CLASSIFYING SOILS OF THE SOUTH AFRICAN SUGAR INDUSTRY ON THE BASIS OF THEIR NITROGEN MINERALIZING CAPACITIES AND ORGANIC MATTER CONTENTS

By J. H. MEYER, R. A. WOOD, R. K. McINTYRE and N. B. LEIBBRANDT

SA Sugar Association Experiment Station, Mount Edgecombe, 4300

Abstract

Results of field and laboratory studies have indicated that the N requirement of ratoon cane can be more reliably estimated from a knowledge of the soil form and/or the organic matter status of the soil. Soils may be classified according to their N mineralizing capacity (high, medium or low) and an incubation study indicated that the release of mineralizable nitrogen correlated well with the organic matter contents of the soils. Soils of low, medium and high mineralizing capacities were found to correspond broadly with soils containing <2, 2 to 4 and >4% organic matter respectively. This was substantiated by yield responses from field trials conducted on a range of soils where indications were that the probability of a response to applied N increased as the organic matter content of soils declined.

Introduction

It was estimated (Moberly *et al*[1]) that in 1981 the South African sugar industry spent more than R23 million on nitrogen fertilizer; almost 60% of the total amount the cane grower spent on fertilizer. The amount of nitrogen being applied to cane on the wide range of soils within the industry must be looked at closely to determine whether this expensive nutrient is being used as effectively as possible.

Soil nitrogen supply

Wood[2] showed that sugarbelt soils varied significantly in their capacity to release N by mineralization following incubation for two weeks in the laboratory. The quantities of mineral N (NH_4^+ and NO_3-N) in ppm in soils derived from various parent materials ranged from 30 ppm in the sandy Table Mountain Sandstone (TMS) soils to 111 ppm in highly fertile alluvial soils (i e 68 to 250 kg N/ha equivalent).

Current N recommendations for plant cane take these differences in mineralizing capacity of the soil into account only to the extent that 90 kg N/ha is recommended for all soils except those derived from Dwyka tillite and the sandy TMS soils where 125 kg N/ha is recommended. For ratoon cane however, estimated cane yield is used as the main criterion for advisory purposes (1,25 kg N/ton expected cane yield per hectare), and variable release of N from different soils has been largely ignored.

N/K fertilizer trials

Additional field experiments were necessary to establish more accurately the average amount of N required by the crop to supplement that not met by each of the major soil types. The results of the current series of N/K fertilizer trials confirm that the N requirement for ratoon cane is substantially higher on the poorly drained, low organic matter soils of the Longlands and Kroonstad forms (140–180 kg N/ha) than it is on the heavier, humic, well drained Inanda form soils (50 to 80 kg N/ha). On many soils, however (Shortlands, Mayo, Bonheim, Arcadia forms), the N requirement falls between these two extremes (110 to 140 kg N/ha).

The organic matter approach

The use of soil form to predict the N requirement of ratoon cane is promising but it will not be easy to implement on an advisory basis because growers do not yet have access to soil form maps. The merits of organic matter (OM) content of the soil, as a means of predicting low, medium and high N requirements for cane were therefore evaluated as an alternative. Wood[2,3] had demonstrated that the magnitude of N release was broadly related to the organic matter content of the soil. A highly significant correlation has subsequently been obtained between the organic matter status of Natal midlands soils and N release (Wood[4]).

Experimental Work and Results

Seventy two composite topsoil samples, representing 11 soil forms and 12 soil series, and varying in organic matter content from 0,5 to 8,0%, were incubated for two weeks to determine their N mineralizing capacity. Each soil form was replicated six times. Average amounts of N released are shown in Table 1.

TABLE 1

Average N release in a range of soil forms (means of six replicates)

Soil form	Soil series	pH (water)	% clay	% OM	Min N (ppm) Before incubn	Min N (ppm) After incubn	*N release ppm N	*N release kg/ha
Fernwood	Clansthal	5,6	7	0,6	21	43	22	49
Fernwood	Fernwood	5,2	9	0,7	22	48	26	59
Cartref	Cartref	5,1	6	0,8	9	42	33	74
Kroonstad	Avoca	5,2	11	1,2	29	49	20	45
Longlands	Waldene	5,0	15	1,5	33	70	37	83
Glenrosa	Glenrosa	5,3	13	1,6	40	75	35	79
Hutton	Makatini	6,2	50	2,0	19	64	45	101
Milkwood	Milkwood	5,5	35	2,2	59	94	35	79
Shortlands	Shortlands	6,2	42	2,6	19	79	60	135
Glenrosa	Trevanian	5,7	20	3,4	61	96	35	79
Clovelly	Balgowan	5,1	42	3,7	66	136	70	158
Inanda	Inanda	4,9	46	4,9	97	178	81	182

* N mineralized during a two week period

As expected, the soil of the Inanda form (4,9% OM) released the greatest amount of N (equivalent to about 180 kg N/ha), whilst the soil of the Kroonstad form (1,2% OM) mineralized least N (about 45 kg N/ha). A regression analysis indicated that N release was positively correlated with the organic matter content of the soil ($r = 0,76$, $y = 14,52 + 12,74x$, where y is the quantity of N mineralized (ppm) and x is the organic matter content). The correlation was slightly better when total mineral N (N mineralized + N present initially) was compared with organic matter ($r = 0,81$, $y = 18,16 + 29,81x$).

