A NUTRIENT SURVEY OF SUGARCANE IN THE SOUTH AFRICAN INDUSTRY WITH SPECIAL REFERENCE TO TRACE ELEMENTS

By J. H. MEYER, R. A. WOOD and P. DU PREEZ*

South African Sugar Association Experiment Station

Abstract

A comprehensive survey was undertaken in order to determine whether large scale deficiencies of major nutrients and trace elements exist within the South African sugarcane industry.

The results indicate that the only extensive major nutrient deficiency is potassium, though sulphur levels in Swaziland and the Eastern Transvaal are low without actually appearing to limit sugarcane growth. There are no widespread trace element deficiencies, though zinc is undoubtedly a problem in certain areas of the midlands and coast lowlands. The survey also revealed that the midlands mistbelt region has considerable areas where toxic levels of soil aluminium may be a hazard to sugarcane production, and there is possibly cause for concern regarding certain of the sandy soils of the coast lowlands.

Introduction

Since 1951 the South African sugar industry has seen a phenomenal increase in the consumption of such fertilizers as ammonium sulphate, urea, superphosphate and muriate of potash. This emphasises the importance attached to major elements such as nitrogen (N), phosphorus (P) and potassium (K) in sugarcane production and their contribution to increases in yield. However, the inorganic nutritional requirements of plants are not fully represented by these and other macronutrients such as calcium (Ca), magnesium (Mg) and sulphur (S). Some minor nutrient elements including copper (Cu), zinc (Zn), boron (B), molybdenum (Mo), iron (Fe) and manganese (Mn) are equally essential for healthy plant growth. As they are only required in very small amounts they are referred to as trace elements, and to date their use as fertilizers in the sugar industry has been very limited.

Three possibilities may account for this:

1. The trace element requirements of sugarcane are lower than those of most other crops.
2. Our soils contain sufficient reserves of trace elements to meet the needs of the crop.
3. Trace element deficiencies do exist and although they may not be sufficiently severe to produce visible symptoms, they may affect productivity in certain areas.

In order to investigate the third possibility, and also that of toxic elements in the soil, growers were asked to participate in an industry-wide survey of soil and leaf samples conducted by experiment station staff. The objective was not only to locate potentially deficient areas but also to recommend early corrective measures to growers where this was considered necessary.

Sampling programme

Variability in soil composition is only one of several factors that can influence the concentration of nutrients in cane leaves. Other factors such as age, variety, season, management and method of sampling may all affect nutrient concentration in the leaf, and consequently the accuracy of diagnosis based on leaf analysis.

To standardise conditions as much as possible the leaf sampling programme was confined to cane of varieties NCo 376, NCo 310 and NCo 293, which were cut as plant or first ratoon in June or July 1969, and then sampled when approximately seven months old during January and February 1970.

Each leaf sample comprised 50 leaves associated with the top visible dewlap. The central 25 cm portion of these leaves was removed and the midribs stripped and discarded, the remaining laminae forming the sample, which was then stored in a polythene bag to prevent contamination.

Composite topsoil samples (0-20 cm) comprising 30 sub-samples were taken concurrently in each field using the Mount Edgecombe sampler (Beater[2]).

Regions sampled

For the purpose of the survey the industry was divided into the following physiographic regions:

(a) *Coast lowlands:* comprising the warm humid and sub-humid areas of the coastal plain, extending from the Umfolozi Flats in the north to Port Edward in the south, and with a rainfall generally exceeding 910 mm per annum.

(b) *Midlands mistbelt:* covering that part of the midland plateau which has a rainfall in excess of 910 mm per annum. The area includes the plateaux around Paddock, Highflats, Inanda, Bruyns Hill, Doornkop, Kranskop, Eshowe and Melmoth.

(c) *Sub-humid midlands:* occupying the drier parts of the midland plateau (710-910 mm rainfall per annum), which lie between 470-1 100 m elevation. These include Eston, Umlaas Road, Camperdown and parts of the Wartburg district.

---

*Present address: ISCOR, Department of Research and Process Development, Pretoria.

TABLE I

Distribution of samples in relation to parent materials and physiographic regions

Parent material	% of Industry	Number of fields	% of fields sampled	Region	Associated soil series
Table Mountain Sandstone	24,9	123	25,0	CL SM MM	Cartref, Longlands, Solferino Cartref, Trevanian Cartref, Oatsdale, Clovelly Inanda, Magwa, Nomanci, Kranskop
Dolerite and basalt	13,5	49	10,1	CL SM MM	Shortlands, Rydalvale, Stanger Shortlands, Umlaas, Sprinz, Balmoral
Granite	11,1	28	5,6	CL	Glenrosa, Mayo
Dwyka tillite	10,7	32	6,5	CL SM MM	Rosemead, Williamson Williamson, Waldene Balgowan, Farmhill, Williamson
Recent sands	8,3	27	5,5	CL	Clansthal, Lytton, Fernwood, Maputa
Alluvium	8,0	30	6,2	CL	Shorrocks, Mposa
Lower Ecca shales	7,6	51	10,5	CL SM MM	Milkwood, Glengazi Mispah Balgowan, Clovelly, Farmhill
Middle Ecca shales	6,3	38	7,8	CL MM	Avoca, Rosehill, Windermere Balgowan, Clovelly, Griffin
Tugela schist	2,2	9	1,9	CL	Glendale
Beaufort sands	1,1	4	0,8	SM	Nyoka

CL=Coast lowlands, SM=Sub-humid midlands, MM=Midlands mistbelt

(d) *Lowveld:* includes the semi-arid parts of the Eastern Transvaal, Swaziland, Pongola, Makatini Flats, Hluhluwe and Nkwalini areas, where irrigation is necessary to sustain sugarcane production.

