THE RESULTS OF P FERTILIZER TRIALS CONDUCTED IN THE NATAL MIDLANDS

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Abstract

The results are reported of six field experiments which were conducted in the Natal Midlands to determine the P requirement of strongly P-fixing soils and to provide data for calibrating the phosphorus desorption index (PDI) procedure for routine advisory purposes.

Measured responses to P treatments were related to soil P-sorption properties. The findings indicated that supplementing the traditional soil Truog P test with the rapid PDI screening technique for measuring P fixation was warranted.

The revised procedure for making P fertilizer recommendations is described and indicates that soils with the same Truog extractable P level but different P retention properties will not necessarily receive the same P recommendations. A survey suggests that about 30% of the soils in the Natal Midlands will benefit from fertilization with high rates of superphosphate.

Introduction

Since the early 1970's a number of investigations have been conducted to study the productivity of sugarcane on the highly leached acid soils in the Natal Midlands. Studies of the effects of wattle brush burning on soil fertility (Meyer[5]), of aluminium toxicity (Moberly and Meyer[8]), and of P fixation (Meyer[6]) have all emphasised the extent of the nutritional limitations of soils in large parts of the region.

Recent developments based on P adsorption isotherm measurements and glasshouse studies have indicated that soils with the same extractable Truog P levels do not necessarily have similar P requirements. Large growth responses to treatment with P were measured in pot experiments when soils received two to three times the normally recommended amounts of single superphosphate. The higher P requirement was attributed mainly to the need to overcome the effects of phosphate retention arising from the chemisorption of phosphate anions by positively charged sesquioxidic compounds in the soil.

A new soil test, known as the Phosphorus Desorption Index (PDI) method (Reeve and Sumner[11]) was therefore proposed to supplement the existing 0,02N H_2SO_4 Truog extraction procedure in order to account for the effects of varying P retention in soils. Before this modification could be implemented fully on an advisory basis it was necessary to verify the laboratory and glasshouse findings by means of field experimentation.

Six field experiments were established in the Natal Midlands in 1974 and 1975 on sites where the soils provided a satisfactory range of combinations of extractable P and P-fixing capacity. Some of the results of the plant crops have been reported (Meyer[7]) and the first ratoon results have since become available. This paper refers to the results of the six field experiments in which the effects on cane and sugar yields of P fertilizer, which was either broadcast or placed in the furrow were compared. Extractable Truog P values, soil PDI and third leaf P values were determined.

Experimental procedure

Description of sites

The sites that were selected for the field experiments were located on soils of the Nottingham soil system (Macvicar[3]). In terms of the new Binomial System of soil classification (Macvicar et al[4]), the soils range from well weathered deep porous red clays with dark humic topsoils (Inanda and Sprinz series) to yellow to red sandy clay loams of variable depth (Balgowan, Griffin, Trevanian and Farningham series), derived mainly from dolerite and Table Mountain Sandstone parent materials. The excellent physical properties of these soils, combined with good rainfall distribution in this region, ensures that moisture is not a serious limiting factor in crop production. The soil series names and selected chemical properties of the sites chosen are shown in Table 1.

Chemically, the soils were strongly acid throughout with low reserves of plant available nutrients and non-toxic levels of exchangeable aluminium. Five of the soils were deficient in P (< 31 ppm). Two were classed as very strongly P-fixing (sites 2 and 3, PDI < 0,1), two as strongly P-fixing (sites 1 and 5, PDI 0,1 to 0,2) and one as moderately P-fixing (site 4, PDI 0,2 to 0,4). Although combinations of high extractable P and low PDI values seldom occur in practice, there was a need to test such a combination and consequently site 6 was also included in the project.

Treatment design

To facilitate the selection of P treatments for testing in the field it was necessary to establish beforehand the theoretical P requirement of the various soils using the method of Ozanne and Shaw.[10] This is estimated from the amount of superphosphate that must be added to raise the concentration of the soil solution to an equilibrium level of 0,2 ppm of P. The required information is obtained in practice by interpolation from the respective P adsorption isotherms, some of which are shown

TABLE 1
Locality and selected properties of soils from experiment sites

Site No.	Locality	Soil series	% Clay (0-20 cm)	Chemical properties of topsoil (0-20 cm)						
				pH (H_2O)	P (ppm)	PDI	K (ppm)	Ca (ppm)	Mg (ppm)	EAI (ppm)
1	Mid-Illovo	Fountainhill	26	5,2	3	0,16	136	953	705	5
2	Richmond	Balmoral	26	5,3	8	0,01	89	550	367	5
3	Glenside	Inanda	33	5,1	5	0,03	64	450	254	39
4	Harden Heights	Inanda	28	5,4	17	0,24	109	750	585	1
5	Harburg	Inanda	39	5,0	8	0,19	96	310	155	19
6	Hillcrest	Inanda	35	5,1	32	0,15	181	567	193	30

