Effects of Filter Cake Application on Sugarcane Yields[1]

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ABSTRACT

Filter cake is an excellent means of adding organic matter to the soil. Among other nutrients, this residual material is rich in phosphorus, and normally sufficient as a substitute for phosphorus mineral fertilizer. In this study, it was observed that filter cake can be applied to plant-cane (broadcast and in furrows) and ratoons (in inter row spaces). It was demonstrated that filter cake plays an important role as a soil amendment agent, by increasing calcium levels and decreasing exchangeable aluminum. These effects persisted in the soil for 30 months after application. The increase in organic carbon promotes an increase in cation exchange capacity (CEC). In this way, it is possible to increase the efficiency of other nutrients such as potassium. The application of filter cake over the total area improved potassium performance. With filter cake application, maximum yields were reached with 160 kg K_2O/ha; and in the absence of the residue, 240 kg K_2O/ha were required.

COMPENDIO

La aplicación de cachaza es una excelente forma de adicionar materia orgánica al suelo. Este material contiene cantidades elevadas de fósforo (P), que normalmente son suficientes para sustituir el P del fertilizante mineral. En este estudio fue observado que la cachaza puede ser aplicada en la caña (en área total y en los surcos de plantío) y en retoños (en las entre líneas). Fue demostrado que la cachaza desempeñó un papel importante como correctivo de la acidez del suelo al aumentar los niveles de calcio (Ca) y disminuir los de aluminio (Al) intercambiable. Esos efectos persistieron en el suelo por un período de 30 meses después de la aplicación. El aumento en el carbono (C) orgánico incrementó la capacidad de intercambio catiónico (CIC). Esto demuestra que es posible acrecentar la eficiencia de otros nutrimentos como el potasio (K); de hecho la aplicación de cachaza en área total mejoró la eficiencia de uso del K. El rendimiento máximo fue obtenido por la aplicación de cachaza asociada a la de 160 kg K_2O/ha. En la ausencia de cachaza fue necesario aplicar 240 kg K_2O/ha para la obtención de un rendimiento similar.

INTRODUCTION

Filter cake is a residual material resulting from the juice clarification process; it shows wide possibilites for use on sugarcane crops with favorable results on yields (1, 2, 5, 7).

The chemical composition of filter cake shows high amounts of carbon, phosphorus and calcium and, to a lower degree, other nutrients which are important in sugarcane nutrition. Thus, it is difficult to isolate the factors which are responsible for the increase in sugarcane yields.

Nevertheless, some effects may be easily inferred: the high phosphorus levels in filter cake permit partial or total substitution of mineral phosphorus fertilization. Filter cake applied to sugarcane crops adds high amounts of organic matter and, consequently, the nitrogen requirement is altered due to changes in the soil carbon/nitrogen relationship.

In Brazil in the last harvest season (1984/85) nine million tons of sugar and 3.3 million tons of filter cake were produced. This is an indication of the high potential use of this residue in sugarcane fertilization.

Several systems of application have been adopted in Brazil. In plant cane, filter cake may be applied in furrows (20 t/ha) or to total area (100 t/ha). In ratoons the residue is applied in interrow space during tillage operations (average 50 t/ha).

This wide range of possibilities suggests the need for a study to determine which system is the most adequate.

The purpose of this work was to characterize the different ways in which the residue exerts an infuence on sugarcane yields; to observe its relationship with other nutrients used in sugarcane fertilization; and the effects of filter cake on the chemical properties of the soil.

MATERIALS AND METHODS

Four field trials were carried out showing the following characteristics:

Trial 1: Set up a the Amalia sugar mill, variety SP70-1143, plant-cane. The design was split plots where the primary treatments were 0 and 100 t/ha filter cake applied to total area; the secondary treatments, 0 and 2 t/ha dolomitic lime (broadcast application); and terciary treatments where 0, 80, 160 and 240 kg K_2O/ha applied in furrows.

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Trial 2: Showed the same characteristics of trial 1, but was set up at the Santa Cruz sugar mill.

Trial 3: Set up at the Ester sugar mill, plant cane, variety NA56-79; randomized block design, with the following treatments: levels of filter cake applied in furrows (0-10-20 t/ha); level of phosphorus (0-75-150 kg P_2O_5/ha) and levels of nitrogen (0, 30 and 60 kg N/ha).

Trial 4: Set up at the Ester sugar mill variety CP51-22, third ratoon, where 0, 40, 90 and 130 t/ha of filter cake were applied in interrow space before tillage operations.

