. Physical and chemical analyses were conducted on the soil from each sampling point. Also, from each sample the numbers of each of the plant feeding nematode genera in the soil and roots of cane were determined and bacterial activities were characterised with the 'Biolog' test. The number, height, weight and sucrose content of the stalks at the various points along the transect were recorded. In addition, chemical analyses were performed on leaf samples collected from each sampling point. The number of internodes damaged by the sugarcane stalk borer, *Eldana saccharina*, was also estimated. The greater stalk length defines the extent of the isiduli (Figure 1). Cane yield was 6 times greater on the isiduli than that elsewhere along the transect, corresponding to 89 and 15 t cane/ha, respectively, at the time of sampling. *Meloidogyne* was absent and *Xiphinema* less abundant in the isiduli, which paradoxically hosted a greater total number of plant feeding nematodes than the neighbouring area. *Helicotylenchus*, *Pratylenchus* and *Paratrichodorus* were more numerous within the isiduli than elsewhere along the transect. The contrasting nematode communities closely matched the limits of the isiduli – as defined by the vegetative parameters. The

levels of the different soil elements in the topsoil (0-30 cm) were always higher within the isiduli. However, the extent of the isiduli, when defined by the greater concentrations of soil elements, did not correspond very well with the limits determined by the vegetative parameters. A better correspondence was observed with the soil characteristics of the deeper (30-60 cm) soil layer, but this was not as good as that achieved with the nematode analysis. The bacterial activity gave the poorest discrimination of the extent of the isiduli. High bacterial activity was observed in samples collected both inside and outside the isiduli. Eldana infestation was slightly higher within the isiduli. Although the termites modified the physical and chemical properties of the soil in a way favourable for sustainable sugarcane growth, the observed effect did not seem to result only from these changes. Biological factors also played a role. As far as plant-feeding nematodes are concerned, the isiduli was not associated with fewer individuals, as might have been expected. On the contrary, it promoted the numbers of one of the species in particular, viz, *Helicotylenchus dihystera*. This species has already been found associated with better sugarcane growth in other fields where isiduli were absent.

ASSESSING NITROGEN FERTIGATION STRATEGIES FOR DRIP IRRIGATED SUGARCANE IN SOUTHERN AFRICA

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Abstract

Standard nutritional advice for irrigated sugarcane in South Africa and Swaziland is based on soil sample analysis and threshold values that have been determined experimentally over many years with surface-applied fertilisers. Fertilisers are normally applied in solid form during the early stages of crop development and watered in by the next irrigation cycle. The increasing popularity of subsurface drip irrigation in the Southern African sugar industries raises opportunities for improved fertiliser management. However, without appropriate recommendations there could be a tendency towards leaching and denitrification associated with poor timing and excessive application of fertilisers by fertigation. While little active research has been carried out on the fertigation requirements of sugar cane in Southern Africa, the results of studies of nutrient uptake patterns in irrigated sugarcane have been used to formulate monthly fertigation programmes that account for seasonal variation in nutrient demand within a single crop cycle (“growth curve nutrition”). This paper reports the initial results of two experiments established in Swaziland to test the benefits of using such an approach against more conventional principles of fertiliser application, with specific reference to nitrogen. Cumulative nitrogen uptake curves were tested for a summer cycle plant crop and for a winter cycle first ratoon crop. Results indicated that the winter nitrogen uptake curve correctly predicted the proportional monthly nitrogen demand of a winter ratoon crop but did not account for the effect of late nitrogen application on cane quality. The summer nitrogen uptake curve appeared to underestimate the nitrogen demand of a summer plant crop between January and April. Splitting nitrogen applications evenly over the first four months of crop development led to more efficient and productive use of nitrogen than the growth curve nutrition approach.

Keywords: Nutrition, nitrogen, fertigation, drip irrigation

EFFECT OF IRRIGATION-INDUCED SALINITY AND SODICITY ON SUGARCANE YIELD

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Abstract

The effects of irrigation-induced salinity and sodicity on sugarcane yields, stalk height and number of nodes per stalk were investigated at a sugarcane estate in the Zimbabwean lowveld. The calcareous, vertic soils in the study area under undisturbed veld were found to have high pH values (8 to 9.5), very high exchangeable Ca and Mg concentrations and there was evidence of accumulation of soluble salts in the surface 0.15 m. Under sugarcane, high values for EC_e , SAR_e and ESP were generally encountered in the surface 0-0.3 m of the profile. In addition, the pH values under sugarcane were often between 9 and 10 particularly in profiles where sugarcane grew poorly or died. As expected, pH was positively related to ESP and SAR_e but negatively related to EC_e . Sugarcane yield, stalk height and number of nodes per stalk were not significantly related to EC_e . Nevertheless, yields were negatively correlated with ESP, SAR_e and pH. Foliar analysis of leaf tissue revealed no substantial differences in macro or micronutrient content between good and poorly-growing sugarcane. Nonetheless, the results suggested that sodicity was a more limiting factor for sugarcane growth than salinity.

SIZE AND ACTIVITY OF THE SOIL MICROBIAL BIOMASS IN THE ROW AND INTER-ROW AREA OF A SUGARCANE FIELD UNDER BURNING AND GREEN CANE HARVESTING

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Abstract

The size and activity of the soil microbial biomass was studied in the plant row and in the inter-row of a sugarcane field under burning or green cane harvesting. The sites sampled were on the long-term trash management trial situated at Mount Edgecombe. Soils were sampled to 30 cm depth in (i) the centre of the plant row, (ii) 30 cm out from the row centre and (iii) 60 cm out from the row centre (i.e. the middle of the inter-row area). Under burning, the only substantial input of organic matter to the soil was from root turnover in the row area where the root biomass was concentrated. As a consequence, the size (microbial biomass C) and activity (basal respiration) of the soil microbial community were concentrated in the row. However, under green cane harvesting there was a large input of organic matter in the inter-row area in the form of the trash blanket itself and through turnover of crop roots that were concentrated in the surface 10 cm of soil below the trash blanket. As a result, soil microbial activity was considerably higher in the inter-row area under green cane harvesting than under burning. Such results highlight the benefit of green cane harvesting to soil quality under sugarcane production.

DETERMINATION OF SOIL INFILTRATION CHARACTERISTICS

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Abstract

In surface irrigation, the soil serves as a medium for infiltration and conveying water from upstream to the downstream end of a field. In this study, infiltration properties of the Sibaya (Si) soil series (Glenrosa in the South African soil classification system) were determined by a volume balance method using a two-point approach technique. The purpose of the study was to examine the effect of different irrigation scheduling on infiltration characteristics, and on irrigation performance. A trial was conducted on a field with predominately Sibaya soil from 1999 to 2001. The five irrigation treatments were the Ubombo system, Penman Monteith (PM) derived irrigation scheduling factors of 1.25, 1.00 and 0.75, and alternate inter-row irrigation using Ubombo and 1.00 x PM scheduling on plant and 1st ratoon cane, respectively. Treatments were arranged in a randomised complete block design with four replications. The Ubombo scheduling method had the highest number of irrigation events followed by the 1.25 x PM, whilst the 0.75x PM had the least. The infiltration variables indicated that, for the Ubombo and 1.25 x PM treatments, irrigation often occurred when the soil water content was still less than 50% depleted plant available water (DPAW). Frequent irrigation resulted in the crop depleting soil water, predominately at the 0.15 - 0.30 m soil depth and hardly any at 0.45 m, particularly when the crop was still young. There were no significant differences in yield between any of the treatments either in the plant or the ratoon crops. The plant crop consistently recorded higher yields than the first ratoon in all the treatments. Ubombo scheduling recorded the highest sugarcane yield in both seasons at 84 t cane ha⁻¹ for the plant and 82 t cane ha⁻¹ for the first ratoon. The 0.75 x PM had the lowest yield (77 t cane ha⁻¹) in the plant crop as well as in the first ratoon (74 t cane ha⁻¹).