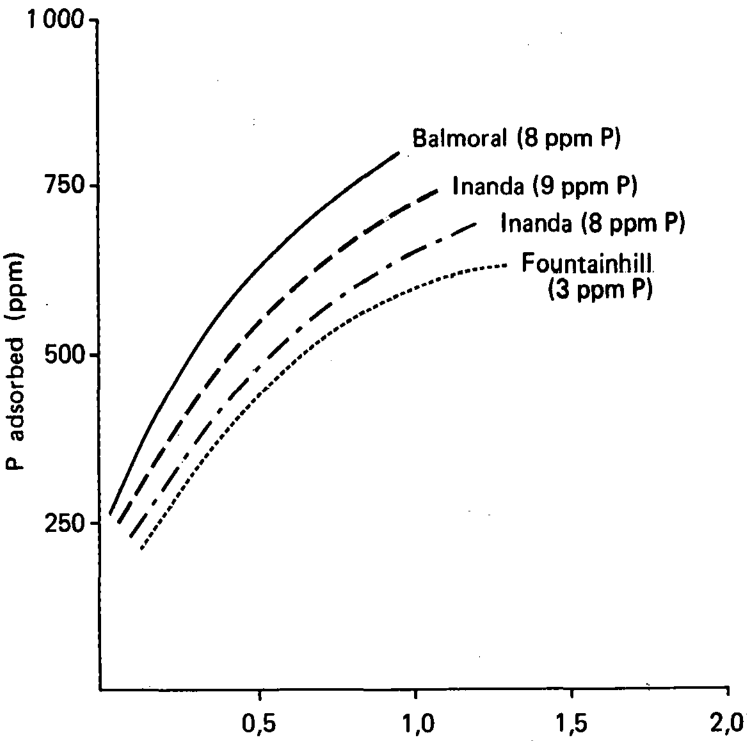

FIGURE 1 P-adsorption isotherms of soils from four trial sites where the soils had similar extractable (Truog) P levels.

in Fig. 1. The theoretical P requirements were on average four to five times higher than would normally be recommended, and ranged from 4,3 tons to 10,5 tons of single superphosphate per hectare for the moderately P-fixing Inanda (site 4) and the very strongly P-fixing Balmoral (site 2) soils respectively.

For practical reasons it was decided to combine the normal treatment with superphosphate in the furrow and supplementary broadcast applications which were economically acceptable. For the plant crop six P treatments were tested in a simple randomised block design and each treatment was replicated five times. The average amounts of P applied as single superphosphate (8,3% water soluble P) are shown in Table 2. Included were standard and high amounts of single superphosphate in the furrow as well as duplicate high and low broadcast treatments combined with the lower amount in the furrow. In all of the trials the high rate of superphosphate in the furrow was double the standard rate. The high levels of broadcast supers were generally about two to four times the standard rate.

The residual effects of treatments P2, P3 and P5 applied at planting were compared with the effects of top-dressing the ratoon cane with additional P at a rate of 50 kg per hectare in treatments P1, P4 and P6. The total P used in the broadcast treatments varied from 12 to 83% of the theoretical P requirements as defined by Ozanne and Shaw.[10]

Placement of superphosphate

The appropriate amounts of superphosphate were banded in the furrow, and immediately after planting the broadcast P treatments were applied and incorporated into the soil by hand rake. It is considered that broadcasting P before the planting furrows are drawn would be equally effective and probably more convenient in commercial practice. All plots were top-dressed with adequate quantities of nitrogen and potassium in the form of 1-0-1(47) fertilizer mixture and a light dressing of zinc sulphate was also applied where the need for zinc was indicated by soil analysis. Each plot comprised six cane rows, 10 m long and 1,3 m apart. The harvested net plot area comprised four rows each eight metres long.

Planting and management

The trials were planted in November and December 1974, with clean seed of variety NCo 293. The age of the plant crops at harvest varied from 17 to 24 months and the first ratoon crops from 18 to 22 months. Stalk counts and heights were recorded at regular intervals while top visible dewlap (TVD) leaf samples were taken when the crops were about 4, 6, 14 and 16 months of age. All plots in the trials were soil sampled in order to assess the effects of the various treatments on relevant chemical soil properties. Measurements made at harvest included the mass of cane and the average length and number of millable stalks. Suitable samples were also taken for sucrose determination.