Samples were collected from 487 fields throughout the cane belt. Table I shows the number of samples representing each parent material together with the associated physiographic regions and commonly occurring soil series.

Comparison of the second and fourth columns shows that the proportion of fields sampled generally corresponded with the percentage area representing each parent material, with the exception of Dwyka tillite and granite, for which the sample size should have been larger. Although the lowveld areas of Pongola and Swaziland were sampled, complete soil and parent material data in respect of these areas are not yet available.

Analytical methods

Leaf material

After dry ashing at 600°C, spectrochemical and atomic absorption procedures were used to determine the elements B, Cu, Zn, Mn, Al, Fe, Ca, Mg and K. Standard colorimetric and turbidimetric methods were used for P and S respectively. N was determined using the macro-Kjeldahl technique.

Soils

Following extraction with 1N ammonium acetate, the amounts of Ca, Mg and K. were determined flame photometrically. Mg was determined by atomic absorption and S turbidimetrically. P was determined colorimetrically, and pH using a 1 : 2,5 soil : water ratio.

Exchangeable Al (EAl) was extracted by a rapid procedure using 0,2N NH_4Cl. A colorimetric method based on pyrocatechol violet reagent was used in preference to aluminon for determining Al in the extracts (Meyer[6]).

Results and discussion

Leaf samples

The mean results obtained for all major nutrients and trace elements from each physiographic region are presented in Table II, together with the number of samples taken within each region. The mean values and the range of values for certain elements show considerable fluctuation. This particularly applies to the trace elements zinc, manganese and aluminium, which showed marked interregional differences.

Major elements

1. Leaf analysis revealed relatively few deficiencies of nitrogen (<4%), phosphorus (<7%), calcium and magnesium (<1%). In contrast, a much larger number of soils showed deficient levels of P, Ca and Mg.
2. Over 40% of all samples were found to be potassium deficient (i.e. 1,15% K or less). The deficiencies did not appear to be confined to any particular region.

TABLE II

Average nutrient content of leaf samples for the various physiographic regions

Physiographic regions	No. of samples	ppm						%					
		B	Cu	Zn	Mn	Al	Fe	Ca	Mg	N	P	K	S
Coast lowlands	228	4,1	6,9	18,3	48	83	146	0,26	0,25	2,16	0,24	1,14	0,18
Midlands mistbelt	135	4,0	7,2	14,9	74	133	163	0,29	0,29	2,36	0,24	1,19	0,17
Sub-humid midlands	36	4,0	6,9	17,1	67	60	103	0,36	0,33	2,32	0,25	1,09	0,19
Lowveld													
Pongola	13	2,6	7,5	15,6	42	40	91	0,30	0,20	2,17	0,25	1,34	0,15
Swaziland	21	4,9	8,0	18,8	25	165	196	0,25	0,18	2,19	0,27	1,37	0,13
E. Transvaal	39	4,4	7,6	17,4	38	112	182	0,31	0,23	2,30	0,27	1,35	0,14
Natal	15	3,5	6,1	23,9	35	132	173	0,24	0,23	2,03	0,21	1,26	0,17
Total	487												
Range	Lowest	1,6	4,2	10,0	11	21	49	0,12	0,07	1,30	0,12	0,53	0,11
	Highest	10,0	12,2	55,3	270	800	915	0,71	0,66	2,81	0,53	1,83	0,45
Threshold value		1	3	14	15	—	50	0,15	0,08	1,65	0,19	1,15	0,13
Number of deficient samples		nil	nil	57	11	—	1	4	1	19	33	212	71
Percentage of total deficient		nil	nil	11,7	2,2	—	<1	<1	<1	3,9	6,8	43,5	14,5

3. Taking 0,13% as the threshold value for sulphur, approximately 14% of the samples were found to be marginal or low in this element. The irrigated areas of Swaziland and the Eastern Transvaal accounted for nearly half of these deficiencies.

Trace elements

1. All regions apparently had adequate amounts of boron, copper and iron in the leaf.
2. Almost 12% of the samples showed zinc levels below the 14 ppm threshold value. Eight per cent of all samples from the coast lowlands, and 13% of those taken from the midlands mistbelt areas were affected, together with several farms in the Pongola area.
3. Only 2% of the samples collected contained marginal or deficient levels of manganese.

TABLE III

Mean soil analytical values for the various physiographic regions.