In practice it is simpler to determine soil organic matter content than to determine the N mineralizing capacity of a soil by the incubation technique. The laboratory investigation was therefore extended by determining the organic matter contents of a range of about 400 topsoil samples that formed part of an industry-wide nutrient survey. The regression equation $y = 14,52 + 12,74x$ obtained from the incubation study was used to estimate the probable amount of N that would be mineralized by soils derived from 12 parent materials based on their organic matter contents. Soils of low, medium and high mineralizing capacity were found to correspond broadly with soils containing less than 2%, 2 to 4%, and more than 4% organic matter respectively (see Table 2).

TABLE 2
Interim classification of important soil series into three N mineralization and organic matter classes

N mineralizing potential	Soil system	Parent material	Main soil series	Organic matter status	Estimated N mineralization capacity (kg/ha)
LOW	Berea	Recent Sand	Fernwood Clansthal	LOW <2,0	Less than 75
	Umzinto	TMS(O)	Cartref Kroonstad Longlands Katspruit		
		Middle Ecca	Avoca		
		Dwyka tillite	Waldene Williamson		
		Granite	Glenrosa		
	Komatipoort Nelspruit	Granite	Mispah Katarra Grovedale		
MODERATE TO GOOD	Umzinto	Dolerite	Shortlands Rydalvale Phoenix	MED-IUM 2,0-4,0	75 to 150
		Lower Ecca	Milkwood		
		Middle Ecca	Swartland		
		Dwyka tillite	Rosemead St Faith's		
		Granite	Mayo Rosemead		
		Tugela Schist	Glendale		
	Komatipoort	Dolerite/ Basalt Swazi Basic	Glendale/ Bonheim		
		Alluvium	Shorrocks Makatini		
	Nottingham/ Umzinto	TMS	Trevanian		
VERY GOOD	Nottingham	TMS	Inanda Farningham	HIGH >4,0	150
		Dolerite	Sprinz		
		Middle Ecca	Farmhill Balgowan		
		Dwyka tillite	Farmhill		

Soil series that belong to the same soil form do not necessarily have the same capacity to mineralize N. For example, the Glenrosa and Trevanian series soils both belong to the Glenrosa form yet they differ markedly in their N release characteristics.

Yield response data from 42 past and present fertilizer trials conducted on a range of soils which had not been treated with N, together with the appropriate analyses of leaves and soil organic matter, were examined to determine what relationship, if any, existed between the following parameters:

(a) relative yield response to applied N and the organic matter content of soil

(b) release of mineral N from the soil in relation to the organic matter content of the soil (based on current N/K trials)

(c) organic matter content of the soil and optimum amount of applied N (rainfed and irrigated cane)

(d) third leaf N content of cane in relation to organic matter of the soil.

(a) Relative yield response to applied N and organic matter content of soil

A summary of all the available response data from the 42 trials in relation to soil organic matter and optimum level of applied N is given in Appendices 1 to 5. They have been subdivided according to the amount of organic matter, less than 1%, 1 to 2%, 2 to 4%, 4 to 6% and greater than 6%. Examination of these data shows that the relative yield response in tons sucrose/ha to the optimum level of applied N (response expressed as a percentage of control yield) is generally inversely related to the organic matter content of the soil. This is illustrated by the regression curve representing results from 66 plant and ratoon cane crops as shown in Figure 1.

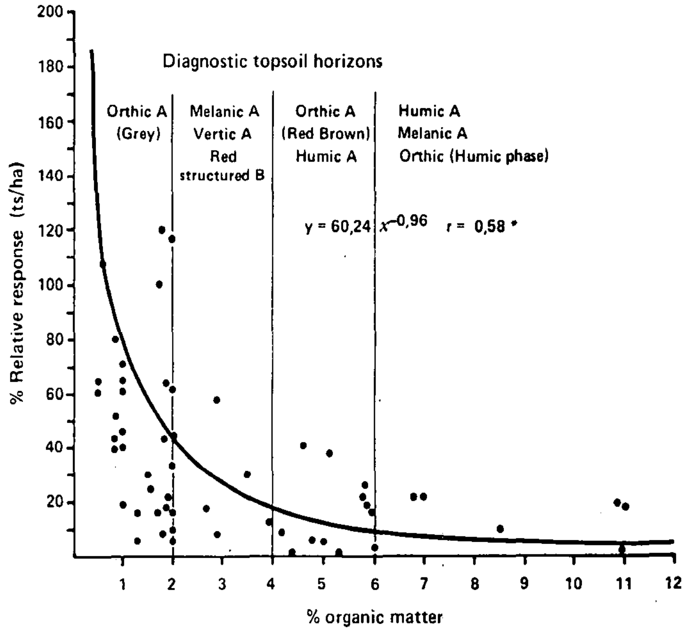

FIGURE 1 Relative response to optimum level of applied N in relation to soil organic matter. (Plant & ratoon cane – 66 crops – 42 trials with zero N treatment)

The relationship was significant at the 5% confidence level. The results imply that the probability of a response to applied N decreases markedly with increasing organic matter content.

Soils with low (<2%), moderate (2 to 4%) and high (>4%) organic matter contents were associated with average relative responses of approximately 50%, 23% and 10% to applied N respectively. Although there were anomalous responses in the low organic matter range, e g Clansthal and Shorrocks series soils of the Hutton form, there appeared to be merit in classifying soils into those with low, medium and high organic matter contents based on the above response data. The actual limits established from the laboratory investigations agreed reasonably well with results obtained from the field. There was also a good correlation between the soil forms that constituted part of the investigation and organic matter contents.

