SHORT NON-REFEREED PAPER

SULPHUR STATUS OF SOILS FROM SOUTHERN AFRICAN SUGARCANE-PRODUCING REGIONS

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Introduction

Sulphur (S) is an essential plant nutrient and is considered the fourth most important nutrient after nitrogen (N), potassium (K) and phosphorus (P) (Meyer, 1985). This nutrient plays a major role in synthesis of amino acids, proteins and vitamins and can improve nutrient use efficiency (Singh *et al*., 2008). Soil samples are often analysed for S for fertiliser advisory purposes. However, until recently this test was offered as supplementary analyses by South African Sugarcane Research Institute's (SASRI) Fertiliser Advisory Service (FAS) and, consequently, S has not been included in recent soil fertility surveys using the FAS database (Mthimkhulu and Miles, 2017). In addition, a study by van der Laan and Miles (2010) revealed widespread S deficiencies in soils submitted for supplementary S analysis. In the light of these findings, a need for routine S analysis was recognised. In April 2018, FAS introduced routine measurement of available S using the anion-exchange resin method (Titshall *et al*., 2019). This study, interrogated the FAS topsoil and subsoil data generated between April and December 2018 to assess S status in the southern African regions.

Materials and Methods

Data extraction and analysis

Soil S data from the FAS database for the period April-December 2018 were analysed. For summary reporting, data were split into the major sugarcane extension areas in South Africa (as used by Mthimkhulu and Miles (2017)) and several southern African countries. Only topsoils (0-20 cm) from sugarcane growers were included (i.e. no research or non-sugar crop samples) in the regional trends. The regions, and sample numbers in parenthesis, included Komatipoort (122), Malelane (97), Pongola (404), Umfolozi (134), North Coast (3238), South Coast (743), Lower South Coast (440), Zululand North (710), Zululand South (984), Midlands North (2491), Midlands South (1345), Swaziland (561), Mozambique (130), Malawi (727) and Zambia (587).

The distribution of S down the soil profile was assessed on grower samples submitted for subsoil acidity analysis and this may present bias towards samples presumed to have subsoil acidity. The following depths are used to present the results: 0-20, 20-40 and 40-60 cm, reported here as 10, 30 and 50 cm, respectively. Each depth had 1417 soil samples.

Results and Discussion

Topsoil regional trends

The topsoil regional trends are presented in Figure 1a-c using box-plots. Sulphur values ranged between 3 mg/L (minimum reported value from FAS) and 1264 mg/L, and also varied widely within each region. Most regions had widespread S deficiencies, i.e. values below the threshold of 15 mg/L (Meyer, 1985). The North Coast, South Coast, Lower South Coast, Zululand South, Umfolozi, Malelane, Swaziland and Zambia all had more than 75% of samples with deficiency. In Midlands North, less than 50% of samples had deficiency, while in Mozambique and Malawi, S deficiency occurred in less than 30% of the samples. The predominance of adequate S levels in Midlands North is likely due to high organic matter levels in these soils as reported by Singels *et al*. (2019). Meyer (1985) found a correlation (r=0.76) between mineral S and organic matter levels of soils. In the case of Mozambican and Malawian soils, the high S levels are likely from S-rich parent materials and high anion exchange capacity of these soils. Parent material has been found to influence S levels in soils with soils derived from TMS (ordinary) and granite having low levels of S and those derived from TMS (mistbelt) have adequate S levels (Meyer, 1985). It is worth noting that the percentage of samples showing S deficiency in this study are considerably higher than those reported by van der Laan and Miles (2010). This disparity suggests that either the sample population used by van der Laan and Miles (2010) was not representative or the occurrence of S deficiencies has increased, meaning that S deficiencies were not addressed. Routine testing for S will enable growers to proactively identify potential deficiencies and take ameliorative action with possible benefit for improved yields (Meyer, 1985).

Sulphur distribution down the soil profile

Overall, there were increasing S levels down the soil profile (Figure 1d). However, closer scrutiny indicated that the distribution of S down the soil profile varied. In some soils S increased down the soil profile while in other soils it decreased. There were also instances where S levels did not change down the soil profile. Preliminary analysis has indicated that clay and organic matter are not primary drivers of the observed trends. These varied trends require further investigations that will enable assessment of drivers of S distribution down the soil profile. These investigations may include multiple linear regression that includes both clay and organic matter, and history of gypsum application as an additional factor.

