# RESULTS OF SOME CO-OPERATIVE FIELD EXPERIMENTS WITH SUGARCANE IN NATAL

By J. LINTNER and OFFICERS* OF THE DIVISION OF CHEMICAL SERVICES, PRETORIA.

## INTRODUCTION AND ACKNOWLEDGMENTS.

This paper records the results of five fairly comprehensive experiments with sugarcane in which the main emphasis is placed on cane responses to nitrogenous, phosphatic and potassic fertilizers. Two experiments included a fourth factor, viz., variety of cane. The experiments were co-operative in so far as they were laid down on the properties of four different owners (who supplied labour) by J. Lintner, who suggested the trials and was responsible for the field work of fertilizing, planting, etc. Officers of the Division of Chemical Services, Department of Agriculture and Forestry, Pretoria, were responsible for the designs, supervision during most of the harvesting, statistical interpretation and recording of yield data, as well as the chemical and physical analyses of the soils. Analyses of the cane samples were conducted at various mills and also at the Mount Edgecombe Sugar Experiment Station by kind permission of the Director.

## SCOPE AND DESIGN OF THE EXPERIMENTS.

The experiments deserve attention, perhaps not so much on account of the degree to which various soils and canes have been shown to respond to different fertilizer treatments, but rather as a demonstration of the efficiency of the newer factorial designs for field experiments described by Yates, 1937.[2] The present trials show that the use of these designs allows the experimentalist to test out several factors simultaneously in one compact trial, e.g., N, P and K, each at three levels and in all possible combinations with three varieties, using only 81 plots, as, e.g., at Reunion. Accurate and reliable conclusions can be drawn from the results. To have tested out these factors in separate experiments would have required a vastly greater effort and the conclusions would still have been less decisive and complete. The factorial designs are therefore admirably suited for such exploratory work covering a wide field of problems.

It is generally conceded that field trials should be conducted over at least five to ten seasons if reliable deductions are to be made. This condition could not be met in the present series owing to difficulties arising from the outbreak of hostilities a year after they had been laid down. In view of the fact that in all the trials, fertilizers were applied only to the plant cane, and that in most cases the initial effects had petered out after the second ratoon (three cuts in five years), a record of the results at this stage will serve some useful purpose.

## SOIL ANALYSES.

The localities selected for the experiments range from Reunion, just south of Durban, to the Umfolozi Flats in Zululand, and include some of the main soil types of the Natal cane belt; both rich and poor soils, silty and sandy, and including soils high and low in nitrogen and organic matter. Immediately before planting and fertilizing, thoroughly representative soil samples were taken from the various experimental areas. These samples were analysed both in Europe at the head laboratories of the Potash Syndicate and also at the Division of Chemical Services' Laboratories, Pretoria. The two series show good agreement, and in Tables 1, 2 and 3 of Appendix I the Pretoria figures only are shown. The S, T and V values of Table 2 are taken from the overseas results.

Before proceeding to an examination of yield data from the individual trials, it will be useful to state at the outset that no correlation, except possibly a negative one, appears to exist between the laboratory analyses of the soils and their responses to fertilizers: Kramer's soil, which has the highest content of available phosphate in the top foot, is the only one to respond to phosphatic dressings. On Hammar's light sandy soil, which shows by far the lowest HCl-extractable potash values, and only moderately good available potash values, the application of potash had a consistently depressing effect on the plant cane crop. The soils from the two Reunion experiments, which have the highest total nitrogen content in both the first and second foot, are the only ones to show a response to nitrogenous fertilizer, in spite of the high nitrogen-forming ability of these soils—refer to Appendix I, Table 3. Similarly, the light sandy soils of Kramer and Hammar, which are low in organic matter and nitrogen, show no response to nitrogen.

## THE NEED FOR FIELD EXPERIMENTS.

Assuming that the perversity and caprice of these soils are typical of the Natal sugar belt soils, then it is obvious that actual field experiments constitute the most direct and reliable means of arriving at a sound fertilizer programme. It has been stated that in some of the world's highest producing sugar soils belonging to the Dutch in the Far East, the more progressive estates initiated a programme which called, on an average, for one field trial to every few acres, and it seems that the highly organised Natal industry could usefully watch this lead. The policy of the Mount Edgecombe Experiment Station in conducting and maintaining large numbers of field experiments is therefore a sound one. Prominence was recently given to this work in a paper by H. H. Dodds[1] which summarises results over a ten-year period ending in 1942. A combination of experience gained in the course of field experimentation with a knowledge of the distribution of soil types is therefore a most potent means of increasing the efficiency of the industry in so far as the fertilizer programme and choice of cane variety is concerned. The elimination of ineffective fertilizers combined with increased yields of even a few per cent. would represent a great annual saving to the industry. The important point to remember, however, is that it is difficult to generalise and predict without the backing and experience of actual results from sound field trials.

## STATISTICAL TERMS.

Before discussing the yields, etc., it may perhaps be useful to those planters not familiar with statistical terminology if some of the terms used throughout the work are briefly explained :—

(1) G.M. represents the General Mean of all plots for the cutting under discussion.

(2) The Standard Error (S.E.) is a measure of the accuracy of the experiment, and it is used to compute the difference between treatments required for significance.

(3) It is also useful to express the S.E. as a percentage of the G.M., i.e. S.E. per cent. (The G.M. being represented by 100 per cent.)

(4) The Value of P, e.g. P = 0.05, 0.01, 0.001, is a measure of the odds (probability) in favour of the conclusions being real and not merely due to chance.