(b) Release of mineral N from the soil in relation to organic matter content of the soil (based on current N/K trials)

To substantiate further the relationship between N release from the soil by mineralization and soil organic matter content, 44 soils of known organic matter content were taken mainly from the zero N plots of the current N/K fertilizer trials many of which were under ratoon cane. They were incubated for two weeks and the quantities of N mineralized and total mineral N were meaned for all soils which fell into one of the five organic matter categories, i e less than 1%, 1 to 2%, 2 to 4%, 4 to 6% and greater than 6% organic matter. The average results are represented graphically in Figure 2 and they clearly show that a highly significant correlation existed between N mineralized or total mineral N and soil organic matter. Amounts of total mineral N present in the soils following incubation ranged from 79 to 243 kg N/ha equivalent.

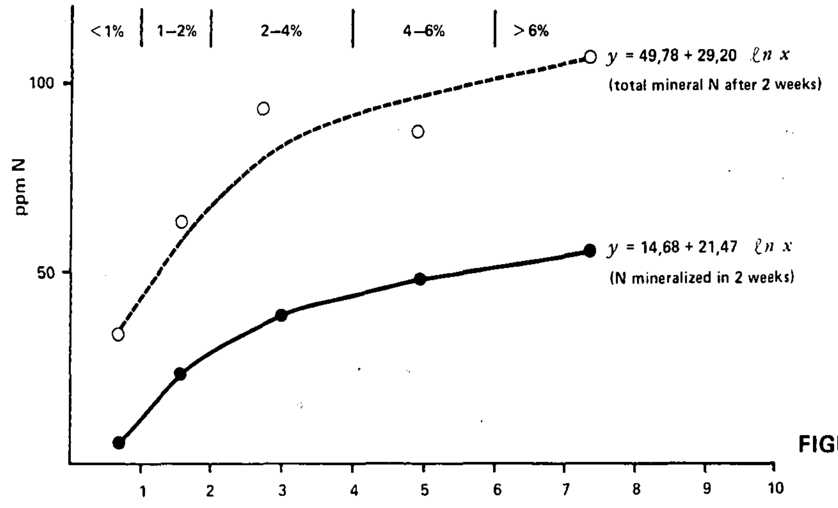

FIGURE 2 Relationship between N mineralized, total mineral N ($NH_4 + NO_3 - N$) and soil organic matter content (current N/K trials)

(*c*) *Organic matter content of the soil and optimum amount of applied N (rainfed and irrigated cane)*

The current series of N/K field trials have been valuable in ascertaining more accurately the optimum requirement of cane for applied N relative to organic matter content and soil form. For rainfed ratoon cane grown on three different soils and harvested when approximately 12 to 13 months old, the optimum amount of applied N declined from 160 kg N/ha on a Longlands form soil containing 2% OM, to an intermediate amount of 120 kg N/ha on a Mayo form soil with 3,9% OM. For a humic soil of the Inanda form containing 5,8% OM the optimum amount of N required was only 60 kg N/ha (see Figure 3).

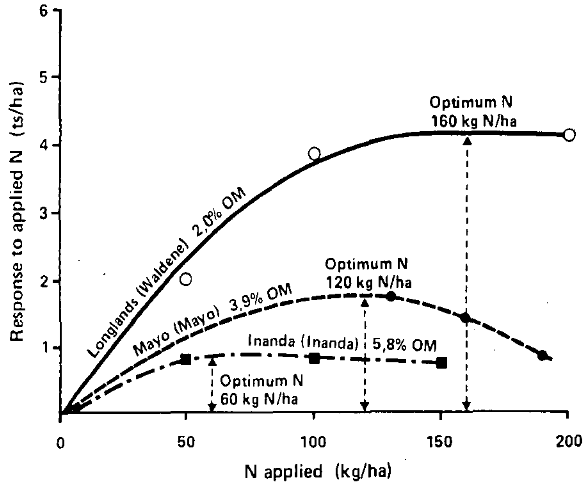

FIGURE 3 Response to applied N in relation to soil organic matter content and soil form (rainfed cane)

For irrigated cane, a similar relationship exists but results to date show that it is not as clearly defined as in the case of rainfed cane, mainly because the range of values of organic matter content of the soil is more restricted; most irrigated soils falling within the 2 to 4% OM category. In Swaziland, the optimum amount of N required by a 12 month old irrigated crop grown on an Estcourt form soil with an OM content of 1,6% was 160 kg N/ha compared with 80 to 120 kg N/ha for cane grown on a Mayo form soil containing 2,6% OM (see Figure 4).

