# FILTER CAKE - A FIELD AND GLASSHOUSE EVALUATION

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**Abstract**

The results are reported of field experiments with filter cake in a number of different soil groups, with particular reference to soil P levels and the treatment effects on cane quality. It is concluded that the greatest industrial advantage can be gained by using filter cake on midland mistbelt soils such as the Inanda series. The factor influencing cane quality is associated with nitrogen availability which, amongst other factors, was measured in a glasshouse pot experiment. Nitrogen availability is apparently a function of both the C/N ratio of filter cake and the soil type to which it is applied. Other characteristics of filter cake such as its nematicidal properties and its moisture content are discussed and its value as an aid in winter planting is considered.

## Introduction

In 1972 the results of 24 experiments with filter cake conducted in the South African sugar industry were reported in a review paper by Alexander [2]. The average response to a furrow application of approximately 50 tons/ha of filter cake was 7% in terms of tons sucrose per hectare. It was concluded that "with the multiple factors involved in the use of this variable product on our highly variable soils, one can say only that its use would be beneficial on many cane fields, especially those with soils low in available phosphorus." Since that time the number of results available have approximately doubled and the increased volume of data now warrants a re-evaluation of filter cake in terms of some of the factors involved and also of the situations in the sugar industry in which the material would be of most value to cane growers.

The early field experiments with filter cake were conducted primarily on sandy soils as it was then considered that the organic matter content and nematicidal effects of the material would be most beneficial on sandy soils. Recently, more experiments have been established on the highly leached, phosphorus deficient soils of the Nottingham soil system[10] than on sandy soils.

While it is generally accepted that the main fertilizer value of filter cake lies in its phosphorus content it has been the practice of the Experiment Station's Fertilizer Advisory Service in the past two years to assume that 50% of the total nitrogen content of filter cake is available to the plant crop. In order to establish more clearly the nutrient value of both fresh and old filter cake a glasshouse experiment was conducted on two different soil types.

In this paper an attempt is made to relate the yield response to filter cake and its effects on cane quality to different soil types, and to study it in terms of nutrient value, moisture content, nematicidal properties and its value for winter planting.

### *Field Experiments*

Most of the experimental work with filter cake has been concentrated on determining its effect when applied in the planting furrow, and comparatively few experiments have measured its effect when broadcast. For furrow application the rates of material applied per hectare have ranged from 25 to 100 tons, but generally the rate was approximately 50 t/ha applied uniformly along the bottom of the planting furrow. Where filter cake was broadcast and disced into the soil prior to planting the rate generally used was 100 t/ha.

The age of the filter cake used in experiments has unfortunately seldom been recorded but an estimate of the average age of filter cake used in the recent experiments is 4 weeks. The chemical analysis of filter cake varies between factories and during the season. The average results from 22 factories given by Alexander [3] are probably a fair reflection of the nutrient content of filter cake used in the experiments reported here. When establishing the experiments two important assumptions were made regarding the available nutrients in filter cake:
(1) where filter cake was applied no superphosphate was required, whereas phosphate was applied to the control plots according to the soil P status, and (2) no other nutrients in the filter cake were considered to be of value and therefore the same quantities of nitrogen and potash were applied to the filter cake treated and the control plots.

### *Glasshouse experiment*

The objectives were to compare the effects of fresh and old filter cake on cane yield, nutrient uptake by the plant and changes in the nutrient status of soils of the Cartref and Inanda series. Both soils were moderately acid and were deficient in P. In terms of PDI (phosphorus desorption index) values the Inanda soil was strongly (<0,20) and the Cartref soil series weakly (>0,40) P fixing.

The old filter cake (± 6 months) contained 50% moisture and was applied at a rate equivalent to 50 t/ha, whereas the fresh material had a moisture content of 75% and was applied at 80 t/ha. The C/N ratio of the fresh filter cake was above 20:1 and for the decomposed filter cake it was below this value. The filter cake was applied in a Vee-shaped furrow prior to the planting of two pre-germinated single-eyed setts of variety NCo 376 in each pot.