Physiographic regions	No. of samples	pH	ppm						
			Ca	Mg	P	K	S	Na	Al
Coast lowlands	228	5.5	1 018	389	55	144	22	45	10
Midlands mistbelt	135	4,9	527	146	36	168	53	28	65
Sub-humid midlands	36	5,3	635	266	32	152	17	29	13
Lowveld									
Pongola	13	6,4	1 511	532	60	380	33	75	1
Swaziland	21	6,6	2 271	977	36	205	14	99	1
E. Transvaal	39	6,7	1 925	804	109	210	15	44	1
Natal	15	6,5	1 817	636	78	498	20	97	10
Total	487								
Range	Lowest	4,4	40	15	2	25	1	1	0
	Highest	7,4	5 000	3 000	650	720	210	370	350
Threshold value	Deficient		150	25	10	125	7	—	—
	Toxic		—	—	—	—	—	460	100*
Number of samples	Deficient		51	20	85	193	80	—	—
	Toxic		—	—	—	—	—	0	46
Percentage of total			10,4	4,1	17,5	40,0	16,4	Nil	9,1

*for soils with a clay content>20%.

TABLE IV

Distribution data for selected nutrients in leaf samples in relation to soil parent materials and physiographic regions

Parent material	Region	No. of samples	Zinc (ppm)			Samples 14 ppm or below	Manganese (ppm)			Samples 15 ppm or below	Sulphur (%)			Samples 0,13% or below	Potassium (%)			Sample 1,15% or below
			mean	high	low		mean	high	low		mean	high	low		mean	high	low	
Table Mountain Sandstone	CL (ord.)	30	15,9	20,2	11,8	8	54	158	21	0	0,16	0,25	0,13	2	1,19	1,35	0,96	14
	MM (ord.)	39	20,1	40,0	14,4	3	72	159	14	1	0,17	0,24	0,13	5	1,18	1,47	0,96	18
	MM (humic)	43	21,5	55,0	11,7	5	62	148	20	0	0,17	0,24	0,11	4	1,15	1,52	0,56	19
	SM (ord.)	11	16,3	22,4	10,2	3	73	153	12	1	0,19	0,45	0,12	2	1,11	1,47	0,82	8
Dolerite	CL	15	18,5	33,0	13,3	2	37	86	14	1	0,20	0,32	0,12	1	1,11	1,56	0,86	8
	MM	15	16,9	28,1	10,6	5	91	169	47	0	0,16	0,22	0,12	1	1,28	1,83	0,86	6
	SM	4	16,5	19,0	13,4	0	76	103	20	0	0,14	0,14	0,13	0	0,98	1,08	0,74	4
	L (Natal)	15	23,3	31,0	16,8	0	35	53	20	0	0,17	0,20	0,14	0	1,27	1,69	0,91	4
Granite	CL	28	17,3	21,7	13,7	1	34	78	12	5	0,16	0,26	0,12	4	1,25	1,56	0,86	7
	L (E. Tvl.)	7	14,8	16,6	11,8	3	44	94	21	0	0,14	0,16	0,12	1	1,31	1,47	1,17	0
Dwyka	CL	22	20,0	40,0	12,2	4	41	79	17	0	0,18	0,32	0,13	1	1,16	1,56	0,86	10
	SM	10	15,5	18,8	11,4	3	58	83	39	0	0,19	0,40	0,12	1	1,11	1,78	0,74	6
Recent sands	CL	27	18,9	22,6	14,3	1	75	200	22	0	0,19	0,25	0,13	2	1,10	1,39	0,65	10
Alluvium	CL	30	20,6	29,5	11,0	1	46	150	21	0	0,18	0,28	0,13	1	1,17	1,52	0,91	15
	L (PA)	13	15,6	19,4	13,2	4	42	68	22	0	0,15	0,17	0,11	4	1,35	1,64	1,17	0
	L (SW)	21	18,8	23,1	14,8	0	25	43	13	1	0,13	0,18	0,11	10	1,37	1,69	1,08	1
	L (E. Tvl.)	5	15,3	20,1	10,2	1	64	103	29	0	0,13	0,15	0,11	3	1,31	1,56	1,08	2
Lower Ecca shales	CL	28	18,3	24,3	14,0	1	42	59	19	0	0,16	0,24	0,11	6	1,04	1,35	0,61	22
	MM	20	17,6	27,6	13,0	4	82	111	55	0	0,16	0,25	0,12	1	1,22	1,60	0,80	8
	SM	3	14,9	16,0	13,0	0	81	102	54	0	0,15	0,16	0,14	0	1,19	1,30	1,13	2
Middle Ecca shales	CL	28	17,4	27,4	10,0	5	48	144	21	0	0,17	0,20	0,12	1	1,08	1,50	0,82	19
	MM	10	17,4	20,8	12,8	1	94	207	71	0	0,15	0,19	0,13	3	0,96	1,69	0,71	6
Schist	CL	9	16,7	20,8	13,5	1	42	77	25	0	0,16	0,23	0,12	1	1,32	1,56	1,02	0
	L (E. Tvl.)	24	18,1	22,4	14,4	1	32	65	11	2	0,14	0,17	0,12	11	1,37	1,64	0,85	3
Beaufort sands	SM	4	23,0	27,0	18,4	0	39	62	30	0	0,21	0,30	0,14	0	0,95	1,21	0,77	3
	Total	461*			Total	57			Total	11			Total	65			Total	195
	Mean			17,9				55,7				0,16				1,18		
	L.S.D. (p=0,05)			3,6				32				0,03				0,18		

CL=Coast lowlands, MM=Midlands mistbelt, SM=Sub-humid midlands, L=Lowveld, PA=Pongola, SW=Swaziland

* Excludes 26 samples where parent materials were not identified.