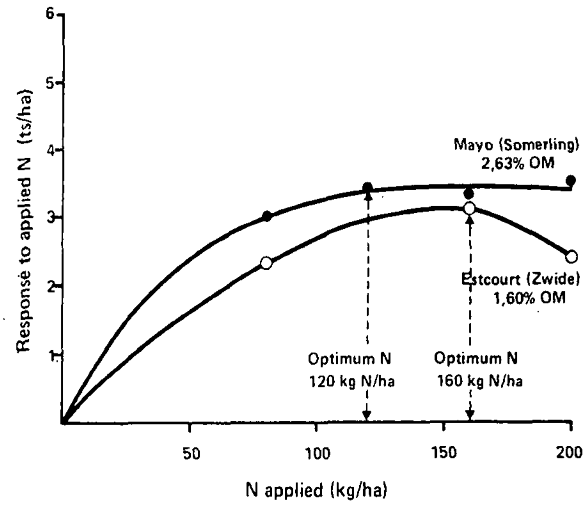

FIGURE 4 Response to applied N in relation to soil organic matter content and soil form (irrigated cane — Swaziland)

(*d*) *Third leaf N content of cane in relation to organic matter of soil*

Based on the results of the 42 fertilizer trials mentioned earlier Figure 5 shows that the uptake of N by plants in the zero N treatments (as indicated by changes in third leaf N percentage), increased markedly as the percentage of organic matter of the soil increased. However, these increases were far less evident where N fertilizer had been applied. The graphs depict the average leaf N values obtained for each of the five classes of organic matter referred to previously.

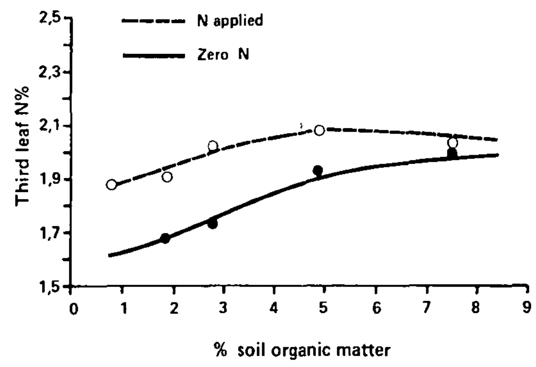

FIGURE 5 Changes in third leaf N percentage in relation to soil organic matter content with and without applied N fertilizer

Results from several of the N/K fertilizer trials illustrated that the rate of decline in leaf N percent with age of sampling was less marked on soils with a high organic matter content than on those where the organic matter content was low. Figure 6 shows that where the N curves flattened out when the cane was between five to six months old, leaf N values tended to reflect the N mineralizing capacity of the various soils in terms of their organic matter content, e g at the age of six months percentage leaf N in cane growing on the Inanda series soil (5,8% OM) was

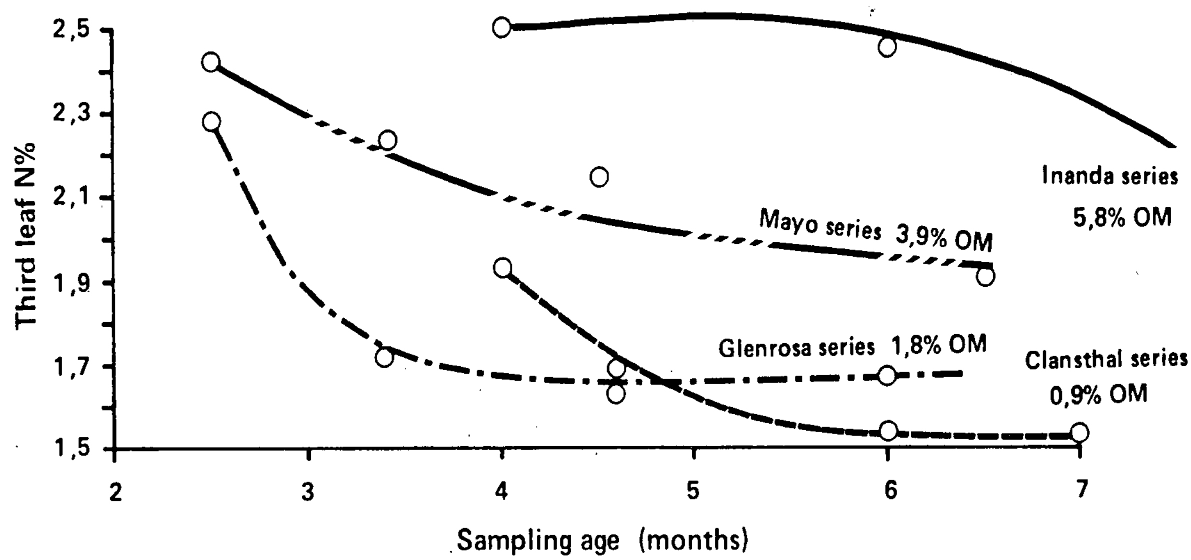

FIGURE 6 Decline in leaf N values with sampling age in relaiton to soil organic matter content (N/K trials)

2,20%, whilst the comparable values in cane growing on the Glenrosa series soil (1,8% OM) and the Clansthal series soil (0,9% OM) were only 1,66% and 1,55% respectively. Such differences in leaf N content may also be attributed partly to physiological age differences of the cane.

Likewise leaf N values in cane growing on soils with a high organic matter content (Inanda and Mayo series) reflected increasing rates of applied fertilizer N far less than they did in cane growing on soils with a much lower organic matter content (Glenrosa and Clansthal series). Figure 7 illustrates this for four month old cane sampled from several N treatments on various soils. Using leaf N data can be valuable, particularly where it draws attention to those areas where N uptake is excessive which can be detrimental to the sucrose content.

