

REPORT ON EXPERIMENT WITH DIFFERENT FORMS OF PHOSPHATIC FERTILISERS AT WILTON PARK ESTATES (FORMERLY ANDREWS ESTATE), EMPANGENI.

By H. H. DODDS and P. FOWLIE.

The following paper was read by Mr. BOOTH on behalf of the authors:—

The results from the cutting of the plant cane crop from these experiments were announced by Mr. Dodds at a farmers' meeting held at the Experiment Station, Mount Edgecombe, on 9th January, 1930, and were published in the *South African Sugar Journal*, for January, 1930. They were also incorporated in a paper published by us in these proceedings for 1931.

The results from the cutting of the first ratoon crop are now available and this paper incorporates all the data about this experiment to date.

This trial was made to obtain information about the relative values of different forms of phosphatic fertilisers, and the following were compared:—

Superphosphate.

Egyptian rock phosphate.

Superphosphate and Egyptian rock phosphate.

Bone meal.

Basic slag.

Controls with no fertilizer.

500 lbs. per acre of superphosphate supplying 90 lbs. per acre of P_2O_5 was taken as the standard dressing for the experiment and the other fertilizers were applied in quantities calculated to give the same weight of P_2O_5 per acre irrespective of the form in which this exists in the different fertilizers compared. As bone meal contains a little nitrogen, the plots fertilized with this fertilizer had an advantage so far as its nitrogen proved beneficial as only its P_2O_5 content was taken into consideration in arranging the dressing.

There were four plots of each fertilizer dressing compared, except bone meal and basic slag which had only three plots each, and there were also four control plots with no fertilizer

The plots were $\frac{1}{10}$ th acre each, being 83½rd feet long and 55 feet wide, and they were arranged at random.

The fertilizers were all applied in the furrow at time of planting and planting was done on 2nd March, 1927. This was very late, and dry weather followed so that very little growth took place before the following Spring, and a good many misses had to be filled in.

The plant cane crop was harvested and gave the following results:—

	Corrected sucrose per cent. cane	Purity	Yield tons per acre	Profit per acre from fertilizer
Control	11.8	88.4	30.78	
Superphosphate	12.4	89.7	43.94	£8 14 5
Rock phosphate	12.4	89.5	37.50	£4 18 5
Superphosphate & Rock phosphate	12.0	88.8	41.46	£6 8 9
Bone meal.. ..	12.0	88.9	44.92	£7 12 9
Superphosphate & Bone meal ..	12.4	89.7	43.42	£7 19 5
Basic slag	12.2	89.2	43.78	£8 4 1

The profit was calculated by deducting the cost of the fertilizer from the value of the increased sucrose yield over and above the yield of sucrose from the control plots without fertilizer.

The sucrose was valued for this purpose at £5.385 per ton which was about the price ruling at the time.

Bone meal gave the highest yield of cane, but very little more than superphosphate, which gave the greatest profit per acre owing to its cost being very much less than that of bone meal. How much the small amount of nitrogen in the bone meal affected the yield is an open question which must be left for the present.

The variation in profit from the various fertilizer combinations is not very great, except that rock phosphate is considerably lower than the others.

The ratoons were allowed to grow without any further fertilizer being applied. They were all treated alike in every respect, and were cut on 15th October, 1931, when the following results were obtained:—

	Corrected sucrose per cent. cane	Purity	Tons cane per acre	Profit per acre from fertilizer
Control	14.42	89.1	23.93	
Superphosphate	14.94	90.7	26.08	£2 0 11
Rock phosphate	14.60	90.0	24.26	8 6
Superphosphate & Rock phosphate	14.94	90.2	26.30	£2 4 3
Bone meal.. ..	14.00	88.8	27.31	£1 14 5
Superphosphate & Bone meal ..	14.56	89.8	25.93	£1 10 1
Basic slag	15.21	91.1	26.87	£2 18 9

The profit on the first ratoon crop was calculated by taking the value of the increased sucrose yield over and above the yield of sucrose from the control plots without fertilizer.

The sucrose was valued for this purpose at £4.62 per ton, an approximately correct figure for the 1931/32 season. The exact figure not being available when this was written.