Of these, six occurred in the coast lowlands area, and the balance were mainly in the lowveld.

4. Little can be concluded from the aluminium figures as the leaf values do not reflect toxic quantities of Al in the soil.

Soil samples

The mean values obtained for all soil nutrients from the various physiographic regions are given in Table III, together with the ranges found, and the threshold values denoting deficiency (P, K, Ca, Mg, S) or toxicity (Al, Na). The main results were as follows:

1. As with the leaf samples, approximately 40% of all soils were shown to be potassium deficient. Soils were least deficient when derived from alluvium and granite and most often deficient when derived from Table Mountain Sandstone and Recent sands.
2. About 17% of the samples were deficient in phosphorus, which was a much greater proportion than indicated by leaf analyses. As the majority of these samples were taken from ratoon fields, a soil sampling factor could partly explain the high number of soils which were apparently deficient in P.
3. The numbers of soils deficient in calcium and magnesium (10% and 4% respectively) were far in excess of the numbers showing leaf deficiencies. Soils derived from Table Mountain Sandstone and Recent sands showed the highest incidence of deficiencies.
4. Based on a tentative threshold value of 7 ppm, more than 16% of the soils were found to be deficient in sulphur. Half of the soils were situated in the coast lowlands, and more than a quarter were in the lowveld areas. Very few deficiencies were found in the midland areas where soils generally have a high organic matter status.
5. No toxic sodium levels were found in any of the soils examined.
6. Using a critical Al value of 100 ppm, which is applicable to soils having a clay content greater than 20%, more than 9% of the soil samples contained toxic levels of aluminium. These were confined mainly to the midlands mistbelt region in which more than a quarter of the soils were affected.

Various aspects of the leaf and soil results will now be discussed in more detail. Table IV shows the distribution of leaf, zinc, manganese, sulphur and potassium within the physiographic regions which have been sub-divided according to the various parent materials present.

Zinc

In the midlands mistbelt the highest incidence of Zn deficiency occurred on soils derived from dolerite, while in the coast lowlands deficiencies were pronounced on ordinary TMS (Cartref series) soils and the sandy soil members derived from Middle Ecca Sandstone.

In Figure 1 the frequency distribution of Zn levels in leaves from cane grown on ordinary TMS (Cartref series) soils from the coast lowlands is compared with that for TMS mistbelt soils. The distribution for the ordinary TMS soils surprisingly shows that about 60% of the samples fall in the marginal range from 15 to 18 ppm, compared with only 42% for the TMS mistbelt soils.

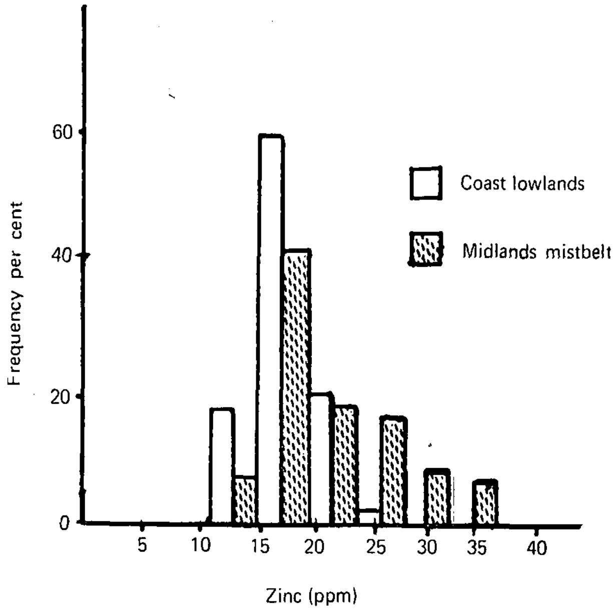

FIGURE 1: Comparison of frequency distributions of zinc levels in leaf samples from cane grown on TMS derived soils in two areas.

In a nutrient survey of cane grown on midlands soils Alexander[1] concluded that Zn deficiency was confined exclusively to TMS mistbelt soils belonging mainly to the Inanda series. He reported that 40% of the samples were deficient in Zn, which is more than double the proportion found in the present investigation. This apparent reduction in Zn deficiencies may be due to increased use of zinc fertilizers in the industry.

However, the fairly high proportion of samples with low Zn levels found in the coast lowlands on ordinary TMS-derived soils implies that zinc deficiency may be more extensive than originally realised. Due cognizance of this should be taken in the management of these soils.

Manganese

Mean Mn values ranged from 25 to 48 ppm in the coast lowlands and lowveld areas, in contrast to the significantly higher mean values of over 70 ppm in the midlands mistbelt area. The magnitude of the inter-regional differences is illustrated in the histograms shown in Figure 2. In the midlands more than 60% of the leaf samples had Mn levels above 50 ppm whereas for the coast lowlands and lowveld areas only 15-20% exceeded this figure.

