FIELD EXPERIMENTS WITH FERTILIZER FOR SUGAR CANE.

RESIDUAL EFFECTS ON FIRST RATOON CROPS.*

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PART II.

Mr. DODDS submitted the following paper to the Conference, but owing to lack of time it was not read:—

A series of experiments were described by us with D. McRae in October, 1928,* in which the results from phosphate, potash, and nitrogen experiments respectively were examined.

The plant cane crops were harvested in July, 1928, in the case of the phosphate series, and September, 1928, in the case of the other two series, after which each field was allowed to ratoon.

Phosphate Series.

These were originally planted in November, 1926, in a brown clay loam situated on a gentle slope, facing west. The soil had been under sugar cane more or less continuously for about 50 years, but had one season's fallow (without green manure) previous to planting. The chemical analysis is given in our previous report and shows the soil to be rather acid (pH 5.5) and low in available phosphorus (0.006% P_2O_5 soluble in 1 per cent. citric acid after 24 hours' shaking), but was otherwise fairly well provided with plant-food for a soil of this type.

The phosphorus was applied in six different forms, as follow :—

Fertilizer.	Lbs. per acre applied.
Superphosphate, 17% water soluble P_2O_5 ..	500
Raw rock phosphate, Egyptian	300
A mixture of equal parts of the two above..	375
Bone dust	410
Rhenania phosphate	320
Basic slag, 19% total P_2O_5	470

The quantities were adjusted each to yield equivalent dressings of phosphate, 90 lbs. P_2O_5 per acre.

* Part I. published in J. S. African Chem. Inst. 1929, **12**, 33.

The cane was Uba cane, planted in rows 5 feet apart, using a continuous single line of cane in the furrow. Each fertilizer treatment and the controls without fertilizer were replicated four times in similar plots of 1-20th acre each, consisting of 8 rows 54 feet 6 inches in length. There was a headland 5½ feet wide at the end of each plot, and a 5-foot cane row without fertilizer and not included in the experiment between each two plots as a dividing line.

The results of the plant cane harvesting showed that all the forms of phosphorus used gave a profit over the cost of the fertilizer of a gross value ranging from 32s. 4d. per acre to 103s. 11d. Superphosphate alone gave the best result, and raw rock phosphate, either alone or mixed with superphosphate, the poorest.

The plant cane grew during a very dry period, only 59.09ins. falling during the 20 months' growing season, of which 19ins. fell during one month only.

The first ratoon crop received a well distributed total of 71.62ins. during 24 months' growth, and consequently made very much better yields. However, about the same relative positions were maintained by the fertilizer treatments, superphosphate proving again the best and raw rock with super the poorest.

No further applications of phosphatic fertilizer were made after the first cutting, the intention being to compare the residual values. An application of nitrogen, however, in the form of 200 lbs. sodium nitrate, was made to all plots, fertilized and controls alike, in order to avoid the possibility of lack of nitrogen becoming a limiting factor. In view of the sufficient available potash content indicated by chemical analysis of the soil, it was not considered necessary to complicate matters further at that time by the addition of any potassic fertilizer.

The first ratoon crop was harvested at the end of June and beginning of July, 1928. The results of the two cuttings are shown in tabular form as follow :—

PLANT CANE RESULTS—HARVESTED JULY, 1928.

TREATMENT.	Control.	Super phos-phate.	Rock phos-phate.	Bone dust.	Basic slag.	Rhenania phos-phate.	†Super and rock phos-phate.
Tons cane per acre	26.46	32.40	29.77	30.97	32.52	30.47	28.57
Increase tons cane per acre ..	—	5.94	3.31	4.51	6.06	4.01	2.11
Per cent. increase tons cane per acre	—	22.4	12.5	17.0	22.9	15.2	8.0
Standard deviation from mean ..	1.71	2.06	4.39	2.68	4.12	3.14	3.74
Standard experimental error ..	0.86	1.03	2.20	1.34	2.06	1.57	2.16
Tons pol (sucrose) per acre) . ..	3.68	4.63	4.08	4.43	4.42	4.36	4.00
Increase tons pol (sucrose) per acre .	—	0.95	0.40	0.75	0.74	0.68	0.32
Per cent. increase tons pol (sucrose) per acre	—	23.8	10.9	20.4	20.1	18.5	8.7
Standard deviation from mean ..	0.24	0.37	0.63	0.40	0.56	0.64	0.60
Standard experimental error ..	0.12	0.19	0.32	0.20	0.28	0.32	0.35†
*Corrected increase tons sucrose per acre..	—	1.02	0.38	0.82	0.71	0.81	0.39
Value of sucrose increase	—	125/11	46/11	101/3	87/9	100/–	48/2
Cost of fertilizer	—	20/–	11/3	35/10	18/10	19/6	15/10
Value of sucrose increase, less cost of fertilizer	—	105/11	35/8	65/5	68/11	80/6	32/4
Sucrose per cent. cane (pol) ..	13.9	14.3	13.7	14.3	13.6	14.3	14.0
Fibre per cent. cane	15.2	15.0	15.2	15.4	15.6	15.4	15.6
Juice :—							
Brix..	22.3	22.7	22.0	22.5	22.4	22.5	22.5
Sucrose (pol)	18.35	18.75	17.86	18.60	18.22	18.70	18.47
Purity	81.8	82.6	81.2	82.7	81.3	83.1	82.1
Reducing sugars per cent. juice ..	1.70	1.68	1.82	1.67	1.93	1.58	1.99
Reducing sugar ratio	9.32	8.96	10.19	8.98	10.59	8.45	10.77
Hydrogen ion concentration (pH) ..	5.28	5.28	5.26	5.25	5.29	5.37	5.41
Phosphate (P_2O_5) per cent... ..	0.0064	0.0098	0.0122	0.0106	0.0107	0.0102	0.0087
Potash (K_2O) per cent.	0.113	0.110	0.129	0.139	0.097	0.132	0.112

* Corrected for bonus for purity according to Fahey Scale.