$P = 0.05$ represents odds of 19 : 1.
$= 0.01$ represents odds of 99 : 1.
$= 0.001$ represents odds of 999 : 1.

(5) The Difference required for Significance (Sig. Diff.) : Two treatments may be said to differ significantly only when their difference exceeds the amount required at the various values of P. The higher the degree of probability attained by a difference, the more reliable is the conclusion which can be drawn.

In presenting the yield tables in the units indicated, usually tons per acre, the adjoining value expresses these same yields as percentages of the mean yield of all plots for the particular crop and experiment being discussed.

### Presentation and Discussion of Experimental Data.

In all five trials to be described the size of the yield plots was one-fortieth of an acre. The cane was planted in rows 4½ feet apart with adequate guard rows between plots.

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* Dr. E. R. Orchard is responsible for the handling of all data collected prior to 1940, as well as for final presentation of the work.
Messrs. E. Fischer, J. van Garderen and E. Greenstein are responsible for the remainder of the data, i.e. harvesting, recording, etc. All statistical work on data gathered since 1940 is due to E. Fischer.
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## I.—CO-OPERATIVE SUGARCANE EXPERIMENT.

**ULOA Agricultural Co-op. Co., Ltd., Mtubatuba, Zululand.**

*Experiment laid down*, December, 1938. *Cane variety*, Co.281.

*Design.*—3 × 3 × 3 in blocks of 9 plots—the whole replicated three times (81 plots).

*Treatments.*—All the possible combinations of N, P and K (27) where each is applied at three different levels, viz., 0, 1 and 2.

*Rates of Fertilizer application.*

| | $N_0$ | $N_1$ | $N_2$ | $P_0$ | $P_1$ | $P_2$ | $K_0$ | $K_1$ | $K_2$ |
|---|---|---|---|---|---|---|---|---|---|
| Lbs./acre ... ... ... ... ... ... ... | Nil | 474 | 948 | Nil | 621 | 1242 | Nil | 258 | 516 |
| | as sulphate of ammonia | | | as basic slag | | | as sulphate of potash | | |
| Lbs./acre N, $P_2O_5$ or $K_2O$ ... ... ... | Nil | 100 | 200 | Nil | 100 | 200 | Nil | 125 | 250 |

The P and K dressings were applied before planting on December 5th, 1938, but in the case of both $N_1$ and $N_2$ half was applied on 7th March, 1939, as a top-dressing and the remaining half on 27th March, 1939.

**Plant Cane Crop.**—Harvested October, 1940 (22 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 77.9 | 97.5 | 79.3 | 99.3 | 82.5 | 103.3 | | | | | |
| P | 78.5 | 98.3 | 79.3 | 99.2 | 81.9 | 102.5 | 79.9 | 8.3 | 10.4 | 4.5 | 5.7 (P=.05) |
| K | 79.9 | 100.0 | 80.0 | 100.1 | 79.8 | 99.9 | | | | | |

*Conclusions.*—There were no significant treatment differences. Sucrose determinations were carried out on a number of cane samples from the plant cane crop in order to see whether it was possible to demonstrate any fertilizer effect on sucrose content of the cane.

*Sucrose per cent. Cane.*

| Treatment. | 0 Per cent. Suc. | 0 Per cent. | 1 Per cent. Suc. | 1 Per cent. | 2 Per cent. Suc. | 2 Per cent. | G.M. Per cent. Suc. | Std. Error Per cent. Suc. | Std. Error Per cent. | Sig. Diffs. Suc. per cent. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 13.9 | 101.2 | 13.7 | 100.2 | 13.5 | 98.5 | | | | | |
| P | 13.8 | 100.3 | 13.5 | 98.5 | 13.9 | 101.2 | 13.7 | 0.7 | 5.1 | 0.8 | 5.9 (P = .05) |
| K | 13.6 | 99.5 | 13.4 | 97.5 | 14.1 | 102.9 | | | | | |

*Conclusions.*—Fertilizer treatments did not affect sucrose per cent. cane significantly.

**First Ratoon Crop.**—Harvested September, 1942. (23 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 94.0 | 101.2 | 91.7 | 98.8 | 92.8 | 100.0 | | | | | |
| P | 91.6 | 98.6 | 93.8 | 101.0 | 93.2 | 100.4 | 92.8 | 7.4 | 7.9 | 4.0 | 4.3 (P = .05) |
| K | 93.5 | 100.7 | 92.6 | 99.8 | 92.4 | 99.5 | | | | | |

*Conclusions.*—There were no significant treatment differences, i.e. no residual effects from fertilizers applied to the plant cane.

Sucrose determinations were made on samples from all 81 plots at the time of harvesting the first ratoon. These values were used to calculate yields of sucrose. The results are shown in the following table :—

*Tons Sucrose per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 14.03 | 100.1 | 13.93 | 99.4 | 14.09 | 100.5 | | | | | |
| P | 13.84 | 98.5 | 14.06 | 100.3 | 14.15 | 100.9 | 14.02 | 1.13 | 8.1 | 0.61 | 4.4 (P = .05) |
| K | 14.24 | 101.6 | 13.80 | 98.4 | 14.10 | 99.9 | | | | | |

*Conclusions.*—There were no significant treatment differences in yield of sucrose.