The first striking thing about the above figures is the very much lower yields obtained from the first ratoons than those from the plant cane crop. These low yields were due to prolonged droughts, especially during 1931. In the opinion of the writer, the drought not only reduced the crop over all the plots but it also reduced the difference between the fertilized and the unfertilized plots.

In a report published by us in these proceedings for the year 1931, page 141, it was shown that profits varying from £1/3/10d. to £6/9/3d. were obtained from the residual value on the first ratoon crop from phosphatic fertilizers applied at planting time in the same manner and the same dressings per acre as those in the experiment under review.

Although it is disappointing that the yields and profits were so slow it is interesting to have some proof that even under such unfavourable weather conditions as prevailed at Empangeni during the growth of this crop, phosphatic fertilizers give a very useful profit.

Heartly thanks are due to Mr. F. V. Ebsworth, manager of the Wilton Park Estates for his co-operation in looking after the experiment and checking the harvesting of the plots and to Mr. F. W. Hayes, planters' chemist at the Empangeni mill for doing separate analysis of the cane from each series.

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CHAIRMAN: This is another example of what I referred to yesterday as good "follow-up" work. An experiment which was started some time ago was not allowed to rest, but was continued, and has been continued now for some time, and results are given to us periodically of its progress; and that is the type of information which we want to see more of—something put in hand and carried on to finality. In agricultural experiments finality is often a very long way off. The older agricultural experiment stations of the world will give you plenty of examples of experiments taking ten, twenty, thirty or more years to bring to conclusion, so that agricultural experimental work is very slow. But we are moving on right lines in a paper of this sort.

Mr. BOOTH: Last year's report on the plant cane (page 141) gives the analysis of the soil and gives the pH value for that soil. In view of the droughty conditions, it would be very interesting to find out whether that pH was also taken during the ratoon period. They had no more fertilisers. You will find the pH was 6. Now during the intervening period no further additions to the soil were made, and also we had droughty conditions, and it would be very interesting to find out what the pH of the soil was at the time the second crop came to reaping point. I ask that question, because in Clark, the authority on pH, they give cases

where 15,000 analyses are given, and the optimum pH of wheat has somewhere about 7.0. I do not think any work has been done in Natal as regards reactions of soil. I am sorry if I have brought up the question in the absence of Dr. Hedley, but I think the pH of the soil is a very important question, much more important than I think we in Natal have realised.

Mr. FOWLIE: I cannot answer very much in connection with this question, but I do know that the analyses referred to in the first report were taken before planting, or at the time of planting, and no further analyses have been made of that soil. So that I do not think there is any further information on the pH of the soil available.

Mr. BOOTH: May I ask Mr. Fowlie, as a practical man, what opinion he has on the benefits of basic slag as against superphosphate. The trend of the whole of these phosphatic fertilisers has been to boost up superphosphate. It is all right in its way, but it does not stand by itself. I think Hall tells us that unless we see to the calcium carbonate content of the soil, phosphate is nearly always wasted. Can Mr. Fowlie advance any hypothesis as to why basic slag, in this instance in a red loamy soil, should show better results than superphosphate by itself.

Mr. FOWLIE: Mr. Booth has made the statement that basic slag showed better results than superphosphate. I think, if you look at the profits from the two crops, you will find the two are nearly identical. The difference between them is certainly no greater than the probable experimental error of these trials, so that we really cannot say definitely that one is better than the other. Now, if you follow up our experimental work on phosphate fertilisers in other places, as well as taking this isolated experiment at Wilton Park Estates, you will find we get pretty much the same results right through; superphosphate and basic slag come fairly close to each other in most cases. When it comes to the practical question of which to advocate for fertilising, the main thing that governs it is the cost, and we find that at the present time superphosphate is very much cheaper, ton for ton, or unit for unit, than basic slag; and that being so, apart from the consideration of which is the best, we have got to regard basic slag as being likely to be the more profitable. Mr. Booth has touched on another question, the question of the effect of these fertilisers on the soil, and the question of residual effect. If you get your analysis of them, basic slag always contains a small amount of excess lime over and above that contained in superphosphate. In other words, it contains a small excess of lime per cent. over superphosphate; but the amount so contained which would be applied to an acre of soil in a dressing of 500 lbs. of either to the acre is so little, that I do not think it has any practical bearing worth talking about on the effects after a period of use of probably four or five or more applications. There are other factors which enter which would be much more likely to make a difference. The question of the effect of super is also worth a word or two. Formerly, we used to talk about super as if it was an acid-forming