Results

Cane growth

Responses to high broadcast P fertilization were apparent within three months of planting at sites 1, 3 and 4. Subsequent height measurements and population counts confirmed this trend. At harvest of the plant cane the plots treated with the high amount of broadcast P produced on average 11% more millable stalks which were 10% longer than the stalks from the standard treatment plots. The best results were obtained on the Fountainhill series soil (site 1), where the high broadcast P treatment produced the greatest increase in number (+13%) and length (+12%) of millable stalks compared with the standard treatment.

In the first ratoon crops treatment effects were relatively small, due mainly to the improved growth of the cane in the standard treatment plots which received additional P. Nevertheless, in three of the trials (sites 1, 3 and 4) differences due to treatment were clearly apparent from an early stage. Treatment effects subsequently disappeared on site 1 probably because the co-operator top-dressed the trial in error.

TABLE 2
Average levels of phosphorus (kg P/ha) applied as single superphosphate

Placement	Levels	Plant Cane		1st Ratoon Cane		Total P applied	
		In furrow (average)	Broadcast	Topdressed (average)	Total	% Truog	% Ozanne and Shaw
In furrow	P1	100	Nil	50	150	100	25
	P2	200	Nil	Nil	200	133	33
	P3	100	125*	Nil	225	150	37
Combined in furrow/broadcast . .	P4	100	125*	50	275	183	46
	P5	100	250†	Nil	350	233	58
	P6	100	250†	50	400	266	67

* 125 kg P/ha = 1,5 t single superphosphate/ha † 250 kg P/ha = 3,0 t single superphosphate/ha

Yield and sugarcane quality

The effects of the higher rates of P application on cane and sucrose yields from the plant and first ratoon crops are shown in Tables 3 and 4 respectively. A summary of the mean combined plant and 1st ratoon responses to the broadcast P treatments together with some relevant soil analyses are shown in Table 5. Comparison of the treatment effects reveals the following:

(1) Plant crop

(i) The treatment with 3 tons of single superphosphate broadcast per hectare (P5 and P6) was markedly superior to the other P treatments, with statistically significant responses being obtained in four trials, (sites 1, 2, 3 and 4) in terms of tons cane per hectare, and also on site 5 in terms of tons sucrose per hectare. The average response to treatments P5 and P6 compared with treatment P1 amounted to 20 tons cane or 2,4 tons sucrose per hectare.

(ii) Smaller but significant responses were obtained to the treatments with low amounts of broadcast P (P3 and P4) and to the treatment with a high amount of P in the furrow (P2) in two of the trials (sites 1 and 3). The effects of methods of P application, however, did not differ significantly.

(iii) A statistically significant linear response to additional P in terms of tons cane per hectare, on the Fountainhill (site 1) and Inanda series (site 4) soils.

(iv) No significant response to any of the P treatments was noted for the Inanda soil in the trial at site 6 where the pre-plant level of extractable P was 32 ppm.

(2) First ratoon crops and combined plant and first ratoon results

(i) Significant residual effects due to broadcast P treatments in the plant crop were apparent in the first ratoon crops in only two trials (sites 2 and 3). The average residual response to both broadcast treatments in all of the trials (excluding site 6) was 5 tons cane or 0,6 tons sucrose per hectare. This represents only 35% of the average response obtained to the two broadcast P treatments in the plant crop.

(ii) Top-dressing of the duplicate plots treated with low and high amounts of broadcast P (P4 and P6) with an additional 50 kg P per hectare proved to be significantly beneficial in only the very high P-fixing Inanda soil at Glenside (site 3). The effect of top-dressing the control plots (P1) with additional P was on average about the same as the residual effect of the high amount of supers placed in the furrow at planting (P2).

(iii) The relationship between total P treatments and the combined yields of the plant and first ratoon crops for all the trials (except site 6) is shown graphically in Figure 2. The final columns of Tables 3 and 4 show the mean combined increases in yield due to treatment, in terms of tons cane and tons sucrose per hectare respectively.