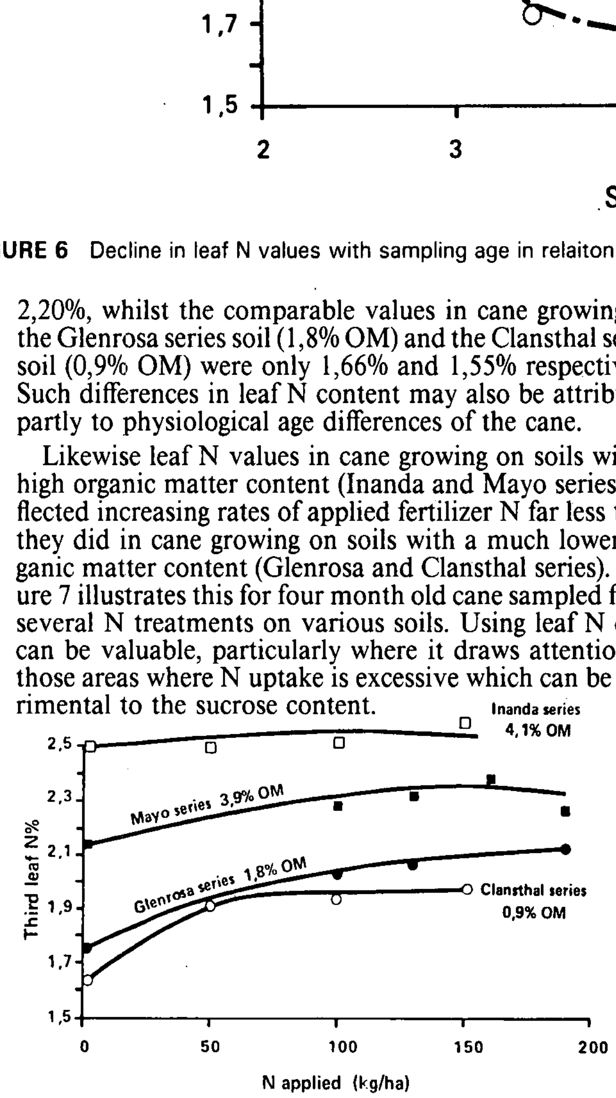

FIGURE 7 Changes in leaf N values (4 month old cane) in relation to increasing rates of applied N and soil organic matter content (N/K trials)

Discussion and Conclusions

The release of soil N from organic matter for use by the crop can be influenced by factors such as pH, temperature, soil depth, moisture content, poor drainage and crop cycle. Nevertheless the results of laboratory investigations and field experiments which were conducted over about 30 years and covered a wide range of soil and environmental conditions, have shown that the organic matter of the soil is important and could be valuable in helping to determine more reliably the N requirement for both plant and ratoon cane, when used in conjunction with soil form.

The system proposed for recommending N for plant and ratoon cane according to soil group, parent material and associated soil form, and organic matter class is shown in Table 3.

Although further work may be necessary, it appears that requirement rates of 60, 90 and 120 kg N/ha for plant cane, and 0,8, 1,25 and 1,60 kg N/ton of the expected cane yield for ratoon cane, would be appropriate for soils with high (>4%), medium (2 to 4%) and low (<2%) contents of organic matter respectively. Such a system will help to rationalize the use of N fertilizer, ensuring increased application on the poorer, less fertile soils, particularly under irrigated conditions (e g many grey soils of the Cartref, Kroonstad and Longlands forms, derived from granite in the Eastern Transvaal). Equally a reduction in rates of N fertilizer applied to soils with a good mineralizing capacity and a high organic matter content, could be anticipated.

It is hoped that it will eventually be possible, for advisory purposes, to categorize soils into classes based on organic matter content and the nature of the diagnostic topsoil horizon. This could be determined by a visual examination of the soil sample when it is received in the laboratory. This approach to improving the reliability of estimating sugarcane N requirements by classifying soils according to their organic matter contents and N mineralizing capacities, could be applied to other crops, provided normal practices of crop rotation are adhered to.

REFERENCES

1. Moberly, P.K., Wood, R.A., Meyer, J.H., Leibbrandt, N.B. and McIntyre, R.K. (1982). Soil: an important factor to consider when making nitrogen recommendations for sugarcane. *Nitrogen symposium. Soils and Irrigation Research Institute, Pretoria. May 1982.*
2. Wood, R.A. (1964). Assessing the potential of sugarbelt soils to supply nitrogen for plant cane. *SASTA Proc* **38**: 176–179.
3. Wood, R.A. (1965). Mineralization studies on virgin and cultivated sugar belt soils. *SASTA Proc* **39**: 195–202.
4. Wood, R.A. (1979). The effect of lime on release and plant uptake of nitrogen from soils of the Natal midlands. *SASTA Proc* **53**: 173–176.

TABLE 3

Proposed system for recommending N on plant and ratoon cane

Soil group	Main diagnostic A horizon(s)	Organic matter status	Estimated N mineral capacity (kg/ha)	Parent material	Soil form	N recommendations Plant (kg/ha)	N recommendations Ratoon (kg N/t cane)
I	Orthic (weak)	Low <2	Low <70	Recent Sand	Fernwood	120	1,6:1 (e g 160 kg N /100 t)
				TMS (ordinary)	Cartref		
				Dwyka tillite	Longlands Glenrosa		
				Granite	Glenrosa		
				Alluvium	Katspruit		
II	Melanic Vertic Orthic (good)	Medium 2-4	Medium 70-140	Lower Ecca shale	Milkwood	90	1,25:1 (e g 125 kg N /100 t)
				Middle Ecca sedt.	Swartland		
				Granite	Mayo		
				Dolerite	Shortlands		
					Arcadia		
				Alluvium	Hutton		
				TMS (ordinary)	Hutton		
III	Humic Orthic (Humic phase)	High >4	High >140	Dolerite	Hutton	60	0,8:1 (e g 80 kg N /100 t)
					Inanda		
				TMS (mist)	Inanda		
					Nomanci		
				Middle Ecca	Clovelly		
				Dwyka tillite	Griffin		