YIELD PERFORMANCE OF SOUTH AFRICAN SUGARCANE VARIETIES IN PLANT CANE TRIALS AT NCHALO SUGAR ESTATE, MALAWI

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Abstract

Within the framework of a requirement to increase productivity, a fluctuating world sugar price, a fixed area for cultivation and increasing financial constraints, the use of improved varieties one of the keys to more efficient and profitable sugar production. The use of superior varieties also reduces the risk of crop failure due to pests and diseases, unfavourable weather and soil conditions. At Nchalo, 85% of the cane grown is variety N14, which has succumbed to smut (*Ustilago scitaminea*) on the estate. New smut-tolerant and high Pol South African (N) varieties from the South African Sugar Association Experiment (SASEX) Station's breeding program are being introduced to reduce the current dependence on N14 and pending an attempt to reduce the level of smut in this variety by improved disease management. Hence the performance of varieties, N19, N23, N25, N26, N28, N29, N30, N32 and unreleased SASEX varieties 82F2907 and 84F3078, were compared to N14 in three randomised block design trials, conducted in plant cane crops harvested early, mid and late season. The results show that N14 had the highest cane and sugar yields in the early-season, 82F2907 in the mid-season and N25 in the late-season trials. This indicates that, in order to maximise sugar production for the season, the timing of harvest of different varieties should coincide with the period of their peak performance.

Keywords: sugarcane, varieties, productivity

THE ESTABLISHMENT OF A SUGARCANE VARIETY EVALUATION NETWORK FOR WESTERN AND CENTRAL AFRICAN COUNTRIES

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Abstract

Sugarcane has been grown for some thirty years in Western and Central Africa. The annual sugar production is now around 500,000 tonnes, all of which is produced by recently privatised sugarcane companies. With a view to increasing productivity, producers aim at renewing the range of varieties grown. Unlike many sugarcane growing areas, this regional sugar industry does not have at its disposal a breeding programme to create its own varieties. It relies entirely on the introduction of varieties by individual producers and their evaluation locally. In 1999, CIRAD organised a workshop on variety improvement with the sugar producers of the region. These comprised some breeding centres (CERF, MSIRI) and the West Indies Sugarcane Breeding and Evaluation Network (WISBEN). The purpose was to set up a regional variety improvement network. It was noted that several existing selection programmes were relatively long, that the variety turnover was low and that some varieties were not being fully exploited. It was therefore decided to improve the existing selection programmes and the current methodologies, with the purpose of sharing information among growers on variety selection, to diversify the variety supply source and to increase the number of introductions. In 2001, during the second workshop, the sugar producers agreed to set up a regional variety evaluation network and to create an association. Once created, the association would establish collaborations with breeding centres to introduce genetic material. In the longer term, the producers of the region could initiate a hybridisation programme.

Keywords: Sugarcane, Varieties, Network, Africa, Western, Central

INVESTIGATING TWO STATISTICAL TECHNIQUES USED IN THE ANALYSIS OF SUGARCANE VARIETY TRIALS

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Abstract

The main objective of the South African Sugar Association Experiment Station (SASEX) Agronomy variety trials is to compare relative yields amongst sugarcane varieties for making variety recommendations for different agroclimatic zones. Analyses of variety trials, and the interpretation of results, are however often complicated when the yield response to the genotype-by-environment (GxE) interaction is statistically significant. The Residual Maximum Likelihood (REML) and the Additive Main effects and Multiplicative Interaction (AMMI) methods were used to analyse data with GxE interaction in order to:

- 1) Predict mean estimated recoverable crystal (ERC) yields across different environments.
- 2) Evaluate the usefulness of AMMI and REML in identifying mega-environments.

Keywords: variety, sugarcane, variety trials, GxE interaction, AMMI, REML AMMI terms of variety performance (Gauch 1992).equation (Gauch, 1992):

Where: μ = additive parameter, grand mean

GENE DISCOVERY AND EXPRESSION ANALYSIS IN SUGARCANE – THE STORY SO FAR

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Abstract

Knowledge about gene expression during sugarcane growth and maturation is limited. A gene discovery programme has been in progress at SASEX since 1994 to identify and analyse genes that are expressed in different sugarcane tissue types and developmental stages. A database of sugarcane gene sequences has been established through the generation of Expressed Sequence Tags (ESTs). This database, containing approximately 1400 sequences from leaf and culm tissues of varying maturity, has facilitated access to a myriad of genes not previously available for sugarcane research. Submission of a proportion of the sugarcane gene sequences to the dbEST international database represented the first sugarcane ESTs released into the public domain. ESTs have been identified and the expression patterns of sugarcane genes examined in maturing internodal tissue to identify genes that may be preferentially associated with culm maturation. Differentially expressed genes detected in the culm included those associated with general cellular metabolism, cell wall synthesis, carbohydrate metabolism, regulatory processes and stress responses. The results indicate that growth and maturation of the sugarcane culm is associated with the expression of genes for a wide variety of metabolic processes. Only one gene known to be involved with sucrose metabolism was detected, suggesting that genes encoding enzymes directly associated with sucrose accumulation may not be abundantly expressed in the culm. This paper reviews the major outcomes of research at SASEX towards the molecular analysis of sugarcane metabolism during growth and maturation.

ENHANCING SUCROSE ACCUMULATION: IDENTIFYING GENE TARGETS FOR MANIPULATION

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Abstract

Between 1950 and 1970, the introduction of new sugarcane varieties and improved crop husbandry in the South African sugar industry contributed to substantial gains in sucrose yield. However, in the subsequent three decades to date, sucrose yield has remained approximately constant, despite an increased rate of variety releases. This lack of progress is a phenomenon common to many sugar industries and has been ascribed to the narrow genetic base of germplasm used in breeding programmes. Consequently, in several industries, modern molecular technologies are being used in concert with more conventional strategies in bids to improve sucrose yield traits in both sugarcane breeding stock and individual lines with commercial potential. One strategy has focused on the genetic modification of the activity of single endogenous sugarcane genes or the expression of single heterologous genes in an attempt to increase the proportion of photo assimilate accumulating as stored sucrose in the culm. This approach has met with mixed success and given that plants are adept at metabolic compensation, it is increasingly acknowledged that robust manipulation of sucrose deposition in the sugarcane stalk may depend on the co-ordinated manipulation of the activity of several genes. However, the capacity to identify and subsequently modify multiple gene targets is contingent on the availability of comprehensive knowledge of the key regulatory steps governing sucrose accumulation. This presentation reviews recent attempts at the molecular manipulation of sucrose accumulation in sugarcane and describes how genomic approaches are being applied at SASEX to enhance the potential of such endeavours.

APPLICATION OF MICROSATELLITE ANALYSIS TO THE SCREENING OF PUTATIVE PARENTS OF THE SUGARCANE CROSS AA40

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Abstract

In 1993 the genetic mapping of South African sugarcane cross, AA40, was initiated. However preliminary RFLP data suggested that the pedigree of the AA40 cross was incorrect. Mislabelling at planting or at seed collection was suspected as the cause of the invalid pedigree. Ten microsatellites (simple sequence repeats; SSRs) were used to analyse 13 potential parent cultivars and investigate the assertion of both mislabelling at planting (six potential parent pairs) and in a restricted manner that of mislabelling at seed collection (two potential parent pairs). The SSR primers chosen generated a total of 75 markers, of which 19 were monomorphic. The number of markers recorded per SSR primer pair across the 13 cultivars tested ranged between 2 and 11 with an average of 8. Although this work failed to identify the parents of the AA40 population, it did imply that the invalid pedigree of the AA40 population came about as a result of mislabelling at seed collection.

ASPECTS OF DRY MATTER PARTITIONING IN SUGARCANE

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*Derived from paper by Inman-Bamber, Muchow and Robertson (2002),
Field Crops Research (in press).*

Abstract

Partitioning of dry matter (DM) in sugarcane is of interest for two fundamental reasons. Firstly sugar production depends directly on partitioning of biomass to the stalk and then to sucrose stored in the stalk. Secondly, various DM components of the stalk and particularly sucrose concentration are used to calculate the value of cane consignments delivered to the mill (Berding, 1997). The value of cane consignments is reduced by leaf and trash and by non-sucrose constituents of the stalk, even if the total mass of sucrose in the consignment is not reduced (Culverwell, 1996). In the case of the Australian sugar industry the payment formula is designed to accentuate the value of sucrose content of cane consignments and this has led to a heightened awareness of variations in sucrose content due to cultivar, harvest season, crop age and many other factors. The moisture, fibre and juice purity components of the payment formulas are also important but will not be considered in this paper.

