REPORT ON A FERTILIZER EXPERIMENT AT THE MILKWOOD KRAAL SECTION OF NATAL ESTATES, LTD.

By H. H. DODDS, P. FOWLIE, AND E. P. HEDLEY.

March 24th 1932.—Congress resumed at 10 a.m.

The following paper was read by Mr. P. FOWLIE :—

This report deals with the results of the plant-cane crop. The experiment plots were planted on 16th December, 1929, and this crop was harvested during the last week of October, 1931.

The piece of land selected for this experiment has so little slope as to be nearly flat. On the north and west sides of the plots and only a short distance away from them, the ground rises sharply and the soil quickly changes character. On the south and east there is a stream a short distance from the boundary of the plots. The soil is a very heavy dark loam over a clay or shale sub-soil. This area had not been cultivated for a good many years and was covered with grass and small wattle trees before it was broken up. It was ploughed and disced by a steam ploughing outfit only a few weeks before planting. When furrowed out the soil was rather lumpy, but after the cane had been planted it was harrowed about once a week until the cane had become too tall and by that time the lumpiness had disappeared. The cane germinated well and there were very few misses to fill in.

When the experiment was laid down it was hoped that irrigation water would be available during the winter of 1930, but it was actually Christmas of that year, more than a year after the experiment was started, before water was available. From then on it was irrigated as regularly as was considered advisable.

During the first twelve months the cane suffered considerably from drought and there was no sign that any of the plots suffered from insufficient drainage.

When the experiment plots and the cane surrounding them had been irrigated once or twice it became apparent that part of th eexperiment area was in danger of suffering from lack of drainage. Some shallow open drains were then dug between the ends of the plots and these helped matters, though perhaps deeper ones would have been better.

It is instructive in studying the results to note that the lowest yields were obtained from the part of the field where the drainage appeared to be worst. It will be seen by referring to Fig. 1 that all the plots giving low yields are roughly clustered round Plot 16 (the poorest drained area). Fig. 1 also shows how the plots were arranged. The figures given show the yield per acre in tons and pounds.

The plots were one-fifteenth acre in extent, being eight lines, 73 feet long and 5 feet apart ; one line was left unfertilised between each plot as a division and at the ends of the plots there was a 6-foot division path left unplanted.

Table I.

The scheme of the experiment was as follows :—
The following manurial treatments are compared.

Plots.		Pounds per acre : Super-phosphate	Chloride of Potash.	Sulphate of Ammonia.
1, 16, 29, 40, 55	..	—	120	240
2, 15, 27, 34, 36	..	240	60	240
3, 14, 26, 45, 53	..		——No Fertiliser——	
4, 10, 24, 35, 50	..	480	30	240
17, 19, 31, 41, 54	..	960	—	240
5, 11, 25, 47, 51	..	240	120	120
6, 12, 28, 39, 48	..	480	60	120
7, 13, 30, 43, 52	..	960	30	120
8, 22, 33, 38, 46	..	480	120	60
9, 21, 32, 37, 49	..	960	60	60
18, 20, 23, 42, 44	..	960	120	—

The plant-cane crop was harvested during the last week of October, 1931, and the results are shown in tabular form in Table II.

An attempt has been made to show the results in a more graphic form in Fig. 2 below. This is after the idea of the now well-known Schreiner diagram, but it is necessarily somewhat different because the scheme of the experiment differs considerably from that of Schreiner.

These results show once again that the predominant fertiliser ingredient required by this soil is phosphorus, or, to use the name more commonly employed by farmers and fertiliser men, phosphates.

The use of superphosphate was very profitable. All the dressings tried gave good results, the largest profits being obtained where the heaviest dressings were used. This probably means that even heavier dressings than 960 lbs. per acre may be profitably used, particularly under irrigation conditions.

In these results the beneficial effects of superphosphate are counteracted and to some extent masked by the fact that the use of ammonium sulphate had a depressing effect on the yield, which was very noticeable where the heaivest dressing, namely 240 lbs., of this fertiliser was used. The medium dressing also diminished the yield, though in a lesser degree.