An interesting feature shown in Table IV is that the mean Mn level for cane grown on Recent sands (Clansthal and Fernwood series) is significantly higher than the mean levels associated with other parent materials occurring in the coast lowlands. Beater[3] reported that localised manganiferous concretions are not uncommon in soils derived from Recent sands. This suggests that Mn may be fairly

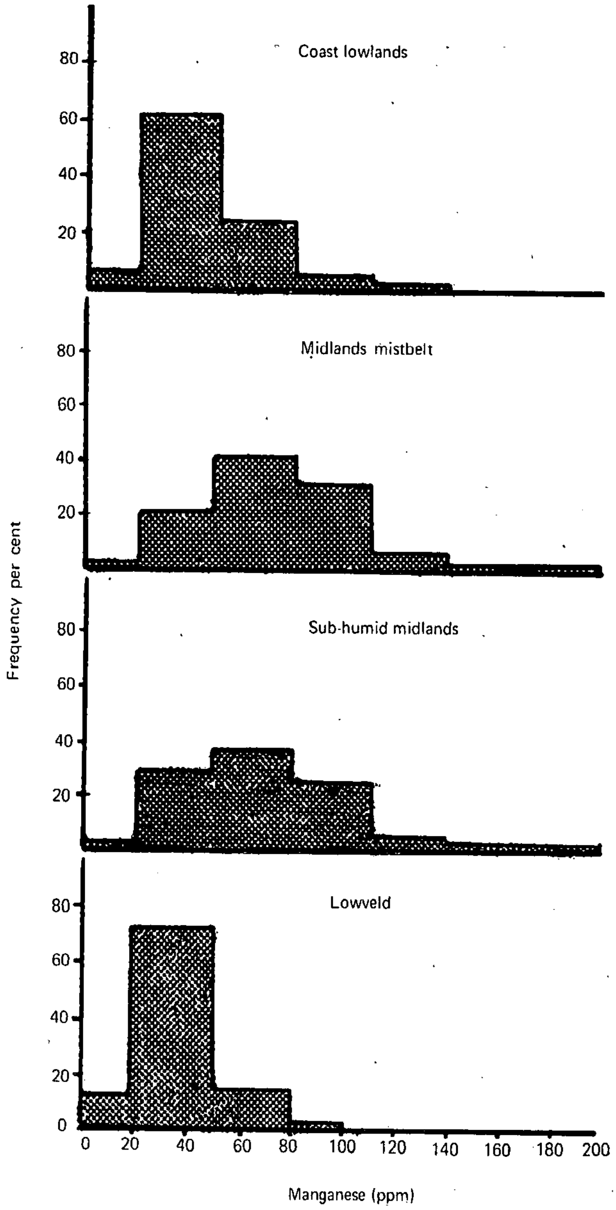

FIGURE 2: Comparison of frequency distribution of Mn levels in leaves from cane grown in four physiographic regions.

abundant in the soil solution especially where the soil pH values are somewhat acid.

About 20% of all lowveld samples bordered on Mn deficiency and further analysis revealed that half of these came from the irrigated areas of Swaziland, which suggests that cane from this area of the lowveld is most prone to possible Mn deficiencies. This is followed by cane grown on soils derived from granite and schists in the Eastern Transvaal.

Wallace[9] states that low Mn levels are often associated with moderate to highly alkaline soils, in which the pH conditions do not favour the presence of readily available Mn in the soil solution. Above a pH value of 6,5 soil organisms convert Mn from the manganous to the manganic form which is not available to plants. As most of the lowveld soils had pH values above 6,5, this may explain their generally low Mn levels.

The high levels of Mn and also Al found in the midlands soils, are to be expected because of the greater degree of weathering of these soils, which causes them to be more acid when compared with coast lowland soils. Although no information is available regarding levels above which Mn is likely to be toxic, nearly all leaf samples with high Mn values were associated with a soil pH below 5,2.

Also in some areas of the midlands, cane had been observed with symptoms similar to those of iron chlorosis. Some of these samples contained excessively high amounts of Mn, and nutrient imbalance was therefore possibly responsible for the iron deficiency symptoms. The high leaf Mn values associated with the Recent sands, mentioned earlier, may also be a contributory factor to iron chlorosis on these soils when pH values are below 5,5. A cheap corrective measure would be to lime the soils, thus causing a reduction in plant uptake of Mn, as shown recently by Du Preez[4] and Meyer[7].

Sulphur

The main reason for the inclusion of this element in the analytical programme arose from the fact that, for economic reasons, double superphosphate and urea are now being used by the majority of growers in preference to single superphosphate and sulphate of ammonia. This has meant a drastic reduction in the amount of sulphur being supplied as a fertilizer and in consequence deficiencies may develop rapidly in certain areas.

While individual leaf S values ranged from 0,11-0,45% (see Table II), the mean values for the different regions were between a fairly narrow range from 0,13% in Swaziland to 0,19% in the sub-humid midlands.