THE RESPONSE OF SUGARCANE TO WATER STRESS

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Abstract

Sucrose accumulation is the end result of many interrelated physical and biological processes, which are affected by water stress. Quantitative knowledge of the effect of water stress on these processes could lead to more accurate predictions of sucrose content and sucrose yield. This in turn could lead to higher sucrose content and yields by better use of limited irrigation and better drying off management. The aim of this communication is to report the preliminary results of a collaborative investigation into the effects of water stress on biomass accumulation, biomass partitioning and plant extension. The communication focuses on (1) the sensitivity of the different processes to water stress (2) the change in biomass components due to water stress, and (3) the implications of the findings for irrigation management.

ROBUST ESTIMATES OF EVAPOTRANSPIRATION FOR SUGARCANE

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Abstract

In both Australia and Swaziland large areas of sugarcane rely on irrigation to produce a viable crop or to improve rainfed productivity. Matching water supply to crop demand is essential for productivity and sustainability in any irrigation scheme. Historically Class-A pan evaporation was used as a basis for determining sugarcane water demand or evapotranspiration (ET_c). ET_c is now frequently obtained using simulation models like CANEGRO (McGlinchey and Inman-Bamber, 1996) and APSIM (Keating *et al.*, 1999). Another approach now endorsed by the United Nations Food and Agriculture Organisation (FAO) is to base ET_c on reference evapotranspiration (ET₀) estimated using the Penman-Monteith equation and crop-specific coefficients (K_c) which are used to convert ET₀ to ET_c for a particular crop at a particular stage of development (FAO 56; Allen *et al.*, 1998). Both the CANEGRO and FAO methods utilize the Penman-Monteith equation to estimate atmospheric demand. In Swaziland a sugarcane reference evapotranspiration estimate (ET_{cane}), derived from CANEGRO, is used extensively to schedule irrigation. In contrast the APSIM-Sugarcane model uses a transpiration use efficiency concept (TUE) to estimate ET_c from the increment in above-ground biomass and vapour pressure deficit (VPD). This paper arises from a collaborative project between the Swaziland Sugar Association Technical Services and CSIRO, Australia to test these mathematical methods for determining ET_c against ET_c measured using the Bowen Ratio Energy Balance (BREB) technique in two countries using different cultivars. Revisions to the models and to FAO crop coefficients (ET_c/ ET₀) could then be advised if necessary.

WHOLE FARM HARVESTING STRATEGY OPTIMISATION USING THE CANEGRO MODEL: A CASE STUDY FOR IRRIGATED AND RAINFED SUGARCANE

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Abstract

There are two conflicting trends to be considered when optimising crop cycles on a farm. While yield and quality increase as harvest age increases, longer crop cycles reduce the total annual area harvested, potentially reducing the farm's total production. Optimisation of crop cycles is a complex problem, which has to account for the dynamic impact of a multitude of agroclimatic and economic factors. The aim of this study was to demonstrate the use of the Canegro model and strategy analysis techniques to identify optimal harvesting strategies for two cases. Seven practical harvesting strategies were simulated for a 27 year period. Annual gross margins were calculated and different criteria of maximum profit and minimum risk applied to identify optimal strategies. Results indicate that, for the irrigated Tala valley scenario, maximum profits would be achieved when 60% of the total area under cane was harvested per annum. The optimal strategy identified for the dryland Tongaat scenario was to harvest 52.9% per annum. This recommendation excludes the effect of the Eldana stalk borer. A sensitivity analysis showed that the recommendations at Tala valley were relatively stable and could absorb normal fluctuations in harvesting costs and the RV price. It was concluded that the methodology developed here is suitable for optimizing harvest strategies and could be applied for other scenarios in the SA sugar industry.

Keywords: harvest age, optimization, crop model, gross margin, strategy analysis, crop cycle

THE IMPACT OF TRASH MANAGEMENT ON SOIL CARBON AND NITROGEN I: MODELLING LONG-TERM EXPERIMENTAL RESULTS IN THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

Trash blankets contain substantial amounts of nitrogen (N) and other nutrients. The availability of N in trash is complicated because most of the N cycles through the soil organic matter. To gain insights into the long-term fate of N contained in trash, N dynamics in the SASEX long-term trash management experiment (BT1) were simulated with the APSIM-Sugarcane cropping systems model. Initially, the model was verified against cane yields and soil organic carbon data from the experiment. Then, simulations were conducted over 60 yr (1940 to 2000) with N fertiliser application rates ranging from 20 to 260 kg/ha. Cane yields and soil organic carbon results from the BT1 experiment were well represented by the model. The N response simulations showed that cane production not only responds positively to trash retention at the BT1 site, but that the response is dependent on the amount of N fertiliser applied to the crops. To maximise the production benefits from trash retention, additional N (approximately 60 kg/ha) should be applied where trash is retained compared to that where trash is burnt. The additional N is required for the crops to reach their potential with the additional moisture available in the trash retained system. The simulations also show that it takes three to four decades for the response of cane yields to N fertiliser application rates to stabilise, although even after this time soil organic C is still simulated to be declining (as occurred in the BT1 experiment). This study illustrates the additional insights that can be gained into the complexities of agricultural systems with the aid of a comprehensive simulation tool. Analyses of the likely impacts of trash retention at other sites in the South African sugar industry will be reported in a companion paper.

Keywords: fertiliser response, green cane harvesting, nitrogen mineralisation, nutrition; soil organic matter; sugarcane

THE IMPACT OF TRASHING ON SOIL CARBON AND NITROGEN II: IMPLICATIONS FOR SUGARCANE PRODUCTION IN SOUTH AFRICA

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Abstract

Trashing has the potential to improve yield by conserving water, soil C and soil N in sugarcane production. However, the benefits of trashing are complex to determine because of variability in rainfall (between regions and seasons) and the long-term effect of cropping soil systems on N dynamics. In a companion paper a cropping systems model, which accounts for the impacts of water and N stress on sugarcane growth, was shown to predict the long-term response of cane yield and soil organic matter changes under a range of trashing treatments. This paper expands the modelling analysis by examining the benefits of trashing over a wider range of soils and climatic conditions. Possible changes to cane production management practices in the South African sugar industry following the adoption of trashing are discussed.

Keywords: APSIM, cane trash, cane yield, soil biomass carbon, soil biomass nitrogen, sugarcane

THE RELATIONSHIP BETWEEN EXTENT OF COLONISATION BY *LEIFSONIA Xyli* SUBSP *Xyli* AND YIELD LOSS IN DIFFERENT SUGARCANE VARIETIES

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Abstract

Large-scale yield trials have traditionally been used to rate the reactions of released sugarcane varieties to ratoon stunting disease (RSD). These trials are time-consuming and require large tracts of land and are therefore not suitable for incorporation into a routine programme of disease screening of new genotypes. Using a tissue blot-enzyme immunoassay (TBIA) to determine the percentage of colonised vascular bundles (CVB) in RSD-infected stalks, it is possible to estimate both the incidence of infection and likely severity of the disease. In previous work, the ranking of a number of released varieties for their reaction to RSD using TBIA has correlated well with estimates of yield loss in field trials, but it was necessary to confirm these findings in one trial comparing both methods of variety evaluation. A good correlation between yield loss and percent CVB in six varieties, N12, N14, N16, N27, N29 and N35, was obtained from the results of a rainfed field trial conducted at Mount Edgecombe. Using both methods of varietal assessment, N35 and N27 were found to be the most resistant of the varieties tested while N14 was the most susceptible. The results from this study indicate that the TBIA can provide an effective and more efficient method for evaluating varieties for their reaction to RSD and that it has potential for application in the disease screening programme at SASEX.

