SOME FERTILIZER EXPERIMENTS SHOWING PROFITABLE RETURNS

By THE EXPERIMENT STATION STAFF.

In the past many of our fertiliser experiments have given either negative or inconlcusive results, and the conclusions drawn therefrom, if any, have been of a negative or at best a tentative character. Whilst negative recommendations may be not without their value, it is much more satisfactory to be able to report experiments that show positive results having a high statistical significance.

The experiments now to be described are in that class, especially the one on top-dressing ratoons on the estate of Mr. Ladlau at Umhlali, where the use of the inorganic nitrogenous fertilisers ammonium sulphate and sodium nitrate proved highly profitable.

It has long been known that phosphatic fertilisers, within certain limits of quantity, are very profitable and indeed highly necessary in nearly all our soils. The following experiments contain efforts to trace these limits on two classes of soil.

During the past season a number of new experiments have been laid down on a number of representative soils in various districts, in an endeavour to obtain definite information regarding the response to be obtained from varying amounts of nitrogen and potash. It is hoped the data to be obtained within the next two or three years will lead the way to the more profitable use of fertilisers.

TOP-DRESSING EXPERIMENT ON THIRD RATOON Co. 281, G. P. LADLAU, UMHLALI.

In 1933 two experiments with fertilisers Nos. 2 and 3 were laid down at Mr. Ladlau's farm, on soil typical of the sandy coastal area which is found near the sea almost from end to end of the sugar belt.

In general type this soil is fairly uniform, but local variations due to antheaps, washes, and probably to the position of clumps of bush on the veld before it was ploughed up for cane, are numerous. It was found impossible to avoid them altogether when selecting land for experiments.

The following analyses of soil from Mr. Ladlau's farm was done on samples taken near the site of the experiments and can be taken as typical of the area.

Physical Analysis of Soil.

	Surface soil %.	Sub-soil %.
Coarse sand	63.60	60.45
Fine sand	21.26	21.88
Silt	3.75	5.25
Clay	9.50	11.25
Moisture	0.64	0.69
Loss by solution (Fe_2O_3, etc.)	1.22	1.18

Results expressed in per cent. of the air-dried total.

Chemical Analysis of Soil.

	Surface soil %.	Sub-soil %.
Insoluble residue	88.70	88.23
Soluble silica	2.30	1.60
Loss on ignition	2.11	2.18
Potash (K_2O)	0.077	0.056
Phosphoric oxide (P_2O_5)	0.006	0.006
Lime (CaO)	0.116	0.085
Magnesia (MgO)	0.068	0.032
Alumina (Al_2O_3)	1.726	2.301
Oxide of iron (Fe_2O_3)	5.837	5.639

Including—

	Surface soil %.	Sub-soil %.
Total carbon	0.745	0.637
Total nitrogen	0.070	0.049
Carbon : nitrogen ratio	10.6	13.0
Available potash	0.005	0.004
Available phosphoric oxide	0.002	0.001
pH value	5.58	5.42
Lime requirement in tons $CaCO_3$ per acre	0.88	—
Moisture	0.638	0.694

Experiment No. 2 was a test of concentrated fertiliser (ammonium phosphate type) against a fertiliser mixture composed of superphosphate, ammonium sulphate and potassium chloride containing the same amount of phosphate, nitrogen, and potash. A medium and a fairly heavy dressing of each type of fertiliser was given at planting time, and three crops at approximately twelve months each were taken without any further fertiliser being applied. The fields were examined crop by crop as harvested and also averaged and compared at the end of three years when the second ratoon results were available.

The fertilised plots gave large gains over the unfertilised controls, but there was no significant difference between the different forms of fertiliser. The ordinary fertiliser mixtures gave a somewhat higher average yield than the concentrated fertiliser, but under the conditions of this experiment they must be considered as being equally effective; but the concentrated fertiliser was less economical in view of its higher cost per unit.