Evaluation of the number of leaf samples deficient in S was somewhat difficult because at present a threshold value applicable to local conditions has not been established experimentally. In Rhodesia Gosnell and Long[5] used a value of 0,16%, but this appears to be too high as cane from areas in many parts of the industry showed excellent growth and no visual deficiency symptoms when values were as low as 0,11%. They also found that S requirements were more accurately assessed by using the leaf N/S ratio. S-deficient cane was invariably associated with a ratio higher than 17.

To determine the leaf S content that corresponded with an N/S ratio of 17, the mean S values for cane grown on the various parent materials given in Table IV were plotted against the respective N/S ratios. The linear regression line obtained (see Figure 3) was found to be highly significant ($r = -0{,}892$). An N/S ratio of 17 corresponded with an S content in the leaf of 0,13%, and this is the empirical threshold value that was used for evaluating S status.

Of the 71 samples considered to be deficient, nearly half were situated in the irrigated areas of the Eastern Transvaal (schists) and Swaziland, with relatively few deficiencies elsewhere except in the Lower Ecca Shales of the coast lowlands. These findings were supported by the soil analytical data, although indications here are that deficiencies could be even more widespread, extending to the ordinary

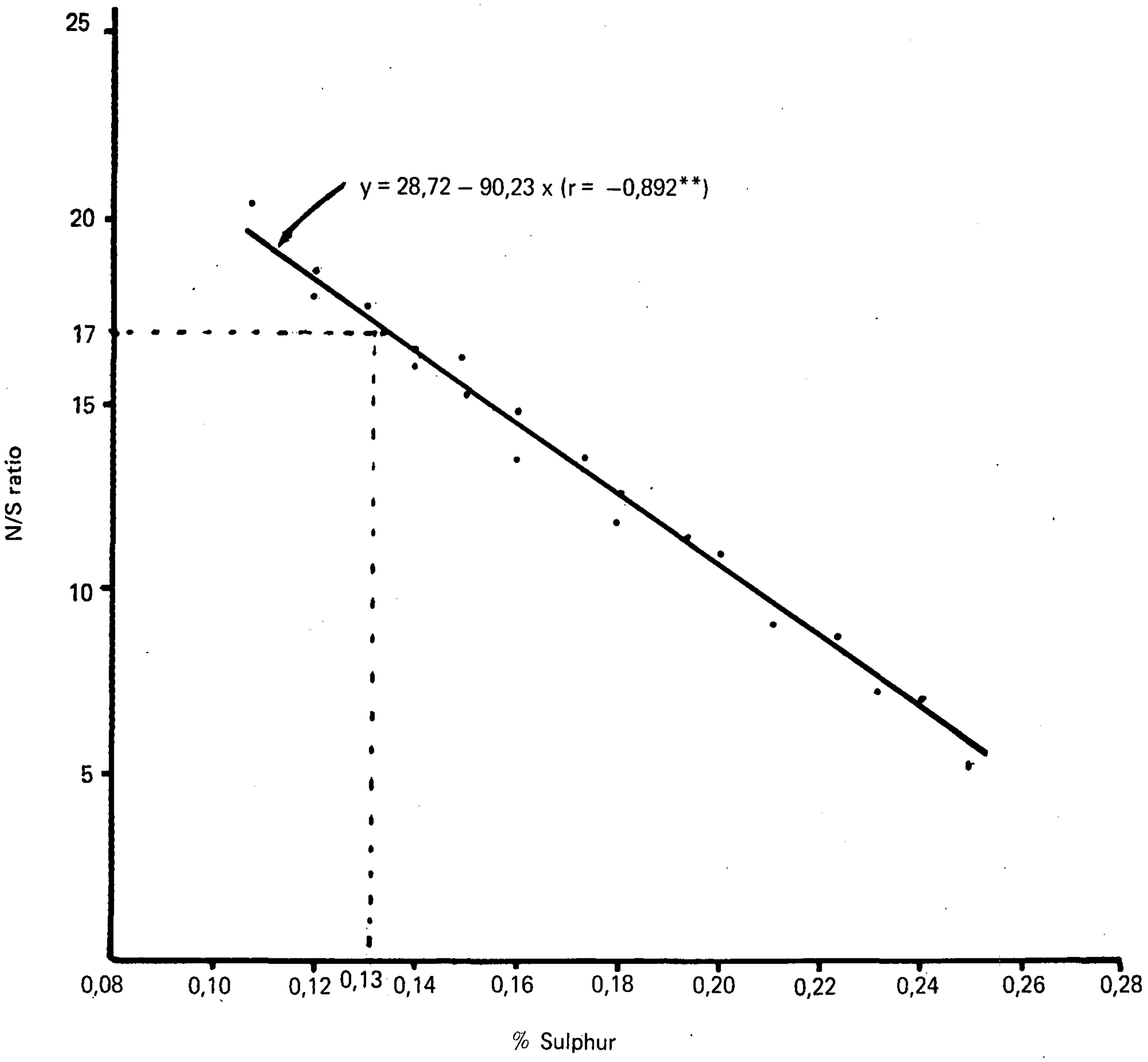

FIGURE 3: Relationship between sulphur and N/S ratio in cane leaf samples.

TMS and granite soils of the coast lowlands. However, further confirmatory evidence is required.