fertiliser. We know that the rock phosphate is treated with sulphuric acid in the making of superphosphate. That acid acts with the phosphate and forms calcium sulphate, setting free a phosphate which is water-soluble and easily taken up by the plant. The calcium sulphate, theoretically, should contain all the sulphuric acid added. In practice it might not contain quite all, but the amount of free acid in the super is practically negligible. In the soil it is found that this does not react with the lime in the soil to any extent so as to deprive the soil of lime. In fact, some experiments that have been carried out in recent years would seem to show that the residual effect of superphosphate, instead of being an acid one, is actually an alkaline one, the explanation given being that when the phosphate is absorbed by the plant, the plant requires more of the phosphate content of the super than it does of the lime, with the result that the phosphoric acid part of the superphosphate is taken up by the plant and a certain amount of lime is set free, which actually has a rather alkaline effect on the soil. That is the most modern theory on the residual effect of super on soil. It is not claimed to have a large effect, but it is claimed that the often asserted statement that super has an acid reaction on the soil has been disproved.

Mr. BECHARD : Last year we had some very strong opinions expressed by several planters, among whom was the late Mr. Patrick, about the unsuitability of using superphosphate at the time of planting ; it had the effect of burning the setts. I would like to know if Mr. Fowlie has found anything further on this point, seeing that this year has been so droughty.

Mr. FOWLIE : I can tell you something about one of our experiments at the Experiment Station this year, which is very interesting and bears on that point. We put down an experiment with the new Co.290 cane, the idea of the experiment being to try and find out whether heavy dressings of potash would have any effect on the growth or sugar content of the cane, as it is claimed by some people that it does. We put down an experiment with no fertiliser, with super alone, with super plus a moderate dressing of chloride of potash, and with super plus a very large dressing of potash, and we put it down after one of the little rains about the beginning of November. The experiment had to stand a matter of five or six weeks with very little rain after planting. The plots with no fertiliser at all came away very well ; the plots with superphosphate only were practically as good—to-day they are better, but for a little time at the beginning they looked as if they had suffered slightly. The plots with superphosphate plus an ordinary dressing of potash were decidedly affected ; in the plots with heavy dressings of potash, I think practically half the plant cane was killed, and the plants that did struggle through grew very slowly. We replanted later and to-day we have a stand on the ground, but if you go to see that field the unfertilised cane and the superphosphate canes are standing 2½ to 3 feet high, and those that had the heavy dressing of potash are still quite small. The superphosphate ones to-day are the best.

Mr. BECHARD : Could you tell us how long before planting the dressings were made ?

Mr. FOWLIE : I think it was not more than 24 hours. It was either the same day they were planted or the day before.

Mr. ASKEW : I see Mr. Dodds favours superphosphates. What he says seems to be borne out by the analyses we have here. Speaking just as a practical man and not a chemist, we use superphosphate on the hill lands and we generally use basic slag on damp lands, and find it gives very good results there. My little experience is that it did not give as good results on the dry lands, so we used the superphosphates.

CHAIRMAN : I can quote some of the figures of the experiment referred to by Mr. Fowlie, given in our Report last year. In the experiment with superphosphate alone, the profit was £6 0s. 4d. The phosphates with ammonium sulphate, £2 4s. 4d. Phosphates with ammonium sulphate and potassium sulphate, £1 8s. 11d. Phosphates with ammonium sulphate and potassium sulphate, £1 12s. 10d. Phosphates, ammonium sulphate and potassium sulphate, 18s. Phosphates, ammonium sulphate and potassium chloride, £2 4s. 4d. There is a very big difference there.

Mr. BOOTH : I think if you would continue that article and go on to the experiments at Chakas Kraal, you will reverse your dictum. I would like to ask Mr. Fowlie something. Seeing there was a very dry period, supposing you applied potash as an after dressing and gave the superphosphate for its proper purpose of extension of the root, have you ever pondered on that subject, so as to release the strain on the soil moisture, so to speak ?