† Mean of three experiments in this series, four in the preceding ones.

FIRST RATOON CROP—HARVESTED JUNE/JULY, 1930.

TREATMENT.	Control.	Super-phos-phate.	Rock phos-phate.	Bone dust.	Basic slag.	Rhenania phos-phate.	Super + rock phos-phate.
Tons cane per acre	37.15	45.11	43.13	44.78	42.81	44.45	39.55
Increase tons cane per acre over controls	—	7.96	5.98	7.63	5.66	7.30	2.40
Per cent. increase tons cane per acre over controls	—	21.4	16.1	20.5	15.2	19.7	6.5
Tons pol (sucrose) per acre	5.717	6.951	6.568	6.739	6.374	6.761	5.948
Increase tons pol (sucrose) per acre over controls	—	1.234	0.851	1.022	0.657	1.044	0.231
Per cent. increase tons pol (sucrose) per acre	—	21.6	14.9	17.9	11.5	18.3	4.0
Standard deviation from mean in Pol (sucrose) per acre	0.563	0.618	0.816	0.647	0.766	0.347	0.796
Standard experimental error in same terms	0.282	0.309	0.408	0.324	0.383	0.174	0.398
Tons pol (sucrose) per acre corrected for purity bonus	5.747	6.988	6.595	6.766	6.400	6.499	5.976
Increase corrected sucrose over controls	—	1.241	0.848	1.019	0.653	0.752	0.299
Value of corrected sucrose increase over controls	—	£6/9/3	£4/8/4	£5/6/1	£3/8/-	£3/18/4	£1/3/10
Pol (sucrose) per cent. cane ..	15.39	15.41	15.23	15.05	14.89	15.21	15.04
Bonus for purity	0.43	0.42	0.36	0.38	0.22	0.32	0.50
Corrected sucrose per cent. cane ..	15.82	15.83	15.59	15.43	15.11	15.53	15.54
Fibre per cent. cane	13.97	13.91	14.42	13.98	14.36	14.29	14.31
Juice :—							
Brix	21.35	21.45	21.35	21.35	21.1	21.1	21.3
Pol (sucrose)	19.50	19.56	19.34	19.42	19.04	19.15	19.15
Purity	91.3	91.2	90.8	90.9	90.1	90.6	92.0
Reducing sugar ratio	1.88	1.85	2.17	2.09	2.78	1.87	1.69
Hydrogen ion concentration (pH) ..	5.35	5.31	5.35	5.33	—	—	—
Phosphate (P_2O_5) per cent. in juice	0.0091	0.0116	0.0192	0.0154	0.0128	0.0131	0.0118
Potash (K_2O) per cent. juice ..	0.0864	0.0890	0.0918	0.0900	0.0904	0.0909	0.0849

It will be seen that the profit from the residual value of the fertilizer in the first ratoon crop is greater than the profit shown from the first cutting, although no more phosphatic fertilizer had been added.

The latter profit, of course, has had the prime cost of the fertilizer deducted from the gross value of the increased yield.

Nevertheless, in the case of the superphosphate, raw rock phosphate, and bone dust plots at least, both the actual increase in sugar yield and the market value of that increase is greater in the second crop than in the first, notwithstanding the diminution in price of sugar in the meantime.

The reason, no doubt, is that the more plentiful supply of soil moisture during the second crop enabled the plant to utilise the remaining fertilizer more fully than during the first drier period.

One would, of course, naturally expect slowly available materials like rock phosphate and bone dust to confer high residual benefits; but it is of interest to note that the superphosphate also gives an increased benefit to the second crop, since it is often supposed that superphosphate, being originally largely water soluble and rapidly available, cannot be expected to yield prolonged results. These experiments show that it can benefit the ratoons equally with the plant cane, even with no more additions of the fertilizer.

It is difficult to explain, however, on these lines, the reduced effect of the basic slag and Rhenania phosphate in the second crop under the same conditions, and particularly why a mixture of superphosphate and raw rock phosphate should be much inferior to an equivalent quantity of either ingredient separately. Admittedly four replications of each treatment are not very many according to modern standards and may result in a fairly large experimental error, as in this case. However, allowing the most weight for the calculated experimental error, the benefits, both original and residual, of the superphosphate, bone dust and Rhenania phosphate are at least undeniable.

The composition of the cane shows no very decided differences from the various fertilizer treatments, except that both in the plant cane and first ratoons there is a marked increase in the phosphate content of the juice where phosphatic fertilizer has been applied.