These results suggest that it may be necessary to revert to the use of ammonium sulphate or single superphosphate periodically, or alternatively to add small amounts of elemental sulphur to fertilizer mixtures.

Potassium

Despite the fact that about 40% of both leaf and soil samples were below the K threshold values, poor agreement was often shown between leaf K values and corresponding soil K values. Over 18% of all leaf samples showing marginal or low K levels were associated with soils having adequate to high levels of K, though this condition was absent in the irrigated lowveld areas apart from the Nkwalini valley. Samples collected from the Umfolozi Flats in Zululand showed dramatic differences between leaf and soil K.

It is thought that this poor correlation is related to the extent to which K is fixed by the 2 : 1 lattice clay minerals, which are commonly found in soils derived from alluvium (Umfolozi Flats), dolerite and shales. The current procedure for extracting soil K using 1 N ammonium acetate is known to remove varying amounts of non-available or fixed K as well as available K and it would seem that a correction factor will have to be introduced to rectify the situation. However, it is obvious that in many instances inadequate amounts of potassic fertilizer are being applied. Sandy soils present particular problems in this regard as potash is readily lost through leaching. Increased leaf sampling during the growing season may well show the need for corrective measures such as top dressing with additional muriate of potash.

Aluminium toxicity

Prior to the survey there had been some concern regarding toxic levels of aluminium in certain soils of the industry. In a recent paper Meyer[7] concluded that Al toxicity was a prime factor limiting growth on various midlands soils.

Figure 4 shows that if a critical value of 100 ppm exchangeable Al is applied to the more heavily textured soils (>20 clay) the lowveld and sub-humid regions are free of Al toxicity. In the midlands mistbelt however 30% of all samples had toxic levels of Al, while 5% were affected in the coast lowlands. Al toxicity was nearly always associated with soil pH values of 5,2 and below.

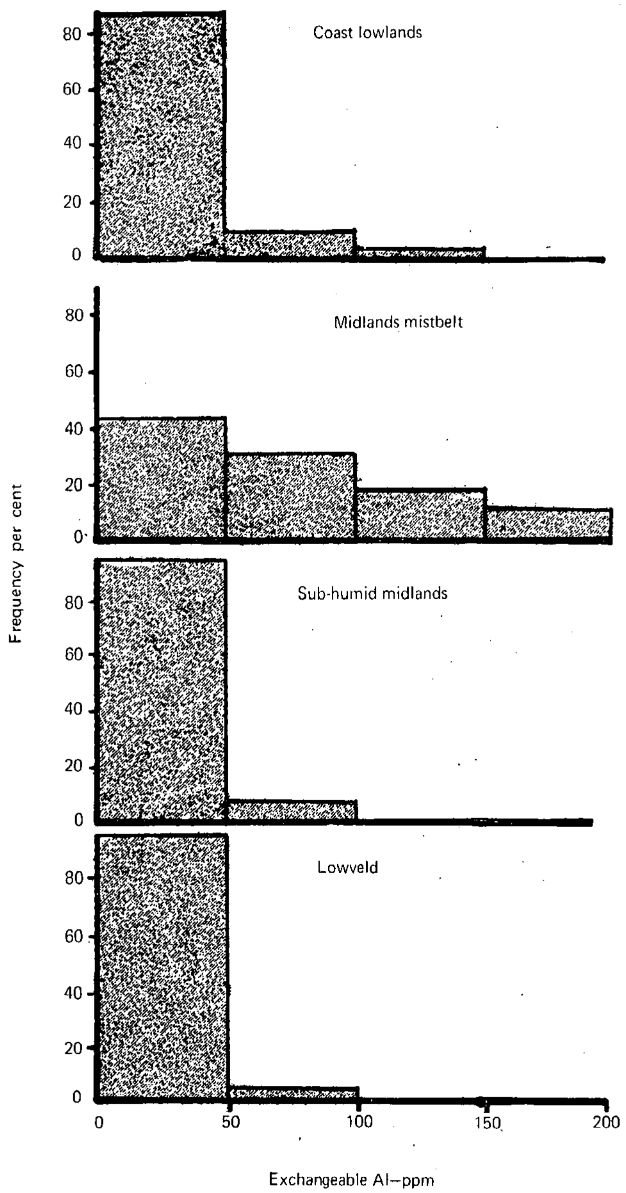

FIGURE 4: Frequency distribution of exchangeable aluminium (EAl) in soils from four physiographic regions.

In the midlands mistbelt area, soils derived from Lower and Middle Ecca shales and Table Mountain Sandstone, most frequently had high Al values. In the case of sandy soils (<20% clay), Sumner and Meyer[8] believe that the level at which Al is toxic to cane is far lower, and probably lies in the range 20-35 ppm. On this basis the survey results indicate that approximately one in every four farms in the coast lowlands with ordinary TMS soil (Cartref series) has fields with marginal to toxic levels of Al.

Conclusions

The survey results indicate that as far as the major nutrients are concerned there are no large scale deficiencies, apart from potassium. Increased rates of potassic fertilizer plus a more intensive leaf sampling programme appear to be required, coupled with further laboratory investigations. Leaf sulphur values in Swaziland and the Eastern Transvaal are generally low, without actually appearing to limit sugarcane growth at this stage. Further studies of this problem are currently under way.