The results from these plots do not show any definite response to potassium chloride, but neither do they show any retarding effect such as was the case with ammonium sulphate.

The effect of the fertiliser combinations on the sucrose percentage of the canes and the purity of the juice has been carefully watched.

Water Course

23 Tons 576 lbs 1	34 Tons 1900 lbs 2	24 Tons 1800 lbs 3	32 Tons 276 lbs 4	32 Tons 50 lbs 5	20 Tons 1476 lbs 6	24 Tons 150 lbs 7	27 Tons 1350 lbs 8	34 Tons 776 lbs 9
33 Tons 1950 lbs 10	32 Tons 1936 lbs 11	33 Tons 1950 lbs 12	35 Tons 724 lbs 13	33 Tons 1124 lbs 14	23 Tons 50 lbs 15	21 Tons 76 lbs 16	30 Tons 1650 lbs 17	35 Tons 1476 lbs 18
35 Tons 576 lbs 19	37 Tons 1600 lbs 20	34 Tons 324 lbs 21	33 Tons 750 lbs 22	34 Tons 776 lbs 23	27 Tons 676 lbs 24	25 Tons 1824 lbs 25	21 Tons 300 lbs 26	30 Tons 1500 lbs 27
33 Tons 624 lbs 28	25 Tons 1150 lbs 29	35 Tons 1100 lbs 30	34 Tons 550 lbs 31	33 Tons 376 lbs 32	32 Tons 1550 lbs 33	29 Tons 1700 lbs 34	29 Tons 800 lbs 35	
32 Tons 1476 lbs 36	32 Tons 1700 lbs 37	38 Tons 950 lbs 38	35 Tons 1324 lbs 39	29 Tons 200 lbs 40	35 Tons 724 lbs 41	33 Tons 524 lbs 42	32 Tons 1250 lbs 43	
		32 Tons 724 lbs 44	30 Tons 1124 lbs 45	37 Tons 250 lbs 46	36 Tons 1124 lbs 47	33 Tons 824 lbs 48	36 Tons 224 lbs 49	
		35 Tons 924 lbs 50	31 Tons 924 lbs 51	38 Tons 424 lbs 52	34 Tons 24 lbs 53	40 Tons 476 lbs 54	26 Tons 724 lbs 55	

Figure 1

Plan of Plots at Milkwood Kraal

TABLE II.