A simulated filter cake treatment was included, the equivalent quantities of all the major nutrients contained in the filter cake being added in solution. When determining the amount of nitrogen to add in the mixture it was assumed that 50% of the total N in the decomposed filter cake would be available to the plants. To identify the order of importance of the nutrients applied in the simulated filter cake treatment, the subtractive technique was employed, each element or combination of elements being omitted in turn from the complete treatment.

## Results of Field Experiments

### *The influence of soils*

The experiments have been categorised according to the following soil groups: Recent Sands and alluvial sands, sandy soils derived from Table Mountain Sandstone (TMS), highly weathered TMS mistbelt soils and others. Results are given separately where filter cake was broadcast or applied in the planting furrow. The yield responses shown in Table 1 are those obtained from the use of filter cake when compared with the yields from the standard plots which received phosphorus according to the soil P status.

### *Recent sands and alluvial sands*

Furrow application

Only 2 of the 16 experiments in this soil group were conducted on alluvial sands; the rest were predominantly Clansthal sands, and there were a few Fernwood sands. The results for the plant crops are given in Table 1.

The response range from + 28 to -11 tc/ha is substantial and difficult to explain. Generally the largest positive responses were obtained in areas where yields were low, and the percentage

TABLE 1

**Plant cane responses to treatment with filter cake, on various soil types, in terms of tons cane per hectare, ers % cane and tons ers per hectare**

| Soil type(s) | No. of expts | F.C. t/ha | Method of application | Mean soil P ppm | Response, tc/ha | | | Response, ers % c | | | Response, ters/ha | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Range | | | Range | | | Range | | |
| | | | | | From | To | Mean | From | To | Mean | From | To | Mean |
| Recent sand / Alluvial sand | 16 | 50 | Furrow | 93 | +28 | −11 | +2,6 | −1,6 | +0,6 | −0,16 | +3,9 | −1,9 | −0,14 |
| Recent sand | 6 | 100 | Broadcast | 52 | +15 | −7 | +7,3 | −1,1 | 0,0 | −0,48 | +1,1 | −0,6 | +0,58 |
| TMS sand | 5 | 50 | Furrow | 25 | +17 | −7 | +6,8 | −0,2 | +0,1 | −0,40 | +2,7 | −0,9 | +1,12 |
| Midland mistbelt | 14 | 50 | Furrow | 16 | +43 | +7 | +20,2 | −2,0 | −0,1 | −0,84 | +4,5 | −2,0 | +1,46 |
| Midland mistbelt | 3 | 50 | Broadcast | 15 | +18 | −5 | +5,0 | −1,3 | −0,1 | −0,19 | +2,7 | −1,0 | −0,30 |

responses in these circumstances were therefore very high. In 10 of the 16 experiments the cane quality was slightly depressed and in only 7 experiments was there a positive response to filter cake in terms of ters/ha. In only two of the 16 experiments was the soil available P level below the threshold value of 31 ppm and there was no indication of the response being associated with soil P values.

The residual effects of filter cake on the first ratoon crop were measured in only 8 experiments and small positive responses were measured in 4 instances, the overall mean response being +3 tc/ha and +0,2 ters/ha.

Broadcast application.

The response to filter cake broadcast at approximately 100 t/ha prior to planting was measured in the plant crops of six experiments established on Recent Sands (see Table 1).

In terms of tc/ha the response was positive in five of the six experiments. Cane quality was adversely affected in nearly all instances, but there was nevertheless a positive mean response of 0,58 ters/ha. Although the responses to broadcast and furrow applications are not strictly comparable, the indications are that a broadcast application of 100 t/ha is likely to be more effective than is a furrow application of 50 t/ha on the Recent Sands. The soil P status did not influence the degree of response to treatment.

*TMS Sandy Soils*

Furrow application

The response to furrow applications of filter cake was measured in five experiments conducted on soils of the Cartref series and the results are given in Table 1. The mean response was positive in terms of both tc/ha and ters/ha and the reduction in ers % cane was not as marked in this soil series as it was in the Recent Sands. The average soil P level was lower in this group of soils than in the Recent Sands, but the degree of response was not apparently influenced by this factor. The residual response to filter cake in the first ratoon crop was measured in four of the five experiments. The responses were inconsistent ranging from +13 to −10 tc/ha, and averaging −0,5 tc/ha and +0,05 ters/ha.

