THE NEED FOR FURTHER RESEARCH INTO SUGARCANE NUTRITION IN SOUTH AFRICA DURING THE 1980's*

(met opsomming in Afrikaans)

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Abstract

The sugar industry in South Africa has maintained a fertilizer advisory service for more than 25 years and the results of a comprehensive programme of field experiments have been used to established a generally reliable basis for recommendations. There is nevertheless reason to believe that further research into the nutrition of sugarcane under local conditions is warranted. Some of the aspects of nitrogen, phosphorus, potassium, sulphur and zinc nutrition which will be investigated are described in this report.

Introduction

Over the past 30 years the amount of field and laboratory experimentation concerning the nutrition of sugarcane conducted in South Africa has been considerable. Whilst most attention has been given to nitrogen, phosphorus and potassium, an appreciable amount of work has been done on subjects such as minor elements, aluminium toxicity, organic manures, the liming of soils and the residual effects of fertilizer applications. In 1954 the South African Sugar Association established Fertilizer Advisory Service Laboratories in Durban, and in 1962 these were moved to Mount Edgecombe and became part of the Experiment Station.

All cane producers are able to obtain fertilizer recommendations from this source, based primarily on the results of soil analyses, but augumented by subsequent leaf analysis data. Nitrogen recommendations are based on expected yield of sugarcane but for other elements threshold values have been established by relating fertilizer experiment results to accompanying soil and leaf analyses.

Concurrently with the carrying out of the research programme and the development of a fertilizer advisory service, a comprehensive soil survey of the sugar belt was being conducted. The results (Beater 1957; Beater 1959; Beater 1962) enabled each cane producer to procure from the experiment station a soil type map of his farm, based on the parent material from which the soils were derived. By using this map in conjunction with a soils bulletin prepared subsequently (MacVicar, 1973), the soil form and often the soil series could be identified in the field.

By 1970, the conclusion was reached that the nutrition of sugarcane in the South African sugar industry could be determined satisfactorily with the resources and information already available. Experience and developments over the ensuing decade have indicated that the need for research, although sometimes in relation to problems affecting limited parts of the industry, remains considerable. Some of the issues to be faced during the 1980's are considered in the sections which follow.

Nitrogen

Nitrogen recommendations in South Africa for plant crops of sugarcane take the mineralizing capacity of the soil into account only to the extent that 90 kg N is recommended per hectare on most soils, but higher amounts are recommended on soils of Table Mountain Sandstone (ordinary) and Dwyka Tillite origins. It was nevertheless demonstrated in the laboratory long ago (Wood, 1965) that the soils of the sugar belt vary significantly from series to series in their nitrogen mineralizing capacities. It was shown that whilst a Cartref series soil mineralized 2,3 mg N per 50 g of air dry soil over a period of two weeks, almost three times as much N (6,3 mg) was mineralized in a Shortlands series soil.

In an era when production costs have to be pared for sugarcane to remain a remunerative crop, it appears that scope for economy exists in the amounts of nitrogren being used. Experimentation is required to establish more accurately for each of the soil types represented extensively in the sugar belt, the amounts of nitrogen required on average to supplement indigenous supplies of nitrogen from the soil during the cropping cycle. It will be necessary also to determine the effects in practice of the phenomenon observed in the laboratory, that the addition of lime to some soils in the Natal midlands increases nitrogen mineralization significantly (Wood, 1979).

The results of experiments conducted prior to 1970 on sandy soils along the Natal Coast showed that there was no advantage to be gained from split applications of nitrogen fertilizer compared with single applications. This was particularly true of the results obtained from experiments conducted on the poor Fernwood and Clansthal sands.

It has subsequently been shown (Harris, 1972; Rostron, 1976) that the yields of sugarcane on these sandy soils can often be increased considerably due to treatment with nematicides. The mean increase in yield on five sites where the treatment was particularly successful was 135% (Moberly, Harris and Millard, 1974). Since the distribution and amount of rainfall on the Natal coast are often such that leaching of soluble nutrients is likely to occur, it should be demonstrated whether or not split applications of nitrogen, on soils such as the Fernwood sand, might not be advantageous when healthy crops are produced with the aid of nematicides.

Filtercake, which comprises the sediment accumulated during the clarification of sugarcane juices during processing, is used as a fertilizer material primarily for its value as a phosphorus carrier. It has nevertheless been shown (Alexander, 1971; Alexander, 1972) that the nitrogen content is also significant, the mean N% dry matter being 1,69 in 1970 and 1,93 in 1971. It will be necessary not only to establish the value of N in filtercake more precisely, but attention will also have to be given to the problems that arise due to the reduction of N content in filtercake from the many mills in South Africa which now use the diffusion instead of the mill tandem method for sucrose extraction (Wood, 1981).

Phosphorus

All of the work done on phosphorus nutrition of sugarcane in the sugar industry prior to 1960 referred to soils which apparently had low P-fixing characteristics. A system for P fertilizer recommendations emerged which was simple and effective. The spread of the sugar industry into the higher altitude regions of Natal during the 1950's and 1960's led to problems being incurred that had not been encountered previously. The first of these was found to be aluminium toxicity (Meyer, 1970), which could be ameliorated by the use of agricultural lime.