TREATMENT.	Control. No fertiliser.	Superphosphate —, Chloride of Pot. 120, Sulph. of Amm. 240	Superphosphate 240, Chloride of Pot. 60, Sulph. of Amm. 240	Superphosphate 480, Chloride of Pot. 30, Sulph. of Amm. 240	Superphosphate 960, Chloride of Pot. —, Sulph. of Amm. 240	Superphosphate 240, Chloride of Pot. 120, Sulph. of Amm. 120	Superphosphate 480, Chloride of Pot. 60, Sulph. of Amm. 120	Superphosphate 960, Chloride of Pot. 30, Sulph. of Amm. 120	Superphosphate 480, Chloride of Pot. 120, Sulph. of Amm. 60	Superphosphate 960, Chloride of Pot. 60, Sulph. of Amm. 60	Superphosphate 960, Chloride of Pot. 120, Sulph. of Amm. —
Tons cane per acre	28.37	25.073	30.263	31.628	35.198	31.786	31.410	33.164	33.885	34.140	34.710
Increase tons cane per acre	—	— 3.764	1.426	2.791	6.361	2.949	2.573	4.327	5.048	5.303	5.873
Per cent. increase tons cane per acre..	—	−13.05	4.94	9.68	22.06	10.23	8.92	15.01	17.51	18.39	20.37
Standard deviation from mean ..	5.04	2.74	4.00	2.92	3.02	3.43	5.40	4.87	3.78	1.07	1.91
Standard experimental error	2.25	1.22	1.79	1.30	1.35	1.53	2.42	2.18	1.69	0.48	0.85
Tons pol (sucrose) per acre	4.616	3.964	4.707	4.893	5.394	4.951	4.927	5.246	5.399	5.330	5.449
Increase tons pol (sucrose) per acre ..	—	—.652	0.091	0.279	0.778	0.335	0.311	0.630	0.783	0.714	0.833
Per cent. increase tons pol (sucrose) per acre	—	−14.12	1.93	6.04	16.85	7.26	6.74	13.65	16.96	15.47	18.05
Standard deviation from mean ..	0.77	0.55	4.02	0.50	0.33	0.61	0.88	0.36	0.67	0.34	0.19
Standard experimental error	0.34	0.24	1.79	0.22	0.15	0.27	0.39	0.16	0.30	0.15	0.08
Corrected tons sucrose per acre ..	4.753	4.031	4.809	4.982	5.522	5.025	5.032	5.397	5.554	5.427	5.593
Value of sucrose increase	—	−66/9	+ 5/2	+21/2	+71/1	+25/2	+25/9	+59/6	+74/-	+62/3	+77/7
Cost of fertiliser	—	45/9	46/5	51/-	63/10	38/9	39/6	52/4	39/6	48/7	48/6
Value of sucrose increase less cost of fertiliser	—	−112/6	−41/3	−29/10	+ 7/3	−13/7	−13/9	+ 7/2	+34/6	+13/8	+29/1
Sucrose per cent. cane (pol)	16.04	15.77	15.49	15.47	15.36	15.55	15.66	15.84	15.91	15.60	15.72
Fibre per cent. cane	12.93	13.26	13.47	13.41	13.83	13.70	13.38	13.87	13.36	13.57	13.65
Juice :—Brix	21.9	21.9	21.4	21.7	21.3	21.7	22.0	22.0	21.8	21.7	21.7
Sucrose (pol)	20.17	19.71	19.43	19.42	19.34	19.66	19.73	20.19	19.99	19.62	19.79
Purity	92.1	90.0	90.8	89.5	90.8	90.6	89.7	91.8	91.7	90.4	91.2
Reducing sugars per cent. juice ..	0.42	0.29	0.50	0.51	0.41	0.46	0.53	0.25	0.30	0.45	0.36
Reducing sugar ratio	2.08	1.47	2.57	2.63	2.12	2.34	2.69	1.24	1.50	2.29	1.82
Phosphate (P_2O_5) per cent.	0.008	0.0076	0.0087	0.0086	0.0098	0.0099	0.0109	0.0101	0.0103	0.0117	0.0099
Potash (K_2O) per cent...	0.130	0.108	0.132	0.114	0.108	0.125	0.124	0.126	0.119	0.134	0.143

Taking value of Sucrose at £4.62 per ton.
„ „ Superphosphate at £3.50 „

Taking value of Sulphate of Ammonia at £12.75 per ton.
„ „ Chloride of Potash at £12.75 „

Results of Fertilizer Experiments at Milkwood Kraal

Plant Cane Crop

Key to Diagram

A Tons Cane per Acre
B Tons Sucrose per Acre
C Sucrose % Cane
D Purity
P Chloride of Potash
K Superphosphate
N Ammonium Sulphate