This series serves to add point to the contention first made by Walker in Hawaii, and later confirmed by others, that the phosphate content of the juice may be a valuable indication of the relative phosphorus deficiency of the soil. How far this is so under our conditions, and how far the phosphate content of the cane varies with age and maturity, as with grasses, or with other factors remains to be seen. At all events these experiments, as well as those described by McRae* in the proceedings of the 1929 Conference, indicate that this may possibly be made a very useful method of soil analysis for our prime plant food deficiency in South Africa—phosphorus.

COMBINED INCREASES OF YIELD AND VALUES FROM PHOSPHATIC FERTILIZER, PLANT CANE AND FIRST RATOON CROPS.

		Super-phosphate.	Raw rock phosphate.	Bone dust.	Basic slag.	Rhenania phosphate.	Super + rock phosphate.
Increased yield of cane in tons per acre	Plant crop..	5.94	3.31	4.51	6.06	4.01	2.11
	First ratoons	7.96	5.98	7.63	5.66	7.30	2.40
	TOTAL ..	13.90	9.29	12.14	11.72	11.31	4.51
Increased yield of pol (sucrose) per acre in tons (corrected for purity bonus)	Plant crop..	1.02	0.38	0.82	0.71	0.81	0.39
	First ratoons	1.24	0.85	1.02	0.65	0.75	0.23
	TOTAL ..	2.26	1.23	1.84	1.36	1.56	0.62
Value of increased yield.. ..	Plant crop..	£6 5 11	£2 6 11	£5 1 3	£4 7 9	£5 0 0	£2 8 2
	First ratoons	6 9 3	4 8 4	5 6 1	3 8 0	3 18 4	1 3 10
	TOTAL ..	12 15 2	6 15 3	10 7 4	7 15 9	8 18 4	3 12 0
Less—Cost of fertilizer	.. ..	1 0 0	0 11 3	1 15 10	0 18 10	0 19 6	0 15 10
Combined profit per acre on first two crops ..		£11 15 2	£6 4 0	£8 11 6	£6 16 11	£7 18 10	£2 16 2

The above results do not take into account such extra debit costs as the cost of transport and handling of fertilizer, interest on investment in fertilizers, cost of harvesting the increased yield of cane, and the like. These charges, however, are relatively small compared with the very large gross profit per acre demonstrated above.

* Proceedings S.A.S.T.A. 1929, 54.

Nitrogen Series.

These are planted in a level clay loam soil, also rather acid (pH 5.5), very low in organic content and in all the ordinary plant foods. There is a very stiff clay sub-soil, and the soil generally is of intractable and poorly draining nature.

It has been under cane almost continually for about 50 years, and yielded 15 tons Uba cane per acre as third ratoons immediately before it became part of the experiment station.

Before re-planting with cane the field was treated with 900 lbs. per acre of raw Egyptian rock phosphate and 60 lbs. of potassium sulphate per acre and fallowed for one season under buckwheat as a green manure crop.

It was planted with cane in December, 1926, and divided into 24 plots of 1-16th acre each comprising 8 cane rows 5 feet apart and 68 feet long. The plots were separated by a single unfertilized cane row not in the experiment, and 5½ feet headland at each end of the plots. The cane was Uba, planted as usual in one continuous line in the furrow, and was fertilized throughout with 250 lbs. per acre of superphosphate. One series was then left as a control without further fertilizer and others treated with the following :—

Fertilizer.	Lbs. per acre applied.
Ammonium sulphate	245
Sodium nitrate	320
Whale guano	415
Calcium cyanamide	265
Urea	110

These quantities were selected each to supply 50 lbs. of nitrogen per acre. Each series was done in quadruplicate.

The water soluble forms, ammonium sulphate, sodium nitrate, and urea were applied in two equal side dressings two months and three months respectively from the date of planting, the insoluble forms, whale guano and calcium cyanamide, being placed in the furrow with the plant cane.

The results of the plant cane crop, harvested in September, 1928, showed a response to all forms of nitrogen applied, but not sufficient to show a profit over the cost of the fertilizer in the case of the urea.

The most profitable nitrogenous fertilizers were nitrate of soda and whale guano, showing a gross profit of 69s. 3d. and 55s. 7d. per acre respectively.

The total rainfall during the crop was 59.39ins., of which 19ins. fell in one month.

The first ratoon crop received in all 71.45ins., well distributed over a period of 23 months.

The yields per acre in each series when harvested in August, 1930, were considerably over the corresponding plant cane crop. The sodium nitrate plots were again the best, followed by the whale guano, but there was now no response to the ammonium sulphate, calcium cyanamide or urea series.

No further treatments with any fertilizer had been given, in order to test the residual value of the original nitrogenous fertilizers.

It is difficult to account directly for the long continued benefit from the application of a highly soluble and unabsorbed material like sodium nitrate, except on the supposition that the physiologically basic residual effect of the sodium improved the character of this acid soil. Conversely, the acid-forming ammonium compounds may have increased the soil acidity. Fudge, at the Alabama Experiment Station,* recently showed that the solubility and availability of the soil phosphates were decreased by ammonium sulphate unless the soil was limed, and that sodium nitrate increased the solubility of the phosphates.

Herein may be the explanation of our results, and further studies of the soil from this point of view are in progress.