TABLE 3

Plant and ratoon crop yields (tc/ha) on six sites

Treatment / Sites		Plant cane yield (t cane/ha)						1st ratoon cane yield (t cane/ha)						Average† (t cane/ha)			
		1	2	3	4	5	6	1‡	2	3	4*	5	6	Plant	1st R	Total (P1+1R)	Increase over P1§
P1		117	92*	106	90	120*	160	103	127*	107	104	134	119	105	114	219	—
P2		133	92	126	93	127	158	101	122	110	96	126	119	114	111	225	6
P3		138	100	124	99	123	157	103	139	113	104	130	122	117	118	235	16
P4		138	100	124	99	123	157	100	133	123	98	128	121	117	116	233	14
P5		152	111	124	108	129	164	100	135	116	98	124	120	125	115	240	21
P6		152	111	124	108	129	164	101	133	121	106	129	114	125	118	243	24
L.S.D.	5%	12	13	10	14	13	19	11	12	7	7	9	15	—	—	—	
	1%	16	18	13	19	18	25	15	18	10	10	13	20	—	—	—	

* refers to mean of 4 replicates
† average excludes site 6
‡ trial top-dressed in error by co-operator
§ means of 75 replications, except treatment P2 (50 reps).

TABLE 4

Plant and ratoon crop yields (t suc/ha) on six sites

Treatment / Sites		Plant cane yield (t sucrose/ha)						1st ratoon cane yield (t sucrose/ha)						Average† (t sucrose/ha)			
		1	2	3	4	5	6	1‡	2	3	4*	5	6	Plant	1st R	Total (P1+1R)	Increase over P1§
P1		16,1	13,6*	14,7	9,3	15,4*	14,7	14,1	17,7*	14,0	12,4	18,9	16,4	13,8	15,4	29,2	—
P2		18,9	13,9	17,1	9,1	16,6	14,1	13,4	16,9	13,9	12,3	18,3	15,9	15,1	15,0	30,1	0,9
P3		18,8	14,6	17,0	9,2	16,2	13,7	13,7	18,5	14,1	13,1	19,3	16,5	15,2	15,7	30,9	1,7
P4		18,8	14,6	17,0	9,2	16,2	13,7	13,9	18,3	15,7	12,6	19,9	16,7	15,2	16,1	31,4	2,2
P5		20,8	15,8	16,8	10,2	17,4	14,0	13,1	19,0	14,3	12,5	18,1	16,0	16,2	15,4	31,6	2,4
P6		20,8	15,8	16,8	10,2	17,4	14,0	13,2	18,7	15,1	13,6	18,6	16,0	16,2	15,8	32,0	2,8
L.S.D.	5%	2,2	1,9	1,6	1,5	1,5	1,3	1,6	1,2	0,8	1,2	1,6	2,7	—	—	—	
	1%	3,0	2,7	2,1	2,1	2,0	1,7	2,2	1,6	1,1	1,7	2,1	3,8	—	—	—	

* refers to mean of 4 replicates
† average excludes results from site 6.
‡ trial topdressed in error by co-operator with additional P
§ means of 75 replications except treatment P2 (50 reps).