Control Plots - No Fertilizer

A 28.87
B 4.62
C 16.04
D 92 10

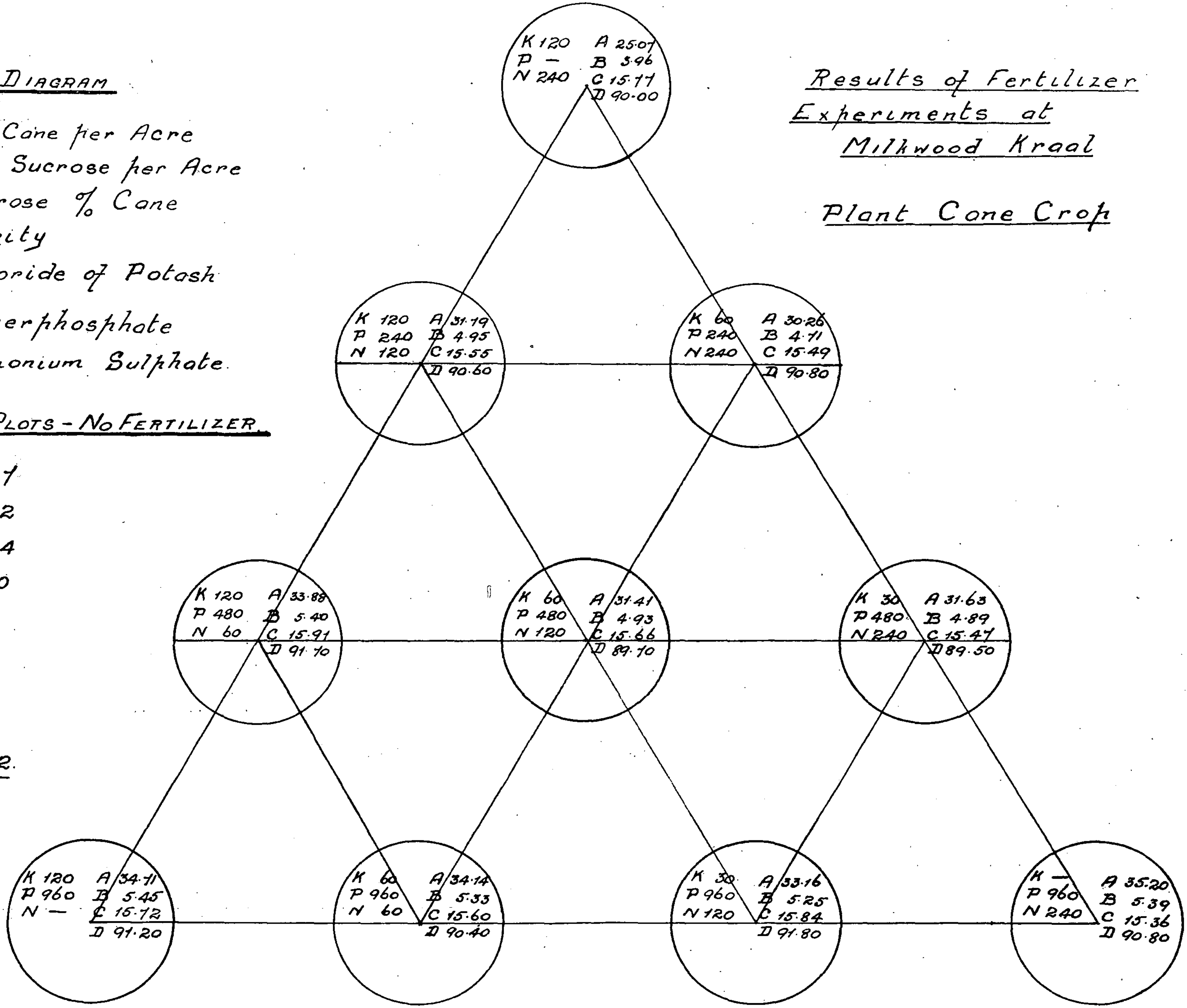

Figure 2.

One does not feel safe in drawing definite conclusions from an experiment such as this, but the indications obtained are perhaps worth mentioning.

Taking superphosphate first, besides its definite effect in increasing the yield of cane per acre, there is nothing that is really significant. The average of the five control plots without fertiliser gave the highest percentage of sucrose in cane and the highest purity of any series in the experiment. The plots having medium to heavy dressings of both superphosphate and potassium chloride came next, and those having the heavy dressings of ammonium sulphate last. This is decidedly noticeable in the case of purity of juice, but there is really no very wide variation between the highest and lowest purities found in the experiment. In the case of sucrose per cent. cane the difference is even less.

