ANALYSES OF FILTER CAKE FROM SOUTH AFRICAN SUGAR MILLS

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Abstract

A table is presented showing the levels of plant food available in filter cake samples collected recently from all 22 South African and Swaziland sugar factories. The overall average mineral contents of N, P and K have been converted to equivalent fertilizer and monetary values.

Introduction

Cane growers quite frequently request information on the analysis of filter cake. They wish to know both the fertilizing and monetary values of the material. Filter cake is a bulky, wet product which is costly to load, transport and apply. Thus, even if it is supplied free, the subsequent handling charges may exceed the value of its mineral constituents. Furthermore, filter cake dressings can improve cane yields by partially eliminating nematodes and aluminium toxicity, whilst increasing the number of beneficial microbes, thus making it virtually impossible to assess its true value to the grower in rands and cents. Even the value of nitrogen in filter cake is difficult to assess in this way because only an unknown and variable portion of it is available to cane plants.

Previous analyses

A perusal of the literature shows that facts and figures relating to South African filter cake have been published on two occasions in the past. In 1923 Dymond[3] quoted the analysis of dry South African filter cake as follows:

Organic matter	63,3%
Nitrogen	1,06%
Soluble silica	4,7%
Phosphorus	0,63%
Potassium	Nil

From these figures he estimated the value of dry filter cake as being R1,86 per ton.

In 1942 the Chemical Department of the S.A.S.A. Experiment Station (Anon[1]), published a table showing the individual chemical analyses of filter cake collected from 21 South African sugar factories during August, 1941. The average mineral content (excluding Natal Estates) was given as:

Nitrogen	0,81%
Available phosphorus	1,10%
Available potassium	0,16%
Calcium	9,77%
Magnesium	0,79%
Silica (four factories only)	4,30%

Later, an estimate (Anon[2]) was made, based on these figures, which showed some of these nutrient values converted to monetary values as follows: N R1,60 per ton, P R1,29 per ton and K 15 cents per ton of dry filter cake, giving a total value of R3,03 per ton. The stringencies of war made it even more desirable to use a local by-product as a fertilizing material in place of expensive, and sometimes unobtainable imported products.

Recent surveys

Various changes in fertilizer practice coupled with modified factory techniques have, over the years, altered the plant-food content of our present-day filter cake. Thus it was decided to update the information available on this subject by conducting two surveys of filter cake taken from all South African sugar factories, plus the two factories in Swaziland. A set of 22 "grab samples" was taken in July, 1970 as the material was being scraped off the filters, followed by a second similar set in October of the same year. Table I presents the average analyses of the two samples taken from each factory. However, these figures should not be regarded as a precise yearly average for any particular factory. In some cases the two samples showed quite a marked variation, whereas in others (mainly from the larger mills) the two analyses were almost identical. All analyses were carried out at the Experiment Station.

Comments on individual analyses

The high calcium content of Malelane filter cake is explained by the fact that, at the time of sampling, this factory mixed its rawhouse and refinery muds for filtration purposes. The two processes have now been separated. The extra lime needed in refining is also shown up by the high calcium content in Sezela filter cake. Entumeni factory uses the suphitation process which calls for extra lime plus a considerable amount of sulphur, most of which ends up in the filter cake.

Lower phosphorus figures in the filter cake from Felixton, Amatikulu, Doornkop and Umzimkulu may reflect a lower level of P in the cane supplied to these factories, but are more likely due to chance variation. A good example of this variation in other elements was found in the two samples from Union Co-op. The analysis of the July sample was fairly close to the mean for most elements, but the October sample was extraordinarily low in many elements. This has resulted in what is probably too low an average for this factory.

TABLE I

Filter-press survey, July and October, 1970

	Moisture %	N %	P%		K%		Ca %	Mg %	Cu ppm	Zn ppm	Mn ppm	S * %
			Total	Avail.	Total	Avail.						
Malelane	66,5	1,01	0,85	0,75	0,24	0,16	10,09	0,57	32	61	713	0,21
Mhlume	73,7	1,76	1,25	1,15	0,21	0,15	2,51	0,65	63	103	847	0,20
Ubombo R.	71,7	1,44	1,14	0,98	0,33	0,20	2,10	0,34	78	110	1 097	0,17
Pongola	78,6	1,76	1,24	0,97	0,30	0,24	2,06	0,41	47	62	773	0,17
Umfolozi	76,2	2,06	0,97	0,78	0,33	0,20	1,66	0,37	81	90	791	0,21
Empangeni	76,0	1,59	0,93	0,70	0,28	0,21	1,76	0,41	57	60	894	0,23
Felixton	74,7	1,21	0,51	0,40	0,33	0,15	0,84	0,23	56	67	867	0,18
Entumeni	73,0	1,50	0,76	0,62	0,26	0,22	3,83	0,35	72	53	1 352	2,91
Amatikulu	77,3	1,64	0,56	0,44	0,26	0,18	0,83	0,23	62	52	646	0,18
Doornkop	80,4	1,41	0,50	0,38	0,22	0,19	0,64	0,19	34	54	539	0,15
Darnall	77,3	1,77	0,73	0,56	0,20	0,13	1,56	0,30	48	64	705	0,19
Glendale	72,6	1,67	0,94	0,79	0,35	0,30	1,62	0,39	40	76	928	0,18
Gledhow	75,7	1,77	0,91	0,52	0,41	0,33	0,93	0,30	30	53	619	0,21
Melville	76,8	2,06	1,16	0,97	0,21	0,12	1,83	0,54	61	111	1 452	0,18
Jaagbaan	71,7	2,39	1,03	0,83	0,21	0,12	2,35	0,27	48	68	1 173	0,21
Union Co-op	66,5	1,38	1,06	0,89	0,24	0,17	1,76	0,11	26	26	711	0,21
Tongaat	79,5	1,61	0,87	0,74	0,29	0,18	1,32	0,37	54	59	839	0,18
Mt. Edgecombe	76,6	1,86	1,22	0,82	0,26	0,14	2,09	0,79	68	100	1 021	0,19
Illovo	74,8	2,23	0,95	0,83	0,23	0,15	2,03	0,35	54	72	1 198	0,25
Renishaw	73,2	1,36	0,92	0,81	0,39	0,33	1,53	0,44	29	54	986	0,25
Sezela	76,7	1,61	0,72	0,58	0,18	0,12	4,61	0,33	68	62	965	0,18
Umzimkulu	77,0	2,09	0,53	0,43	0,28	0,27	0,83	0,24	38	51	651	0,17
Average	74,8	1,69	0,90	0,72	0,27	0,19	1,84 **	0,37	52	69	898	0,19 ***
Average at 74,8% H_2O		0,43	0,23	0,18	0,07	0,05	0,46	0,09	13	17	226	0,05