**Second Ratoon Crop.**—Harvested November, 1943. (14 months growth.)

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 44.2 | 97.8 | 46.2 | 102.3 | 45.1 | 99.9 | | | | | |
| P | 44.3 | 98.1 | 44.8 | 99.3 | 46.3 | 102.5 | 45.2 | 3.6 | 7.9 | 1.9 | 4.3 (P= .05) |
| K | 45.7 | 102.6 | 45.9 | 101.7 | 43.9 | 97.1 | | | | | |

*Conclusions.*—There were no significant main-treatment differences, but the interaction NP was significant as shown in the following table:—

*Table showing NP interaction. Cane yields in tons per acre.*

| Treatment | $N_0$ T./ac. | $N_0$ Per cent. | $N_1$ T./ac. | $N_1$ Per cent. | $N_2$ T./ac. | $N_2$ Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_0$ | 44.7 | 99.0 | 45.1 | 99.9 | 43.1 | 95.5 | | | | | |
| $P_1$ | 40.9 | 90.6 | 47.0 | 104.0 | 46.6 | 103.2 | 45.2 | 3.6 | 7.9 | 3.4 | 7.4 (P = .05) |
| $P_2$ | 46.9 | 103.9 | 46.6 | 102.9 | 45.5 | 100.8 | | | | | |

(a) *For* $N_0$: $P_2 > P_1$; (b) *For* $N_2$: $P_1 > P_0$; (c) and *for* $P_1$: $N_1$ and $N_2 > N_0$. (a), (b) and (c) significant at P = 0.05.

**Discussion.**—(See Tables 1, 2 and 3, Appendix I.) The soil from this locality is a neutral relatively fertile silty-clay, rich in organic matter and nitrogen, being of alluvial and reedy marshland origin (Umfolozi Flats). Soil micro-organisms are active in this soil, as show by the high values for $CO_2$ production and nitrogen formation when the soil is incubated in the laboratory under ideal conditions for the breakdown of organic matter—see Table 3. In view of the high state of fertility and productive capacity of this soil, relatively heavy fertilizer dressings were applied.

*Plant cane crop, first ratoon.*—Yields of cane and the sucrose values are remarkably uniform for both crops, showing that no fertilizer had any direct or residual effect on yields. The low standard errors show that the experiment yielded accurate figures and relatively small treatment effects could have been detected had there been any.

*Second ratoon.*—Yields are still high, bearing in mind the short growth period of this crop. There were no residual main effects but the interaction of NP attained a low degree of significance. This is difficult to interpret rationally and is perhaps best ignored.

In general, it may therefore be said that this highly fertile soil produced three heavy crops but showed no response to any of the fertilizers as measured by yield or sucrose content of the cane.

## II.—CO-OPERATIVE SUGARCANE EXPERIMENT.

### Reunion—Illovo Sugar Co.

In this trial, as well as in an adjoining one to be described under III, four factors were used, viz. N, P, K and Variety, while retaining a total of 81 plots. Consequently in neither of these two trials is there any direct replication, since no two plots receive the same treatment.

*Experiment laid down*, November 11, 1938.

*Design.*—3 × 3 × 3 × 3 quasi-Latin square (81 plots).

*Treatments.*—These consist of the 81 possible combinations of N, P, K and V, where N, P and K are each applied at three levels (0, 1 and 2), and V represents three varieties. $V_1$ = Co.281; $V_2$ = Co.301; $V_3$ = Co.290.

*Rates of Fertilizer application.*

| | | 0 | 1 | 2 |
|---|---|---|---|---|
| Lbs. N/acre as sulphate of ammonia ... ... ... ... ... ... ... ... ... | N | Nil | 100 (474 lbs. S.A.) | 200 (948 lbs. S.A.) |
| Lbs. citric acid-soluble $P_2O_5$/acre as super-rock, 1 : 1.86 mixture ... ... | P | Nil | 100 (700 lbs. S.R. mixture) | 200 (1400 lbs. S.R. mixture) |
| Lbs. $K_2O$/acre as sulphate of potash ... ... ... ... ... ... ... ... ... | K | Nil | 125 (258 lbs. $K_2SO_4$) | 250 (516 lbs. $K_2SO_4$) |

**Note.**—(1) Nitrogen applications took the form of a basal dressing of 50 lbs. N per acre to appropriate plots at planting, followed on 20th February, 1939, by the first top-dressing of 50 lbs. and 75 lbs. N to plots receiving $N_1$ and $N_2$ respectively. The remainder of the nitrogen (75 lbs. N) still due to $N_2$ plots was applied in a final top-dressing on 13th April, 1939.

(2) The idea of using a 1 : 1.86 super-rock mixture was to apply in the mixture equal quantities of water-soluble and citric acid-soluble $P_2O_5$. As the rock phosphate had 11 per cent. citric-soluble and 33.5 per cent. total $P_2O_5$, it will be seen that the total amounts applied per acre were 200 lbs. and 400 lbs. $P_2O_5$ for $P_1$ and $P_2$ respectively; both are relatively heavy dressings.

In order to follow the influence of N, P, K and V on the development of the young cane, the following observations were made on all plots in June, 1939, i.e. seven months after planting:

(*a*) Number of shoots per stool.

(*b*) Total shoot length per stool.

Suitable estimates of these measurements were obtained by using a recognised technique of random sampling. It was thought that any treatment effects which might be demonstrated at harvest time, could possibly be usefully interpreted in the light of these biometrical observations at an earlier stage of growth.