Broadcast treatments with filter cake were not included in the experiments conducted on the TMS sandy soils.

*Midlands Mistbelt soils*

Furrow application

In these soils which have a comparatively low soil P status and high P sorption properties the response to filter cake in tc/ha was substantial and consistently positive in all of the 14 experiments conducted. (Table 1). Equally consistent however, was the very marked and consistent depression in cane quality, which consequently reduced the magnitude of the response in terms of ters/ha. The average response was nevertheless about +1,5 ters/ha, representing an increase of approximately 10%. The adverse effect on cane quality of applying filter cake to this group of soils, represented primarily by the Inanda series, is of considerable concern. There is evidence that these soils have the capacity to mineralize relatively large amounts of nitrogen[1], and it is considered likely that the presence of filter cake would enhance the rate of nitrogen mineralization, so resulting in luxury uptake of nitrogen by the plant and a consequent reduction in ers % cane. Although this hypothesis is not supported by third leaf analytical data it is nevertheless considered advisable that, when filter cake is applied to these high organic matter soils, the rate of nitrogenous fertilizer applied to the crop should be reduced substantially.

The reason for the large mean response of +20 tc/ha to filter cake in these Midland mistbelt soils is considered to be due primarily to phosphate nutrition. The mean soil P level of 16 ppm is lower than that shown in the other soil categories, and yet the degree of response does not appear to be directly associated with the soil P level. However, the phosphate fixing capacity of these soils, as measured by the PDI is known to be considerable[11], and results from the glasshouse experiment show that the PDI level is favourably influenced by filter cake.

The residual effects of filter cake on the first ratoon crops were measured in 10 out of the 14 experiments and in 9 of these the residual effect was positive, averaging 9,1 tc/ha and 1,0 ters/ha. In 6 of the 10 experiments the negative response in terms of ers% cane persisted in the first ratoon crop but at a lower level, averaging −0,24. In the experiment at Mid-Illovo a response of +40 tc/ha was measured in the third ratoon crop. Only in this soil group was the residual effect of filter cake substantial in the following crop, which tends to support the hypothesis that the primary factor involved in this instance is phosphorus availability.

Broadcast application

In three experiments the effects of broadcasting filter cake on Midland mistbelt soils were determined, but unfortunately the levels applied per hectare were relatively low compared with the 100 t/ha applied to the other soil groups. Only where 70 tons of filter cake were applied per hectare was there a marked response. It is of interest that, despite the low levels of filter cake applied, the cane quality was consistently reduced. The residual effects of filter cake were measured in the first ratoon crops of all three experiments. The average responses were +14 tc/ha and +1,9 ters/ha, which exceeded the mean responses measured in the plant crop.

*Other soils*

Only two filter cake experiments have recently been conducted in soils other than those already considered here. One was established at Tongaat on a fine sandy loam soil of the Waldene series, and the other at Ottawa on a sandy clay loam of the Windermere series. In both experiments filter cake was applied at approximately 50 t/ha in the planting furrow. The available soil P at both sites was well above the accepted threshold value.

The responses in the plant crop to filter cake applied to the Windermere and Waldene series soils were +12 and +8 tc/ha respectively, and +1,5 ters/ha at both sites. Filter cake did not

depress ers%c at either site. The mean residual response in the first ratoon was marginal, being +2,3 tc/ha and +0,2 ters/ha.

*Filter cake composts*

Reports from Brazil[7] indicate that substantial yield increases can be obtained from the use of filter cake and bagasse when composted with a material called Cofuna which contains cellulose-decomposing bacteria. Two different mixtures were made up: Compost A comprising 10% Cofuna, 45% filter cake and 45% bagasse; Compost B consisted of 20% Cofuna and 80% bagasse. After composting for 5 months, the effects of these mixtures were compared with those of filter cake applied in the planting furrow in the Inanda and Clansthal series soils. The results of these experiments are given in Table 2.