In each trial, the other nutrients not under study were applied at sufficient levels not to limit yields. All the filter cake dosages mentioned are expressed as humid matter.

The data relating to chemical soil analysis of the different trials are shown in Table 1.

Table 1. Chemical characteristics of soils of trials.

Trial	pH	P	K	Ca	Mg	Al
		ppm	me/100 ml soil			
1	5.6	23	0.07	1.83	0.52	0.13
2	5.0	8	0.06	1.50	0.55	0.75
3	5.6	23	0.13	2.75	0.85	0.06
4	5.2	130	0.14	2.15	0.46	0.15

RESULTS AND DISCUSSION

Yields (t cane/ha) obtained from the application of the residue in total area, in two locations (Amalia and Santa Cruz sugar mills) are shown in Table 2.

Table 2. Effect of the application on filter cake in total area on yield of variety SP70-1143, plant-cane.

Treatment	Sugar mill	
	Amalia	Santa Cruz
	cane t/ha	
Control	160	92
100 t/ha F.C	174	126
	F Values	
Filter cake effect	4.79*	281.32**

* Significant at the 90% level of probability.
** Significant at the 99% level of probability.

Highly significant results were observed, indicating the beneficial effects of the incorporation of high amounts of organic matter.

The productivity increase at Santa Cruz sugar mill was higher due to the poor soil conditions prevailing in the trial site.

In this case, in addition to acting as a nutrient source, filter cake also promoted higher water retention in the soil plow layer. This was essential for sugarcane growth in view of the low rainfall conditions which prevailed during that period. These observations are in agreement with those of Lugo Lopes and Paul (3, 4), who demonstrated that filter cake enhances soil water retention capacity at low tensions.

Table 3 shows the beneficial effects on yields for filter cake application in planting furrows. Maximum yields was obtained from 10 t/ha and no additional gains were obtained from 20 t/ha.

Table 3. Yield of variety NA56-79, plant-cane, in relation to filter cake dosages applied in planting furrows.

Treatment	Cane t/ha
Control	56
10 t/ha F.C	72
20 t/ha F.C	73
Trends	F Values
Linear of filter cake	3.24*
Quadratic of filter cake	25.05**

* Significant at the 90% level of probability.
** Significant at the 99% level of probability.

In that case, filter cake acts mostly as a source of phosphorus, and may show a higher efficiency than that of mineral phosphorus fertilization, as suggested by Prasad (6).

The application in planting furrows shows an additional advantage of improving germination when climatic conditions are unfavourable (1).

Ratoon productivity is also enhanced by filter cake applications, as indicated in Table 4. However, in this case the benefit is probably due to the improvement of the soil's physical and chemical characteristics, since ratoons usually do not react to phosphorus fertilization. Nevertheless, in ratoons after fourth or fifth harvest, some effect of phosphorus on yields may be expected.

Table 4. Yield of variety CP51-22, third ratoon, in relation to filter cake dosages.

Filter cake treatment	Cane t/ha
Control	60
40 t/ha	70
90 t/ha	72
130 t/ha	74
Trends	F Values
Linear of filter cake	40.32**
Quadratic of filter cake	7.80**

** Significant at the 99% level of probability.

Plant cane response to phosphorus fertilization, in the presence and in the absence of filter cake applied in furrows, is shown in Table 5. In the absence of filter cake there was a reaction to phosphorus up to 75 kg P_2O_5/ha. No reaction was observed from the application of 10 t/ha; this indicates that such an amount was sufficient to supply the crop's need for phosphorus. This confirms the findings of Prasad (6), since 45 kg P_2O_5, contained in filter cake, substituted for a higher amount of mineral phosphorus.

Table 5. Response to phosphorus and filter cake for variety NA56-79, plant-cane.

Filter cake t/ha	P_2O_5 kg/ha	Cane t/ha
0	0	54
0	75	71
0	150	74
10	0	78
10	75	78
10	150	74
Trends		F Values
Linear phosphorus		9.43**
Linear interaction phosphorus x filter cake		16.25**

** Significant at the 99% level of probability

Filter cake may also act as a soil amendment agent in view of its high calcium content. In addition, the residue's organic matter may complex the soil's exchangeable aluminum.

The data shown is Table 6 are in agreement with the above, since 100 t/ha of filter cake applied to total area substituted for 2 t/ha of lime for both trials (Amalia and Santa Cruz sugar mills). These results indicate that, at least in the plant cane cycle, the addition of filter cake to the soil may substitute for lime.