Keywords: RSD, ratoon stunting, sugarcane, disease screening, tissue blots

IMPROVEMENTS IN THE SMUT SCREENING PROGRAMME AT THE PONGOLA RESEARCH STATION

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Abstract

In 1974 the first resistance screening trials for smut (*Ustilago scitaminea* H. & P. Sydow) were planted at the Pongola Research Station in northern KwaZulu Natal. Since then, with the continued breeding, selection and adoption of more smut resistant genotypes, there has been a gradual decrease in smut susceptible varieties grown in the Pongola area and, presumably, a decrease in smut spore inoculum. Certainly, increasingly low levels of infection had been recorded in the autumn (March) planted smut screening trials that rely on natural infection, even in the susceptible standard variety NCo376. The timing of the autumn planted screening trials has been a matter of convenience, being related to the availability of suitable planting material. However, previous observations had indicated that the susceptibility to smut was greater in cane planted in spring or summer than in autumn or winter. A trial was therefore conducted to compare the susceptibility of genotypes planted in March with the same genotypes planted in September. Results from the two planting dates, covering the plant crop and the first and second ratoon crops, confirm that higher and more consistent levels of smut infection are obtained when the cane is planted in spring.

PROMOTING PLANT HEALTH: POTENTIAL FOR THE USE OF PLANT- ASSOCIATED MICROORGANISMS IN THE BIOLOGICAL CONTROL OF PATHOGENS AND PESTS IN SUGARCANE

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Abstract

Bacteria and fungi that colonise plant surfaces and internal plant tissues (epiphytes and endophytes respectively) are ubiquitous, residing latently or actively colonising the plant locally as well as systemically. Endophytic microorganisms generally originate from the epiphytic communities of the root or aerial surfaces as well as from within seed material. Besides entering plants through natural openings or wounds, many endophytes appear capable of actively penetrating their hosts using hydrolytic cellulases and pectinases. In these respects endophytes resemble pathogens. Historically many of these microorganisms have been thought to be weakly virulent plant pathogens. However, some have since been discovered to have beneficial effects on host plants, such as growth promotion and increased resistance against plant pathogens, insect pests and nematodes. Increased resistance can occur through competitive exclusion, direct antibiosis and induced systemic resistance in the plant, or combinations of these. Conversely, some epiphytes and endophytes might be regarded as plant antagonists in that they retard plant growth and increase susceptibility to pathogens, pests and nematodes. This review assesses the potential for the biological control of important sugarcane pathogens and pests using beneficial epiphytic and endophytic micro-organisms based on results achieved with other crop plants.

ASSESSMENT OF SUGARCANE ENDOPHYTIC BACTERIAL AND RHIZOSPHERIC *BURKHOLDERIA* SPECIES AS ANTIFUNGAL AGENTS

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Abstract

Naturally occurring bacterial endophytes were isolated from the stalks of six different sugarcane varieties. The highest numbers of bacterial populations were isolated from variety N12 and this variety was used for further investigations. Xylem sap as well as crushed cane sap was used for isolations, but no differences were observed between the type and numbers of species isolated. Endophytic bacterial populations decreased from the lowest to the upper-most internode. The lowest internode was surface sterilized and used to extract bacterial species on four different media (modified PW, TSA, PCAT and *Candida* medium). Most bacterial species were isolated on PW while PCAT medium was used to isolate *Burkholderia* and *Pseudomonas* species. The most common bacterial species isolated from sugarcane stalks were *Pseudomonas* spp., *Zymomonas* spp., *Burkholderia* spp., *Bacillus* spp., *Serratia* spp., *Klebsiella* spp. and *Xanthomonas* spp. *Burkholderia* reference strains, local endophytic stalk isolates as well as local *Burkholderia* isolates from the sugarcane rhizosphere were tested for their antifungal activity against sugarcane smut (*Ustilago scitaminea*) and *Fusarium* spp. causing stalk rot. Forty-seven strains inhibited the growth of *Ustilago* while seventy-two strains inhibited the growth of *Fusarium* *in vitro*. Twenty-one of these bacterial strains inhibited the growth of both *Fusarium* and *Ustilago*.

ISOLATION AND CHARACTERISATION OF SUGARCANE RHIZOBACTERIAL AND THEIR EFFECT ON NEMATODES

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Abstract

Root feeding nematodes cause a considerable loss in yield of sugarcane in South Africa. Some species cause more damage than others and yield loss appears to be related to the proportions of pathogenic (*Meloidogyne* and *Xiphinema*) to less pathogenic species (*Helicotylenchus*) within the nematode community (Cadet *et al.*, 2002). There is a possibility that this balance is controlled by the composition of the bacterial flora associated with sugarcane roots. Soil microorganisms naturally regulate the activity of pathogens, leading to suppressiveness (Rouxel, 1991). The widespread soil bacteria, *Burkholderia* and fluorescent *Pseudomonas*, are very efficient root colonizers even in the presence of indigenous microorganisms (Schroth and Hancock, 1982). They promote plant growth by preventing or minimising the deleterious effects of pathogenic organisms (including nematodes) through the synthesis of antibiotics, toxins and enzymes. A *B. cepacia* strain (Bc-2) has been shown to inhibit egg hatch and mobility of second-stage juveniles of *M. incognita* *in vitro* (Meyer *et al.*, 2000) and *in vivo* (Meyer *et al.*, 2001). Moreover, it was found that *B. cepacia* and *B. gladioli* were the dominant bacteria obtained from plants antagonistic to *M. incognita* and the soybean cyst nematode, *Heterodera glycines*, but were not present in soybean which is susceptible to both nematodes (Kloepper *et al.*, 1992). Reports have also shown that treatment of soils with chitin and powdered pine bark could control plant-parasitic nematodes in cotton and suppress *H. glycines*. It was noted that numbers of *B. cepacia* were higher in the amended soils compared with non-amended soils (Hallmann *et al.* 1999, Kokalis-Burelle and Rodríguez-Kábana, 1994). The objective of the project was to isolate and genotypically characterise *Burkholderia* and fluorescent *Pseudomonas* strains from sugarcane roots and to assess their effect on the juveniles of *Meloidogyne*.

Keywords: Burkholderia, Pseudomonas, nematode biocontrol, sugarcane, rhizosphere

BIOLOGICAL CONTROL OF *CHILO SACCHARIPHAGUS* (LEPIDOPTERA: CRAMBIDAE) IN MOÇAMBIQUE: THE FIRST STEPS.

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Abstract

In 1999, it was confirmed that *Chilo sacchariphagus* Bojer was attacking sugarcane at Açucareira de Moçambique, Mafambisse, and in 2001 from Companhia de Sena, Marromeu. In 2000, Açucareira de Moçambique requested that the South African Sugar Association Experiment Station investigate a classical biological control programme against this exotic borer using *Xanthopimpla stemmator* Thunberg. To this end, during March and June 2001, intensive pre-release surveys for this borer and possibly already established parasitoids were completed. No pupal parasitoids were recorded, and only 1.3% parasitism of the larval population was found. However, many egg batches were parasitised by *Trichogramma bournieri* Pintureau and Babault. Because of the absence of pupal parasitoids in these collections, it was deemed safe to release *X. stemmator*, as it was likely that no native species would be displaced. Releases were planned to coincide with the *C. sacchariphagus* pupal peak expected during July /August 2001. One thousand mated female parasitoids were released in five selected sugarcane fields, in batches of 200 at fortnightly intervals over the two-month period. When post-release surveys were completed in October 2001, population reductions of between 31% to 90% in *C. sacchariphagus* larval and pupal numbers were recorded in all the release fields, when compared to control fields. In the light of these findings, it seems that a classical biocontrol programme against *C. sacchariphagus* using *X. stemmator* in Moçambiquan sugarcane is beneficial. The way forward is discussed, as well as an augmentation biocontrol programme using *T. bournieri*. The possibility of importing and introducing larval parasitoids of *C. sacchariphagus* is proposed.