TABLE 2

The yields obtained from applying filter cake composts and filter cake alone in the planting furrow in Clansthal and Inanda series soils

| Treatment | tc/ha | |
|---|---|---|
| | Clansthal | Inanda |
| Standard | 136 | 85 |
| Filter cake, 45 t/ha | 126 | 96 |
| Compost A | 134 | 99 |
| Compost B | 136 | 95 |

The two composts gave similar yields in both experiments, and in the Inanda series soil increased yields approximately to the same extent as did filter cake. Whatever the reason for the yield increase, it is interesting that only 3 t/ha of the composts was as effective as was 45 t/ha of filter cake. There was no response to the composts in the high yielding Clansthal series soil, and the yield depression caused by filter cake, although not uncommon, is difficult to explain.

*Moisture in filter cake*

An application of 50 t/ha of fresh filter cake (75% moisture) supplies 5,25 $\ell$ water per metre of cane row when the spacing is 1,4m, and older filter cake (50% moisture) would supply 3,5 $\ell$ of water. There is good reason to believe therefore that when planting under dry conditions or into a soil having cloddy tilth where poor seed/soil contact is likely to occur, the moisture contained in filter cake, and the fine texture of the material, will improve germination and ensure good cane establishment. A comparison of the effects of filter cake applied in the planting furrow under sprinkler irrigated and rainfed conditions was made in a clay soil of the Windermere series[8].

Filter cake containing 56% moisture was applied at 50 t/ha into the bottom of the planting furrow. To the irrigated plots twenty five millimetres of irrigation water were applied on a minimum cycle time of 17 days, providing that the soil moisture deficit at the time of irrigating was at least 25 mm. Taking the mean yields of the two varieties NCo 376 and N55/805, the response to filter cake was 16% and 10% in terms of tc/ha and 27% and 13% in terms of ters/ha respectively for the rainfed and irrigated cane. It is interesting that filter cake increased yields even where soil moisture was not limiting but the response was greatest under rainfed conditions.

A trial was established in 1977 on a Fernwood series soil to compare the effects of applying filter cake at 45 t/ha in the planting furrow, and of water at 2,5 $\ell$ per meter of row applied over the seed prior to covering, with the standard procedure of planting into a relatively dry planting furrow. The shoot populations 12 weeks after planting are shown in Table 3.

Good rains were recorded only one week after planting, but it is clear that wetting the seed and the immediately surrounding soil at planting was almost as effective in stimulating germination as was the filter cake. These results indicate that the moisture component of filter cake is an important factor in stimulating germination and subsequent tillering.

TABLE 3

**The effect of applying filter cake or water to the planting furrow, in terms of shoot counts made 12 weeks after planting**

| Treatment | No. of shoots/ha |
|---|---|
| Standard | 740 |
| Filter cake, 40 t/ha | 25 370 |
| Water, 2,5 $\ell$/m of row | 21 850 |

*Nematodes and filter cake*

In only 5 of the 16 experiments conducted on Recent and alluvial sands was the response to filter cake greater than 10% in terms of tc/ha. In all five of these experiments the phosphorus level in the soil was well above the currently accepted threshold value. The responses, which were substantial in four of the experiments, are considered to have been due in part to some reduction in the effects of parasitic nematodes immediately after planting.

On an alluvial sand in the Nkwalini Valley cane growth was extremely poor despite supplementary irrigation and adequate nutrition[13]. The effects of the soil fumigant ethylene dibromide (EDB) and filter cake at 100 t/ha applied in the planting furrow were compared with the standard field practice in an experiment established in 1970. The initial growth response in terms of shoots per hectare was greatest in the filter cake plots, but in time the response to EDB in terms of cane stalks per hectare equalled that in the plots treated with filter cake. The EDB treatment resulted in markedly superior stalk elongation and cane yields were increased by 92%, whereas the increase due to filter cake was only 27%. The yield response to filter cake in these circumstances was too small relative to that obtained by using a soil fumigant, to warrant the labour intensive, time consuming and expensive application of 100 t/ha in the planting furrow.

In the Recent Sands the response to filter cake broadcast at approximately 100 t/ha prior to planting appeared to be slightly more effective than was 50 t filter cake/ha applied in the planting furrow. However, the mean responses to both treatments (+7,3 and +2,6 tc/ha respectively) were relatively poor.

The comparative values of filter cake broadcast at 95 t/ha and of EDB (4,5) injected into the soil at 75 kg a i/ha on a weak growth area on a Clansthal sand were tested near Mount Edgecombe[11].