Following are the results in tabular form of the first two cuttings :—

* J. Amer. Soc. Agron. 1928, 20, 381.

PLANT CANE RESULTS—HARVESTED SEPTEMBER, 1928.

TREATMENT.	Control.	Ammonium sulphate.	Sodium nitrate.	Whale guano.	Calcium cyanamide.	Urea.
Tons cane per acre	25.11	27.90	31.47	30.49	28.23	26.29
Increase tons cane per acre	—	2.79	6.36	5.38	3.12	1.18
Per cent. increase tons cane per acre	—	11.1	25.32	21.43	12.4	4.7
Standard deviation from mean	2.34	2.57	3.33	2.22	3.59	2.07
Standard experimental error	1.17	1.28	1.66	1.11	1.80	1.04
Tons pol (sucrose) per acre	3.84	4.25	4.79	4.66	4.33	4.04
Increase tons pol (sucrose) per acre	—	0.41	0.95	0.82	0.49	0.20
Per cent. increase tons pol (sucrose) per acre	—	10.7	24.7	21.4	12.8	5.2
Value of pol (sucrose) increase	—	50/7	117/3	101/3	60/6	24/8
Cost of fertilizer	—	41/2	48/–	45/8	34/5	31/11
Nett profit per acre	—	9/5	69/3	55/7	26/1	– 7/3
Pol (sucrose) per cent. cane	15.3	15.3	15.2	15.3	15.3	15.4
Fibre per cent. cane	14.8	14.5	13.9	14.3	14.7	14.4
Juice :—						
Brix	22.1	22.3	22.0	22.2	22.3	22.2
Pol (sucrose)	19.61	19.72	19.35	19.65	19.84	19.82
Purity	88.7	88.4	87.9	88.5	89.0	89.3
Reducing sugars per cent. juice	0.46	0.50	0.52	0.50	0.51	0.48
Reducing sugar ratio	2.3	2.5	2.7	2.5	2.6	2.4
Hydrogen ion concentration (pH)	5.33	5.33	5.31	5.32	5.32	5.35
Phosphate (P_2O_5) per cent.	0.057	0.050	0.057	0.052	0.043	0.048
Potash (K_2O) per cent.	0.140	0.165	0.183	0.151	0.129	0.134

FIRST RATOON CROP—HARVESTED IN AUGUST, 1930.

TREATMENT.	Control.	Ammonium sulphate.	Sodium nitrate.	Whale guano.	Calcium cyanamide.	Urea.
Tons cane per acre	30.92	30.89	35.60	33.90	30.85	29.32
Increase tons cane per acre over controls	—	– 0.03	+ 4.68	+ 2.98	– 0.07	– 1.60
Per cent. increase tons cane per acre over controls	—	– 0.1	+15.1	+ 9.6	– 0.2	– 5.2
Tons pol (sucrose) per acre	4.724	4.754	5.468	5.214	4.816	4.577
Standard deviation from mean	0.525	0.348	0.354	0.264	0.397	0.621
Standard experimental error	0.262	0.174	0.177	0.132	0.198	0.310
Increase tons pol (sucrose) per acre	—	0.030	0.744	0.490	0.092	0.147
Per cent. increase tons pol (sucrose) per acre over controls	—	+ 0.6	+15.7	+10.4	+ 1.9	– 3.1
Pol (sucrose) per cent. cane	15.28	15.39	15.36	15.38	15.61	15.61
Bonus for purity of juice	+ 0.47	+ 0.53	+ 0.50	+ 0.50	+ 0.59	+ 0.54
Sucrose per cent. cane corrected for bonus	15.75	15.92	15.86	15.88	16.20	16.15
Corrected sucrose per acre in tons	4.870	4.918	5.646	5.383	4.998	4.735
Increase over controls of corrected sucrose in tons per acre	—	0.048	0.776	0.153	0.128	– 0.135
Value of sucrose increase	—	5/–	£4/0/11	£2/13/6	13/4	– 14/9
Fibre per cent. cane	14.58	14.63	14.58	14.61	14.62	14.62
Juice :—						
Brix	21.6	21.6	21.6	21.9	22.0	21.9
Pol (sucrose)	21.78	19.96	19.90	20.14	20.40	20.22
Purity	91.7	92.3	92.0	92.0	92.9	93.4
Reducing substance ratio	10.4	0.92	0.67	0.90	0.61	0.79
Phosphate (P_2O_5) per cent.	0.031	0.034	0.031	0.027	0.028	0.029
Potash (K_2O) per cent.	0.077	—	—	—	0.074	—

It is notable that the cane juice shows a very high content of phosphate in both crops. This may be a consequence of the heavy basic dressing of rock phosphate that was given the season before planting the cane, or may be merely due to the physical peculiarities of this soil. This is a matter that requires further experiment, in view of the suggestion that the phosphate content of the cane juice may be indicative of the relative phosphorus deficiency of the soil.

As before, there are no significant differences in the quality of the cane as a result of the varying treatment with nitrogenous fertilizer.

COMBINED INCREASES OF YIELD AND VALUES FROM NITROGENOUS FERTILIZERS, PLANT CANE CROP AND FIRST RATOONS.