Experiment No. 3 was a test of the following combinations of fertilisers, all applied in the furrows before planting :—

	TOTAL YIELD FROM THREE CROPS IN THREE YEARS.		
	Tons Cane per acre.	Sucrose % Cane.	Tons Sucrose per acre.
1. No fertiliser...	62.89	15.09	9.49
2. 640 lbs. superphosphate	77.59	15.00	11.64
3. 640 lbs. superphosphate ... ... 80 lbs. potassium chloride	80.40	15.00	12.06
4. 640 lbs. superphosphate ... ... 80 lbs. potassium chloride ... ... 160 lbs. ammonium sulphate	77.34	15.17	11.73
5. 640 lbs. superphosphate ... ... 80 lbs. potassium chloride ... ... 200 lbs. whale guano No. 1	85.15	15.02	12.79

This experiment was harvested at the same time as experiment No. 2, without any further fertiliser being applied to the ratoons. The fertilised plots gave very significant gains over controls in the plant cane crop, and continued to give increases over controls in a diminishing ratio in the first and second ratoons.

The plots receiving potash and potash and nitrogen along with superphosphate gave higher yields than those receiving superphosphate alone, but they were not significantly better at 19 : 1, even in the plant cane crop.

After the second ratoon crop had been reaped it was decided to use the sixty plots comprising Nos. 2 and 3 experiments for a new experiment on ratoons. In laying out this new experiment the performance of each plot over three crops was taken into account to eliminate the error due to the variable nature of the soil, as much as possible.

The following table gives the fertilisers applied to and the yields from the third ratoon crop.

EXPERIMENTS Nos. 2 and 3.—TOP-DRESSING OF RATOONS, G. P. LADLAU, UMHLALI (Co. 281). Third Ratoon Cane. Harvested as 11 months old, November, 1937.

The fertilisers were applied 6th January, 1937.

	480 Super, 80 KCl., 400lbs. W.G.	480 Super, 80 KCl., 200lbs. A.S.	480 Super, 80 KCl., 250lbs. N.S.	480lbs. Super, 80lbs. KCl.	480lbs. Super,	Con-trol.
Tons cane per acre	21.56	22.09	22.13	18.09	18.60	17.03
Increase tons cane per acre over controls	4.53	5.06	5.10	1.06	1.57	—
Percentage tons cane per acre compared with controls	126.6	129.7	129.9	106.1	109.2	—
Tons pol (sucrose) per acre...	3.51	3.59	3.62	2.95	3.04	2.78
Increase tons pol per acre over controls	0.73	0.81	0.84	0.17	0.26	—
Percentage tons pol per acre compared with controls	126.3	129.1	130.2	106.1	109.3	—
Pol (sucrose) % cane	16.27	16.33	16.43	16.30	16.40	16.42
Fibre % cane	15.01	14.96	14.98	14.86	14.93	14.96
Juice: Brix	21.8	21.9	22.0	21.9	21.9	21.9
Pol (sucrose) %	20.42	20.47	20.62	20.49	20.51	20.56
Purity	94.0	93.6	93.9	93.7	93.5	93.9
Mgms. per 100 ml. phosphate content	37.9	22.4	20.4	29.9	25.2	20.3
,, ,, potash content	163.6	230.3	179.3	250.6	166.1	165.6
,, ,, chlorides content	140.4	145.8	131.4	155.4	131.4	152.6

	480 S. per, 80 KCl., 400lbs. W.G.	480 Super, 80 KCl., 200lbs. A.S.	480 Super, 80 KCl., 250lbs. N.S.	480lbs. Super, 80lbs. KCl.	480lbs. Super,	Con-trol.
Reducing sugar ratio	0.55	0.42	0.45	0.39	0.45	0.43
Total value of sucrose per acre at £5.4303 per ton	£19 1 3	19 9 11	19 13 2	16 0 5	16 10 2	15 1 11
Soft cane bonus at 1.23d. per ton Co.281 ...	0 2 3	0 2 3	0 2 3	0 1 10	0 1 11	0 1 9
	£19 3 6	19 12 2	19 15 5	16 2 3	16 12 1	15 3 8
Value of gain or loss compared with controls for this crop	£3 19 10	4 8 6	4 11 9	0 18 7	1 8 5	—
Cost of fertiliser	£3 2 2	1 19 5	2 5 2	1 3 2	0 15 1	—
Gain after deducing cost of fertiliser	£0 17 8	2 9 7	2 6 7	0 4 7	0 13 4	—