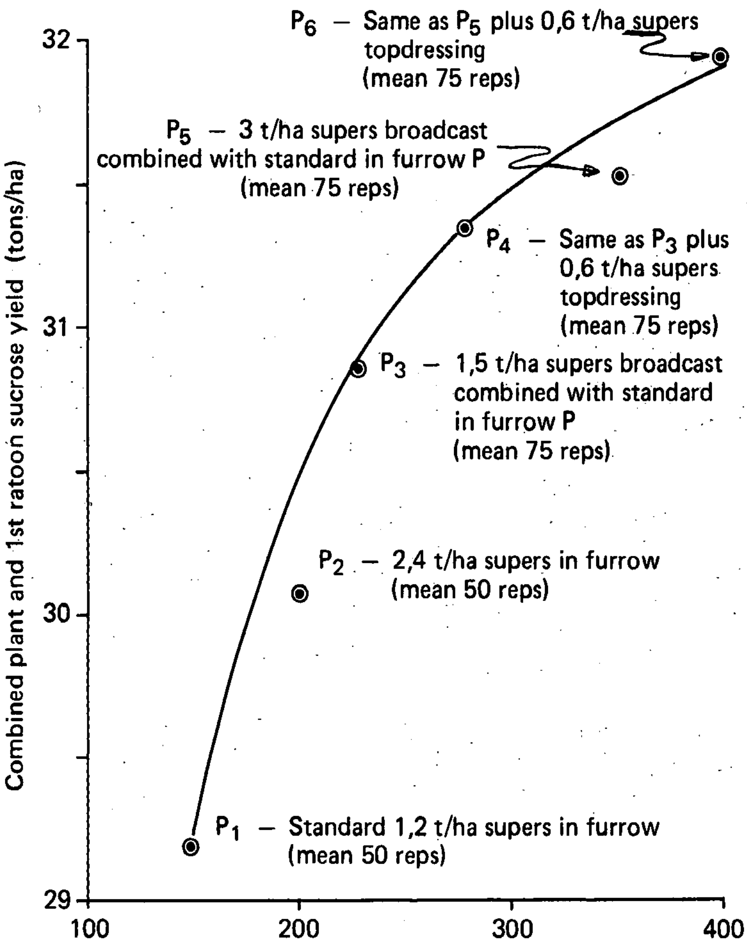

FIGURE 2 Combined plant and first ratoon yields of five trials in relation to applied P.

Residual soil Truog P-PDI levels

As shown in Fig. 3, the decline in levels of extractable P of the soils from the plots receiving the two broadcast P treatments over a four year period was relatively small, and amounts on average to approximately 30% of the extractable P levels measured in the same plots at the commencement of the trials.

The residual effects of these treatments on extractable soil P levels was found to be inversely related to P sorption capacity of the soils, as illustrated in Fig. 4. On average a broadcast application of 3 tons single super phosphate per hectare increased extractable P by approximately 20 ppm in the high P-fixing soils (PDI < 0,20), compared with 40 ppm in the moderate P-fixing soils (0,2 to 0,4).

Apart from marked increases in the available Ca, no major treatment effects on other soil chemical characteristics were apparent. There were slight increases in the PDI values in some of the soils, but the effects were not statistically significant.

Third leaf P analysis as a measure of P deficiency

In both the plant and first ratoon crops, third leaf P % dry matter declined slightly over the sampling period. In only two of the trials where there was a response to treatment with additional P in the plant crop, did the third leaf P content in the standard treatment indicate a deficiency of P. Furthermore, the small differences between the treatments in terms of leaf P content were not consistent with the large yield responses obtained due to treatment with P. This point is illustrated in Fig. 5 where the average third leaf P values and the average yields of plant cane are related to the amounts of P applied in five trials.

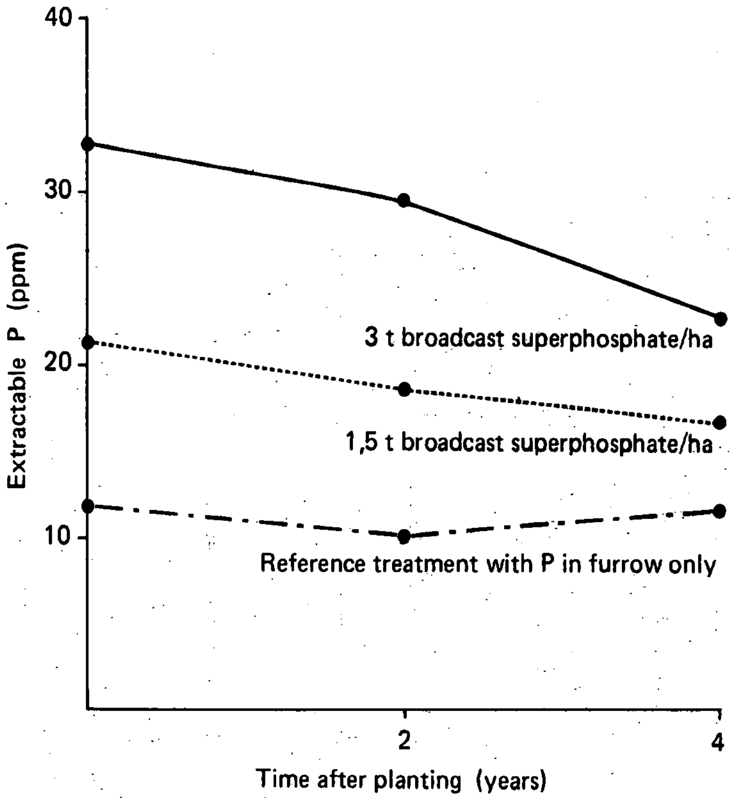

FIGURE 3 Soil extractable P levels measured on three occasions over a four-year period (average of four trials).

Using DRIS (diagnosis and recommendation integrated system) as developed by Beaufils,[2] the likelihood of a response to treatment with P was correctly predicted in the plant crop in the four trials in which a response was obtained to P. However, as shown in Fig. 5, the DRIS P-index values were not associated any better with the degree in yield response than were the leaf P values.