(a) *Number of shoots per stool.*

| Treatment. | 0 No. | 0 Per cent. | 1 No. | 1 Per cent. | 2 No. | 2 Per cent. | G.M. No. | Std. Error No. | Std. Error Per cent. | Sig. Diffs. No. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 8.5 | 93.7 | 9.0 | 99.4 | 9.6 | 106.8 | | | | | |
| P | 8.7 | 96.3 | 9.4 | 103.9 | 9.0 | 99.9 | | | | 0.7 | 7.9 (P=.05) |
| K | 8.9 | 98.5 | 9.0 | 99.5 | 9.2 | 102.0 | 9.0 | 1.28 | 14.2 | 1.0 | 10.7 (P=.01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | 1.3 | 14.1 (P=.001) |
| V | 9.0 | 100.0 | 9.8 | 109.0 | 8.2 | 91.0 | | | | | |

*Conclusions.*—N and V effects are significant at P = 0.01 and P = 0.001 respectively.
(1) *For N* : $N_2 > No.$ (P = 0.01); (2) *for V* : $V_2 > V_1 > V_3$ (P = 0.05) and $V_2 > V_3$ (P = 0.001).

(b) *Total shoot length per stool (inches).*

| Treatment. | 0 Inches. | 0 Per cent. | 1 Inches. | 1 Per cent. | 2 Inches. | 2 Per cent. | G.M. Inches. | Std. Error Inches. | Std. Error Per cent. | Sig. Diffs. Inches. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 293 | 87.7 | 344 | 103.1 | 365 | 109.3 | | | | | |
| P | 319 | 95.4 | 337 | 101.0 | 346 | 103.6 | | | | 29 | 8.7 (P=.05) |
| K | 292 | 87.4 | 345 | 103.3 | 365 | 109.3 | 334 | 52 | 15.6 | 39 | 11.7 (P=.01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | 52 | 15.5 (P=.001) |
| V | 302 | 90.5 | 355 | 106.2 | 345 | 103.3 | | | | | |

*Conclusions.*—N and K effects are significant (P = 0.001). V effect and the interaction NV are significant (P = 0.01).
(1) *For N* : $N_2$ and $N_1 > N_0$ (P = 0.01); and $N_2 > N_0$ (P = 0.001).
(2) *For K* : $K_2$ and $K_1 > K_0$ (P = 0.001. (3) *For V* : $V_2$ and $V_3 > V_1$ (P = 0.01).
(4) *For NV* : The significant *NV interaction* is shown in the following table :—

*Total shoot length per stool (inches).*

| Treatment. | $N_0$ Inches. | $N_0$ Per cent. | $N_1$ Inches. | $N_1$ Per cent. | $N_2$ Inches. | $N_2$ Per cent. | G.M. Inches. | Std. Error Inches. | Std. Error Per cent. | Sig. Diffs. Inches. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | 271 | 81.1 | 327 | 98.0 | 309 | 92.5 | | | | 50 | 15.0 (P=.05) |
| $V_2$ | 301 | 90.2 | 330 | 98.8 | 433 | 129.6 | 334 | 52 | 15.6 | 68 | 20.3 (P=.01) |
| $V_3$ | 306 | 91.7 | 375 | 112.4 | 353 | 105.7 | | | | 90 | 26.9 (P=.001) |

(a) *For* $V_1$ (Co.281) : $N_1 > N_0$ (P = 0.05). (b) *For* $V_2$ (Co.301) : $N_2 > N_1$ and $N_0$ (P = 0.01). (c) *For* $V_3$ (Co.290) : $N_1 > N_0$ (P = 0.01).

**Discussion.**—*Observations on young cane.*—When the plant cane yields from this experiment are discussed in the following section, it will be seen that the measurements made on the young cane (under the climatic and other conditions which prevailed) accurately foreshadowed the yield responses to the different fertilizer applications. The cane measurements, however, indicated marked varietal differences, whereas plant cane yields showed virtually no such differences.

Nitrogen increased the number of shoots per stool, and this effect was more than maintained in the figures for "total shoot length per stool" since individual shoots also grew taller as a result of nitrogen applications. Potash, although not increasing the number of shoots, made them grow considerably taller. Potash and nitrogen effects are to all intents and purposes identical when considering "total shoot length per stool." For total shoot length there was also a significant interaction between nitrogen and variety, in that for Co.281 and Co.290 the lower nitrogen dressing ($N_1$) already exerted the maximum effect, whereas for Co.301 only the highest nitrogen application was effective.

**Plant Cane Crop.**—Harvested August, 1940 (21 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 58.1 | 93.5 | 63.6 | 102.3 | 64.8 | 104.2 | | | | | |
| P | 61.0 | 98.1 | 62.9 | 101.3 | 62.6 | 100.6 | | | | 2.8 | 4.5 (P=.05) |
| K | 58.4 | 93.9 | 63.7 | 102.5 | 64.4 | 103.6 | 62.2 | 5.0 | 8.0 | 3.7 | 6.0 (P=.01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | 4.9 | 8.0 (P=.001) |
| V | 61.4 | 98.7 | 62.7 | 100.8 | 62.5 | 100.5 | | | | | |

*Conclusions.*—N and K effects are highly significant (P = 0.001).
(1) *For N* : $N_2$ and $N_1 > N_0$ (P = 0.001). (2) *For* K : $K_2$ and $K_1 > K_0$ (P = 0.001).

**First Ratoon Crop.**—Harvested October, 1941 (15 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 40.1 | 97.8 | 41.1 | 100.2 | 41.8 | 102.0 | | | | | |
| P | 41.4 | 101.0 | 40.6 | 99.0 | 41.1 | 100.1 | | | | 1.7 | 4.1 (P=.05) |
| K | 40.9 | 99.7 | 41.6 | 101.3 | 40.6 | 99.0 | 41.0 | 3.0 | 7.4 | 2.3 | 5.5 (P=.01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | 3.0 | 7.3 (P=.001) |
| V | 38.4 | 93.5 | 44.9 | 109.5 | 39.8 | 97.0 | | | | | |

*Conclusions.*—There is no significant residual fertilizer effect, but varietal differences are highly significant (P = 0.001).