The most noticeable effect of any of the fertilisers on quality of cane and juice was the depressing effect of ammonium sulphate on purity.

It perhaps ought to be mentioned here that profitable results were obtained from the use of ammonium sulphate at the Experiment Station on a field that had been long under cane.

It must be borne in mind that these results were obtained from a piece of land that had not been cultivated for a long time and which had been more or less under wattles (*Acacia decurrens var. Mollis.*). The wattle, being a legume, probably enriched the soil in nitrogen to some extent.

It will be interesting to see how the next crop on these plots will turn out under irrigation and without further applications of fertiliser.

Experiment Station,
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Mr. FOWLIE continued: Besides what has been written in the paper I would like to make one or two suggestions or guesses—call them what you like—as to the cause of this depressing effect which we have noticed in the case of ammonium sulphate dressings. I think one possible reason why ammonium sulphate seemingly affected the cane so badly as it did in this case must have been that we put it on at planting time as is usually the case and during the early part of the growth of the cane there was never sufficient water available to allow that cane to grow vigorously and make use of the ammonium sulphate in its early life as it ought to have done. The water was applied during the second growing season and then of course the growth shot away and the ammonium plots probably took up a great deal of nitrogen during that second half of the crop without being able to make as full use of it as they would have done if they had got it earlier. But it was taken up and it had the effect of retarding ripening; and as you know if a cane is nor ripe its purity is low and that really is what we found when we harvested these plots. Although it was October when you would expect the cane to be really ripe the assumption I think is that the ammonium sulphate plots were not as ripe as the others.

CHAIRMAN: We have had in past years a number of papers on fertiliser experiments and we have had a number of papers on irrigation; now we have a little of both. Unfortunately as is pointed out here the irrigation was not carried out to the extent it was thought possible so we hope next year or in two years' time we will have a paper showing the effects under full irrigation. The paper is interesting in that some of the results are entirely definite.

Mr. ASKEW: Perhaps Mr. Fowlie could help us by summarising a few of the outstanding points in this paper. It seems to me that 960 lbs. of superphosphate is a heavy dressing and comes rather expensive.

Mr. FOWLIE: I do not think I ought to spend very much time going over the figures this morning. If you look at Table II. you find "Tons cane per acre" on the top line and all the fertiliser dressings along the top. If you look along you will see that the only case where the average of five plots is lower than the control plot is the one where no superphosphate was applied. In other words the ammonium sulphate without superphosphate decreased the yield by over three tons and it is not possible to say for certain that it had as much depressing effect where it was applied in conjunction with a suitable amount of super. But looking through these the higher dressings of ammonium sulphate had a depressing effect even in conjunction with the dressing of phosphate. Now with regard to this 960 lbs.—call it 1,000 lbs., as we used 960 lbs. because it was a very convenient amount to weigh out per line. We have been thinking for quite a while that probably the ordinary dressing of superphosphate of about 500 lbs. might not be the most profitable dressing, and we decided to try some experiments. The idea here was to get the most suitable combinations. As you see, we have varied all the dressings, first one ingredient up and then another, to see if there was any more favourable combination than the one we have been using. So far, there is not too much one can say about that. But so far as the 960 lbs. of super is concerned it appears to pay, and pay well too. You will be interested to hear that we have a similar experiment to this at the Experiment Station which is not intended to be irrigated, which will be ready for cutting during this coming cutting season. Perhaps this time next year we will be able to report on that, although it will be two years from now before we can report on the ratoons from this experiment.

