SHORT NON-REFEREED PAPER

DEVELOPMENT OF A WHOLE-STALK JUICE PURITY CALCULATOR TO SIMPLIFY CHEMICAL RIPENER DECISION-MAKING: PRELIMINARY FINDINGS

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Abstract

Chemical ripeners are used widely in South Africa to increase recoverable value (RV) yields. However, efficacy becomes poor above certain chemical-specific whole-stalk juice purity (JP) thresholds. Unfortunately, JP determination is cumbersome and cannot be performed by sugarcane growers. This study aimed at developing a simple calculator that would estimate JP from total sugar content (brix%), which can easily be measured in the field with affordable hand-held refractometers. Brix% was measured with hand-held refractometers in a large number (>1000) of stalk samples submitted to the South African Sugarcane Research Institute's cane quality testing laboratories situated in Mount Edgecombe and Pongola. From each of these samples, consisting of 12-16 stalks, three representative stalks were selected for brix% measurements. Each stalk was divided into three equal sections (bottom, middle and top) and pliers were used to squeeze juice from the centre point of each section for Brix% measurement. The entire sample of 12-16 stalks was then tested by the laboratory for whole-stalk JP. Data were analysed by averaging the three brix% values recorded along the length of the three stalks. This method proved to be the most reliable when correlated with laboratory determined JP. Results revealed a significant ($p<0.01$) positive correlation ($R^2=0.61$) between average brix% and laboratory determined JP, regardless of variety, cutting cycle or whether the crops were irrigated or rainfed. The data collected will be used to determine the nature of the JP calculator, in terms of variety and cutting cycle specificity, before release to growers and extension specialists.

Keywords: brix%, chemical ripeners, juice purity, juice purity calculator, refractometer

Introduction

Chemical ripeners are used widely in South Africa to increase RV yields (Donaldson, 2001; van Heerden *et al*., 2013). Research has shown that the two sugarcane ripeners registered for use in South Africa, Ethephon and Fusilade Forte, have juice purity thresholds of 75% and 85% respectively, above which efficacy becomes poor (van Heerden *et al*., 2013). Growers are therefore encouraged to determine juice purity in target fields before deciding on chemical ripener use.

However, a large proportion of chemical ripener application occurs during the early season (Jan-March), when the cane testing service (CTS) at the respective mills is closed and cannot accommodate juice purity testing. Growers therefore require a more practical method for juice purity testing.

It is possible to measure total sugar content (brix%) in sugarcane stalks with affordable hand-held refractometers. However, it is well known that there is a brix% gradient from the top to bottom of the stalk, the magnitude of which depends on crop maturity. In immature cane the brix% gradient is large, whereas in mature cane the brix% gradient is small or even absent. Therefore, a more efficient method for determining brix% in sugarcane stalks needs to be established.

Furthermore, there is a possibility that accurate quantification of the brix% gradient in sugarcane stalks could be used to estimate juice purity, which is an excellent indicator of crop maturity. The aim of this study was to develop a practical method of measuring brix% gradients in sugarcane stalks and estimating juice purity from these gradients. The practical outcome of this research would be a whole-stalk juice purity calculator for use by growers and extension specialists to simplify decisions on the use of chemical ripeners.

Materials and Methods

Quantification of brix% gradients

Samples tested for brix% were obtained from various chemical ripener, plant breeding and variety trial samples sent to the South African Sugarcane Research Institute (SASRI) Mount Edgecombe and Pongola millrooms for cane quality analysis. To date, 1159 samples have been tested for brix% on 29 varieties. The sample disposition consisted of 497 samples from the annual cycle (12 months) and 662 from the longer cutting cycle (18-24 months), with both cycles including rainfed and irrigated samples.

Three stalks were randomly selected from each millroom sample. Using a tape measure and secateurs, each stalk was divided into three equal sections (bottom, middle and top). A few drops of cane juice was squeezed with pliers onto the hand-held brix refractometer from the midpoint of each of the stalk sections. These stalk sections were returned to the larger sample for standard cane quality analysis by the millroom laboratory in order to obtain the whole-stalk juice purity of each sample.

Data analysis

The measured brix% gradients were subsequently correlated to whole-stalk juice purity (%) as determined by the millroom laboratory. Two analysis methods (‘average brix%’ and ‘bottom minus top brix%’) were evaluated for correlation to whole-stalk juice purity. The average brix% method is when the brix% values from the three sections (bottom, middle and top) of each sample are averaged and the average value correlated to whole-stalk juice purity. The bottom minus top method is when the brix% value obtained in the top third section of the stalk is subtracted from the brix% value obtained from the bottom third section of the stalk and the difference correlated to whole-stalk juice purity.

Statistical analysis

Data was processed using Microsoft Excel 2013 and analysed for significant differences using Genstat® v14. A non-linear regression analysis was done to evaluate the relationship between brix% and juice purity for each of the varieties analysed. An exponential curve was fitted separately for each variety, and evaluated for varietal differences using regression analysis.

Results and Discussion

A positive correlation between average brix% and whole-stalk juice purity was established for all varieties, regardless of age, cutting cycle or whether the crop was irrigated or rainfed (data not shown). The bottom minus top method yielded unsatisfactory results, with a very poor correlation with whole-stalk juice purity (results not shown).