(1) *For V*: $V_2 > V_3$ and $V_1$ (P = 0.001). $V_3$ is very nearly significantly greater than $V_1$ at (P = 0.05).

**Sucrose yields.**—*First ratoon.*—At the time of harvesting about six large samples of cane per variety were taken and analysed. The results are shown in the following table:—

| | Variety. | Brix. | Purity. | Sucrose per cent. Cane. | Sucrose per cent. Extraction. | Java Ratio. | Reducing Sugar Ratio. | Fibre per cent. Cane. |
|---|---|---|---|---|---|---|---|---|
| $V_1$ ... | Co.281 | 20.1 | 92.0 | 14.22 | 66.3 | 77.1 | 1.36 | 16.78 |
| $V_2$ ... | Co.301 | 19.9 | 92.4 | 14.70 | 67.6 | 79.6 | 1.52 | 13.98 |
| $V_3$ ... | Co.290 | 20.7 | 93.0 | 15.63 | 67.7 | 81.4 | 0.68 | 13.24 |

Using the cane yields and the values for sucrose per cent. cane, the following sucrose yields are obtained (tons sucrose per acre):

$V_1 = 5.45$; $V_2 = 6.60$; $V_3 = 6.22$.

**Discussion.**—The silty soil from this locality is in many respects similar to that described under I (Uloa), being a fertile alluvial, low-lying soil rich in organic matter. It is slightly acid, but the values for available potash are relatively good.

The plant cane yield showed no varietal differences, but the first level of both nitrogen and potash ($N_1$ and $K_1$) gave good returns over the control: 5.5 and 5.3 T./ac. respectively. It is remarkable that although the beneficial nitrogen and potash effects were almost identical, their combination NK showed no additional advantage over N and K applied separately, since the NK interaction was not significant.

There are no residual fertilizer effects to be seen in the first ratoon crop. Varieties, however, now show highly significant differences, whereas in the plant cane crop their yields were almost identical. Co.301 outyielded its nearest rival, Co.290, by 5 tons and Co.281 by 6.5 tons per acre.

An examination of the sucrose yields (first ratoon) shows that Co.290 becomes a close second to Co.301 owing to its high sucrose content. Co.281 falls to the position of a bad third owing to its relatively low yield and its poor sucrose content. It must be emphasised, however, that owing to insufficient analyses the above statements involving sucrose cannot be proved statistically, although they may be correct.

## III.—CO-OPERATIVE SUGARCANE EXPERIMENT.

### Reunion—Illovo Sugar Co.

This trial adjoins the experiment described under II. Except for the fact that the plots were differently randomised, the two experiments are identical with regard to design and treatments. Tables 1, 2 and 3, Appendix I, show that the soils were closely similar.

By comparing data from these two adjoining areas the means is provided for testing the efficacy of the $3^4$ designs in a most searching manner.

**Plant Cane Crop.**—Harvested August, 1940. (21 months growth.) Reunion "B"

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 59.4 | 95.0 | 63.4 | 101.5 | 64.7 | 103.6 | | | | | |
| P | 61.3 | 98.1 | 63.5 | 101.6 | 62.8 | 100.4 | | | | 3.0 | 4.7 (P = .05) |
| K | 60.0 | 96.0 | 61.9 | 99.1 | 65.5 | 104.7 | 62.5 | 5.4 | 8.6 | 4.0 | 6.4 (P = .01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | | |
| V | 62.6 | 100.2 | 63.0 | 100.8 | 61.9 | 99.0 | | | | | |

*Conclusions.*—N and K effects are significant (P = 0.01). The interaction NV is very nearly significant at P = 0.05).

(1) *For N*: $N_2$ and $N_1 > N_0$ (P = 0.01). (2) *For K*: $K_2 > K_1$ and $K_0$ (P = 0.05); $K_2 > K_0$ (P = 0.01).

**First Ratoon Crop.**—Harvested October, 1941 (15 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 43.9 | 100.5 | 43.8 | 100.2 | 43.4 | 99.2 | | | | | |
| P | 42.7 | 97.6 | 44.5 | 101.7 | 44.0 | 100.6 | | | | 1.8 | 4.0 (P=.05) |
| K | 43.9 | 100.5 | 43.6 | 99.7 | 43.6 | 99.8 | 43.7 | 3.2 | 7.2 | 2.4 | 5.4 (P=.01) |
| | $V_1$ | | $V_2$ | | $V_3$ | | | | | 3.1 | 7.2 (P=.001) |
| V | 40.2 | 91.9 | 48.6 | 111.1 | 42.4 | 97.1 | | | | | |

*Conclusions.*—There is no significant residual fertilizer effect, but varietal differences are highly significant (P = 0.001).

The interaction NV is significant at P = 0.05 and probably so at P = 0.01.

(1) *For V*: $V_2 > V_3 > V_1$, P = 0.05; $V_2 > V_3$ and $V_1$, P = 0.001. ($V_1$ = Co.281; $V_2$ = Co.301; $V_3$ = Co.290.)