Keywords: Biological control, *Chilo sacchariphagus*, *Xanthopimpla stemmator*, *Trichogramma bournieri*, Moçambique, sugarcane

GENETIC DIFFERENTIATION IN *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE): EVIDENCE FROM THE MITOCHONDRIAL CYTOCHROME OXIDASE I AND II GENES

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Abstract

The sugarcane stemborer *Eldana saccharina* is an indigenous African moth found throughout much of subsaharan Africa. Previous research has revealed ecological differences among geographical populations, raising the possibility that *E. saccharina* may consist of different biotypes. As a first step towards evaluating this hypothesis, *E. saccharina* populations from across Africa were surveyed for mitochondrial DNA variation. The complete coding regions of the mitochondrial cytochrome *c* oxidase I (COI) and COII genes were sequenced for three individuals from Benin, Uganda and South Africa, and a fragment of COI was sequenced for additional specimens representing a wider geographical range. The levels of sequence divergence found in comparisons between the northern *E. saccharina* populations of Benin, Uganda and Cameroon and those of southern Africa were at least as high as those between recognized biotypes in other species. This suggests potentially limited gene flow among *E. saccharina* populations that merits further investigation.

GENETIC MODELS TO ASSESS THE DEVELOPMENT OF COUNTER-RESISTANCE IN INSECT PESTS EXPOSED TO *Bt*-SUGARCANE

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Abstract

The use of transgenic sugarcane expressing insecticidal toxins is one potential method of reducing the damage caused by eldana in the South African sugar industry. This approach carries the risk that the pest may quickly develop resistance to the toxin, rendering transgenic sugarcane ineffective in controlling eldana. Insect resistance to the *Bacillus thuringiensis* (*Bt*) toxin is usually controlled using the so-called high-dose/refuge, or HDR strategy. In essence, this approach is based on the use of transgenic lines expressing high levels of the toxin, combined with planting refuges of non-transgenic plants to maintain a population of insects in which selection pressure for counter-resistance is absent. The speed at which insect populations develop resistance is dependent on factors such as the frequency of resistance genes in the initial population exposed to the toxin, the mode of gene action and the size of the non-transgenic refuges. A genetic model has been developed to examine the rate of development of resistance under different conditions. Results suggest that the current permit requirement for the planting of refuges may be inadequate, and that refuges comprising 50% of the planted area may be required to effectively delay the evolution of counter-resistance in insects exposed to *Bt*-crops.

Keywords: counter resistance, transgenic sugarcane, genetic model, *Bacillus thuringiensis*, refuge Size

TREATMENT OF SUGARCANE SETTS FOR SUPPRESSION OF THE PYRALID BORER *ELDANA* *SACCHARINA*

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Abstract

Trials were conducted in which commercial formulations of the insecticides cypermethrin, cyhalothrin, chlorpyrifos and phoxim were tested for their efficacy as insecticidal dips against *Eldana saccharina* Walker larvae in sugarcane setts. Insecticides were tested at three rates: 0,08g, 0,15g and 0,38g active ingredient/L. Setts were immersed in the solutions for five or 10 minutes and larval mortality assessed 48hrs later. The synthetic pyrethroids (cypermethrin and δ -cyhalothrin) were the more effective insecticides tested, with larval mortalities of over 90% recorded at the highest rate. The least effective insecticide was phoxim where larval mortality was most frequently below 30%, irrespective of rate. Previous trials had shown that water with a wetter alone could be effective as a sett dip and results showed that average mortality of 23% (s.d. 17.6) was recorded from such a treatment. Where setts were dipped in water only, an average mortality of 19,0% (s.d. 10,7) was obtained (values corrected for control mortality). No significant effect of immersion period on mortality could be shown for all insecticides and rates. While it is recommended that uninfested sugarcane stalks be used for seedcane, this study shows that when this is not possible, the use of synthetic pyrethroids in a sett dip could reduce the survival of eldana larvae in treated setts.

Keywords: *Eldana*, insecticides, sett dipping, sugarcane, seedcane

FACTORY SESSIONS

MILL SETTINGS AND REABSORPTION

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Abstract

This paper describes the Natal Method for the calculation of mill settings. Particular attention is given to the effect of the reabsorption coefficient on these calculations. Experiments were carried out on the last de-watering mill at Umzimkulu to estimate this coefficient. Weekly average values of 1,36; 1,48 and 1,46 were found. This is higher than most figures quoted for other countries but lower than the only reference found related to the South African sugar industry.

FEEDING BAGASSE TO MULTIPLE BOILERS WITH A “SMART-FEED™” BAGASSE FUEL CONVEYANCE AND DISTRIBUTION SYSTEM, INCORPORATING “RENTON PLOUGHS”

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Abstract

Sugar mills conventionally use either chain-slat conveyors or belt-plough installations to feed their boilers.

Chain-slat conveyors predominate, but are expensive and their mechanical components are constantly subjected to the abrasive action of bagasse and sand and are therefore costly to maintain. Slat conveyors also have a tendency to choke. Trapped foreign materials often cause the slats to break and the chains to stretch non-uniformly, resulting in conveyor breakdown. Consequently, chain-slat conveyor systems often contribute to poor plant availability. Previous belt and plough installations, on the other hand, have experienced operational problems, which has limited their use as an alternative to slat-chain systems.

The performance and merits of the “Smart-feed™” system, installed at the Hippo Valley Estate Sugar Mill (HVE) in Zimbabwe are evaluated. This installation has successfully demonstrated that the problems experienced with previous designs are eliminated by the “Smart-feed™” system, which uniquely integrates “Renton Ploughs”, innovative conveyor and chute designs and state-of-the-art automation and control.

Now entering its third season of operation, the HVE “Smart-feed™” installation, which includes a 2.1m wide and 80m long slider bed conveyor feeding six adjacent boilers via 23 ploughs, has achieved the anticipated savings in capital and operating costs and has resulted in improved availability and reliability. Improved boiler control has also resulted from the ability to control the fuel flow to individual feeders.

A REVIEW OF THE COMMON CAUSES OF BOILER FAILURE IN THE SUGAR INDUSTRY

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Abstract

Unscheduled boiler outages in process industries are a major problem resulting not only in expensive emergency repairs, but also loss of production. This paper draws on the experience of the author's company relating to common failures of pressure parts of boilers. The paper identifies the most common types of pressure part failure and the metallurgical mechanism involved. With a knowledge of the underlying failure mechanism a number of basic causes can be identified. The paper suggests solutions that, if implemented, can reduce the incidence of unscheduled outages and thereby improve profitability.

Keywords: fatigue, pressure parts, wear

THE ENGINEERING, INSTALLATION, INTEGRATION AND OPERATION OF A 20 MW CO-GENERATING TURBINE ALTERNATOR AT HIPPO VALLEY ESTATES

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Abstract

The installed backpressure power generation capacity at Hippo Valley Estates (HVE) comprised a number of old and small sets, which had become inadequate to reliably supply the total power requirements of the mill and estate. A new 20 MW backpressure turbine alternator (TA) was installed to satisfy the full factory demand on its own and export a surplus to the national grid. The project was completed in fifteen months and the TA was synchronised during the crushing season as planned. This article describes the benefits, identifies the issues and shares some of the lessons learned in engineering, installing and operating the largest unit of its kind in Africa to secure operations and cash flow.

THE IMPLEMENTATION OF A STEAM TRANSFORMER SYSTEM

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Abstract

Steam transformers are evaporators that operate as dedicated vapour and condensate producing cells. This practice is found in the sugar refining industry and beet sugar factories, but is generally not found in raw sugar factories. Green field investments often overlook the need for such equipment, but its application can have tremendous benefits for the safe operation of the boiler. This paper describes the evolution of a successful steam transformer station, detailing past failures, be they due to design, operation or material of construction related. The water chemistry aspect is also discussed at length. The station is now operational and performs robustly within design expectations. The use of this unit is directly in line with the operational target for zero effluent and maximum water recovery.