In a preliminary investigation into possible varietal differences, a comparison was made between NCo376 and N41. The choice of these varieties was based on the abundance of data points (at the time of writing this paper) and contrasting cane quality, with NCo376 and N41 being low and high sucrose varieties respectively (Figure 1a and b). In both varieties, a strong (R^2=0.67 for NCo376 and 0.53 for N41) and highly significant ($p<0.01$) correlation between average brix% and juice purity was observed. There were no significant ($p>0.05$) differences in the average brix% - juice purity correlation across the two varieties when comparing juice purity data in the range of 70-96%. Juice purity values in the range of 50-70% were not yet considered in this comparison, due to lack of sufficient data points within this low purity range for variety N41.

These preliminary results suggest that average brix% explains juice purity in a very similar fashion in different varieties, at least within the 70-96% range, which is of practical relevance when making decisions regarding chemical ripening. Therefore, early indications are that one generic juice purity calculator, encompassing all varieties, might be possible.

However, data analysis comparing all 29 varieties that were tested is currently in progress. The reasons for some of the variation in the data, especially at lower average brix% values, also needs further scrutiny to improve the accuracy of the juice purity calculator. It is suspected that anomalies (e.g. low average brix% yet high juice purity) exist in severely drought-stressed cane. Methods to deal with these anomalies need further consideration.

Conclusion

The research results obtained thus far provided evidence for a strong and highly significant correlation between easily measureable brix% and the much more cumbersome juice purity determination. This relationship was observed across all varieties. The two varieties analysed statistically for the purposes of this short paper were not significantly different from each other, suggesting that a generic juice purity calculator, encompassing all varieties, might be possible.

More data analysis will be conducted to refine the juice purity calculator further before release to growers and extension specialists.

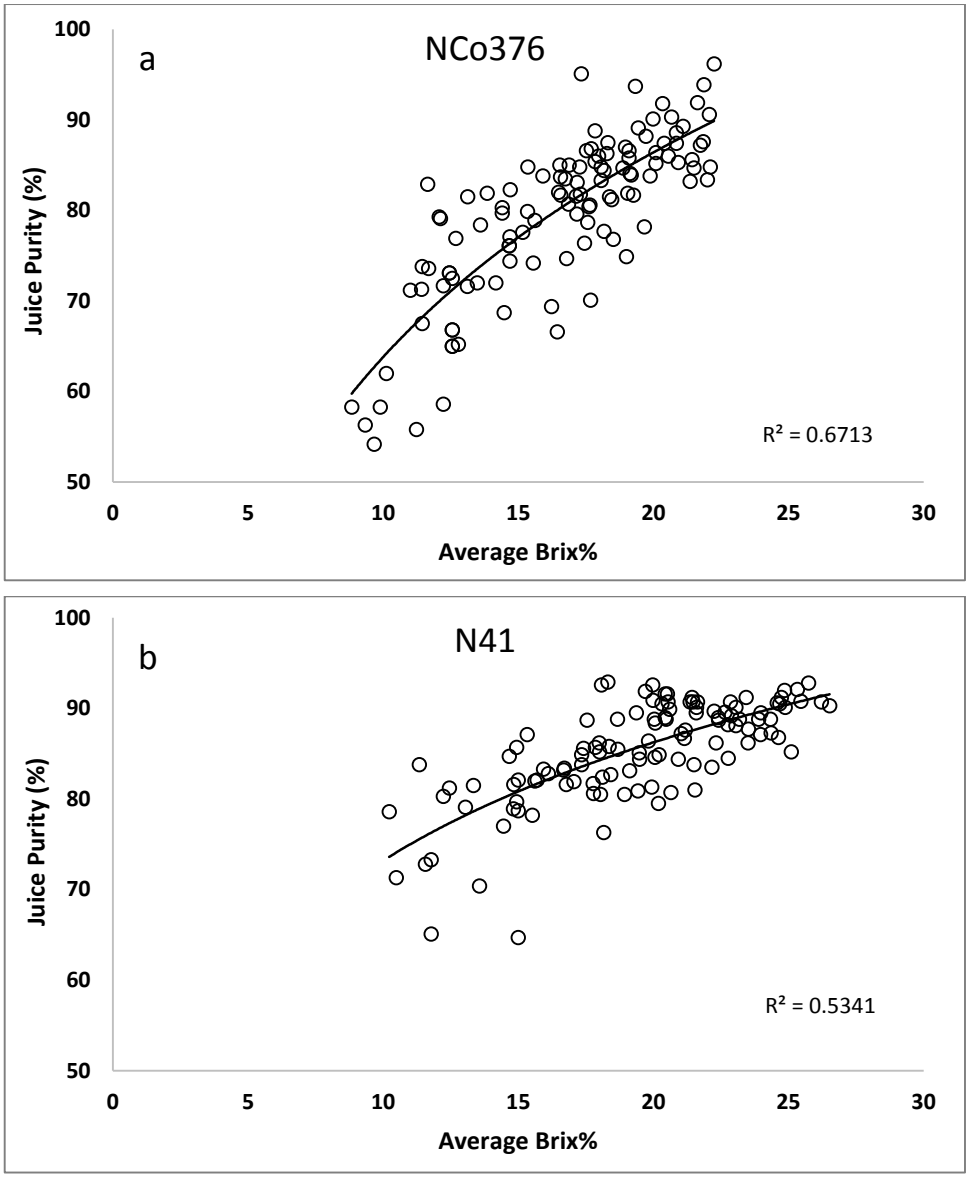

Figure 1. Correlation between average brix% and whole-stalk juice purity in (a) NCo376 and (b) N41 sugarcane varieties.

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