The effect of filter cake broadcast and disced into the soil prior to planting was negligible in comparison with that of EDB, the latter increasing yields of tc/ha by 57% and of ters/ha by 35% whereas the comparable figures for the filter cake treatment were 15% and 25% respectively. The residual effect of EDB in the first ratoon was also substantial compared with that of filter cake, the increases in tons cane per hectare being 56% and 5% respectively.

More recently the granular nematicide Temik has been extensively used in the Recent Sands. When planting such sandy soils under unfavourable conditions e.g. in winter and autumn, a common commercial practice is to apply filter cake over the seed before covering. A direct comparison of the effects of Temik and filter cake in out-of-season planting was made in three recent experiments and the results are given in Table 4.

It is clear that under these circumstances Temik is superior to filter cake. The question of whether Temik should be applied together with filter cake when planting out-of-season also required elucidation, particularly as it was considered likely that Temik would be inactivated through adsorption by the organic matter in filter cake. A trial was established at Tongaat in July 1976 to investigate the effects of filter cake applied at 30

and 60 t/ha on top of the seed in the presence and absence of Temik, applied either in the planting furrow on top of the filter cake or applied seven weeks after planting in a shallow furrow on either side of the cane row. The harvest results are presented in Table 5.

TABLE 4

A comparison of the effects of filter cake and Temik applied when planting cane out-of-season in a Clansthal sand

| Trial | Month Planted | tc/ha | | | ters/ha | | |
|---|---|---|---|---|---|---|---|
| | | Temik | Filter cake | Diff. | Temik | Filter cake | Diff. |
| 1 | Feb | 136 | 125 | −11 | 19,3 | 18,2 | −1,1 |
| 2 | July | 82 | 72 | −10 | 13,7 | 11,7 | −2,0 |
| 3 | May | 95 | 91 | −4 | 14,2 | 13,3 | −0,9 |

TABLE 5

The response, in a plant cane crop established in winter, to filter cake in the presence and absence of Temik

| Filter cake, t/ha | tc/ha | | | | ters/ha | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 30 | 60 | Mean | 0 | 30 | 60 | Mean |
| No Temik ..... | 78 | 71 | 73 | 74 | 12,5 | 11,4 | 11,9 | 11,9 |
| Temik at plant .. | 84 | 84 | 82 | 83 | 14,0 | 13,7 | 13,5 | 13,7 |
| Temik delayed .. | 80 | 83 | 78 | 80 | 13,3 | 13,5 | 12,9 | 13,2 |
| Mean ..... | 81 | 79 | 78 | 79 | 13,3 | 12,9 | 12,9 | 12,9 |

The positive response to Temik, applied in the furrow or later, was not influenced by the presence of filter cake. Filter cake, particularly at the highest rate, had slightly suppressing effects on germination and initial tillering which did not persist. The ultimate effect of filter cake on yield was slightly negative, although it did not attain a level of statistical significance.

The above comparisons of the effects of filter cake and either EDB or Temik indicate that filter cake is appreciably less effective than both nematicides. Because the rate of decomposition of filter cake in the Recent Sands is comparatively rapid the biological control phenomenon, of which there is abundant evidence particularly in pot experiments[5], is also likely to be of short duration.

*Filter cake for winter planting*

Because it is not always possible to complete the planting programme in spring and summer it has become common commercial practice in some areas, particularly along the coast, to plant in winter. Low winter temperatures and rainfall increase the probability of poor germination at this time of year, and for this reason cane growers frequently apply filter cake at approximately 50 t/ha over the top of the seed before covering, in an attempt to ensure satisfactory germination. The merits of this planting practice have been investigated recently in three experiments conducted on Recent Sands and two in Midland mistbelt soils. In all the experiments filter cake was applied over the seed shortly before covering and this treatment was compared with the standard planting procedure, where only superphosphate was applied according to the soil phosphate requirements. No phosphate was applied to those plots receiving filter cake, but the same amounts of nitrogen and potash were applied to all plots. The results of these experiments are shown in Table 6.

