SHORT NON-REFEREED PAPER

ACID SATURATION STATUS OF SOILS IN RAINFED REGIONS OF THE SOUTH AFRICAN SUGAR INDUSTRY WITH CONSIDERATION OF SAMPLING INTENSITY

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Introduction

Excessive acidity limits the productivity of many soils under rainfed sugarcane in South Africa. Inhibited root growth and restricted nutrient and water availability or uptake are considered the key constraints to better production on acid soils. The permissible acid saturation (PAS) level for sugarcane, as advised by the South African Sugarcane Research Institute (SASRI), is 20%, with liming recommendations given for values >20%. However, a recent survey by Mthimkhulu and Miles (2017) has indicated high AS values for the rainfed regions with many grower fields with AS values >90%. A concern with using data derived from grower submitted samples (as compared to a structured industry survey) is that differences in the numbers of samples submitted per region (and also depth), as well as possible biases in the attitude of growers that submit samples, may distort the true representation of the measured parameters. This is an important aspect to understand where one is attempting to obtain a representative view of the status of parameters derived from the FAS database.

The aim of this study was to evaluate the AS status of soils in the rainfed regions of the South African sugar industry through the use of the SASRI Fertiliser Advisory Service (FAS) 2018 database, with consideration of the representation of these data in each region based on sample numbers submitted.

Materials and Methods

This survey examined the status of AS levels of topsoil (0-20m) and subsoil (20-40, 40-60 and >60cm) samples submitted to the FAS from rainfed regions of the South African sugar industry during 2018 for soil fertility testing. Acid saturation was determined by expressing 1 *M* KCl exchangeable acidity (Al + H) as a percentage of the total exchangeable cations:

$$\text{Acid sat. (\%)} = \frac{(Al + H)}{(Al + H) + Ca + Mg + K + Na} * 100$$

Data from each region were summarised using standard summary statistics (mean, standard deviation, median and range). The number of samples submitted for each depth and region were tallied to provide an indication of the representation of measured values for a given region. This was related to land area under sugarcane for each region. The irrigated regions were excluded partly due to low sample numbers and as these regions were found to have negligible acidity levels.

Results and Discussion

A summary of the soil acidity saturation (AS) levels and the number of samples from each region for the calendar year 2018 is presented in Figure 1. All regions had topsoil median AS levels below 10% while the third quartile levels were lower than the permissible AS level of

20%, except for North Coast and South Coast. Some extreme AS levels (70-80%) that were found in all regions are of concern. The median AS levels from subsoils across all regions were also nearly all ≤20% (and several <10%), with the notable exception of the >60 cm samples from Zululand South (about 35%). The third quartile values of subsoils AS, however, indicate that AS levels exceeding 30% in the subsoil depths occurred in most regions, with several sites having values exceeding 60%. Findings by Mthimkhulu and Miles (2017) showed elevated AS levels, but these were averages of five years results. Singels *et al*. (2018) also showed higher values of AS but they did highlight that 2017 AS levels were lower compared to 2013 AS levels. This continuous decline in AS levels over the years is an indication that growers are adopting soil acidity ameliorative strategies that could be resulting in reduced levels of AS in the industry.

As expected, topsoil sample numbers were higher than for subsoils, and the North Coast region had the most for both top- and subsoil samples followed by the Midlands North and South regions (Figure 1). When evaluated against the area under sugarcane, topsoil sampling intensity ranged from a sample per 20 ha (Midlands North) to a sample per 72 ha (Lower South Coast), while subsoil sampling intensity was considerably lower (Table 1). For topsoil sampling, current guidelines suggest that a single sample should represent no more than 5 ha, and ideally should represent homogenous field units. These data suggest that while some farmers may be sampling at the recommended sampling density, others may be doing so at a much coarser density or not at all in some years, which may lead to acidity problems remaining undetected and so compromising sugarcane production. This is cause for concern given the variability of soil resources in the sugarcane industry (van der Laan and Miles, 2010). The declining sampling intensity for depths beyond 20 cm raises concern that the AS distributions based on the survey are not adequately represented for subsoil depths. Therefore, there is a need to promote frequent sampling following SASRI guidelines, which may address the observed spikes in AS levels. Obtaining better location data, associated with sample collection would permit better tracking of sample representation across the industry and allow for more localised attention to problem areas.

Table 1. The area under sugarcane in hectares (ha) for rainfed extension regions and the corresponding sampling intensity in hectares per sample for topsoil and subsoil soil samples submitted for analysis to the Fertiliser Advisory Service for 2018.