It was found also that some of the soils in the newly developed areas were capable of fixing significant proportions of the P contained in normal fertilizer applications (Meyer and Dicks, 1979). In several experiments statistically significant increases in yield were obtained by using more than 100 kg P per hectare for the plant crop and in one instance there was a significant improvement due to the application of 350 kg P instead of 225 kg P per hectare. In the first ratoon crops however, the yields from plots dependent on residual P from the plant crop treatment were similar over the range from 200 to 350 kg P per hectare and a top-dressing of the ratoon crop with a further 50 kg P per hectare did not improve yields. The effects of P-fixation in the soil on plant and ratoon crops require to be investigated further.

Since P-fixation has been exposed as a serious problem on some soil types, consideration has been given to the possibility that it may be a lesser but still significant problem in soils in the coastal region. Some fairly precise experimentation will be required to establish the amount and importance of P-fixation in soils such as those of the Shortlands and Milkwood series.

Potassium

Laboratory and glasshouse investigations carried out during the 1970's have illustrated that the subject of potassium nutrition of sugarcane is not always explained adequately in terms of K in an ammonium acetate extract from the soil (Anon, 1980a). Particularly in soils having a heavy texture, non-exchangeable available K (NEAK) appears to play a significant role, as it provides a better measure of the ability of these soils to supply K on a long term basis (Haysom, 1971). However, it remains to be established how recognition of this property can be used to improve the economics of K fertilizer programmes. Results obtained so far indicate that the difference between nitric acid extractable K and ammonium acetate extractable K gives a satisfactory estimate of NEAK, and average values vary from 40 ppm for a Fernwood sand to 833 ppm for a Makatini clay loam.

An unexplained anomaly exists regarding some particular soils near Mhlume in Swaziland and at Monzi on the Umfolozi flats. Ammonium acetate extracts indicate that soil available K is usually very high but sugarcane leaf samples from the same sites often contain less than the threshold percentage (1,05) of K. The Rondspring soil, on which the problem occurs in Swaziland, also shows no shortage of NEAK. This situation will have to be investigated further, a possibility being that irrigation and soil temperatures are contributory factors. It has also been suggested that high levels of calcium and magnesium may in some instances have an antagonistic effect on potassium uptake (Wood, 1980).

Sulphur

When single superphosphate and ammonium sulphate are used to supply the P and N requirements of a crop, the likelihood of a sulphur deficiency can generally be neglected. With the introduction of phosphate carriers having high P and low S contents and with the extensive use of urea and ammonia as sources of N, there is an increasing probability that S deficiencies will occur (Gosnell, 1969). An instance occurred recently on a sugar estate in Malawi (Anon, 1980b) where land levelling had exposed a bleached, infertile subsoil. Where ammonium sulphate had been applied, the severe deficiency symptoms observed elsewhere were entirely absent.

More attention will have to be given to the assessment of soil available S reserves in the sugar belt and the reliability of the following threshold values will need to be confirmed:

Leaf S, %	0,13
Leaf N/S ratio	17
Soil S, ppm	10

Zinc

Deficiencies of minor elements in sugarcane in southern Africa appear to have occurred infrequently, although an isolated instance of copper deficiency was once observed (du Toit, 1956) and symptoms of zinc deficiency have been seen more frequently (du Toit, 1962). The zinc problem has persisted, although its identification in the field has been difficult due to the often fugitive nature of the symptoms. Continued cropping of sugarcane on some soil types is likely to lead to an increased incidence of zinc deficiency and its recognition by means of leaf and soil analyses needs to be developed more precisely. A threshold value of 2,0 ppm Zn in midlands mistbelt soils (Inanda series) is presently reduced to 1 ppm for other soil types, the amount present being determined by the EDTA/ammonium carbonate soil test procedure. The third-leaf threshold value for zinc is currently 15 ppm. In order to meet the zinc requirements of a plant crop and several ratoon crops, the farmer needs not only to have sound recommendations but also the fertilizer combinations that supply a sufficient amount of zinc.

Conclusion

The objective of a fertilizer advisory service is to provide the crop producer with recommendations which will lead to the attainment of maximum economic advantage. Whilst the system of soil and leaf analyses used traditionally in the sugar industry no doubt meets this requirement reasonably well, increased costs of production and smaller profit margins demand that such recommendations should be made even more precise if possible. Furthermore, there are soils in the sugar belt for which more complex methods of analysis are required if their nutritional status is to be assessed properly.

Opsomming

DIE BEHOEFTE AAN VERDERE NAVORSING OOR SUIKERRIETVOEDING IN SUID-AFRIKA GEDURENDE DIE TAGTIGERJARE

Die suikerbedryf in Suid-Afrika handhaaf reeds vir meer as 25 jaar 'n kunsmisadviesdiens. Die resultate van 'n uitgebreide program van landproewe is gebruik om algemeengesproke 'n betroubare grondslag vir aanbevelings daar te stel. Daar is nogtans rede om te glo dat verdere navorsing in verband met die voeding van suikerriet onder plaaslike toestande geregverdig is. Sommige van die fasette van stikstof-, fosfor-, kalium-, swael- en sinkvoeding wat ondersoek sal word, word in hierdie verslag beskryf.

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