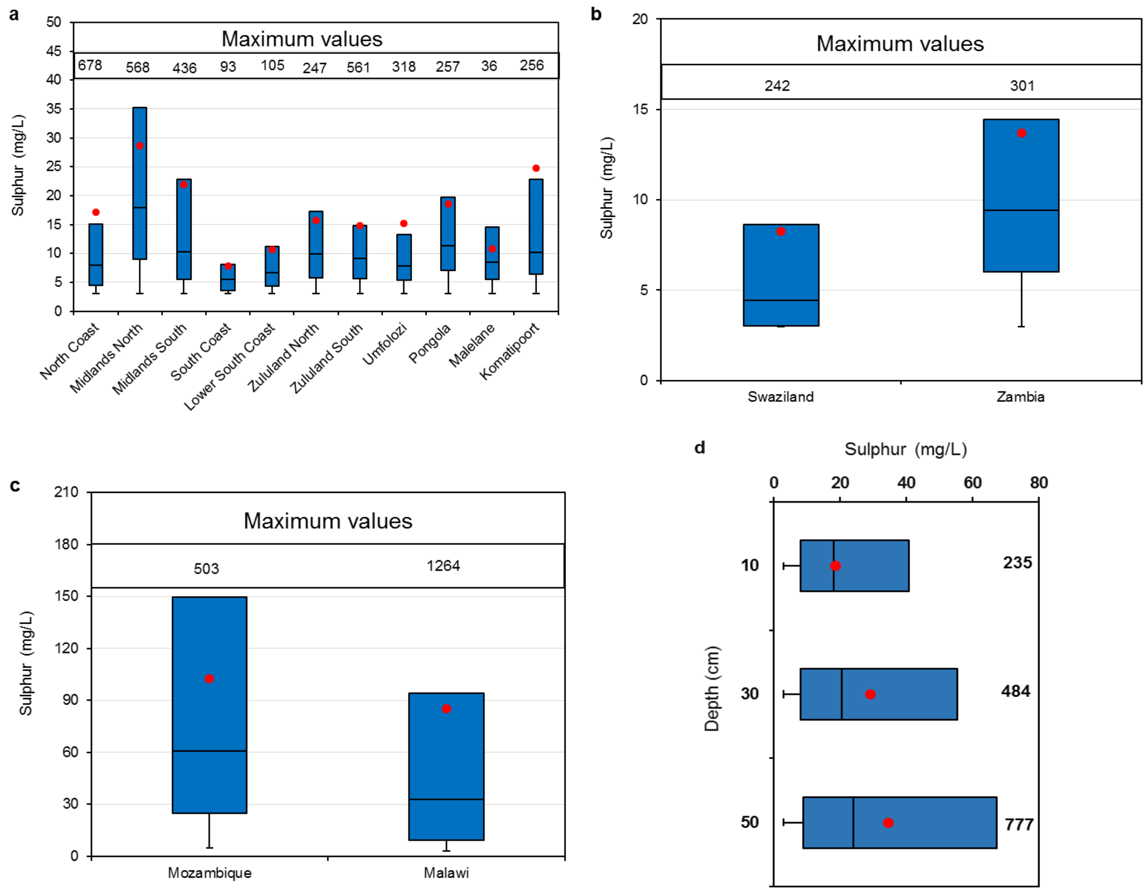

Figure 1. Variations in sulphur (S) levels in (a) South African extension regions, (b) Swaziland and Zambia, (c) Mozambique and Malawi and (d) down the soil profile as indicated by boxplots. The maximum values for each column are written on tops to aid with the visibility of the boxplots. Red dots represent the average values. The lower error bar, lower box and upper box represent the 25th 50th (median) and the 75th percentiles, respectively.

Conclusions

This study revealed the widespread S deficiencies (as related to the applied soil threshold) in the Southern African sugar industry and that more regular testing is necessary to identify S deficient soils. Addressing S deficiencies through application of soil ameliorants, particularly gypsum, as well as adopting practices that increase soil organic matter, could help to raise levels of this nutrient in the soil and, consequently, improve yields.

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