Keywords: steam transformer, heat exchanger, boiler, condensate, boiler feed water, zero effluent

A PILOT SCALE BATCH PAN

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Abstract

The existing small scale batch pans used for research in the South African sugar industry have limited capabilities for simulating industrial operations. In particular, these pans have been designed and used primarily for determining equilibrium conditions and have not been designed to achieve the rates of crystallization which are achieved in full scale pans. Operating an existing laboratory scale pan under closely controlled conditions also produced much wider crystal size distributions than are obtained in industrial scale pan boiling. To address these limitations and provide a facility to study crystallisation under closely controlled conditions which simulate industrial scale pan boiling, a new pilot scale batch pan has been designed and constructed. Features included in the design of the pan are, a steam heated calandria, the use of standard diameter pan tubes (100mm), a variable speed mechanical stirrer and a high level of instrumentation and control. The design of the pan is described in terms of the experience gained on the small laboratory scale pan. Some performance data from the pan are presented.

Keywords: Batch pan, massecuite, automation, boiling, mechanical circulation

AIR COOLING OF 'A' CRYSTALLISERS

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Abstract

This paper examines the rationale for air cooling of 'A' Crystallisers at the Malelane Mill. The 'A' Crystalliser Station at the Malelane Mill comprises two banks of agitated but un-cooled 42m³-cylindrical units connected in series. During periods of high purity brix loading and/or high volumes of refinery returns, the 'A' Masecuite exhaustion drops off significantly. This manifests itself as a constraint on factory throughput. Various alternatives were considered to improve A crystalliser cooling. After a technical and economic evaluation, surface air-cooling was identified to be a quick and easy as well as cost-effective option. This short paper describes the factors considered in the design of the air cooling fans and examines the effectiveness of the air cooling process.

Keywords: Air Cooled Crystallisers

A NEW COMPACT, VERTICAL MASSECUITE REHEATER.

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Abstract

A new design of massecuite reheater has been developed. The equipment has a number of significant advantages over traditional designs. Features described in the paper include:

- Compact vertical configuration, requiring less floorspace.
- Vertically finned tubes, having higher fin efficiency than conventional transverse fins.
- Considerably higher heating surface / volume ratio than traditional designs.
- An even massecuite flow distribution, minimising the possibility of any short-circuiting or dead pockets.

A key feature of the design is the unique configuration of the fins, which ensures close proximity of every part of the massecuite to a heated surface. Various considerations regarding heat transfer coefficients and resistance to flow are discussed. Preliminary results from the first installation are given. These indicate a higher than expected heat transfer coefficient. International patents on the design are pending.

Keywords: Massecuite Heater, Curing, Reheater, Finned Tubes, Heat Transfer, Heat Exchange

STAINLESS STEEL LASER-DRILLED SCREENS FOR CONTINUOUS CENTRIFUGALS

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Abstract

Stainless steel laser-drilled screens (SSL screens) for continuous sugar centrifugals are compared with several types of chrome/nickel screens. Assessments are made of trials and routine operations at several factories around the world, and results of final molasses purity analyses, screen service life, and centrifugal capacities are examined. A semi-quantitative comparison is made between Australia and South Africa on the use of SSL screens and chrome/nickel screens in these two sugar producing regions, which share similarities. The comparison illustrates some of the cost benefits of SSL screens. SSL screens are shown to be a cost effective alternative to both the standard and modified versions of chrome/nickel screens, in high grade and low grade continuous centrifugals.

Keywords: Screens, centrifugals, lasers, milling, purity, durability age, particularly in large centrifugals.

MIXED JUICE CLARIFICATION REVISITED

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Abstract

The clarification of mixed juice has been the subject of research for decades, due mostly to its large impact on sugar quality. Much, if not all, of the work has however been done on mixed juice originating from milling rather than from diffusion. This paper examines a back-to-basics, laboratory approach, involving cane juices produced from conditions simulating milling and diffusion. Furthermore, different types of cane, for example fresh versus deteriorated, clean stalks versus stalks plus tops and trash, have been used. Saccharate and milk of lime have also been compared. Analytical techniques were carefully considered and methods such as X-ray fluorescence were used, and material balances across clarification were done. The laboratory work shows that, for the same cane quality, clear juice quality in terms of phosphate, calcium, magnesium, silica and sulphated ash is the same whether milling or diffusion has been used. Saccharate liming always yields better clear juice in terms of turbidity, colour, phosphate and calcium contents. Material balances closed well across clarification, except for phosphate and for silica; this highlights the need for sampling/analytical improvements for these two species. Finally, the effect of clarifier mud carryover on sugar quality is discussed.

A SUCCESSFUL MODIFICATION TO THE DORR 444 CLARIFIER

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Abstract

CFD modeling was used to design a simple modification to one of four compartments of a Dorr 444 clarifier at Maidstone. The model was validated via tracer testing but the best validation would be implementation of the modification. The modification consisting of a system of two baffles was installed during the season and results in terms of clear juice absorbances were obtained. There was a clear improvement when comparing the clear juice absorbance of the modified compartment to that of the unmodified compartment. There were doubts about the differences between flows to the compartments. Tracer testing did show that the flow characteristics between modified and unmodified compartments were similar.

ENZYMIC REDUCTION OF DEXTRAN IN PROCESS - LABORATORY EVALUATION OF DEXTRANASES

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Abstract

The dextran content of both mixed juice and very high pol sugar has shown an increase in recent seasons. Laboratory trials have been used to show that thermally stable dextranase could be used to reduce the dextran concentration in evaporator syrup when high levels of dextran are unavoidable. Dextranase treatment of diffuser juices is unsuitable because of the high temperature, low Brix conditions encountered in this part of process. Potential benefits probably include viscosity decreases leading to increased sugar recovery whilst the enzymic reduction of dextran in process will result in improved sugar quality.

THE USE OF SIMULINK FOR PROCESS MODELLING IN THE SUGAR INDUSTRY

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Abstract

Process modelling for the purposes of equipment design, simulation or evaluation has been carried out in the sugar industry using a range of different techniques. Methods employed in the past have included the development of specialised simulation tools using computer programming languages or spreadsheets. Some use has also been made of commercial flow sheeting packages, as well as the SUGARS software package which was developed specifically for this application. However, each of these modelling techniques suffers from a number of limitations, with none providing both ease of use and the flexibility to allow detailed in-house process knowledge to be designed into the system. SIMULINK is a commercial software system, overlaid on the MATLAB programming language, which is widely used for modelling, simulating and analysing steady state or dynamic systems using block diagrams. In the current study, the use of the SIMULINK software to develop a library of model blocks describing sugar industry operations is demonstrated, focusing on the diffuser extraction and boiling house operations. The potential of the software for future application is highlighted.

Keywords: modelling; simulation; diffuser; boiling house; flowsheeting; SIMULINK knowledge. technology. modelling techniques utilised.

THE ANALYSIS OF ETHANOL IN SHREDDER GASES

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Abstract

It has been established that post harvest deterioration of burnt cane results in the formation of ethanol. In South Africa the ethanol content of cane, as sampled through the Direct Analysis of Cane (DAC), is measured at factories. A procedure involving the continuous sampling and automated analysis of shredder gases is proposed in this short communication. Preliminary results show that the method can estimate the ethanol concentrations in cane consignments, but that the presence of moisture in the gases causes problems. Procedures to clean the gases are required.

Keywords: ethanol, cane deterioration, shredder gases

APPLICATION OF ARTIFICIAL NEURAL NETWORK TECHNIQUES FOR MEASURING GRAIN SIZES DURING SUGAR CRYSTALLISATION

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Abstract

This paper discusses the development of a system for the automated real-time measurement of crystal size distributions during crystallisation. An optimised selection of the Daubechies wavelet coefficients is used as input to a Multi-Layer Perceptron artificial neural network to characterise the crystal scale lengths. This technique gives significant advantages over the sampling-based measurements, which require an individual measurement of single crystals. Test results obtained using simulated crystals, and actual images from a crystallisation pan and a laboratory crystaloscope are presented.

Keywords: Artificial neural network, wavelet, sugar crystallisation, image analysis, crystal sizing

OPTIMISING THE CARBONATATION PROCESS

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Abstract

Refinery carbonatation is widely practised in South Africa and about 80% of the refined sugar produced in South Africa is clarified/decolourised using this method. Attempts have therefore been made to optimise the carbonatation process with regard to impurity removal. Some of the main factors that have been investigated to improve the decolourisation and filterability of the carbonated liquor are: -

- Lime quality.
- Method of lime addition.
- Effect of saturator configuration.
- Addition of cationic polymers.
- Addition of hydrogen peroxide.
- Addition of ozone.