Discussion

Crop response in relation to P fertilizer placement

The results of this investigation confirm the results of exploratory studies conducted six years ago, which suggested that P fertilizer applied to plant cane in excess of the amounts

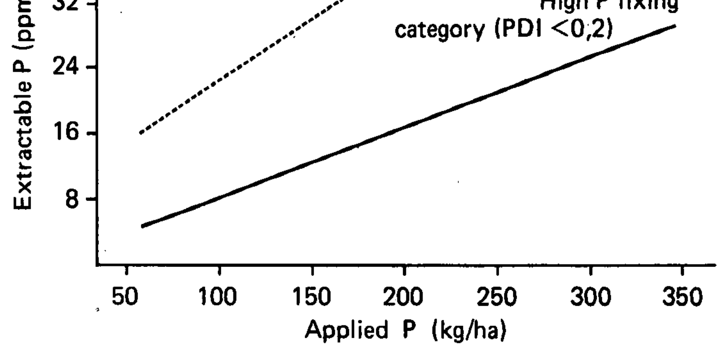

FIGURE 4 Relationship between P applied at planting and average extractable P for moderate and high P-fixing soils.

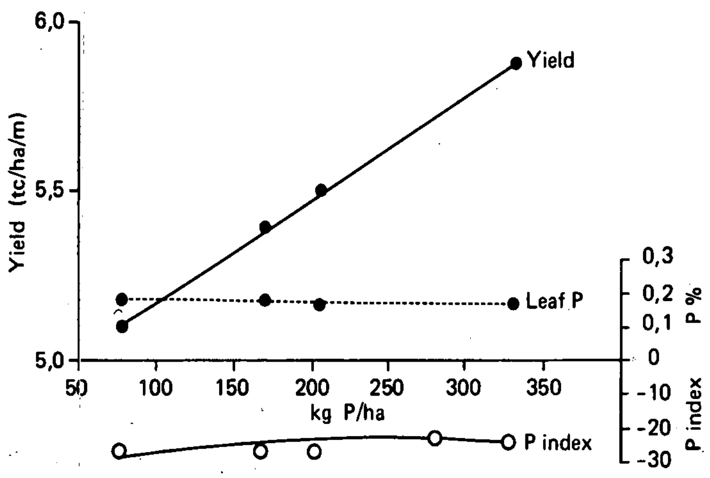

FIGURE 5 Relationship between yields (tc/ha/month), applied P, third leaf P composition and the DRIS P-index in the plant crop.

indicated to be necessary according to the Truog extraction method, would enhance the productivity of high P-fixing soils. Normally, all P fertilizer for sugarcane is applied in the furrow prior to planting but in these trials the best results were obtained when the normal furrow dressing of P was accompanied by a heavy broadcast application of superphosphate. This trend was also apparent when the lower amount of superphosphate was broadcast. The advantages to be gained from broadcast applications of P in these soils suggest that the plant crop cannot effectively obtain all of its P requirement from an application in the furrow alone.

Studies conducted by Schroo,[12] on acid high P-fixing soils in Trinidad, indicated that phosphate fertilizer exposed to the maximum possible extent to the fixing capacity of a P deficient soil, was apparently more effective than the material which was placed in the furrow before planting. Investigations by Barber[1] with maize, using the split root technique, have shown that P uptake by the plant is proportional to the fraction of the root system exposed to fertilizer P. Roots in a solution containing P, branched and developed more rapidly than those in a solution without P, despite the fact that a certain amount of P was translocated from the healthy to the poorly grown roots. It was shown that P uptake by roots in soil was limited by the small distance (approximately 0,5 mm) over which P diffused, and only 5 to 15% of a band application of P was utilised by the first crop following fertilization. The efficiency of phosphate fertilizer was found to be significantly greater when it was broadcast and incorporated to a depth of 5 cm in the soil.

The results of the present investigation supports those obtained previously with sugarcane, when broadcast ^{32}P labelled superphosphate was shown to be superior to labelled banded superphosphate in first ratoon cane grown on a high P-fixing Inanda soil (Moberly and Wood[9]).

Residual effects of broadcast P treatments

P-fractionation studies conducted previously on soil samples from the sites of these experiments indicated that increases in extractable P following treatment with superphosphate were generally accompanied by marked increases in the moderately available Al-bound fraction.[7]

The residual effects of the low and high dressings of P broadcast on the plant crops were apparently sufficient to meet the full requirements of the first ratoon crops except on the high P-fixing Inanda soil (site 3) where a top-dressing of 50 kg P per hectare on the first ratoon increased yields.