APPENDIX 1

Less 1% Soil Organic Matter - Summary of Responses to Applied N

Trial RFT	Locality	Soils: Parent material	Soils: Soil form	Avg O.M.% <1	CROP	Nitrogen: Level	Nitrogen: Rate kg N/ha	Yield: tc/ha	Yield: ts/ha	Response: tc/ha	Response: ts/ha	% Rel. Resp: tc/ha	% Rel. Resp: ts/ha	Avg. leaf N%
30/57/1P	Gingindlovu	Recent Red Sand	Hutton	0,60	P	N1 N3	0 100	34 55	4,9 7,9	— +21	— +3,0	— 61,8	— 61,2	1,36 1,39
32/57	Poynton	Recent Red Sand	Hutton	0,52	P	N1 N2	0 50	65 108	10,9 18,0	— +43	— +7,1	— 28,0	— 65,1	1,62 1,65
				0,68	1R	N1 N2	0 100	57 118	9,9 20,7	— +61	— +10,8	— 107,0	— 109,0	1,58 1,95
7/56/1R	T.G. Garland	Recent Sand	Hutton	0,78	P	N1 N4	0 150	43 77	6,2 10,6	— +34	— +4,4	— 79,1	— 71,0	1,78 1,88
51/58/1R1	Ocean View Estate	Recent Red Sand	Hutton	0,86	P	N1 N4	0 150	78 115	12,9 18,0	— +37	— +5,1	— 47,4	— 39,5	2,20 2,33
FT9NK	Umhlanga	Recent Red Sand	Hutton	0,92	5R	N0 N2	0 150	47 68	7,0 10,0	— +21	— +3,0	— 44,68	— 42,86	— —
FT15N/78	N. Coast La Mercy	Recent Grey Sand	Kroonstad	0,8	1R	N0 N6	0 200	73 116	10,7 16,4	— +43	— +5,7	— +59	— +53	1,65 1,99
			Average Average	0,74		Cont. N+		57 94	8,9 14,5	— +37	— +5,6	— 61,0	— 63,1	1,70 1,87

APPENDIX 2

1-2% Organic Matter — Summary of Responses to Applied N

Trial RFT	Locality	Soils: Parent material	Soils: Soil form	Avg O.M.% 1-2	CROP	Nitrogen: Level	Nitrogen: Rate kg N/ha	Yield tc/ha	Yield ts/ha	Response tc/ha	Response ts/ha	% Rel. Resp tc/ha	% Rel. Resp ts/ha	Avg. leaf N%
8/56/1P-R1	Umhlali	Recent Red Sand	Hutton	1,0	P	N1	0	109	14,8	—	—	—	—	1,76
						N2	50	130	17,6	+21	+2,8	19,3	18,9	1,78
				1,0	1R	N1	0	93	12,7	—	—	—	—	1,33
						N2	100	135	18,5	+42	+5,8	45,2	45,7	1,39
31/57/1R1	Cornubia	Recent Red Sand	Hutton	1,4	P	N1	0	96	13,9	—	—	—	—	1,94
						N4	150	103	14,7	+7	+0,8	7,3	5,8	1,98
				1,6	1R	N1	0	155	20,0	—	—	—	—	1,46
						N2	100	176	25,1	+21	+5,1	13,5	25,5	1,44
16/56/1P	Compen-sation	Dwyka	Glenrosa	2,0	P	N1	0	70	12,2	—	—	—	—	1,52
						N4	150	93	16,3	+23	+4,1	32,9	33,6	1,75
6/56/1P	Farmhill	Dwyka	Longlands	1,9	P	N1	0	111	19,3	—	—	—	—	1,85
						N4	150	142	22,7	+31	+3,4	27,9	17,6	2,06
				1,9	1R	N1	0	67	11,0	—	—	—	—	1,33
						N4	300	117	18,0	+50	+7,0	74,6	63,6	1,63
				1,9	2R	N1	0	71	10,8	—	—	—	—	—
						N3	200	100	15,5	+29	+4,7	40,8	43,5	—
12/56/1P	Darnall	Dwyka	Longlands	1,9	P	N1	0	87	14,7	—	—	—	—	2,08
						N4	150	108	18,0	+21	+3,3	24,1	22,4	2,33
47/58/1R1	Nyoni	Dwyka	Longlands	1,8	P	N1	0	104	18,3	—	—	—	—	2,05
						N2	50	113	20,0	+9	+1,7	8,7	9,3	2,22
FT4	Pongola	Alluvium	Hutton	<2	P	N1	0	106	12,5	—	—	—	—	1,77
						N3	168	119	13,3	+13	+0,8	+12	6,4	1,90
				<2	1R	N1	0	121	14,8	—	—	—	—	1,97
						N3	252	144	16,9	+23	+2,1	+19	14,2	2,31
				<2	3R	N1	0	107	12,7	—	—	—	—	1,59
						N2	164	136	15,2	+29	+2,5	+27	+20	—
FT1NPK/58	Chakas Kraal	Dwyka	Longlands	2,0	2R	N1(c)	0	73	13,3	—	—	—	—	1,31
						N5(NPK)	100	131	21,6	+58	+8,3	79,5	62,4	1,78
				<2	3R	N1(c)	0	55	9,0	—	—	—	—	1,44
						N5(NPK)	100	118	19,6	+63	+10,6	114,5	117,8	1,56
				<2	4R	N1(c)	0	39	6,2	—	—	—	—	1,46
						N5(NPK)	100	94	13,7	+55	+7,5	46,6	120,9	1,64
				<2	5R	N1(c)	0	52	8,7	—	—	—	—	1,56
						N5(NPK)	100	110	17,4	+58	+8,7	111,5	100,0	2,08
FT7N/60	Mtunzini	Ecca Shales	Longlands	<2	1R	N1(c)	0	128	20,1	—	—	—	—	1,73
						N5 S/A	224	138	22,2	+10	+2,1	7,8	10,4	1,82
				<2	4R	N1(c)	0	43	4,7	—	—	—	—	1,45
						N5 S/A	224	105	15,9	+62	+11,2	144,2	238,3	2,18
FT7N	Chakas Kraal	Dwyka	Longlands	2,0	4R — 5R	N0	0	66	8,5	—	—	—	—	—
						N3	220	93	11,4	+27	+2,9	40,9	34,1	—
				2,0	1R — 3R	N0	0	75	10,7	—	—	—	—	—
						N3	220	110	15,5	+35	+4,8	46,6	44,8	—
NK1/81	Zwide Mhlume	Middle Ecca	Estcourt	1,60	2R	N0	0	77	11,3	—	—	—	—	1,74
						N3	160	117	14,7	+40	+3,4	+52	+30	2,08
FT11NK/80	Umzinto South Coast	Granite	Glenrosa	1,75	4R	N0	0	65	8,9	—	—	—	—	1,72
						N4	190	77	10,4	+12	+1,5	+13	+17	2,11
FT12NK/80	South Coast Nkwifa	Granite	Kroonstad	1,27	5R	N0	0	60	8,0	—	—	—	—	1,92
							190	68	9,3	+8	+1,3	+13	+16	2,10
			Average	1,79		Cont		85	12,4	—	—	—	—	1,67
			Average			N+		116	16,8	+31	+4,4	42,6	46,6	1,91

