SHORT COMMUNICATION

COMBINED ANALYSES OF IRRIGATED SUGARCANE VARIETY TRIALS IN SWAZILAND AND SOUTH AFRICA

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Abstract

The South African Sugarcane Research Institute (SASRI) and Swaziland Sugar Association Technical Services (SSATS) routinely evaluate commercial sugarcane varieties in replicated trials across a range of sites to provide recommendations to growers for different agroclimatic conditions and management practices. The two organisations have similar logistical constraints in their variety evaluation programmes and agreed to share resources through joint analyses of variety trial results in order to streamline the variety evaluation process regionally and identify areas where past results could be combined.

The analyses required an evaluation of trial results for all the different trial sites. Unripened, estimated recoverable crystal yields of fourteen varieties at 11 sites were collated and analysed. Not all varieties were planted in all trials. Due to the unbalanced nature of this data the Residual Maximum Likelihood model was used to assess variety, site and variety x site effects across and within sites. The relative performance of varieties across sites was used to detect significant variety x site interactions.

Analyses indicated that variety performance at some trial sites was similar to others. For example, results from trial sites at Ubombo and Pongola SASRI were statistically similar ($p=0.4$), suggesting that trial results from both sites could be transposed. Over time it might be possible to remove one of these sites from a regional trial programme or, alternatively, resources could be combined to evaluate a broader spectrum of varieties across both sites to represent a single agroclimatic region. Analyses also showed that variety performance was different at some sites compared with others. For example, results from Mhlume and Tonga differed significantly from most other sites ($p<0.001$), indicating that variety performance at these sites is unique, confirming that variety recommendations for the agroclimatic conditions that they represent should be distinct.

The study showed that collaboration between SASRI and SSATS is valuable and trial procedures could be changed to use resources more effectively.

Keywords: agroclimate, varieties, sites, REML, SASRI, SSATS

Introduction

Despite their geographical proximity, the research institutes of the South African and Swaziland sugar industries have since the early 1980s independently evaluated sugarcane varieties that are common to both countries. The South African Sugar Research Institute (SASRI) and the Swaziland Sugar Association Technical Services (SSATS) evaluate the

performance of released varieties at sites chosen to represent different agroclimatic conditions.

The aim was to explore the opportunities for optimising resources for variety evaluation in the region. Past results from both organisations' programmes were combined and analysed to identify trial sites with common or unique genotype by environment (GxE) interactions. With this knowledge, sites with similar environmental conditions could be identified with a view to reducing duplication. It would also be possible to predict variety performance in areas where historical trial data is scarce.

Materials and Methods

Yield data from the plant crop and first three ratoons of 130 SASRI and SSATS variety trials were used. Trials were conducted between 1993 and 2003, at 11 sites representing different soils and climate (Table 1). Unripened, estimated recoverable crystal (erc) yields of fourteen varieties were collated, annualised and analysed.

It was assumed that irrigation at all sites was well managed although the soils at Mhlume and Pongola P were extremely variable, making irrigation management at these particular sites difficult.

The Residual Maximum Likelihood (REML) model (GenStat 5, 2000) was used to perform paired-site analyses on erc yields for all pair-combinations of 11 sites to establish the significance of GxE at the different sites. A χ^2 probability (p) close to one indicates a non-significant GxE interaction and hence a very strong correlation in variety performance (ranking of varieties based on erc yield) between two sites. Conversely, a χ^2 probability less than 0.05 suggests a significant GxE interaction and a weak correlation in variety performance between two sites. This allows some characterisation of the environment by indicating the degree of similarity between two sites.

Table 1. Soils (according to Anon, 1999), latitude, longitude, altitude, mean annual rainfall, solar radiation and heat units (Inman-Bamber, 1995) for 11 sites.

Sites	Soil forms (SA)	Soil set (Swazi)	Latitude (°S)	Longitude (°E)	Altitude (m)	Rainfall (mm)	Annual Solar Radiation (MJ/m^2)	Annual Heat Units (T_b = 10°C)
Ubombo	Hutton	R	26.77	31.93	106	632	6772	4526
Ubombo S	Glenrosa	S	26.77	31.93	106	632	6772	4526
Mhlume	Katspruit, Bonheim, Sterkspruit	H C Z	26.03	31.80	280	798	7233	4348
Simunye	Shortlands	R	26.20	31.90	233	711	7094	4414
Malkerns	Hutton	M	26.50	31.20	740	931	6564	3481
Komatidraai (TSB)	Shortlands	R	25.33	31.87	179	629	7196	4524
Komati SASRI	Shortlands	R	25.33	31.87	179	629	7196	4524
Tonga	Fernwood	-	25.67	31.57	366	926	7091	4394
Mhlati	Shortlands	S	25.48	31.52	309	604	7308	4344
Pongola SASRI	Hutton	R	27.40	31.58	308	683	6947	4071
Pongola P[1]	Katspruit, Valsrivier	H	27.40	31.58	308	683	6947	4071

1 Data from four off-station sites in Pongola were combined to obtain a better idea of variety performance on low potential soils in the Pongola area (Pongola P).