Although 100 kg P per hectare in the furrow in the P1 treatments on sites 1 to 5 was insufficient to meet the full requirements of the plant crops, an application of 50 kg P top-dressed on the first ratoons was apparently sufficient to produce maximum crops from the same plots on all sites, except the two very strongly P-fixing Balmoral and Inanda soils (sites 2 and 3).

Improved P fertilizer advice

Until recently the highest rate of P fertilizer recommended to growers in the Natal Midlands was 1,3 tons single superphosphate per hectare in the furrow. A response of 1 ton of sucrose per hectare is needed to cover the cost of applying an an additional 1,5 tons single superphosphate per hectare.

It is apparent from the combined plant and first ratoon results in Table 4 that the application of 1,5 tons superphosphate per hectare was economical in four trials, while the application of 3,0 tons was profitable in the two very strongly P-fixing Balmoral and Inanda soils (sites 2 and 3). The same can be said of the severely P-deficient, strongly P-fixing Fountainhill series soil (site 1). Obviously, more P fertilizer should be recommended for certain midlands soils. The PDI procedure may provide a rapid means of assessing the P-fixing capacity of a soil but calibration needs to be carried out to confirm this contention.

TABLE 5
Comparison of combined plant and 1st ratoon response to broadcast P in relation to soil Truog P and PDI levels

Order of response	Site	Combined plant + 1st ratoon response (tons sucrose/ha)			Soil P status	
		Low BC* (P4 – P1)	High BC (P6 – P1)	Mean BC response	Truog P (ppm)	PDI
1	1	2,5‡	3,9‡	3,2‡	3	0,16
2	3	2,4‡	3,2‡	2,8‡	5	0,03
3	2	1,6†	3,2‡	2,4‡	8	0,01
4	5	1,8†	1,7†	1,7†	8	0,19
5	4	0,6	2,1†	1,4	17	0,24
6	6	– 0,7	– 1,1	– 0,9	32	0,15

* BC refers to broadcast placement
† response significant at 5% level
‡ response significant at 1% level.

The development of suitable criteria for P recommendations

In general, the best responses to treatment with P fertilizer were associated with soils with low Truog P and low PDI values. This effect is illustrated by the data given in Table 5, which shows the mean combined plant and 1st ratoon response to broadcast P, ranked in decreasing order of magnitude in relation to Truog P and PDI values. Although there is a satisfactory correlation between yield response to applied P and Truog P values, it is evident that extractable Truog P values cannot be used alone in some circumstances in order to predict the fertilizer requirements for sugarcane. For example the Inanda (site 5) and Balmoral (site 2) soils contained the same amount of pre-plant extractable P, yet the P requirements differed significantly. If the P fixation capacities of the soils are considered, then it can be seen that the higher P requirement is associated with the more strongly P-fixing Balmoral (PDI 0,01).

The value of supplementing the Truog procedure with the PDI method was shown when the results of previous fertilizer trials, including those from 28 3N × 3P × 3K factorial experiments were grouped into high (PDI $<$ 0,20), moderate (PDI 0,20 to 0,40) and low (PDI $>$ 0,40) P-fixing categories. The response surface which relates the response to applied P to soil Truog values and PDI values, is shown in Fig. 6.

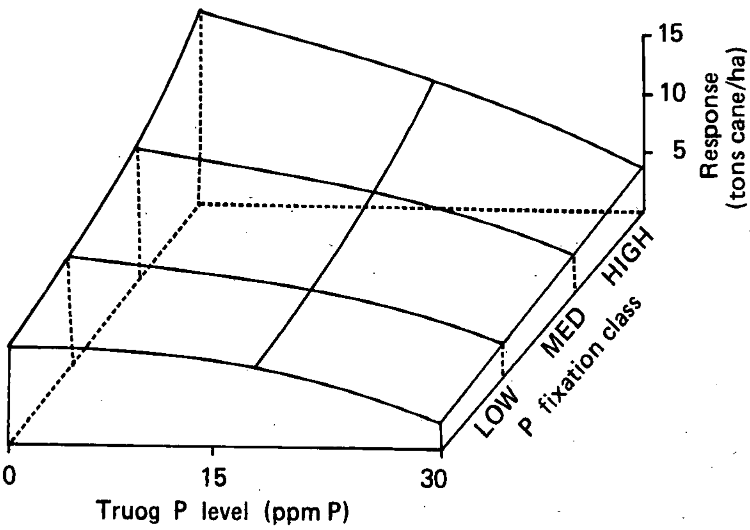

FIGURE 6 Response surface showing yield responses in relation to Truog P and P-fixation class (after Meyer[7]).