The most interesting thing about these results is that all three forms of nitrogenous fertiliser gave practically the same increase over controls in tons sucrose per acre, and that the increase obtained was highly significant. As the fertiliser dressings varied in cost there was a larger profit from the use of the nitrogenous salts, sulphate of ammonia and nitrate of soda, than from the more expensive organic nitrogen in whale guano No. 1.

This experiment is being carried on and for this growing season the applications of nitrogenous fertilisers and potassium chloride have been increased 50 per cent. and applied in two dressings, whilst the superphosphate has been omitted. At the present time there is a marked difference in colour and growth in favour of the plots receiving nitrogenous top-dressings.

FERTILISER EXPERIMENT AT WILTON PARK ESTATE, EMPANGENI.

This was an experiment to test the effect of different amounts of superphosphate along with 200 lbs. of sulphate of ammonia and 100 lbs. of potassium sulphate, all applied in the furrows at planting time. The experiment was planted in 1930 and three crops were taken without any further applications of fertiliser to the ratoon crops.

The experiment was carried out in reddish-brown soil. It is a clay loam having a crumbly structure and very similar to many other so-called chocolate soils in various parts of the North Coast of Natal and Zululand. The subsoil in the experiment area is not sharply defined from the surface soil, but has somewhat more clay in it. It is also of a crumbly nature. In most parts there is an admixture of ironstone gravel from about the second foot downwards. The texture does not vary much down to a depth of about six feet.

This area is on the western or inland side of the Empangeni sugar district and has a somewhat lower average rainfall than nearer the sea. This, together with the fact that the cane, variety Uba, was badly affected with streak disease, accounts for the low yields of cane harvested on this soil.

Chemical Analysis of Soil.

	Surface soil %.	Sub-soil %.
Insoluble residue	69.16	68.46
Soluble silica (SiO_2)	0.96	0.72
Loss on ignition	9.58	9.32
Potash (K_2O)	0.14	0.11
Phosphoric acid (P_2O_5)	0.02	0.03
Lime (CaO)	0.16	0.10
Magnesia (MgO)	0.06	0.05
Alumina (Al_2O_3)	6.72	8.63
Oxide of iron (Fe_2O_3)	13.25	12.75

Containing—

	Surface soil.	Sub-soil.
Total carbon	2.712	2.241
Total nitrogen	0.151	0.147
Carbon : nitrogen ratio	17.9	15.2
Available potash	0.015	0.007
Available phosphoric acid	0.001	0.001
pH value	6.21	6.85
Moisture	4.16	4.54

Physical Analysis of Soil.

Coarse sand	14.24
Fine sand...	30.28
Silt	10.02
Clay	39.18

The following table gives details of the yields obtained from the various treatments. The plant cane and first ratoon crops were reported in a paper by Mr. J. E. Colepeper in the South African Sugar Technologists' Proceedings, 1936 (vol. 10, page 169).

EXPERIMENT G.—WILTON PARK ESTATE, EMPANGENI.

Cane Variety—Uba.