APPENDIX 3

2-4% Organic Matter — Summary of Responses to Applied N

Trial	Locality	Soils		Avg O.M.% 2-4	CROP	Nitrogen		Yield		Response		% Rel. Resp		Avg. leaf N%
RFT		Parent material	Soil form			Level	Rate kg N/ha	tc/ha	ts/ha	tc/ha	ts/ha	tc/ha	ts/ha	
34/57/1R1	Nkwaleni	Alluvium	—	2,0	P	N1 N4	0 150	136 163	24,6 28;7	— +27	— +4,1	— 19,9	— 16,7	1,56 1,72
				2,0	1R	N1 N4	0 300	135 191	24,7 30,8	— +56	— +6,1	— 41,5	— 24,7	1,65 1,86
28/57/1R1	Gingind-lovu	Ecca Shale	Longlands	2,7	P	0 100	N1 N3	75 87	10,9 12,9	— +12	— +2,0	— 16,0	— 18,3	1,97 2,08
				2,9	1R	N1 N4	0 300	127 164	19,9 24,9	— +37	— +5,0	— 29,1	— 25,1	1,24 1,32
45/58/1R1	Pongola	Dolerite	Shortlands	2,6	P	N1 N4	0 150	142 151	19,4 18,1	— +9	— −1,3	— 6,3	— −6,7	1,90 1,95
				2,9	1R	N1 N4	0 30	106 167	7,6 12,0	— +61	— +4,4	— 57,5	— 57,9	— —
FT8N/60	Mtunzini	Ecca Shale	Longlands	2,5	3R	N1(c) N2(ur)	0 112	101 124	17,8 22,1	— +23	— +4,3	— 22,7	— 24,6	1,70 2,13
				2,5	4R	N1(c) N5 S/A	0 224	79 90	12,7 14,8	— +11	— +2,1	— 13,9	— 9,50	2,17 2,55
NK1/80/1	Somerling Ubombo Ranches	—	Mayo	2,63	2R	N0 N1	0 80	82 103	12,7 15,4	— +21	— +2,7	— 26	— 21	1,56 —
NK2/80/R5	Vimy Tambankulu	—	Bonheim	2,89	6R	N0 N4	0 200	76 84	10,8 10,9	— +8	— +0,1	— 10,0	— 9,0	1,72 1,87
NK3/81	T. Set Tambankulu	Middle Ecca	Tambankulu	2,61	4R	N0 N5	0 240	82 151	11,8 19,0	— +69	— +7,2	— +84	— +61	1,56 2,37
NK2/81	Canterbury Ubombo Ranches	—	Bonheim	3,50	2R	N0 N2	0 120	78 96	10,5 13,7	— +18	— +3,2	— 23	— 30	1,67 1,92
FT1N/80	South Coast Experanza	Granite	Mayo	3,9	4R	N0 N2	0 130	92 105	13,4 15,2	— +13	— +1,8	— +14	— +13	2,23 2,33
			Average Average	2,74		Cont N+		101 129	15,1 18,3	— +28	— +3,2	— 28	— 23,4	1,74 2,01