Table 6. Yield of variety SP70-1143, plant-cane, in relation to filter cake and lime rates.

Filter cake in total area	Lime t/ha	Cane t/ha Sugar mill	
		Amalia	Sta. Cruz
0	0	154	85
0	2	163	98
100	0	175	124
100	2	171	128
Trend		F Values	
Linear interaction filter cake x lime		5.8*	5.45*

* Significant at the 95% level of probability

Table 7 shows that filter cake (100 t/ha applied to total area) promoted significant alterations on the chemical properties of the soil; phosphorus, calcium, organic carbon and CEC contents were raised while exchangeable aluminum was lowered. These alterations persisted up to 30 months after application of the residue.

The data shown in Table 7 confirm filter cake characteristics as a source of nutrients as well as a soil acidity amendment agent.

A higher cation retention may be expected as a result of the increase in both soil organic carbon and CEC contents. This is of special interest for potassium fertilization, for instance. Figure 1 depicts response curves for potassium in the presence and in the absence of filter cake applied to total area.

As shown in Fig. 1, in the absence of the residue, plant-cane reacted up to 240 kg K_2O/ha. In the presence of filter cake the rate of 160 kg K_2O/ha rendered maximal productivity. Probably, the potassium fertilization efficiency was significantly increased as a reflex of a higher nutrient retention in the plow layer of the soil. The F values for the interaction between filter cake and potassium was 7.41, significant at the 99% level of probability.

Table 7. Variation in s[illegible] chemical properties as a function of time after filter cake application.

Determinations		Control	100 t/ha F.C. 8 th month	100 t/ha F.C. 30th month
pH		5.00	5 20	5.00
Phosphorus	(ppm)	32	188	109
Potassium	(me/100 ml)	0.12	0.12	0.10
Calcium	(me/100 ml)	1.07	3.63	3.15
Magnesium	(me/100 ml)	0.54	0.61	0.57
Aluminum	(me/100 ml)	1.11	0.25	0 45
Titrotable acidity	(meq/100 ml)	6.63	5.58	5 72
CEC	(meq/100 ml)	8.40	10.00	9.53
Effective CEC	(meq/100 ml)	2 75	4 62	4.29
Organic carbon	%	1 07	1.24	1.21

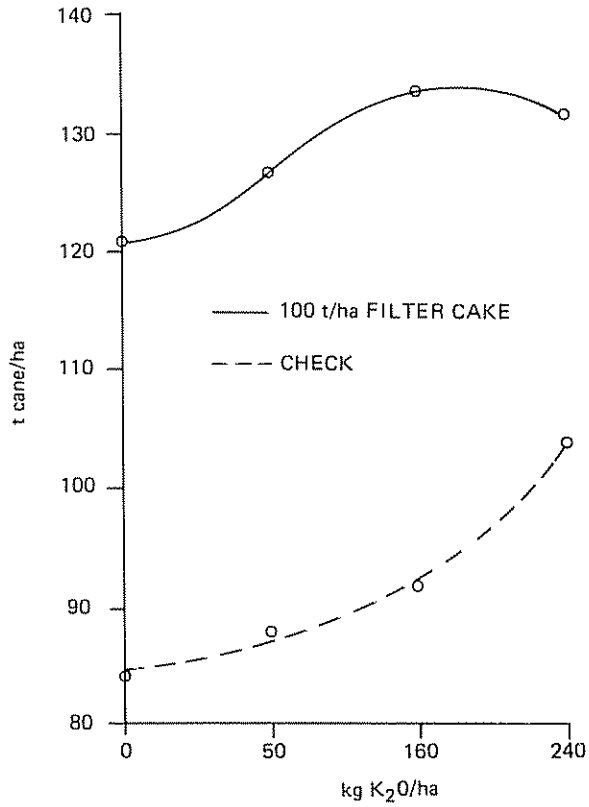

Fig. 1 Response curves of potassium in the presence and in the absence of filter cake applied in total area, variety SP70-1143.

RESULTS

- Sugarcane reacted to filter cake, irrespective of application method (total area, in planting furrows and in ratoon interrows).
- Filter cake in planting furrows (10 t/ha) substituted for 75 kg P_2O_5/ha provided by mineral fertilization.
- Filter cake in total area (100 t/ha) substituted for 2 t/ha of lime.
- The efficiency of potassium fertilization in plant-cane was increased in the presence of filter cake.
- Filter cake altered soil chemical properties (calcium, phosphorus, carbon, CEC, and aluminum) in such a way as to justify the former conclusions.

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