Mr. FOWLIE : The position is simply this, that in ordinary practice we give very small dressings of potash. The dressings given in this experiment I have been telling you about are larger, but in the ordinary way we only recommend quite a small dressing of potash, and to put that on later, when the crop is up, is rather a difficult matter, and it is expensive to do that also. If it was intended to give a top dressing of nitrogenous fertiliser, it might be quite a good practice to mix the nitrogenous fertiliser and potash together, and put them on two months after planting. But in the ordinary way, if one gets sufficient rainfall at planting time, none of these fertilisers have any injurious effect. We know from experience that it is purely a concentration of these results around the young buds and young growing part of the cane plants when they first start that does the harm. If the water is sufficient to dilute the fertiliser things will be all right.

Mr. ASKEW : What would Mr. Fowlie consider a fair proportion of potash for an ordinary farm ? Would 10% be a big or small dressing ? What effect has potash on the cane ?

Mr. FOWLIE : First of all, with regard to the dressing of phosphate we generally recommend for cane, I will tell you the percentage we have been using at the

Experiment Station for our ordinary propagation canes where we are using just a fertiliser to keep the cane growing. We generally use roughly 10% of chloride of potash in the fertiliser. Our formula lately has been roughly four parts of superphosphate, one part of sulphate of ammonia, and half part of chloride of potash, or 8—2—1 if you bring it up to one in potash.

With regard to the effect of potash on crops, in a general way it is claimed that potash has a good deal to do in the sap of the plant in the formation of starch, probably in the formation of carbohydrates generally, which includes sugar; and that, from the sugar cane point of view, is supposed to be the most important function of potash. I fancy there are other things that one could drop on. I am not inclined to give too much from memory, but that is the point that is always insisted upon most clearly. The effect of potash is not nearly so noticeable in plants, as a general rule, as the effect of phosphate or the effect of nitrogen, but it is claimed in connection with cereals that potash affects the size of the kernel of wheat, oats and barley very considerably, that its effect is largely in the formation of starch. If it affects carbohydrates it should affect the sugar, as we have no starch, or practically no starch, in sugar cane.

Mr. BOOTH: It was not in a frivolous sense that I suggested putting potash on as a top dressing. If you refer to last year's Proceedings, you will see this statement on page 140:—

"If I may take up a little more of your time, I would like to mention a matter I intended to refer to when I was giving you the outlines of our fertiliser experiments. You will remember that yesterday I stated that we had not yet had any direct positive evidence of the effect of potash or any fertiliser in increasing the sucrose content of the cane apart from increasing the yield and affecting the maturity of the cane. But by the kindness of Mr. Lintner, of the S.A. Potash Syndicate, I have had handed to me two very interesting papers. One is by Dr. Wagner, the well-known agricultural authority in France, who shows an increase in sucrose content of beet by the application of very heavy dressings of potash. The increase in the sucrose content of beet amounted from 0.5 to over 1% from the application of as much as 2,000 kgms. of potash. The other deals with sugar cane and is from Guadeloupe, in the West Indies, and records some experiments in which the sucrose content of cane was increased apparently from 13.4 to 15.6% by the application of very heavy dressings of potash, far more than we are in the habit of applying in this country, to the soil. So it may be said that we can get this effect by applying dressings greater than we have been in the habit of doing, and it will be very interesting to carry out a few experiments on those lines."

Hence I say, fertilise with phosphate and top-dress with potash if the water is scarce.

Mr. BECHARD: I can give you the result of some analyses I did on an experiment made at Mr. Johnson's estate at Fort Pearson two years ago. There were

some plots with potash fertiliser, and all I can tell you is that it was a very dry year in 1929, and the average weight of the cane on the plots receiving potash was, on the whole, very much heavier than those without potash; also, on examining the cells of the cane under the microscope, I found there were fewer cells that were empty of sugar in the case of those receiving potash than the others.