	Tons Cane per acre.	Sucrose % Cane.	Tons Sucrose per acre.	Purity of Juice.	Cost of fertiliser at 1937 prices.	Value of Sucrose at 1937 price.	Value of increase over controls.	Gain after allowing for cost of fertiliser.	% of control.
Controls.					£ s. d.	£ s. d.	£ s. d.	£ s. d.	
Plant crop	17.83	11.40	2.04	83.9					
First ratoon crop...	24.13	11.73	2.83	79.5					
Second ratoon crop	21.69	12.09	2.62	90.3					
Total	63.65	11.77	7.49	84.6	—	40 13 5	—	—	—
NK only.									
Plant crop	18.57	11.80	2.19	84.6					107.4
First ratoon crop...	24.96	11.53	2.88	79.5					101.8
Second ratoon crop	24.19	12.17	2.94	90.3					112.2
Total	67.72	11.83	8.01	84.8	1 5 9	43 9 11	2 16 6	1 10 9	106.9
NK+250 lbs. Super.									
Plant crop	22.07	11.90	2.63	85.4					128.9
First ratoon crop...	29.00	11.30	3.28	79.5					115.9
Second ratoon crop	25.27	12.05	3.05	90.5					116.4
Total	76.34	11.74	8.96	85.1	1 12 11	48 13 1	7 19 8	6 6 9	119.6
NK+500 lbs. Super.									
Plant crop	25.20	12.30	3.10	86.6					152.0
First ratoon crop...	30.02	11.45	3.44	79.5					121.6
Second ratoon crop	24.84	12.01	2.98	90.6					113.7
Total	80.06	11.89	9.52	85.6	2 0 0	51 13 11	11 0 6	9 0 6	127.1
NK+750 lbs. Super.									
Plant crop	26.28	12.00	3.15	85.4					154.4
First ratoon crop...	31.40	11.30	3.55	79.5					125.4
Second ratoon crop	26.27	11.95	3.14	90.6					119.8
Total	83.95	11.72	9.84	85.2	2 7 2	53 8 8	12 15 3	10 8 1	131.4
NK+1,000 lbs. Super.									
Plant crop	25.29	12.20	3.09	85.6					151.5
First ratoon crop...	31.21	11.24	3.51	79.5					124.0
Second ratoon crop	25.83	11.82	3.05	90.6					116.4
Total	82.33	11.72	9.65	85.2	2 16 11	52 8 1	11 14 7	9 0 4	128.8

General mean of total yield = 8.9103 tons sucrose per acre.
Significant difference at 19 : 1 odds = 0.99 tons, equal to 11.1% of general mean, or 13.2% on the percentage of controls.

The value of sucrose taken above is £5.4303 per ton, which was the price received by large estates harvesting 15,000 tons or over. The price to smaller estates was larger in proportion to the amounts they received from the Equalisation Fund.

These results do not show the NK plots to be significantly better than the controls, nor do they show the higher dressings of superphosphate to be significantly better than the lowest (250 lbs. per acre). There is, however, a highly significant increase from the use

of a complete fertiliser compared with controls, and there is a fairly steady increase from each addition of fertiliser up to NK+750 lbs. superphosphate per acre.

From this we are led to conclude that under the conditions of this experiment the most profitable dressing of superphosphate is probably over 500 lbs. per acre and may be over 750 lbs.

The results of the experiment at Wilton Park Estate are corroborated by those obtained from the plant cane crop at Williamson, cut in 1936.

The soil on this estate is not so deep as that at Wilton Park. It is a greyish-brown, fairly heavy loam. The texture is rather fine and it tends to set hard in periods of dry weather following rain. Williamson also is in an area of rather low rainfall and in some seasons the cane suffers severely from drought. There is no analysis of the soil available, but the Government soil survey party found that the average pH value of the surface soil ran from 6.0 to 6.5, increasing at depth.

This experiment is planted with Co.281 cane.

The following table gives the results from the plant cane crop.

N = 120 lbs. ammonium sulphate; K = 60 lbs. potassium chloride per acre.

EXPERIMENT No. 1.—JOHNSON & SONS, WILLIAMSON, DARNALL.

Co. 281.—Harvested as 21 months old Plant Cane, September, 1936.