Calibration of the Truog P/PDI procedure

It has been established from the slopes of the curves shown in Fig. 4 that on average an application of 12 kg P per hectare was required to raise the extractable P level by 1 ppm in the plough layer of strongly P-fixing soils (PDI < 0,20), while half this rate was sufficient for moderately P-fixing soils (PDI 0,20 to 0,40) currently, for low P-fixing soils an amount of 3 kg P per hectare is considered to be adequate.

The aim of present P fertilizer recommendations is to make up the difference between the soil test value and the threshold value of 31 ppm (70 kg/ha). It has therefore been possible to propose simple procedures for adjusting the Advisory Service P fertilizer recommendations for growers in the midlands. The proposed amounts of P to be recommended for plant cane on obtaining different soil Truog P and PDI values are shown in Table 6. They are additional to the standard recommendations of P in the furrow. In practice, broadcast applications of P at planting are supplemented in ratoons with the standard top-dressing of single superphosphate in order to maintain satisfactory Truog P levels.

Since P is an expensive nutrient, marginal cost analysis was used to check that the proposed rates were economically warranted. The calculated economic yield optimum of 290 kg P per hectare was slightly higher than the highest amount of total P recommended in Table 6.

TABLE 6

Revised procedure for making supplementary broadcast P fertilizer recommendations in Natal Midlands
(After Meyer[7])

Soil Truog P	P (ppm)		> 18	18	13	< 9
	P (kg/ha)		> 40	40	30	20
	Single supers (55 kg/ha)		> 500	500	350	250
	PDI class		Supplementary Broadcast P requirement (kg/ha)			
Plant cane	< 0,2	P	Nil	80	130	170
		SS	Nil	1 000	1 500	2 000
	0,2 to 0,4	P	Nil	80		
		SS	Nil	1 000		

Extent of the P-fixation problem

A survey was conducted of the extractable P and PDI values obtained for soil samples taken from nearly 1 600 fields in the Natal Midlands over a period of two years. The samples were classified into high, medium and low P-fixing categories and four Truog P classes as shown in Table 7.

Of the samples examined, 23% were found to be strongly P-fixing, 19% moderately P-fixing and 58% weakly P-fixing. Slightly fewer than half of the 296 fields in the high P-fixing category were found to have a low level of extractable P (4 ppm or less), whereas the comparable figures for the moderately and weakly P-fixing soils were 19% and 36% respectively. Only two percent of the samples showed high P-fixation in association with high Truog P values.

TABLE 7

Frequency of P fixation in Midlands soils containing differing amounts of extractable (Truog) P

Truog P (ppm)	No. of fields	% Fields with soils showing following degrees of P-fixation: High	Medium	Low
< 4	296	9	4	6
5–9	361	7	5	10
10–18	437	5	6	16
> 18	497	2	4	26
TOTAL	1 591	23	19	58

Conclusions

The results of this study confirm that applications of superphosphate to sugarcane at levels in excess of normally recommended rates will increase the productivity of sugarcane on high P-fixing soils. Indications are that a combined in-furrow/broadcast placement of superphosphate is an effective means of applying P to plant cane, since it combines the advantages of high P availability during early stages of growth with a large soil P/root contact area during later growth.

For routine advisory purposes the currently used threshold value of 31 ppm P for the Truog test appears to be satisfactory for predicting when P fertilization is necessary but a rapid PDI screening technique may be warranted in order to account for the varying degrees of P sorption in soils. Soils with the same deficient Truog P level need not necessarily receive the same P recommendation.

The value of third leaf P% as an indication of the adequacy of P in the plant is questioned and it is possible that this approach needs to be supplemented with an assessment of nutrient balance. Alternatively the merits of using a more sensitive diagnostic tissue such as the meristem or 8 – 10 internode needs to be tested for cane in the midlands.

The survey shows that about 30% of the cane grown on soils of the Nottingham system will benefit from the new system of recommendations. P-deficient soils of the Inanda, Fountainhill, Balmoral, Farmhill, Balgowan and Farningham series are all prone to P-fixation and are therefore likely to respond to increased P fertilization. The trials are being continued in order to assess the residual effects of the various P treatments on cane yield on the second ratoon crops.

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