There was no worthwhile response to filter cake in the experiments on the Clansthal sands. In experiment No. 2 germination was markedly suppressed by filter cake and this resulted in an uneven stand of cane, with the number of cane shoots reduced initially by as much as 90%, but at harvest by only 5%. This adverse effect was due primarily to the very dry two months after planting when only 7mm of rainfall were recorded. In experiment No. 3 germination was delayed by the use of filter cake but tillering was not affected, despite a reasonable rainfall of 117 mm in the two months after planting.

TABLE 6

The yield response in tc/ha to the use of filter cake in winter planting

| Region | Experiment No. | Soil series | Planting month | Filter cake applied t/ha | Response, tc/ha |
|---|---|---|---|---|---|
| Coastal | 1 | Clansthal | June | 50 | +5 |
| | 2 | Clansthal | May | 40 | +2 |
| | 3 | Clansthal | July | 30 | −2 |
| | 3 | Clansthal | July | 60 | −3 |
| | Mean | | | | +0,5 |
| Mistbelt | 4 | Griffin | August | 25 | +10 |
| | 5 | Griffin | July | 50 | +7 |
| | Mean | | | | +9 |

The responses to treatment with filter cake in the winter-planted experiments in the Griffin soil series were considerable in terms of improved germination, tillering and ultimate cane yield.

In three of the winter-planted experiments the responses to filter cake were compared with the responses to a polyethylene film laid over the cane row immediately after planting[12]. The responses to the PE film in the Midlands mistbelt region were considerable and similar in terms of tc/ha to when filter cake was used. Because filter cake, unlike the PE film, reduced ers%c, the response in terms of ters/ha was inferior to that from the PE film. It seems likely that under these conditions the factors influencing cane growth were different in each treatment, e.g. increased soil temperature due to the PE film and increased nutrient availability due to the filter cake treatment. Neither treatment affected growth or yield to any extent when applied to the Recent Sands on the coast.

*Results from the glasshouse experiment*

The results given in Table 7 show that for the 5 month old plant crop decomposed filter cake was substantially superior to fresh filter cake in both soils, and that simulated filter cake was clearly the best treatment. In the 4 month old ratoon crop the situation was reversed, the simulated filter cake treatment being inferior to both natural filter cake treatments, and the fresh being marginally superior to the old filter cake.

TABLE 7

Relative yields of plant and 1st ratoon cane on two soils in a glasshouse experiment, based on control yields of 100

| Treatment | Cartref | | Inanda | |
|---|---|---|---|---|
| | P | IR | P | IR |
| Control (no nutrients) ..... | 100 | 100 | 100 | 100 |
| Fresh filter cake ..... | 84 | 254 | 98 | 266 |
| Old filter cake ..... | 155 | 231 | 129 | 234 |
| Simulated filter cake ..... | 242 | 190 | 181 | 200 |
| −N | 118 | 106 | 98 | 143 |
| −P | 210 | 141 | 123 | 133 |
| −K | 239 | 185 | 140 | 200 |
| −NPK | 105 | 83 | 88 | 164 |
| −Ca Mg | 247 | 100 | 157 | 223 |
| −Traces | 224 | 203 | 169 | 210 |
| −Si ..... | 237 | 165 | 194 | 188 |

The results for nutrient uptake can be seen in Table 8 and they indicate clearly the reason for the yield differences between

**TABLE 8**

**Nutrient uptake (mg) by the plant crop in relation to the filter cake treatments**

| Treatment | Cartref (mg) | | | | | Inanda (mg) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | N | P | K | Ca | Mg |
| Control (no nutrients) | 289 | 41 | 678 | 183 | 181 | 524 | 99 | 1336 | 267 | 307 |
| Simulated filter cake | 930 | 249 | 1270 | 327 | 340 | 1228 | 190 | 2612 | 502 | 502 |
| Fresh filter cake | 197 | 45 | 586 | 143 | 123 | 459 | 136 | 1249 | 212 | 255 |
| Old filter cake | 476 | 170 | 1088 | 238 | 255 | 889 | 127 | 1867 | 343 | 355 |

treatments. In the Cartref series soil the uptake of nutrients, particularly N and P, was considerably inhibited by both filter cake treatments, and especially by the fresh filter cake. The same effect occurred in the Inanda series soil but to a lesser degree.