		Ammonium sulphate.	Sodium nitrate.	Whale guano.	Calcium cyanamide.	Urea.
Increased yield of cane per acre in tons..	Plant crop ..	2.79	6.36	5.38	3.12	1.18
	First ratoons	— 0.03	4.68	2.98	— 0.07	— 1.60
	TOTAL ..	2.76	11.04	8.36	3.05	— 0.42
Increased yield of pol (sucrose) per acre in tons, corrected for purity bonus	Plant crop ..	0.41	0.95	0.82	0.49	0.20
	First ratoons	+ 0.05	0.78	0.51	0.13	— 0.14
	TOTAL ..	0.46	1.73	1.33	0.62	+ 0.06
Value of increased sucrose	Plant crop ..	£2 10 7	£5 17 3	£5 1 3	£3 0 6	£1 4 8
	First ratoons	0 5 0	4 0 11	2 13 6	0 13 4	—0 14 9
	TOTAL ..	£2 15 7	9 18 2	7 14 9	3 13 10	0 9 11
Less—Cost of fertilizer		2 1 2	2 8 0	2 5 8	1 14 5	1 11 11
		£0 14 5	£7 10 2	£5 9 1	£1 19 5	£1 2 0*

* Loss.

It should be pointed out that the price of both ammonium sulphate and sodium nitrate has fallen considerably since these materials were applied in this experiment, over four years ago.

It is evident that under the conditions of this experiment, the use of nitrogenous fertilizer as an adjunct to a phosphatic and potassic fertilizer, especially in the form of sodium nitrate or whale guano, is very profitable in soils of this type that have been long under sugar cane; also that considerable residual benefits may be expected from both these fertilizers.

Potash Series.

The field containing this series adjoins the nitrogen experiments, but consists of a somewhat heavier clay surface and a less compacted subsoil. Drainage is a little less difficult, but the soil has very poor capillarity, only 70 mm. rise in 24 hours. This soil is also somewhat acid (6.0 pH) and according to the chemical analysis is very deficient in available phosphate and moderately well supplied (0.001% K_2O) with available potash, soluble in 1 per cent. citric acid.

This field also had been continuously under cane for very many years and had given an average yield of 16 tons of cane per acre over the last cycle of plant cane and three ratoon crops before becoming part of the experiment station.

It was planted with Uba cane in December, 1926, with plots of the same dimensions and area (1-16th acre) as those in the nitrogen experiment. There were nine plots in all, each being treated with superphosphate at the rate of 250 lbs. per acre. Three of them had no other fertilizer, being left as controls, and two series of three each were treated with 75 lbs. of potassium chloride and 90 lbs. of potassium sulphate respectively.

Three plots unfortunately had to be discarded from the experiment, owing to the influence of a belt of trees planted on neighbouring property within 20 feet of these plots. Consequently only duplicate plots that could be taken in account remained of each treatment, which is insufficient to supply very reliable results.

There was, however, a small response to the chloride, though not enough to show a profit, and a somewhat larger one from the sulphate.

The plant cane crop was harvested in September, 1928, while rather seriously affected by the drought then prevailing. The total rainfall during the crop was 57.77ins., of which 19ins. fell in one month, March, 1927.

The first ratoon crop received in all 67.04ins. of rain, fairly well distributed up to the time of harvesting, June, 1930.

In view of the poor results given by the plant cane crop, the first ratoon roots were treated a month after the first cutting with 400 lbs. superphosphate and 130lbs. ammonium sulphate per acre to all plots, including controls, and the potash plots were given further doses of the sulphate and chloride respectively as at the first dressing.

In this series, therefore, we are not dealing in the ratoon crop solely with the residual effect of the fertiliser element in question, as in the phosphate and nitrogen series.

There was a much better response to the potash at the second cutting. This was either because the more regular supply of moisture enabled the plant better to utilise the potash, or possibly because the lack of phosphorus or of nitrogen was originally the limiting factor, which was supplied by the ammonium sulphate or the further dressing of superphosphate applied to the ratoon crop.

In any case, the increased benefit from the application of potash is quite definite in this case, even though there are only duplicate plots available for record, with consequently large experimental error.

There appears to be no significant difference between the sulphate and the chloride, except that the former appeared to show a somewhat higher sucrose content of cane. No conclusions in this matter can be arrived at from the analyses of only two samples of cane, however.

The results of the first two cuttings are as follow :—

PLANT CANE CROP—HARVESTED SEPTEMBER, 1928.

Treatment.	Control.	Potassium chloride.	Potassium sulphate.
Tons cane per acre ..	19.69	20.62	22.80
Increase tons cane per acre	—	0.93	3.11
Per cent. increase tons cane per acre..	—	4.7	15.8
Standard deviation from mean	0.33	0.34	0.29
Standard experimental error	0.23	0.24	0.21
Tons pol (sucrose) per acre	3.02	3.09	3.49
Increase tons pol (sucrose) per acre..	—	0.07	0.47
Per cent. increase tons pol (sucrose) per acre ..	—	2.3	15.6
Corrected increase tons pol (sucrose) per acre ..	—	0.08	0.53
Value of sucrose increase.	—	9/10	65/5
Cost of fertilizer	—	9.7	12.4
Nett profit per acre ..	—	-/3	53/1
Pol (sucrose) per cent. cane	15.33	15.00	15.31
Juice extracted per cent. cane	59.0	56.3	57.6
Fibre per cent. cane ..	13.4	13.8	12.7
Juice :—			
Brix	21.9	21.9	21.8
Pol (sucrose)	18.89	18.61	18.79
Purity	86.2	85.0	86.2
Reducing sugars per cent. juice	0.75	0.96	0.74
Reducing sugar ratio ..	4.0	5.2	3.9
Phosphate (P_2O_5) per cent.	0.030	0.020	0.023
Potash (K_2O) per cent. ..	0.097	0.084	0.103

FIRST RATOON CROP—HARVESTED JUNE, 1930.