Mr. BOOTH: I have a strong grouse to offer, and it is this, that here we get a paper full of meat given to us two days ago, and we who come to town only now and again have not the time to digest these figures. Some of us take them home to digest, but then it is too late. We have got to go to the Experiment Station to get illustrations. I quite understand the pressure at which these things are published, but at the same time, I think we should have a little more grace to stody these papers. I would like to raise a question which I did yesterday, and perhaps Dr. Hedley can give us some enlightenment. As I mentioned, it has been found, after a series of experiments, that the optimum pH of beet growth is somewhere in the region of 7.0. Now here we have lots of experiments, and Mr. Fowlie has been explaining away the depressing effect of ammonium sulphate, which is universally accepted to be on the acid side, so much so that in certain cane countries they will not have it at all. I would like to ask Dr. Hedley whether anything has been done on the pH of the soils apart from the preliminary analysis, but in the control of the pH of the soil in all these experiments after having added the various ingredients. A further question I would like to ask in the tests of the soil pH, has the Experiment Station arrived at any specific method which is an improvement on any other?

Dr. HEDLEY: I will deal with the "grouse" first. I too will endorse what Mr. Booth says. There is no question about it, that the value of the paper is greatly enhanced when it is possible for the papers to be in the hands of the members some time before the paper is read. This year we had a very good reason for not letting these papers out before the meeting. The Pórto Rico Conference and the general condition of the Industry, the depression, made us think that we would not hold a Conference this year. I sent out, at the instruction of the General Committee, letters to the convenors of all the Committees, and asked them whether they thought we should hold a Conference this year. The replies were about "fifty-fifty," and we then discussed the matter in committee. We felt that the Porto Rico Conference should not be allowed to interfere with it, that is, owing to the absence of Mr. Dodds and Mr. Dymond. Mr. Eadie was of the opinion that for the sake of continuity we ought to hold our Conference, and as we had the money to do so there was no obstacle in that direction. It meant then writing back to all the Convenors of Committees and telling them we were going to hold the Conference. One or two of them sent back a "grouse", as there was hardly time to get their Committees together. Anyhow, we scouted round and Mr. Fowlie got busy with his pencil, and he did the major portion of the work which has made this Conference. (Hear, hear, and applause.) We managed to come out with one or two small things from the other side, and some of the Committees came along and were able to give us papers. There is another reason why the papers have not gone out, and that is this: last year, most of the papers were ready to go out long before the Conference, and they went out to members. They got them, and forgot them! They came to the Congress and they did not have their copies, with the result that we ran out of our papers almost on the first day. So we really do not know what to do. It means a considerable expenditure if we have to get 400 of these papers printed so as to provide for those who have forgotten to bring their copies with them. On the other hand, it is also true that those who are really interested and prepare discussion, will not forget to bring their copies. I would like to know what you would suggest for next year. There is no question whatever that the discussion is enhanced when there is time to prepare your remarks.

With reference to the pH, my recollection is that as a general rule we find a pH round about 5.0 to 6.0, and it would appear that round those figures give the best results. My own experience of agriculture is more on the golf side, and in the preparation of grass greens for bowling greens. A pH of 5.5 is probably about the best pH for the growing of good grass, and that is produced by using ammonium sulphate. It has two good effects, it kills the weeds also, but the grass does not respond to a soil which is much higher.

Mr. BOOTH: That is acknowledged.

Dr. HEDLEY: With regard to the super, we are not in a position to say definitely, because we are accumulating results, but it looks as if it has to have a fairly acid soil. With regard to the methods used, we use the quinone hydrone cell, and if you are at the Experiment Station I would be glad to explain the methods to you. To do so here is impossible without the apparatus.

Mr. BOOTH: You raise the question of ammonium sulphate being a good fertiliser for grass. Would it be a coincidence that a heavy dressing of ammonium sulphate produces that acid condition which is responsible for the decrease in these experiments that Mr. Fowlie has told us about?

Dr. HEDLEY: I made a statement to some of the Natal Estates men that we had found that nitrogen as straight nitrogen was not very useful. They said they had also found it was not of much use, but they found ammonia was, and the way they have done it is really rather difficult to do. They have given it to the stools and not broadcast it over the field, and they found it is useful. I wish some of them were here to tell you about it.