	Control.	NK.	NK 240lbs. Super per acre.	NK 480lbs. Super per acre.	NK 720lbs. Super per acre.	NK 960lbs. Super per acre.
Tons cane per acre	25.88	26.91	31.52	33.11	35.14	34.13
Increase tons cane per acre over controls	—	1.03	5.64	7.23	9.26	8.25
Percentage tons cane per acre compared with controls	—	104.0	121.8	127.9	135.8	131.9
Tons pol (sucrose) per care	4.35	4.42	5.31	5.59	5.96	5.78
Increase tons pol per acre over controls	—	0.07	0.96	1.24	1.61	1.43
Percentage tons pol per acre compared with controls	—	101.6	122.1	128.5	137.0	132.9
Pol (sucrose) % cane	16.81	16.43	16.85	16.88	16.97	16.92
Fibre % cane	16.71	16.04	16.18	15.77	15.93	15.87
Juice: Brix	—	—	—	—	—	—
Pol (sucrose) %	—	—	—	—	—	—
Purity	94.1	94.1	94.0	93.5	94.1	94.3
Reducing sugar ratio	0.54	0.54	0.59	0.63	0.53	0.59
Total value of sucrose per acre at £5.55615 per ton	£24 3 4	24 11 2	29 10 1	31 1 2	33 2 3	32 2 3
Soft cane bonus at 1.26d. per ton	0 2 8	0 2 9	0 3 3	0 3 4	0 3 7	0 3 6
	£24 6 0	24 13 11	29 13 4	31 4 6	33 5 10	32 5 9
Value of gain or loss compared with controls for this crop	—	£0 7 11	5 7 4	6 18 6	8 19 10	7 19 9

General mean = 5.26223 tons sucrose per acre.

Significant error of difference between treatments at 19 : 1 odds = 1.07 tons sucrose per acre.
Percentage significant error of difference between treatments at 19 : 1 odds = 20.4%.
Value of significant difference between treatments per acre at 19 : 1 odds = £5 18s. 11d.

The results from this experiment agree with those from the Wilton Park Estate experiment so closely that it is unnecessary to restate the conclusions based thereon. The yields at Williamson were more affected by soil irregularities than those at Wilton Park, hence the larger experimental error in this trial.

SUMMARY.

A number of fertiliser experiments with sugar cane in different types of soil are described.

An experiment at Umhlali, a coarse wind-blown sandy soil, showed in the third ratoon crop a significant response to 40 lbs. per acre of nitrogen, whether applied in the form of ammonium sulphate, sodium nitrate or whale guano, additional to 40 lbs. per acre of superphosphate 20% and 80 lbs. of potassium chloride.

In a reddish-brown clay loam at Empangeni, also in a heavy loam at Darnall, varying quantities of superphosphate from 250 lbs. up to 1,000 lbs. per acre showed an apparent maximum response at about 750 lbs. per acre.

ACKNOWLEDGMENTS.

Thanks are tendered to Mr. Ladlau, Mr. Ebsworth, manager of Wilton Park Estate, and to Mr. T. Johnson for the help they so willingly gave in looking after the experiments, and for many acts of kindness to members of the Experiment Station Staff.

Experiment Station,
South African Sugar Association,
Mount Edgecombe, Natal.
March, 1938.

The PRESIDENT: Opened the paper for discussion.

Mr. MOBERLY: Referring to the assessment of costs, said that the gross extra return was given in the paper. He made reference to the advisability of modifying the methods of assessing the extra values under our new conditions—extra sucrose not necessarily implying extra money. Cost saving was more important than extra sucrose production.

The PRESIDENT: Asked Mr. Fowlie if a paper could be prepared on statistical method.

Mr. FOWLIE: Replying to the President said that while he himself could not promise a paper on statistical methods, there were others who would probably be prepared to do so on request. He made reference to a paper on this subject appearing at the last International Congress at Queensland.

Replying to Mr. Moberly's question on values he emphasised that the nett gain after deducting cost of fertilisers had been given. This was done at Mr. Ladlau's and at Wilton Park, but not at Darnall where only the plant cane crop had been reaped.

Mr. DODDS: Reverting again to the subject of statistical method gave some assurance of a paper on this subject by the Experiment Station next year. Dr. Sander's bulletin, gave a very simple illuminating statement of the scheme.

Returning to the subject of fertiliser response Mr. Dodds said that this had only been obtained over the last year or two, owing to a variety of causes, principal amongst which could be named the recent seasonable rains.