Tons cane per acre	30.58	35.96	35.40
Increase tons cane per acre over controls	—	5.38	4.82
Per cent. increase tons cane per acre over controls..	—	17.6	15.8
Tons pol (sucrose) per acre	4.758	5.556	5.678
Standard deviation from mean	0.020	0.465	0.130
Standard experimental error	0.014	0.328	0.092
Increase tons pol (sucrose) per acre over controls..	—	0.798	0.920
Per cent. increase tons pol (sucrose) per acre over controls..	—	16.8	19.3
Pol (sucrose) per cent. cane	15.56	15.45	16.04
Bonus for purity	0.44	0.30	0.48
Corrected sucrose per cent. cane	16.00	15.75	16.52
Corrected tons sucrose per acre	4.893	5.664	5.848
Corrected increase tons sucrose per acre over controls	—	0.771	0.955
Value of sucrose increase ..	—	£4 2 6	£4 15 6
Less cost of extra potash..	—	0 9 7	0 11 11
Net gain	—	£3 12 11	£4 3 7
Fibre per cent. cane ..	14.02	13.90	13.91
Juice :—			
Brix	22.1	21.9	22.2
Pol (sucrose)	20.20	19.86	20.40
Purity	91.4	90.5	91.8
Reducing substance ratio .	1.24	1.06	1.15
Phosphate (P_2O_5) per cent.	0.030	0.027	0.028
Potash (K_2O) per cent. ..	0.072	0.088	0.112
Hydrogen ion concentration (pH)	5.22	5.22	5.26

Given a season of favourable rainfall, there is evidently a real response to potash as a fertilizer as an adjunct to phosphatic and nitrogenous fertilizer under the conditions of this experiment, in a soil such as this, a heavy clay loam of very low capillarity.

General Summary and Conclusions.

The conclusions of the plant cane experiments are confirmed, namely, that a "complete" fertilizer is required for this class of soil—that is, a heavy clay loam deficient in organic matter and most of the ordinary plant foods, and in drainage quality, and has been long under sugar cane without adequate fallowing.

This complete fertilizer should contain phosphorus in the form of superphosphate, nitrogen as sodium nitrate or whale guano, and potash as potassium chloride or sulphate.

Further experiments are in progress to determine which is the most profitable quantity of each ingredient, but a treatment of 500 lbs. of superphosphate and 75 lbs. of potassium chloride applied at time of planting cane, with a top dressing two months later of 300 lbs. sodium nitrate per acre, has been shown to give good results. It appears probable, however, that this dressing of superphosphate, at least, may be increased with advantage.

The residual value of superphosphate, bone dust and raw rock phosphate has been shown to be as great or greater than the original benefit under the conditions of this experiment—that is, a drought-stricken plant cane crop with rather better supply of moisture during the first ratoon crop. The potash, in fact, gave very little result at all during the first dry period.

There are no significant effects on the sucrose content of the cane from the application of fertilizer, but only on the sucrose yield per acre, by increasing the quantity of cane.

Treatment with phosphatic fertilizer brings about an increase in the phosphate content of the cane juice, which may possibly be used as an indication of the relative phosphorus deficiency of the soil.

The experiments are being continued, to test the further effects of the fertilizer on the later ratoon crops.

Acknowledgments are due to the U.S. Steel Trust for the generous gift of ammonium sulphate, also to the Chilean Nitrate Committee for supplies of sodium nitrate, and to Messrs H. Jungheinrich & Co. for Rhenania phosphate.

Natal Sugar Experiment Station,
South African Sugar Association,
Mount Edgecombe,
Natal.

March, 1931.

APPENDIX

Since writing the above paper some of the laboratory tests of the soil referred to near the foot of the second column on page 144 are now available, and the chemical and mechanical analyses of each series in the nitrogen experiment are appended.

Although the soil naturally still suffers from the disadvantages of shallowness with no surface gradient and a very stiff clay subsoil, so that natural drainage is very poor, it is evident both from the changes in chemical composition and enhanced yields of cane that there has been considerable amelioration as a result of the fertilizer treatment and suitable cultivation and surface drainage.

The soil is also in a much better state of tilth and has vastly improved in drainage quality though still apt to be troublesome in very wet weather.

The soil is now much less acid, in fact being now close to true neutrality as shown by pH determinations with a quinhydrone cell and platinum electrode. This is a result probably partly of improved drainage, and partly of the heavy dressing (900 lbs. per acre) of raw rock phosphate given at the beginning of operations which will have increased the calcium content as well as the phosphorus.