There would seem to be little justification for suspecting widespread deficiencies of trace elements, though zinc is undoubtedly a problem in certain areas of the midlands and coast lowlands. On the other hand the midlands mistbelt region does have areas, especially those previously under wattle, where toxic levels of soil aluminium may be a hazard to sugarcane production. Also there is possibly some cause for concern regarding certain of the sandy soils of the coast lowlands. A detailed programme of field and laboratory investigations is being undertaken to determine the best way of treating these soils so that the grower can attain maximum productivity.

Acknowledgements

The authors would like to thank all growers who participated in the survey, and the extension staff for their co-operation and assistance. Thanks also to Mr. M. Murdoch for his examination of the results, and to Dr. C. N. MacVicar for defining the physiographic regions.

REFERENCES

1. Alexander, K. E. F., 1967. A nutrient survey of cane on TMS soils in Natal. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 41: 197-200.
2. Beater, B. E., 1955. A new pattern soil sampler. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 29: 113-114.
3. Beater, B. E., 1957. Soils of the sugar belt. Part one: Natal North Coast. Oxford University Press, Cape Town.
4. Du Preez, P., 1970. The effect of silica on cane growth. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 44: 183-188.
5. Gosnell, J. M. and Long, A. C., 1969. A sulphur deficiency in sugarcane. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 43: 26-29.
6. Meyer, J. H., 1970. Rapid analysis of igneous rocks. M.Sc. thesis (unpublished) — Natal University.
7. Meyer, J. H., 1970. The influence of wattle brush burning on cane growth. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 44: 189-199.
8. Sumner, M. E. and Meyer, J. H., 1971. Incidence of toxic aluminium in sandy soils. Proc. Ann. Cong. S. Afr. Sug. Technol. Ass., 45: (in press).
9. Wallace, T., 1951. The diagnosis of mineral deficiencies in plants. (2nd edition). H.M.S.O. London.

Discussion

Mr. Gilfillan: Is there any connection between calcium and nitrogen deficiency? At Tongaat recently we have had a disturbing number of samples showing deficiency of calcium on foliar analysis and usually there has also been deficiency of nitrogen. And yet in the fields concerned 120 kg/ha nitrogen have been applied.

Mr. Wood: We have no evidence for such connection. If your nitrogen deficiencies were associated with sandy soils then there could be no losses due to leaching.

Mr. Meyer: We found relatively few nitrogen and calcium deficiencies so that this aspect was not investigated further.

Mr. Andries: Table IV shows the deficiencies of potash in many coastal zone soils. If we could find a better way of determining potash requirements we might be able to correct this.

Mr. Meyer: The reason for most of the deficiencies, particularly those associated with sandy soils, is due to the loss of potassic fertilizer through leaching. The problem involves finding the most efficient way of applying the fertilizer in order to minimise losses by leaching.

Mr. Andries: Are you suggesting the potash should be applied after the N and P.

Mr. Meyer: I am suggesting that deficiencies are less likely to develop when the recommended amount of potassic fertilizer is spread over at least two applications instead of a whole single application at the beginning of the crop cycle.

Mr. Moberly: Mr. Andries was referring to many types of coastal zone soils whereas Mr. Meyer is referring specifically to sands.

Mr. Meyer: As far as the other coast lowland soils are concerned, particularly those derived from Lower Ecca and Alluvium, deficiencies are related to the fixation characteristics of these soils, which render substantial amounts of K unavailable to the plant needs. Under these conditions the rates of potassic fertilizer will have to be increased in order to counter as best as possible losses due to fixation of K. Research is being undertaken with a view to improving the method for determining the potash requirements under these conditions.

Dr. MacVicar: Do the authors know if the growers in the survey had followed Fertilizer Advisory Service recommendations?

Dr. Shuker (in the chair): The type of grower who would volunteer to take part in such an investigation would almost certainly follow recommendations.

Mr. Lamusse: Farmers in the lower South Coast area use a lot more fertilizer than recommended by FAS.

Mr. du Toit: It is a tendency throughout the industry for growers to use more fertilizer than is recommended by the FAS and certainly the amount of potash recommended is being exceeded. And yet we find that more than 40% of the soils are deficient.

It was recently suggested that a new mixture 5-1-5 should be used instead of 4-1-6, containing more nitrogen and a lesser proportion of potash. But on these figures it would appear that the proportion of potash should be increased, unless our threshold value is too high. It has been reported, also, that no response is found to the application of additional potash.

From the results for sulphur it appears that certain areas are reaching the borderline of sulphur deficiency. Zinc also appear to be deficient in the coastal areas.

Dr. Gosnell: In Rhodesia we have taken a threshold value of 1,10% for K on five month old fully irrigated sugarcane and we think this may be high and are thinking of reducing it to 1,05%. With increasing age there is a slight decline of foliar potassium and in dry conditions there is a marked drop in potassium.

Regarding sulphur, it is possible to get a significant drop in yield before a visible sulphur deficiency becomes apparent.

Mr. Long: We considered a lot of leaf analyses with 1,1% K as marginal. These were on soils that had high reserves of potassium.