Where old filter cake was used only 20% of the applied N was recovered in the plant crop from the Cartref soil compared with 40% from the Inanda soil. Where fresh filter cake was used a nitrogen loss was suffered from both soils. Including the N recovered in the ratoon crop it is possible that 50% of the total N in old filter cake might be available over a nine month period in an Inanda series, and approximately 30% in a Cartref series soil.

The effects of the subtractive treatments show that the omission of NPK had the greatest overall depressing effect on yield, followed by the minus N and P treatments, with the omission of other nutrients being comparatively unimportant.

Analyses of the soils at the end of the experiment showed that the filter cake treatments caused Truog P to be higher in the Inanda series than in the Cartref series soil. Residual P levels from the natural filter cake treatments were also two to three times greater than those resulting from the simulated filter cake treatment. The PDI values in the Inanda soil were also marginally improved by filter cake.

## Discussion

Results of the field experiments indicate that where possible filter cake should be applied preferably to Midland mistbelt soils, where the combined responses in the plant and first ratoon crops averaged approximately 30 t/ha and 2,5 ters/ha. In no other soil group did the response approach even half this level, the lowest average response being that obtained in the Recent and alluvial sands, and only a moderate response was recorded in the heavier soil types.

The large response in the midlands soils appears to be associated primarily with P nutrition which confirms the findings of earlier work reported by Meyer[11]. These soils are inherently low in plant available P and in addition they have high P fixation characteristics. The residual effects of filter cake on soil P and PDI values was shown in the glasshouse trial to be greater on the Inanda series than on the Cartref series soil, and the residual effects in ratoon crops grown in the Midlands soils were substantially greater than those in any other soil group. A number of workers have reported a reduction of P fixation in soils following the addition of organic matter [4, 6, 15, 16], which would explain in part the surprising response obtained to only 3 t/ha of the Cofuna-filter cake composts in an Inanda series soil.

The marked reduction in cane quality due to filter cake applied to Midlands mistbelt soils is considered to be due to nitrogen, which was shown by the subtractive treatments in the glasshouse experiment to be the only other important nutrient component of filter cake. Although the glasshouse experiment showed a loss of soil N in the filter cake pots, particularly where fresh material was applied, there was no indication in the field experiments of the occurrence in the early growth stages of a 'nitrogen negative period', although this could perhaps be the reason for the growth suppression reported from using filter cake in sands when winter planting. Locsin[9] attributed lodged cane and low sucrose levels, resulting from filter cake application, to a late release of N and advocated the use of decomposed filter cake in preference to fresh material. The greater recovery of nitrogen from the old compared with the fresh filter cake in the glasshouse experiment supports Locsin's hypothesis. However, in a field experiment[17] on an Inanda series soil, where the effects of fresh and old filter cake were compared, the two forms were shown to be equally effective in increasing cane yield and depressing ers% cane; both treatments received additional nitrogen fertilizer which may have masked differential effects.

It is likely that filter cake in high organic matter Midlands soils enhances, through greater microbial activity, the rate of nitrogen mineralization, which can lead to a drop in cane quality. For advisory purposes when calculating N availability in filter cake it would seem important to differentiate between soils. For Midlands soils it is proposed that 50% of the total N in filter cake be assumed to become available to the plant crop, which is in agreement with the results of the glasshouse trial, and a value of 20%, slightly lower than the value derived from the glasshouse experiment, is suggested for use in other soils.

The apparent limited nematicidal effect of filter cake on the Recent Sands is important, but need be of little concern because nematicides are available for use in sandy soils where parasitic nematodes are known to be a problem. However, where filter cake has to be disposed of on the Recent Sands the evidence favours a broadcast application of 100 t/ha or more in preference to furrow placement. At this level of application cognisance must be taken of the N content in filter cake because normal rates of fertilizer N applied in addition will depress cane quality. The efficacy of Temik is not apparently affected when it is applied with filter cake.

The value of filter cake for winter planting in the Recent Sands is debatable. Experimental results indicate that adverse effects can result. It seems likely that when dry conditions follow planting with filter cake in the furrow, the desiccation of filter cake will result in poor seed/soil contact and hence seed desiccation and poor germination. However, even with moderate rainfall after planting no advantages from the use of filter cake were recorded on Recent Sands. This is evidently not the case in the Midlands mistbelt soils where good yield responses were recorded.