As was to be expected the plots treated with ammonium sulphate are more acid than the sodium nitrate plots, and the available phosphate is also lower in the ammonium sulphate series as suggested in column 2 on page 144. Nevertheless the differences in chemical composition shown are not sufficient to account for the striking differences in yield results from the ammonium sulphate series when compared with the sodium nitrate plots and particularly with the whale guano plots whose soil would appear according to the chemical analysis to be on the whole inferior to that of the ammonium sulphate plots.

Besides the improvement in soil reaction, there is a great increase in the proportion of phosphate in available form (soluble in 1 per cent. citric acid) as well as available potash.

There is also a marked increase in loss on ignition and in most cases an appreciable increase in nitrogen content compared with the earlier analysis.

The ratio of carbon to nitrogen is high, which may contain the clue to the marked response to some forms of nitrogenous fertilizer in this soil, and the content of nitrate nitrogen (determined colorimetrically by the phenoldisulphonic acid method), although small, shows a considerable increase in the fertilized plots compared with the controls.

As usual the chemical analysis of the soil for certain constituents on more or less conventional lines has thrown somewhat more light on the field results, but is far from giving one all the information hoped for.

ANALYSIS OF SOIL FROM FIELD A3 USED FOR NITROGENOUS FERTILIZER EXPERIMENT — SAMPLED IN JANUARY, 1925, SOME MONTHS BEFORE EXPERIMENTS WERE BEGUN.

Classification.	Greyish brown clay loam
Reaction to litmus.	very slightly acid.
Hydrogen ion concentration.	5.5 (pH).
	Per cent.
Hygroscopic moisture	1.66
(a) Loss on ignition	1.48
(b) Total lime (as CaO)	0.26
(c) Total potash (as K_2O)	0.17
(d) Total phosphate (as P_2O_5)	0.02
Above includes:—	
(a) Nitrogen	0.07
(b) Carbonate of lime	0.040
(c) Available potash	0.009
(d) Available phosphate	0.002
Acidity (requirement of calcium carbonate)	0.001
Water capacity	32.5
Capillarity (rise in 24 hours)	426 mm.

ANALYSES OF SOIL FROM NITROGENOUS FERTILISER EXPERIMENT. FIELD A3.
CHEMICAL ANALYSES.

	Ammonium sulphate.	Sodium nitrate.	Calcium cyanamide.	Controls.	Whale guano.	Urea.
Plot Numbers.	139 148 161 165	140 149 154 164	142 153 158 162	144 147 157 160	141 150 152 163	146 151 156 159
Moisture in air dried soil per cent.	.92	.81	1.01	.67	1.08	1.06
Loss on ignition	2.51	2.49	2.74	2.06	2.99	2.81
Hydrogen ion concentration with Platinum electrode (pH)	6.785	7.145	6.985	7.115	6.77	6.87
Available Phosphate (P_2O_5) per cent.	0.0115	0.0140	0.0110	0.0095	0.0098	0.0104
Available Potash (K_2O) per cent.	0.0216	0.0152	0.0203	0.0190	0.0200	0.0160
Total Carbon per cent.	2.210	2.010	2.270	1.780	2.205	2.220
Total Nitrogen per cent.	0.0835	0.0755	0.0870	0.0740	0.0905	0.0810
Carbon/Nitrogen ratio	1 : 26	1 : 27	1 : 26	1 : 24	1 : 24	1 : 27
Nitrate Nitrogen, parts per million	0.25	0.25	0.25	0.16	0.30	0.21

MECHANICAL ANALYSES

	Ammonium sulphate.	Sodium nitrate.	Calcium cyanamide.	Controls.	Whale guano.	Urea.
Gravel and Coarse Sand per cent.	47.92	43.28	44.12	44.18	43.38	42.13
Fine Sand	21.00	28.50	28.60	24.70	28.60	27.50
Silt	6.50	7.40	8.25	7.60	8.80	6.75
Fine Silt	4.80	4.80	4.70	4.35	4.65	4.75
Clay	5.25	5.45	5.55	4.70	6.15	5.50
Moisture	0.92	0.81	1.01	0.67	1.08	1.06
Loss on ignition	2.51	2.49	2.74	2.06	2.99	2.81
Loss by difference	11.10	7.27	5.03	11.74	4.35	9.55

Natal Sugar Experiment Station,
MOUNT EDGECOMBE.
May, 1931.

SPECIAL CANE TRUCKS, S.A.R.

SECRETARY: I am sorry Mr. Simpson is not present to report on this matter, but as I have been brought in touch with it a good deal I will tell you what has been done. Two designs have been submitted to the Railway authorities, and a specimen truck built on one of the designs was ready towards the end of the season, but too late to be put out for trial. It is now at the workshops waiting to be issued when the new season begins. The second design is still under the consideration of the Railway authorities, because I understand there is some question of finance arising out of it, but we expect at any rate that specimens of both trucks will be available for trial early in the next season. These trucks, of course, are in accordance with the two designs that were selected at the last Congress.

Mr. PULLAR stated he had had the advantage of meeting Mr. Kidd, and he had gone out to the estates to see the conditions, and as a result he had sent out designs to be put before the Technologists. He now handed over the designs for what they worth, as he personally was not interested in the matter.