The results from both pilot plant and full-scale tests are discussed.

Keywords: carbonatation, colour, lime, impurity removal and decolourisation

PRODUCTION OF ACTIVATED CARBON FROM SOUTH AFRICAN SUGARCANE BAGASSE

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Abstract

Activated carbons were produced from compressed South African sugar cane bagasse in a pyrolysis furnace by adopting the physical method of processing viz. carbonization followed by partial gasification with steam. Feasible processing conditions were determined by varying the temperature, hold times and partial pressure of steam in the reactor at a heating rate of 10°C/min. Consequently, the char and activated carbons were characterized with respect to iodine number, methylene blue number, molasses number, surface area, pore volume and pore size distribution. Increasing temperature and the partial pressure of steam increased the degree of activation within a smaller residence time thereby producing activated carbons with, for example, a BET surface area of 995 m²/g, iodine number of 994 mg/g, molasses number of 700 and methylene blue number of 256 mg/g. Activated carbons exhibiting the best properties were produced by pyrolysis at 680 °C and a hold-time of 1 hour followed by activation with steam at 900°C for 2 hours reaching a 50% burn-off. The resultant activated carbon's ability to adsorb colour from raw sugar was also investigated and compared to a commercial reference carbon. Results reveal that activated carbon produced from sugar-cane bagasse has a significant potential in the sugar industry.

Keywords: Activated carbon, sugar-cane, bagasse, pyrolysis, activation, decolourisation

COLOUR REMOVAL WITH THE SPARAC PROCESS: PRELIMINARY RESULTS

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Abstract

Following previous tests done on chemically regenerable carbon, Norit has developed a new grade of carbon that has faster adsorption kinetics. The effect of repeated cycles and chemical regenerations on the colour removal performance of this carbon has been investigated. Decolourisation trials were performed on brown liquor with a pilot plant supplied by Norit at the SMRI. Tests were carried out at 1 bed volume per hour (BV/h) at 80°C. Preliminary results show that calcium salt fouling can reduce the effectiveness of colour removal. The use of a pre-filter of spent carbon and different regeneration procedures is discussed. Overall the colour removal performance of SPARAC is lower than expected. Reasons for the poor performance are discussed.

MECHANICAL REDESIGN OF ION EXCHANGE RESIN VESSEL BOTTOMS AT HULETT'S REFINERY

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Abstract

A third party inspection failure of one of the flat bottom resin vessels, combined with repeated failures of the lateral distribution system collecting the exiting liquor, caused the mechanical and process design of these vessels to be reviewed. This has resulted in modifications to the fabricated flat bottom design and the replacement of the lateral distribution system with a stone fill and top hat distribution design. This paper discusses the causes of the mechanical failure, modifications implemented and the benefits experienced after redesigning some of the ion exchange resin vessels at Hulett's Refinery, which include a lower pressure drop and higher throughput.

Keywords: ion-exchange resin vessel, structural design, liquid distribution, stone bed

TOWARDS A NEW PROCESS TO PRODUCE WHITE SUGAR DIRECTLY FROM CANE JUICE

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Abstract

The options for producing white sugar directly in a raw mill are reviewed. Two broad approaches are considered, the first being to extract a purified sucrose stream from impure sugar juice and the second is selectively to remove the impurities from the impure juice leaving a pure sucrose solution. In the first category, chromatographic separation and crystallisation are considered and, in the second, membrane separation, ion exchange and decolourisation are reviewed. Possible processes are summarised and, where these have been practically demonstrated, this has been highlighted.

Keywords: demineralisation, chromatography, direct white sugar, membrane, separation, ion-exchange propose a process to achieve this needs to meet the following requirements:

IMPROVING PRODUCTIVITY IN AN ANALYTICAL ENVIRONMENT - IMPLEMENTATION OF A LIMS

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Abstract

Increasing demands have been made on the Analytical and Consulting services provided by the SMRI to the industry, leading to an internal drive to improve productivity, particularly with respect to paperwork. Central to this has been the installation, configuring, customisation and implementation of an Oracle based Laboratory Information Management System (LIMS). LabSystems "SampleManager" has been configured to incorporate analytical data calculation and storage, checking of validity of results, report generation, subsequent billing and management costing reports. ISO 17025 laboratory accreditation has been incorporated by inclusion of SQC control charts and audit functions.

ESTIMATING DRY SOLIDS AND TRUE PURITY FROM BRIX AND APPARENT PURITY

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Abstract

Brix and apparent purity are well known to be biased estimators of dry solids and true purity respectively, particularly on lower purity streams. Correlations which estimate dry solids from brix and apparent purity and estimate true purity also from brix and apparent purity are presented. The suitability of these correlations is evaluated in the light of available historical data.

Keywords: pol, brix, dry solids, sucrose, purity

A MODIFIED CONSTANT PRESSURE FILTERABILITY TEST FOR RAW SUGAR

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Abstract

The filtering properties of sugar liquors have been, and are, an important research topic. Two aspects need consideration; the first deals with the behaviour of the sugar during refining and the second is the actual mechanical measurement of the sugar liquor in the laboratory. Many laboratory methods are based on comparative, time dependent procedures. This paper describes a method based on a filtration theory developed for solutions containing small amounts of particles, as opposed to the conventional slurries. It is shown that the filtration of raw sugar solutions in the laboratory follows the proposed theory well. The test has been used to investigate the effects of factors such as the pH and temperature at which the filtration is done, the impact of the presence of residual polyacrylamide flocculant, that of suspended solids, and that of microbiological activity. Sugars from different factories and produced at different times of the year were used to investigate geographical and seasonal effects. Finally, further work, which includes the automation of the laboratory equipment

CRYSTAL RECOVERY EFFICIENCY AS AN OVERALL MEASURE OF SUGAR MILL PERFORMANCE

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Abstract

The South African sugar industry has recently moved from a cane payment scheme based on the sucrose content of cane to one based upon the concept of recoverable value (RV), which is itself a modification of the estimated recoverable crystal (ERC) quantity as originally presented by van Hengel (1974). While the definitions of ERC and RV attempt to discount the effect of cane quality on factory performance, it has been acknowledged that some important factors, such as the quality of the non-sucrose fraction in the cane (as typically represented by the reducing sugar to ash ratio), are not effectively accounted for. An additional limitation of the new RV system lies in the lumping together of cane evaluation and payment terms into one concept, which can result in the measured value recovery (VR) of a sugar mill varying from month to month as a result of changes in the relative prices of raw sugar and molasses, even if the actual performance of the mill has remained constant. Thus, while value recovery properly represents the financial outcome of mill operations, it is not an effective tool for the evaluation of the process performance of mill operations. The concept of crystal recovery efficiency is proposed as a new factory performance yardstick which allows for the optimal evaluation of mill performance independent of cane quality factors. The use of the new measure is outlined and factory data for all South African mills is presented, highlighting the variation of the crystal recovery efficiency during the season and from year to year.

Keywords: Factory performance; Estimated recoverable crystal; Recoverable value; Crystal recovery efficiency; Cane quality; Yardsticks

BROWN SUGAR BAGGING AND STORAGE - NEW ADVANCES IN TECHNOLOGY

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Abstract

The packing, storage and loading of bagged sugar has traditionally been a labour intensive and time consuming operation. A new sugar packing station and warehouse has been built at Simunye, Swaziland by the Swaziland Sugar Association. As a result of this experience, similar technology is now being incorporated in sugar stores elsewhere in the world. This new facility incorporates advances in packing and storage technology. It can pack up to 70 tons of sugar an hour and can store up to 50 000 tons of bagged sugar under cover. Fast stacking and destacking techniques are used involving overhead cranes and slingbags. The store was built to pack and store 25kg, 50kg and one ton bags. The same method is used for loading 34 ton trucks. The new loading arrangements allow a truck to be loaded within 30 minutes. More traditional methods take 6 hours. The store employs 20 people per shift and the system around the packing machines is automatically controlled from a centralized control room using SCADA software. It is also possible to load bulk tankers from concrete silos. Each silo holds 550 tons of sugar. Loading is done by means of a clam gate and takes place in a fast and effortless manner. The store has now been operating for a year and is achieving production and storage and capacities, which are in excess of the original design parameters.