Although the value of Cofuna composts has not been thoroughly investigated, the labour and costs involved in compost-making in relation to the yield responses reported here are such that further research is not warranted unless the cost structure of artificial fertilizers changes substantially.

The moisture in filter cake appears to be of value when the material is applied in the furrow for summer planting. The cost of applying equivalent quantities of water would probably be lower and the effects appear to be similar; this phenomenon warrants further investigation.

## Conclusions

1. Approximately 800 000 tons of filter cake are produced annually in South African mills, and it is potentially of great value to the industry. It should be applied in order of preference to the following soils: Midlands mistbelt soils with high P fixing characteristics and low Truog P values; any soil with a low Truog P value; heavy and medium textured soils of the Umzinto Soil System; and finally to the sandy soils of the Berea Soil System.

2. Phosphorus and nitrogen are the nutrients of importance in filter cake and the amount of available nitrogen is influenced by the soil type involved. Approximately 50% and 20% of the total N content is considered to be available in the Midland mistbelt and "other" soils respectively.

3. The nematicidal effect of filter cake in sandy soils is considered to be of short duration and of limited value in comparison with that of commercially available nematicides. The efficacy of Temik is not adversely influenced by the presence of filter cake.

4. The merits of applying filter cake when planting the Recent Sands in winter are questionable.

5. The moisture in filter cake plays an important role under rain-fed conditions and alternative ways of providing small amounts of moisture in the planting furrow require investigation.

6. Glasshouse investigations indicate that considerable advantages may be gained by using decomposed rather than fresh filter cake in respect of nitrogen availability. These findings require confirmation in field experiments.

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## REFERENCES

1. Anon (1977). Ann Rep Exp Sta S Afr Sug Ass 1976/77: 34.
2. Alexander, K.E.F. (1972). Filter cake. S Afr Sug Ind Agronomists' Assoc Review Paper No. 6
3. Alexander, K.E.F. (1972). A note on the analysis of composite samples of filter cake from South African factories. SASTA Proc **46**: 224.
4. Bhat, K.K.S. and Bouyer, S. (1968). Effect on organic matter on the isotopically exchangeable P on some types of tropical soils. Proc symp IAEA/FAO Vienna.
5. Dick, J. and Harris, R.H.G. (1975). Nematodes and Sugarcane. S Afr Sug Ind Agronomists' Assoc Review Paper No 7.
6. Guar, A. C. (1969). Studies on the availability of P in soil as influenced by humic acid. Agrochimica 14: 65.
7. Humbert, R.P. (1972). Cofuna increases sugarcane yields at Motzorongo. Unpublished report.
8. Iggo, G.A. (1976). The effect of quantity of seedcane, filter cake and irrigation on sugarcane yield. SASTA Proc 50: 42.
9. Locsin, C.L. (1953). Filter cake as fertilizer. Sugar News 29: 405-409.
10. MacVicar C.N. (1973). Soils of the Sugar Industry. Exp Sta S Afr Sug Ass. Bull No. 19.
11. Meyer, J. H. (1974). P fixation a growth limiting factor in some soils of the South African Sugar Industry. ISSCT Proc **15**: 586-600.
12. Millard, E.W. (1975). Further studies on the use of a polyethylene mulch in the growing of sugarcane. SASTA Proc **49**: 182.
13. Moberly, P.K. (1971). An evaluation of poultry manure as a sugarcane fertilizer. SASTA Proc **45**: 136.
14. Moberly, P.K. (1972). Deep tillage investigations on five soil types of the South African Sugar Belt. SASTA Proc **46**: 205.
15. Monojilovic, S. (1976). Contribution to the study of the role of humic acid on the fixation of soluble P in the soil. Phosphorus in Agric Bull Docum inter Superph Manu Assoc 46: 50.
16. Olsen, R.J., Hensler, R.F. and Attac, O.J. (1970). Effect of manure application and soil pH on soil N transformation. Soil Sci Soc Am Proc **34**: 222-225.
17. Roth, G. (1971). The effects of filter cake on soil fertility and yield of sugarcane. SASTA Proc **45**: 142.