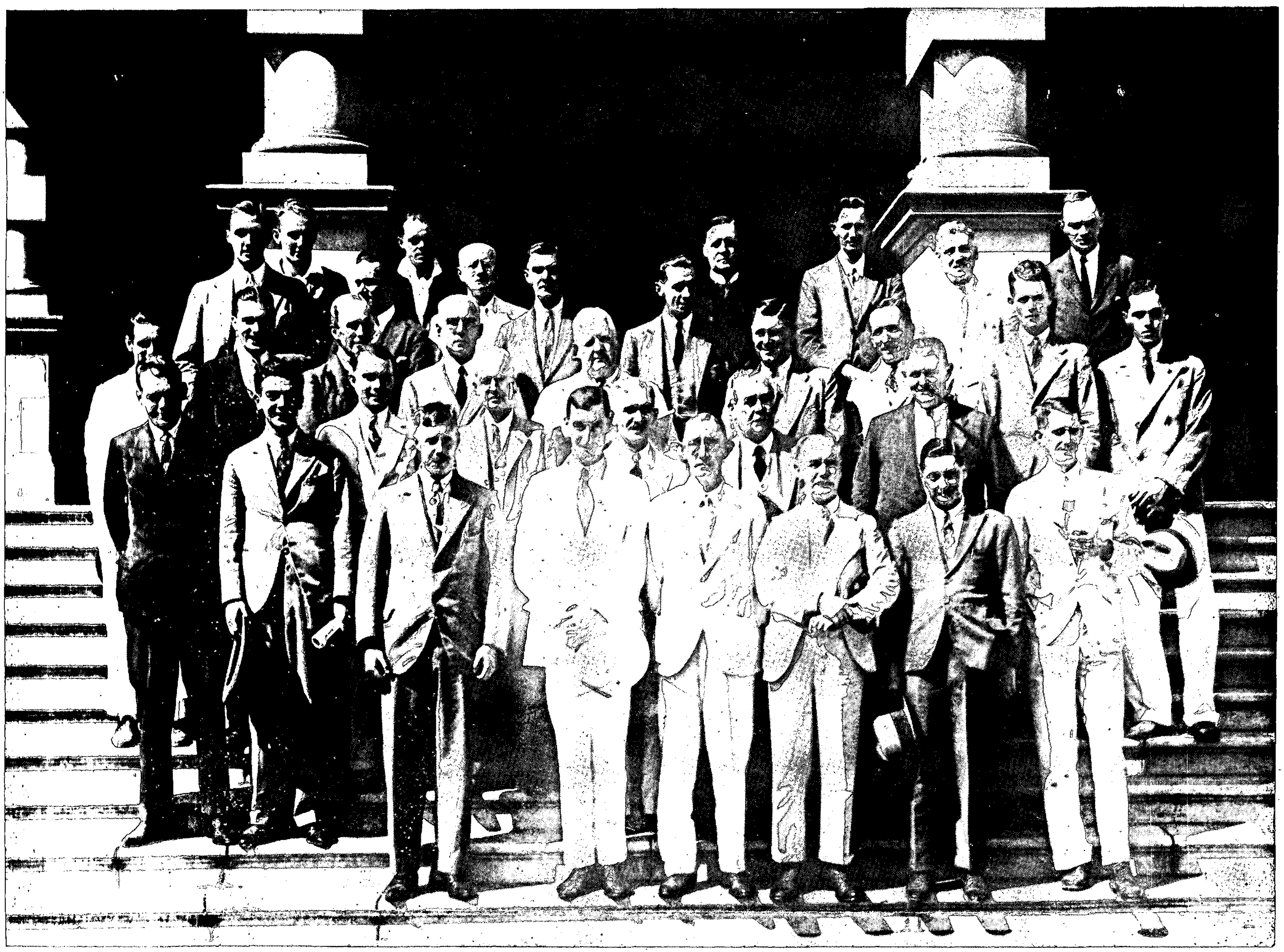
CHAIRMAN thanked Mr. Pullar for the diagrams, which would be shown to the Committee concerned.

CONCLUSION OF CONGRESS.

CHAIRMAN: We have come to the end of our Fifth Annual Congress. I think we can say it has been a successful one. From the point of view of attendance it has been a record and, I think, from the point of view of discussions. I will be handing over the Chairmanship to Mr. Dymond, and I know in him you will have a very useful Chairman. He is a man who is experimentally minded, who is always keen on attempting to carry through research on different problems, and one who has given a great deal of hard work and thought to this Association. I have been connected with this Association very intimately during the last five years, and during all that time Mr. Dymond has been one of our standbys, and I am very pleased to hand over to him. In closing, I would like to move a vote of thanks to the Secretary, and if anybody is deserving of a word of appreciation for hard work it is our friend the stenographer, Mr. Macgregor. (Applause.)

Mr. DYMOND: I should like to propose a very hearty vote of thanks to Mr. Moberly. I think you will all agree that the undoubted success of this Congress has been largely due to the manner in which he has prepared the work for the Congress, and the able manner in which he has conducted the meetings. I am sure you will all join with me in saying that we hope it is not the last occasion on which Mr. Moberly will occupy the chair of the Technologists' Association. I have now stepped into his shoes. I thank him very much for his kind words, and I only hope that the work of the following year will at least be somewhere equal to the work as carried out by Mr. Moberly. (Loud applause.)

The CHAIRMAN thanked all for attending, and declared the Congress closed.



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