OVERVIEW OF CONTINUOUS ALCOHOL FERMENTATION AND MULTIPRESSURE DISTILLATION TECHNOLOGY

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Abstract

Ethanol production from agro-based raw materials normally involves two major steps, fermentation and distillation. These steps are reviewed, mainly in relation to molasses, which is the most common raw material in tropical countries. The specific effect on fermentation efficiency of molasses quality in terms Fermentable Sugars, the ratio of fermentable to non-fermentable solids, Volatile Acids, Caramel and other inhibitors and Calcium and other inorganic elements are discussed. The improvement in fermentation kinetics by using efficient yeast strains and hygienic yeast propagation with cell recycle is also discussed. Major aspects of ethanol fermentation by various techniques are discussed. The advantages and limitations of batch fermentation, its variants, and those of continuous fermentation, based on operational experiences from commercial scale ethanol plants are discussed. The concept of Pressure cascading distillation (multi pressure distillation) and its advantages over atmospheric distillation is described. It is concluded that an efficient fermentation plant coupled with multi pressure distillation system can provide competitive advantage for ethanol producers.

Keywords: fermentation, distillation, continuous, distillery, ethanol, energy efficiency

POSTERS

CAUSTIC RECOVERY VIA MEMBRANE MICRO-FILTRATION

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Abstract

Spent caustic from chemical cleaning of evaporators and pre-heaters was cleaned by membrane micro-filtration. A rig supplied by Tongaat-Hulett Technical Management Department (TH-TMD) was refurbished and used for this purpose. It was determined that pretreatment was necessary to improve permeate flux rates and prevent clogging of the membrane. Experiments run over 6-18 hours showed that high trans-membrane pressures improved reduction of permeate viscosity and hence lowered suspended solids content but at the sacrifice of lower overall flux rates. Cross-flow velocity had a favourable influence on flux rates. The best operating point tested was a trans-membrane pressure of 400 kPa and a cross-flow velocity of 1.2 m/s. Chemical cleaning with weak caustic and acid solutions was necessary between runs.

THE EFFECT OF BURNING AND TRASHING ON SUGARCANE LEAF ANALYSIS

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Abstract

Leaf nutrients of sugarcane variety N16 are discussed and reasons for certain trends put forward. The fertilised versus non-fertilised treatment comparison showed that although where fertiliser was applied that leaf N, P and K were higher, Mn was also higher but Ca, Mg, Si, Zn and Fe were all lower. The trashed versus burnt treatments had a less drastic effect on leaf nutrient levels and it was mainly N, P, K and Mn that benefited from trashing while higher Mg and Fe were found for the burnt treatment. Leaf Si was for the first time measured and of all the nutrients showed the most market evidence of nutrient mining. Keywords: leaf nutrients, sugarcane, N16, trashing, fertiliser, BT1.

DEVELOPMENT OF NEW METHODS FOR DIAGNOSING YELLOW LEAF SYNDROME

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Abstract

A disorder of sugarcane (*Saccharum* species hybrid) characterised by yellowing of the leaf midrib and lamina was first reported in East Africa in the 1960s. This disorder was termed yellow wilt (Ricaud, 1968). A similar disorder was reported as autumn decline in Brazil (Hughes, 1964). Some thirty years later similar symptoms were observed on sugarcane in Hawaii (Schenk *et al.*, 1990) and Brazil (Comstock *et al.*, 1994) and described as yellow leaf syndrome (YLS). Today YLS is prevalent in all sugarcane growing regions of the world (Lockhart and Cronje, 2000). YLS first became apparent in the South African sugar industry in 1995 when large areas of sugarcane suddenly began exhibiting yellowing symptoms (Bailey *et al.*, 1996; Cronje *et al.*, 1998). In some cases, YLS has been associated with significant yield losses, although this depends largely on varietal resistance/susceptibility and causal agent (Vega *et al.*, 1997; Comstock *et al.*, 1998). Two pathogens, a phytoplasma (sugarcane yellows phytoplasma, SCYP, Cronje *et al.*, 1998) and a luteovirus (sugarcane yellow leaf virus, SCYLV, Scaglusi and Lockhart, 2000) have been implicated in this disease. In South Africa it was found that SCYP was consistently associated with the disease and found throughout the industry, whereas SCYLV was found to a lesser degree and mainly occurred in the northern, irrigated areas (Cronje *et al.*, 1998). Diagnosis of YLS based on symptoms alone is not accurate since similar symptoms can be induced by abiotic factors such as moisture and nutrient stress, insect feeding, physiological stress, lodging of cane and damage to leaves (Bailey *et al.*, 1996; Matsuoka and Meneghin, 1999)

UPDATE ON METHODOLOGY USED IN SCREENING FOR RESISTANCE TO *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE) IN POTTED SUGARCANE TRIALS

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Abstract

Routine screening of fourth (primary variety trial) and fifth (secondary variety trial) stage sugarcane clones for susceptibility to the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae), has been carried out as a part of the SASEX sugarcane selection programme since 1985 (Anon, 1988; Leslie and Nuss, 1992; Nuss, 1991). This report is an update on modifications and new additions to the screening methodology originally developed by Nuss and Atkinson (1983) and Nuss (1991), and includes results of screening trials conducted between 1999 and 2001. Changes in methodology and statistical analysis have aimed at both enhancing the discrimination of resistance among test clones and discerning progress in selection for resistance. Recently, the number of clones screened per year increased from about 208 to 360.

FIELD VARIATION OF ABIOTIC FACTORS AND THEIR RELATIONSHIP WITH NEMATODE COMMUNITIES IN SUGARCANE

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Abstract

The abundance and distribution of nematodes in the soil is influenced by biotic and abiotic soil factors. A previous study based on soil samples collected over a large part of KwaZulu Natal showed that numbers of *Pratylenchus*, *Helicotylenchus* and *Paratrichodorus* were inversely related to pH and positively related to iron levels in the soil. Weaker relationships occurred between both aluminium and manganese and the three nematode genera. In contrast, numbers of *Xiphinema* showed no strong association with any of the soil characteristics. To determine whether the same relationships occurred on a much smaller scale, a study was made of the levels of certain abiotic soil factors and the distribution of the plant parasitic nematodes in a single sugarcane field. The data were derived from soil samples collected from five, adjacent, 200m rows across the field. *Xiphinema elongatum* dominated one part of the five transects while *Helicotylenchus dihystra* dominated the other part. The relationship between the soil elements and the nematodes differed from that found in the large scale survey. Co-inertia analysis showed a strong positive association between the numbers of *H. dihystra* and levels of magnesium in the soil whereas the reverse was true for *X. elongatum*. There was also a strong positive association between the numbers *X. elongatum* and levels of phosphorus. *H. dihystra* showed a positive association with most of the soil cations. The opposite was true for *X. elongatum*. The differences between the two studies is thought to be a consequence of the difference in scale.

HOMOGENEOUS CLIMATE ZONES FOR THE SOUTH AFRICAN SUGAR INDUSTRY: PRELIMINARY BOUNDARIES

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Abstract

Sugarcane in South Africa is grown under a wide range of climatic conditions and requires a range of varieties and localised agronomic practices. Point-based climatic data and models have been used to derive both tactical and strategic recommendations. Such results need to be extrapolated to larger areas, which necessitates the need to identify reasonably homogeneous climate zones. Previously described boundaries of rainfall zones were carefully revised after taking into account (1) the sugar producing areas, (2) altitude and (3) mean annual precipitation estimates. The results were presented to area extension officers who proposed further subdivision of some zones. Boundaries were tested by comparing the climate variability of the new zones with that of previously derived zones and by quantifying the difference between neighbouring zones. The proposed zones can be used to identify strategic points for data collection. They can also support the extrapolation of recommendations and model output, which in term will support strategic and tactical decision-making.