Results and discussion

Table 2 summarises results.

Table 2. Significance of GxE interaction between trial sites as indicated by χ^2 probabilities at 5% level.

Sites	Ubombo	Mhlume[d]	Ubombo S	Simunye	Malkerns	Komati-draai	Komati SASRI	Tonga[e]	Mhlati	Pongola P
Mhlume[d]	0.003									
Ubombo S	0.205	0.007								
Simunye	0.149	0.114	0.038							
Malkerns	0.091	0.192	**0.387**[b]	0.09						
Komatidraai	0.082	0.045	0.497	**0.744**[a]	0.133					
Komati SASRI	0.142	0.138	0.108	**0.824**[a]	0.14	**0.903**[a]				
Tonga[e]	<0.001	<0.001	<0.001	0.066	<0.001	<0.001	0.573			
Mhlati	0.136	0.017	**0.617**[b]	0.259	**0.404**[b]	0.642	0.022	0.004		
Pongola P	0.015	0.095	0.007	**0.583**[a]	0.188	**0.733**[a]	**0.750**[a]	0.452	0.086	
Pongola SASRI	**0.400**[c]	0.003	0.01	0.011	0.249	0.150	0.075	<0.001	0.142	0.057

a. Komatidraai, Komati SASRI, Simunye, Pongola P
b. Mhlati, Ubombo S, Malkerns
c. Ubombo, Pongola SASRI
d. Mhlume
e. Tonga

It was possible to group the 11 sites into five broad groups based on similar variety performance. There were some sites that were strongly correlated ($p>0.4$) with one site within a group but weakly correlated ($p<0.1$) with other sites within this group, e.g. Mhlati was well correlated with Komatidraai ($p=0.642$), but weakly correlated with Komati SASRI ($p=0.022$). For this reason they were excluded from that group.

One group consisted of Simunye, Komati SASRI, Komatidraai and Pongola P (a). The soil and climate at Simunye is broadly similar to that found at Komati SASRI and Komatidraai, which may explain the relationship among these sites. Tonga was strongly correlated with Pongola P but weakly correlated with all the other sites. For this reason Tonga was put into its own grouping.

A second group consisted of Mhlati, Ubombo S and Malkerns (b). While the radiation was very different between Mhlati and Ubombo S, the soils were similar (Table 1). The inclusion of Malkerns in this group was unexpected because physical characteristics have little in common with Mhlati and Ubombo S (Table 1). The combination of these sites in this group needs to be investigated further to understand the reason for the grouping.

A third group consisted of Ubombo and Pongola SASRI (c). Both these sites are on deep Hutton soils, are well irrigated, have similar annual solar radiation and heat units, and are used to make recommendations for the highest potential soils in South Africa and Swaziland (Table 1). The grouping on statistical grounds therefore makes agroclimatic sense.

Variety performance at Mhlume was weakly correlated with all other trial sites (d). For this reason Mhlume could not be grouped together with any of the other sites. The same was true for Tonga (e). Mhlume and Tonga were not grouped together with other sites suggesting that variety performance at these sites is unique.

Conclusion

The statistical grouping suggests that there are similarities between some trial sites in Swaziland and South Africa with respect to variety performance in terms of erc yield. Some of these groupings are supported by the similarity in agroclimatic conditions, while others are not.

Results indicate that there is some duplication of trial sites used by the two industries for variety evaluation. It may be possible to make more effective use of resources, and variety evaluation and recommendations could be made on a regional basis. Swaziland could use the data and recommendations from Pongola SASRI, Komati SASRI and Mhlati to make variety recommendations to Swaziland growers when a new variety is imported into Swaziland. This could reduce the additional cost of testing these varieties in Ubombo, Simunye and Ubombo S respectively, and could reduce the time taken by the Swaziland industry to adopt varieties released by SASRI.

Further investigation is still required into the variety ranking and recommendations for each of these five broad environmental groups. This preliminary investigation has, however, shown that collaboration between SASRI and SSATS is valuable and resources of these two organisations could be used more effectively.

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