(2) *For NV*: The significant NV interaction is shown in the following table:—

*Cane yields in tons per acre.*

| Treatment | $N_0$ T./ac. | $N_0$ Per cent. | $N_1$ T./ac. | $N_1$ Per cent. | $N_2$ T./ac. | $N_2$ Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $V_1$ | 39.4 | 90.2 | 42.8 | 98.0 | 38.2 | 87.4 | | | | | |
| $V_2$ | 48.4 | 110.8 | 47.8 | 109.4 | 49.5 | 113.1 | 43.7 | 3.2 | 7.2 | 3.1 | 7.0 (P=.05) |
| $V_3$ | 44.0 | 100.6 | 40.8 | 93.4 | 42.5 | 97.2 | | | | 4.1 | 9.4 (P=.01) |

(a) *For* $V_1$: $N_1 > N_2$ and $N_0$ (P = 0.05); $N_1 > N_2$ (P = 0.01).
(b) *For* $V_2$: There are no significant differences between N treatments.
(c) *For* $V_3$: $N_0 > N_1$ (P = 0.05).

Alternatively, this NV interaction can also be indicated as follows:—

(a) *For* $N_0$: $V_2 > V_3 > V_1$
(b) *For* $N_1$: $V_2 > V_1$ and $V_3$ } (P = 0.01).
(c) *For* $N_2$: $V_2 > V_3 > V_1$

**Sucrose yields.**—*First ratoon.*—As in the case of experiment II, analytical data on the three varieties were collected, with the following results:—

| | Variety. | Brix. | Purity. | Sucrose per cent. Cane. | Sucrose per cent. Extraction. | Java Ratio. | Reducing Sugar Ratio. | Fibre per cent. Cane. |
|---|---|---|---|---|---|---|---|---|
| $V_1$ ... | Co.281 | 20.2 | 91.7 | 13.99 | 72.6 | 75.5 | 0.54 | 15.38 |
| $V_2$ ... | Co.301 | 19.4 | 90.0 | 13.96 | 73.9 | 80.0 | 1.66 | 16.48 |
| $V_3$ ... | Co.290 | 19.6 | 90.8 | 14.64 | 74.9 | 82.3 | 0.67 | 11.03 |

Using cane yields and the values for sucrose per cent. cane, the following sucrose yields were obtained (tons sucrose per acre):—

$V_1 = 5.62$; $V_2 = 6.78$; $V_3 = 6.21$.

**Discussion.**—The extra effort involved by conducting two similar trials side by side produced data which amply justified the use of this design for comprehensive exploratory experiments. Plant cane yields of the main treatments in experiments II and III were almost identical.

In experiment II the first dressing of potash was slightly more effective than in experiment III, and this constitutes the only dissimilar main treatment effect between the plant cane crops.

Comparing the two first ratoon crops (from experiments II and III), it will be seen that $V_2$ (Co.301) gave even higher yields in experiment III, but for the rest the two sets of data are closely similar and almost identical for the varieties when considering the percentage yields. There is, however, a significant NV interaction in experiment III which is difficult to explain, as this effect is absent in experiment II. Although it just failed to reach significance, it will be recalled that there was a strong indication of an NV interaction in the plant cane crop from this experiment (III). It will further be recalled that in the measurements of total shoot length discussed under II, a significant NV interaction was also found. The trends of the interactions, although similar in the main, are not parallel throughout. It seems as if the varying responses of these varieties to nitrogen might be studied more carefully in future. With regard to the sucrose yields from the first ratoon there is nothing which calls for special comment. Co.301 still leads by virtue of its high yield of cane, while Co.290 is a close second by virtue of its high sucrose content; Co.281 comes last, more than 1 ton sucrose per acre behind Co.301, as was also the case in experiment II.

In view of the low values shown for available phosphoric acid by these Reunion soils (values were lower than at any of the other three localities discussed), the ineffectiveness of relatively heavy super-rock dressings is remarkable.

## IV.—CO-OPERATIVE SUGARCANE EXPERIMENT.

**Mr. Hammar, Empangeni.**

*Experiment laid down*, 20th October, 1938. *Variety*, Co.290.

*Design.*—3 × 3 × 3 in blocks of 9 plots—the whole replicated three times (81 plots).

*Treatments.*—All the possible combinations (27) of N, P and K where each is applied at three different levels, viz., 0, 1 and 2.

*Rates of Fertilizer application.*

| | $N_0$ | $N_1$ | $N_2$ | $P_0$ | $P_1$ | $P_2$ | $K_0$ | $K_1$ | $K_2$ |
|---|---|---|---|---|---|---|---|---|---|
| Lbs /acre... ... ... ... ... ... ... | Nil | 237 | 474 | Nil | 500 | 1000 | Nil | 125 | 250 |
| | as sulphate of ammonia | | | as superphosphate | | | as muriate of potash | | |
| Lbs./acre N, $P_2O_5$ or $K_2O$ ... ... ... | Nil | 50 | 100 | Nil | 100 | 200 | Nil | 75 | 150 |

All fertilizers were applied as a basal dressing on 22nd September, 1938.

**Plant Cane Crop.**—Harvested 30th October, 1939 (12 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 39.5 | 98.8 | 40.4 | 101.2 | 39.9 | 99.9 | | | | | | |
| P | 39.4 | 98.7 | 39.5 | 98.9 | 40.9 | 102.4 | 39.9 | 5.4 | 13.6 | 3.0 | 7.4 | (P=.05) |
| K | 42.1 | 105.5 | 39.5 | 99.0 | 38.1 | 95.5 | | | | | | |

*Conclusions.*—Potash applications significantly depressed cane yields, P = 0.05.

(1) For K : $K_0 > K_2$, P = 0.05.