* Only July samples analysed for sulphur
** Omitting Malelane
*** Omitting Entumeni (sulphitation process)

Mineral content and monetary value

The last line in the table gives the average analysis of fresh filter cake from all factories, whilst the penultimate line indicates the overall average for oven-dry material. One ton of dry filter cake therefore contains, on average, nitrogen equivalent to that present in 36,7 kg of urea; available phosphorus equivalent to 36,7 kg of double superphosphate; and available potassium equivalent to 3,8 kg of muriate of potash. At present prices (1971) these ingredients would be worth R2,73, R2,37 and 17 cents respectively or R5,27 per ton of dry filter cake. In practice, the wet material coming from the filters will have dried off to about 50% moisture by the time it is applied in the field. Thus the value of its plant-food components at this stage should be assessed at roughly R2,64 per ton. In arriving at this figure, no allowance has been made for the fact that only a portion of the nitrogen is available to the plant. On the other hand the value of the organic matter and other plant foods such as calcium, magnesium, sulphur and the minor elements has not been taken into account.

Acknowledgement

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REFERENCES

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2. Anon, 1942. The cash value of filter cake. S.A. Sug. J. 26: 257-258.
3. Dymond, G. C., 1923. Cane by-products and their manurial value. S.A. Sug. J. 7: 87.

Discussion

Mr. du Toit (in the chair): It is noticeable that the calcium content of filter cake has changed considerably since the 1942 figures were published but in those days most factories used the sulphitation process and there was one double carbonation factory.

The surprise increase in N reflects the increased use of N by the industry and although potash is still low it has increased and also reflects changes in fertilizer practice.

Mr. Alexander has included trace elements in his analyses and I think it is a pity he did not also include soluble silica.

Professor Sumner: Available potassium is given, so by inference there are also insoluble organic potassium compounds present. What are these?

Mr. Alexander: Total potassium is that extracted by strong mineral acid and available potassium is that extracted by citric acid.

Potash in filter cake seems to be readily available to plants as shown by Dr. Roth and other workers.

Mr. Sherrard: Growers at Umfolozi think that potash may have an effect on sucrose even though it may not affect yield of cane per hectare.

Dr. Gosnell: How much of the nitrogen in filter cake is immediately available?

Mr. Alexander: The nitrogen has not been split into various components so it is not known what is or is not available.

In 1939 Borden stated that none of the nitrogen in filter cake was available to sugarcane but this does not now appear likely. However, in many cases a nitrogen deficiency results from application of filter press, for a temporary period, and extra nitrogen has to be applied despite the large amount of nitrogen present in the filter cake. Possibly soil organisms are using it up. I think phosphorous, and not nitrogen, is the most valuable constituent of filter press.

Mr. Rostron: Regarding Professor Sumner's question, the probable reason for the difference between total potassium and available potassium is that we are dealing with living plant material, not chemicals in a test tube.

Mr. Truen: Is it possible to use the figures in the filter cake analyses to obtain some idea of plant nutrient balance and also the variations in filter cake at the beginning and end of the season?

Mr. Alexander: No differing trends were noticed during the year of the nutrient balance of raw material going into the factory.

I do not think filter cake can be used as an indicator of the amount of nitrogen required by the crop.

Professor Orchard: Silica can have an important effect on phosphate availability in soils. Is the silica mentioned in the old analyses water soluble or not?

It is a pity that silica, particularly if water soluble, was not included in the recent analyses.

Mr. Alexander: I have no idea of the type of solubility of the silica mentioned in Dymond's 1923 tables.

Unfortunately, as silica is not carried out as a routine analysis it was not included in the tables presented in this paper.

Mr. du Toit: I think special analyses of filter cake for silica should still be carried out.

Mr. Wood: The samples are still available and will be analysed for soluble silica.

Mr. Boyce: What is known of the availability of nitrogen in chicken manure?

Mr. Alexander: With good quality chicken manure a high percentage of nitrogen will be available, but in poor quality chicken manure it is possible none of it will be available.