Mr. FOWLIE: With regard to the pH for growing various crops, I think I disclaimed having any particular knowledge about that yesterday, but in the evening I was looking up something on the subject—Sir John Russell's book on "Soil Condition and Plant Growth"—and he states very distinctly that plants seem to vary very considerably in what one might call the optimum pH in their growth, most of the lgeumes and sugar beet requiring a neutral or even slightly alkaline soil, whereas most of the cereals can stand a certain amount of acidity, and some of them can stand quite a lot. He explains that, as a rule, although crops may be tolerant of a certain amount of acidity, or even a considerable amount, most of them really are best when somewhere near neutrality can be attained.

Dr. HEDLEY: There are several ways of preparing the soil for the pH. This is a matter we are studying. We have a rotary soil crusher at the Experiment Station, and if you crush it to a fineness that will pass a 100 mesh that soil will give you one pH, and if you crush it finer still, which is very laborious, to say 200 mesh or 180, you get another pH and a rather more acid one. It is a question none of us can find any reference to in the literature. The practical thing is this: we take a test tube and draw it out to a very fine capilliary point and pack the soil above that, and then put the requisite water to it. It is a definite ratio, 1 to 2½. If that soil is very finely ground, even to 100 mesh, the water does not percolate with all the soils; there are some which are very heavy and rich in humus and the extraction water does not penetrate and drop through the other end and give you a soil extract. On the other hand, if you take a soil which is only crushed to 50, 60 or 70, you can get it to percolate sufficiently rapidly to consider you have really got the soil extract, and the figures we obtain compare exceedingly well with the figures which are obtained, for instance, with the B.D.H. method.

Mr. ASKEW: Are we to understand that it is not advisable to use ammonium sulphate as a fertiliser generally?

Dr. HEDLEY: Oh, no; Natal Estates find it very useful.

Mr. FOWLIE: I should like to put it like this. We have been using ammonium sulphate and recommending ammonium sulphate to a considerable extent, and generally speaking we find it is useful. We have got these results, and naturally we are publishing them, and we are rather anxious to explain away the results we have got because they are not in accordance with what we generally have got. The point about it would appear to be that, after all, ammonium sulphate is not such a certain and safe thing to recommend as some of the other fertilisers, and this exception to its general usefulness is worth investigating, and probably it will enable us to save ammonium sulphate under certain conditions when it would not be expected to give good results.

Mr. PALAIRET: It seems that results in this particular case have been, so far as nitrogen is concerned, to follow previous experience in this country with sugar cane. There is one point I would like to raise. These countries where nitrogen and sulphate of ammonia are very profitable are countries which contain soil of a higher calcium content than appears to be usual here. Have any experiments been carried out in connection with various dressings of lime? It seems as if the plants take up ammonia if there is plenty of free lime. Undoubtedly, on present experience, the planters would be well advised to keep clear of nitrogen until we get such results. I hope the Experiment Station will consider whether it might not be possible to compare the effects when lime is being used. I would like to mention that Mr. Williams, of Cedara, is in agreement on this point. It seems to me the real use of nitrogen is with your trash, immediately after hand trashing, more particularly if you irrigate and keep that trash moist. I hope Mr. Fowlie and Dr. Hedley will give us some views on that point, because where we do hand trash there is no doubt we have to consider the question of the better rotting of the trash.

Mr. FOWLIE: I would like to mention once again the results we published in last year's paper on experiments at the Experiment Station. We have got there the results of a fertiliser experiment where we used ammonium sulphate, sodium nitrate, whale guano, calcium cyanamide and urea, and we got profitable results from all of them. That soil, I know, had an acid pH. We have got the pH here of the juice, but I do not know whether that helps in any way. There was practically no difference in the pH of the juice from the different fertilisers used and from the controls without any. But the point is that even sulphate of ammonia gave a profit; and yet in this other soil at Milkwood Kraal we had an exceedingly depressing effect.

CHAIRMAN: This paper raises hopes that in the near future the Experiment Station will give us a similar paper showing the effect of these fertilisers on the ratoon crops. The information given here is extremely useful and it has given us a good deal of fruitful thought. We hope that with the ratoon crops we will get something equally satisfactory.