Mr. PALAIRET: Two very interesting points have arisen which nobody has linked together in the discussions. Mr. Fowlie has pointed out the theory of the use of potash. I think it can be summed up this way: Nitrogen is known to throw the growth into leaf; I think it is a recognised thing by many of the authorities that the tendency of potash is to throw the growth in the case of cereals into grain. Potash is in many cases used to counter too heavy a dressing of nitrogen. Now, I believe the theory of the potash authority here is that potash throws growth into sucrose, which certainly appears to correspond to the results with cereals. I would like to mention the point Mr. Johnson raised this morning, that Co.290 had a tendency to too much leaf, and in view of that point it seems to me rather interesting to hear that suggestions have been put forward that Co.290 requires potash, and I hope these special experiments with potash and Co.290 will continue, as it will do a great deal to support or discount that theory.

Mr. ASKEW: I have done a lot of experimenting as a layman, and this year I have done a great deal of fertilising with 50 super, 40 bone meal, and 10 potash, that is for the ordinary heavy chocolate soils. I gather from the discussion now that 10% of potash is considered very heavy. If these crops come off very well next season, or not as well as we thought, we might have to alter that and come back to 5% potash. We have so many different forms of fertiliser that we use, and we keep a record of every field and the results, so that we will be able to say what is the result of these different fertilisers.

CHAIRMAN: We are pleased to hear Mr. Askew keeps these records, and next year we will look forward to a paper from him giving us the results. (Applause.) Mr. Booth's quotations just now are a very good example of the point I tried to make in my opening remarks yesterday, of the necessity of using these documents as books of reference and to know what is there. I am afraid too many of us come to these meetings with all the discussions of the previous years entirely erased from our minds. But we know that we have one member here, at least, who is co-ordinating this discussion with what has taken place in previous years. Mr. Watson has asked me to ask Mr. Fowlie a question. Has he any experience or opinion on the use of boiler ash, not so much from its potash content as from its value in loosening the soils?

Mr. FOWLIE: I am afraid I cannot answer that question. From my own practical experience I do not know anything about it, and I do not know that I have

read or seen anything that would be of any interest on the subject. There is a certain amount of fertiliser value in ash if it is put on in limited quantities, but if put on in sufficient quantities to loosen up the soil and ameliorate its mechanical condition, I am wondering whether it might or might not contain substances that were actually injurious to plant growth. I do not like to make any definite statement on that.

Mr. BOOTH: If you go back to the records of 1922, you will find a paper by Mr. Dymond, in which he gives information concerning the by-products of the sugar industry. Mr. Dymond is not here, so I can say with perfect frankness that it is one of the best papers we have ever had before us, inasmuch as it deals with one of our by-products. There he advocated a systematic handling of all the by-products—scums, molasses, also spare bagasse (those who are lucky to have it) should be combined together in some sort of material that could be handled economically; and I think that Mr. Dymond dealt thoroughly with that subject and recommended application of the whole lot combined as an excellent soil ameliorator, and he dealt extensively with its potash value so far as the ash was concerned, and the molasses and the phosphatic value of the filter press cake and the nitrogen value of it also.

CHAIRMAN: This discussion is rather interesting, as it shows an aspect of chemistry which is rather different from its ordinary aspect. We usually consider chemistry as being one of the exact sciences, but when we come to soil science we are bordering on the verge of inexact science. The knowledge gained from

soil tests is not positive in the same way as that obtained from other chemical experiments. In most chemical work the chemist can tell you exactly what will happen if you follow his directions accurately. But in the study of soils you do not get that. You get recommendations based on the outcome of a series of experiments, and almost anybody can repeat those conditions as given, and get absolutely contradictory results. That does not mean that we do not know anything at all of what we are tackling, but that we are dealing with a subject in which there are a large number of unknown factors. Of the number of the chemical constituents in the soil, only a few enter into the growth of the plant. Most of them merely constitute the mechanical support of the roots and the soil has various other mechanical properties. But it is possible for almost infinitesimal quantities of various substances to affect the result to a very large degree. So do not be discouraged if you find that in the study of soils and fertilisers you get contradictory results. By continuing the experiments over a long period of time we can give you results, such that if you follow out the recommended method of procedure, you will not always get the results that we give you, but the probability—and a strong probability, too—is that over a large number of repetitions you will come out in the way we show you. So bear that in mind, that soil science as it is at present is not claimed to be an exact science, and cannot be until we have all the different factors at our disposal.

We must thank Mr. Dodds and Mr. Fowlie, who prepared this paper, and Mr. Booth for reading it, and Mr. Fowlie for the answers he has given to the various queries. (Applause.)