At the time of harvesting the above experiment, cane samples were taken from all the plots and analysed for sucrose content. The results were calculated to sucrose yields (tons/acre) with the following results :—

*Sucrose in tons per acre (Plant Cane crop).*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 5.75 | 99.5 | 5.82 | 100.7 | 5.76 | 99.6 | | | | | | |
| P | 5.75 | 99.5 | 5.75 | 99.5 | 5.83 | 100.9 | 5.78 | 0.63 | 11.0 | 0.35 | 6.0 | (P=.05) |
| K | 6.11 | 105.7 | 5.75 | 99.5 | 5.47 | 94.6 | | | | 0.46 | 7.9 | (P=.01) |

*Conclusions.*—Potash applications significantly depressed sucrose yields, P = 0.01.

(1) For K : $K_0 > K_1$ and $K_2$, P = 0.05, and $K_0 > K_2$, P = 0.01.

**First Ratoon Crop.**—Harvested October, 1940 (12 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 27.5 | 95.3 | 30.3 | 104.8 | 28.8 | 99.9 | | | | | | |
| P | 28.9 | 100.1 | 29.4 | 101.8 | 28.3 | 98.2 | 28.9 | 5.0 | 17.4 | 2.6 | 9.1 | (P=.05) |
| K | 29.0 | 100.6 | 28.8 | 99.7 | 28.8 | 99.7 | | | | | | |

*Conclusions.*—There are no significant residual fertilizer effects.

**Discussion.**—Considering the light sandy nature of this hillside soil (over 80 per cent. sand) and the short growth period for the plant cane, the yield is good. Attention has already been drawn to the low total potash content of this soil, but this is offset by its relatively high percentage availability (approximately 10 per cent. as against only 1 per cent. availability for the Reunion soils described under II and III; see also Appendix I, Table 2). That the high potash application ($K_2$) should depress the plant cane yield is therefore most surprising. When considering sucrose yields the depressing effect of potash becomes even more significant, and the harmful effect of even the lower potash dressing ($K_1$) becomes apparent.

In the ratoon crop there are no residual fertilizer effects, even the depressing effect of potash applied two years earlier having disappeared. As the ratoon gave a relatively light crop, it may be assumed that growth factors other than potash or phosphate limited the yield. The standard errors of this experiment are higher than those for any of the other localities. From the relatively low nitrogen content and also low nitrogen supplying power of this soil one would have expected a response to sulphate of ammonia, but this was not the case.

## V.—CO-OPERATIVE SUGARCANE EXPERIMENT.

**Mr. Kramer, Gingindhlovu.**

This experiment was similar to that described under IV, with the following modifications :—

*Laid down*, 13th December, 1938. *Variety*, Co.281.

*Rates of application.*—N and P and K applications were the same as for experiment IV, with the single exception that $K_1$ applications were heavier, viz. 167 lbs. muriate of potash per acre (100 lbs. $K_2O$) in place of 125 lbs.

All fertilizers were applied before planting except for plots receiving $N_2$, which were given 50 lbs. N at planting and the balance (50 lbs. N) as a top-dressing on 6th March, 1939.

**Plant Cane Crop.**—Harvested September, 1940 (21 months growth).

*Cane yields in tons per acre.*

| Treatment | 0 T./ac. | 0 Per cent. | 1 T./ac. | 1 Per cent. | 2 T./ac. | 2 Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 50.1 | 102.5 | 49.5 | 101.2 | 47.1 | 96.3 | | | | | |
| P | 46.6 | 95.4 | 49.5 | 101.3 | 50.5 | 103.4 | 48.9 | 5.1 | 10.5 | 2.8 | 5.7 (P=.05) |
| K | 47.7 | 97.5 | 48.9 | 99.9 | 50.2 | 102.6 | | | | | |

*Conclusions.*—P effect is significant and N effect approaches significance at P = 0.05. The interaction NP is just significant and PK very nearly so at P = 0.05.

(1) *For P*: $P_2$ and $P_1 > P_0$, P = 0.05.

(2) *For N*: Nitrogen ($N_1$ and $N_2$) has a depressing effect but not significantly so.

(3) *For NP*: The significant NP interaction is shown in the following table :—

*Cane yields in tons per acre.*

| Treatment | $N_0$ T./ac. | $N_0$ Per cent. | $N_1$ T./ac. | $N_1$ Per cent. | $N_2$ T./ac. | $N_2$ Per cent. | G.M. T./ac. | Std. Error T./ac. | Std. Error Per cent. | Sig. Diffs. T./ac. | Sig. Diffs. Per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_0$ | 46.7 | 95.5 | 46.3 | 94.6 | 46.9 | 96.0 | | | | | |
| $P_1$ | 50.5 | 103.3 | 48.9 | 100.1 | 49.2 | 100.6 | 48.9 | 5.1 | 10.5 | 4.8 | 9.9 (P = .05) |
| $P_2$ | 53.2 | 108.9 | 53.3 | 108.9 | 45.1 | 92.3 | | | | | |

*Conclusions*(a) *For $P_0$ and $P_1$*: There were no significant differences between $N_0$, $N_1$ and $N_2$ treatments.

(b) *For $P_2$*: $N_0$ and $N_1 > N_2$, P = 0.05.

The above findings show that high nitrogen combined with high phosphate dressings lead to decreased yields.

(4) The interaction PK nearly reached significance. The tendency was for potash dressings to improve the yield on treatments receiving no phosphate or $P_1$, but to decrease the yield on plots receiving $P_2$.