APPENDIX 4

4–6% Organic Matter — Summary of Responses to Applied N

Trial RFT	Locality	Soils: Parent material	Soils: Soil form	Avg O.M.% 4-6	CROP	Nitrogen: Level	Nitrogen: Rate kg N/ha	Yield: tc/ha	Yield: ts/ha	Response: tc/ha	Response: ts/ha	% Rel. Resp: tc/ha	% Rel. Resp: ts/ha	Avg. leaf N%
4/56/1P/1R	Darnall	Ecca Shale	Milkwood	5,3	P	N1	0	157	26,6	—	—	—	—	1,46
						N4	150	166	26,8	+9	+0,2	5,7	0,8	1,55
				5,1	1R	N1	0	115	18,9	—	—	—	—	1,41
						N4	300	163	26,1	+48	+7,2	41,7	38,1	1,73
53/591P	Barrow Green Estate	Ecca Shale	Milkwood	4,6	P	N1	0	62	9,6	—	—	—	—	2,03
						N3	100	87	13,5	+25	+3,9	40,3	40,6	2,21
41/57/1R1	Gingindlovu	Ecca Shale	Milkwood	4,8	P	N1	0	53	8,4	—	—	—	—	1,56
						N4	150	59	8,9	+6	+0,5	11,3	6,0	1,65
35/57/1R1	Empangeni	Tugela Schist	Shortlands	4,4	P	N1	0	86	14,9	—	—	—	—	2,00
						N3	100	88	15,0	+2	+0,1	2,3	0,7	1,97
				4,5	1R	N1	0	220	31,7	—	—	—	—	1,89
						N4	300	250	30,0	+30	−1,7	13,6	−5,4	1,95
46/58/1P	Empangeni Rail	Tugela Schist	Shortlands	4,0	P	N1	0	113	18,4	—	—	—	—	1,56
						N2	50	109	17,6	−4	−0,8	3,5	4,3	1,56
				4,7	1R	N1	0	137	—	—	—	—	—	1,68
						N4	300	134	—	−3	—	2,2	—	1,84
49/58/1R1	Mposa	Tugela Schist	Shortlands	5,0	P	N1	0	112	18,6	—	—	—	—	1,82
						N4	150	121	19,6	+9	+1,0	8,0	−5,4	1,81
FT14N/78	Hillcrest	TMS (Mist)	Inanda	5,8	2R	N0	0	126	16,5	—	—	—	—	1,87
						N5	250	150	20,1	+24	+3,6	19,0	21,8	2,57
FT12	Hillcrest	TMS (Mist)	Inanda	5,8	4R	N0	0	63	8,3	—	—	—	—	2,49
						N2	75	82	9,9	+19	+1,6	30,0	19,2	2,84
FT14NK	Hillcrest	TMS (Mist)	Inanda	5,8	4R	N0	0	63	7,2	—	—	—	—	2,00
						N2	75	82	9,1	+19	+1,9	30	26	2,35
FT6NK	Mid Illovo	TMS (Mist)	Inanda	4,1	3R	N0	0	64	7,2	—	—	—	—	2,47
						N2	100	73	8,1	+9	+0,9	+14	+12	2,48
FT5NK	Harden Heights	TMS (Mist)	Inanda	4,2	3R	N0	0	66	6,7	—	—	—	—	2,30
						N4	150	71	7,3	+5	+0,6	+8	+9	2,50
FT7NK	Harburg	TMS (Mist)	Inanda	5,8	3R	N0	0	40	4,2	—	—	—	—	2,20
						N3	150	46	5,1	+6	+0,9	+15	+21	2,20
			Average	4,9		Cont		98	14,1	—	—	—	—	1,92
			Average			N+		112	15,5	+14	+1,4	+15,3	+13,0	2,08

APPENDIX 5

>6% Organic Matter — Summary of Responses to Applied N

Trial RFT	Locality	Soils: Parent material	Soils: Soil form	Avg O.M.% >6	CROP	Nitrogen: Level	Nitrogen: Rate kg N/ha	Yield: tc/ha	Yield: ts/ha	Response: tc/ha	Response: ts/ha	% Rel. Resp: tc/ha	% Rel. Resp: ts/ha	Avg. leaf N%
48/58/1P	Amatikulu	Ecca	Milkwood	6,0	P	N1	0	58	9,5	—	—	—	—	1,89
						N2	50	60	9,8	+2	+0,3	3,4	3,2	1,90
15/56/1P-R1	Umhlali	Ecca Shale	Milkwood	7,9	P	N1	0	106	14,8	—	—	—	—	1,88
						N2	50	109	15,2	+3	+0,4	2,8	2,7	1,84
				6,8	1R	N1	0	60	8,2	—	—	—	—	1,53
						N2	100	74	10,0	+14	+1,8	23,3	22,0	1,73
COF1	Upper Tongaat	TMS (Mist)	Inanda	10,9	2R	N0	0	85	12,0	—	—	—	—	2,08
						N2	150	87	11,2	+2	−0,8	2,3	−0,67	1,97
COF1	Upper Tongaat	TMS (Mist)	Inanda	10,9	3R	N0	0	60	8,0	—	—	—	—	2,14
						N1	100	70	9,5	+10	+1,5	16,6	18,75	2,21
FT8NK	Richmond	Dolerite	Balmoral	8,5	3R	N0	0	63	8,2	—	—	—	—	2,42
						N1	100	69	9,0	+6	+0,8	+14	+10	2,52
			Average	8,5		Cont		72	10,1	—	—	—	—	1,99
			Average			N+		78	10,8	6	+0,7	10,4	9,3	2,03