Region	Area (ha)	Number of hectares per soil sample			
		0-20 cm	20-40 cm	40-60 cm	>60 cm
North Coast	93 519	35	123	161	236
South Coast	48 709	66	64	855	1433
Lower South Coast	34 565	72	364	804	4321
Zululand North	23 858	32	157	223	555
Zululand South	23 230	22	139	113	447
Midlands North	34 163	20	62	64	161
Midlands South	35 707	25	64	97	376

Conclusions

The findings of this survey showed lower topsoil AS levels compared to previous studies. However, the variations in the sample intensity between regions and soil depths may present bias in the results presented, which may lead to acidity problems remaining undetected and so compromising sugarcane production.

REFERENCES

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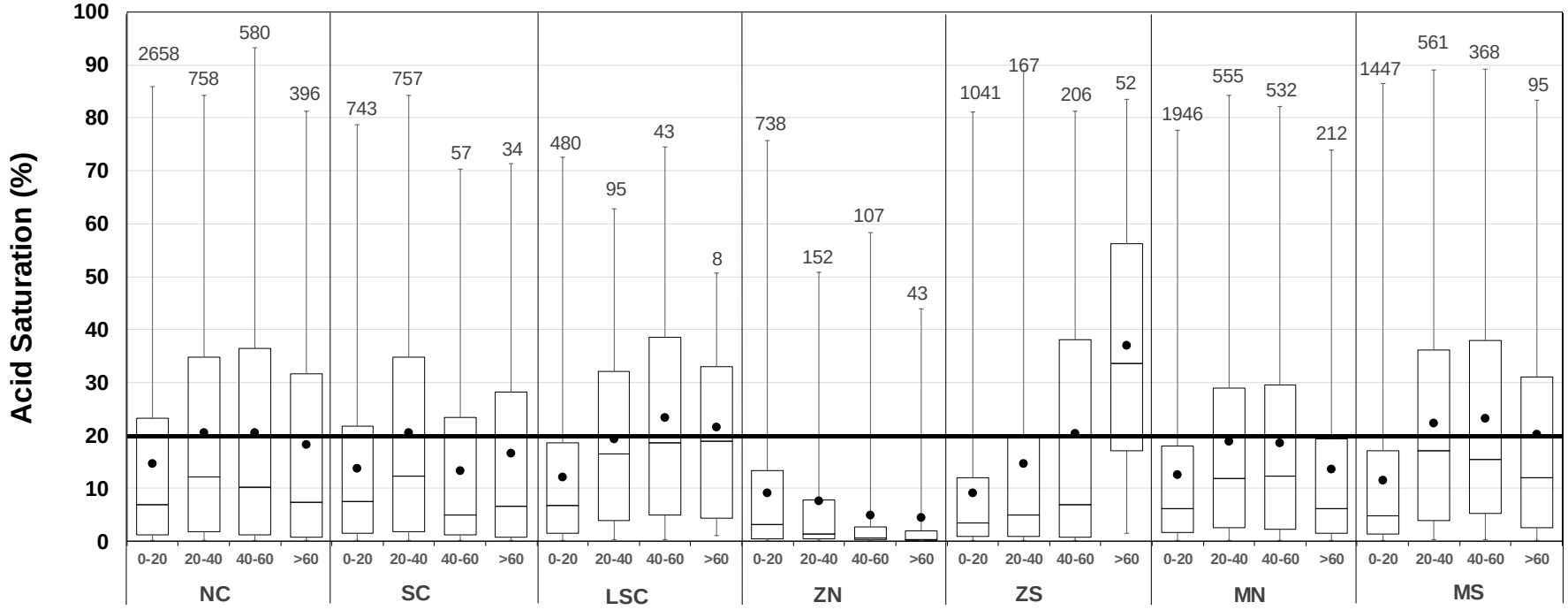

Figure 1. Acid saturation (%) levels of topsoil (0-20cm) and subsoil (20-40, 40-60, and >60cm) grower samples from rainfed extension regions (NC = North Coast, SC = South Coast, LSC = Lower South Coast, ZN = Zululand North, ZS = Zululand South, MN = Midlands North, and MS = Midlands South) of the South African sugar industry. The lower and upper limits of the open boxes show the first and third quartile, the centre line the median and the error bars the minimum and maximum measured values. Solid circles indicate average value. Numbers above each bar indicate actual number of samples. The solid horizontal line is the currently advised permissible acid saturation (20%)