**Discussion.**—This sandy hillside soil (over 60 per cent. sand) yielded a relatively light plant cane crop, considering it was 21 months old when cut. This soil, however, was the only one to show a significant response to phosphate. The lighter dressing ($P_1$), which increased the yield by nearly 3 tons of cane/acre, was already nearly as effective as the higher dressing ($P_2$), since doubling the superphosphate application from 500 lbs. to 1,000 lbs. per acre merely added one more ton of cane.

The significant NP interaction is interesting, in that high nitrogen ($N_2$) depressed yields in the presence of high phosphate applications ($P_2$), whereas in the absence of nitrogen ($N_0$) phosphate increased the yield substantially. This effect, which has often been encountered with other crops in this country, is usually associated with a dry period during the growing season. A possible explanation is that growth stimulated to a maximum by N and P together, suffers more from a subsequent dry spell than growth which was not so luxuriant, e.g. P only or N only, prior to such dry period. The PK interaction mentioned above was closely similar to the NP interaction in that K and N acted in the same way.

## CONCLUSION.

In summarising the five experiments described, it may be said that a great diversity of responses was obtained—some of these responses being of an unexpected nature. The absence of any initial or even residual effect of phosphate in four out of five of the trials is surprising, as also the rather poor response to nitrogen applications. In this respect it would perhaps be advisable to devote more attention in future work to the effects of nitrogen applications to ratoons. A study of the summary of Dodds[1] already referred to, clearly shows that ratoons, speaking generally, respond nearly twice as well to nitrogen as do plant cane crops.

On reviewing the results from these complex or factorial experiments, the question of the suitability of these designs for general application in agricultural work arises. The evidence presented shows that from a limited number of plots it is possible by this means to derive a great deal of information, e.g. experiments II and III. No other layout, even assuming all four factors could be evaluated jointly or separately, could provide a more complete picture. However, once a specific problem is recognised, simpler designs would be adequate.

## REFERENCES.

[1] Dodds, H. H. (1944) : A Preliminary Survey of Recent Fertilizer Experiments for Sugarcane. The S.A. Sugar Journal No. 1, **28**, 11.

[2] Yates, F. (1937) : The Design and Analysis of Factorial Experiments. Tech. Comm. No. 35 of the Imp. Bureau of Soil Science.

# APPENDIX 1. ANALYTICAL DATA ON SOILS.

**TABLE I.—MECHANICAL ANALYSIS.**

| | Diam. (mms.) | Per cent. Coarse sand > 0.1 | Per cent. Fine sand < 0.1 | Per cent. Silt 0.5–0.005 | Per cent. Clay I 0.005–0.002 | Per cent. Clay II < 0.002 | Per cent. total. |
|---|---|---|---|---|---|---|---|
| I. U.L.O.A. ... ... ... 0″—12″ | | 0.8 | 12.5 | 32.5 | 11.1 | 44.2 | 101.1 |
| 12″—24″ | | 3.5 | 24.5 | 40.7 | 4.5 | 21.7 | 99.9 |
| II. REUNION ... ... ... 0″—11″ | | 2.6 | 10.4 | 42.1 | 8.7 | 34.7 | 98.5 |
| 11″—24″ | | 11.8 | 20.5 | 32.4 | 7.1 | 29.2 | 101.0 |
| III. REUNION ... ... ... 0″—11″ | | 3.4 | 20.9 | 36.1 | 6.8 | 31.4 | 98.6 |
| 11″—28″ | | 3.9 | 19.9 | 33.7 | 8.2 | 33.3 | 99.0 |
| IV. HAMMAR ... ... ... 0″—14″ | | 57.8 | 25.8 | 8.1 | 1.6 | 7.2 | 100.5 |
| 14″—26″ | | 62.9 | 24.9 | 8.2 | 1.1 | 4.3 | 101.4 |
| V.—KRAMER ... ... ... 0″—18″ | | 31.3 | 33.0 | 16.7 | 4.1 | 14.6 | 99.7 |
| 18″—30″ | | 31.0 | 32.8 | 18.8 | 3.2 | 15.5 | 101.3 |

**TABLE 2.—CHEMICAL ANALYSIS.**

| | pH | Total C per cent. | Total N per cent. | Available $P_2O_5$ per cent. | Available $K_2O$ per cent. | In HCl Extract $P_2O_5$ per cent. | In HCl Extract $K_2O$ per cent. | Mgm. equivalent per cent. S. | T. | V. |
|---|---|---|---|---|---|---|---|---|---|---|
| I. U.L.O.A. ... ... 0″—12″ | 6.5 | 1.44 | 0.13 | 0.003 | 0.008 | 0.071 | 0.55 | 27.4 | 29.4 | 93.2 |
| 12″—24″ | 7.1 | 0.66 | 0.06 | 0.004 | 0.004 | 0.045 | 0.33 | 17.6 | 18.8 | 93.4 |
| II. REUNION ... ... 0″—11″ | 5.6 | 1.84 | 0.17 | 0.001 | 0.005 | 0.080 | 0.47 | 14.4 | 19.5 | 73.8 |
| 11″—24″ | 6.1 | 1.23 | 0.09 | <0.001 | 0.003 | 0.053 | 0.43 | 10.6 | 13.4 | 79.2 |
| III. REUNION ... ... 0″—11″ | 5.7 | 1.86 | 0.16 | 0.002 | 0.004 | 0.094 | 0.48 | 13.1 | 17.6 | 74.3 |
| 11″—28″ | 6.1 | 1.29 | 0.11 | 0.001 | 0.003 | 0.059 | 0.45 | 15.1 | 18.2 | 82.8 |
| IV. HAMMAR... ... 0″—14″ | 6.5 | 0.65 | 0.05 | 0.022 | 0.006 | 0.033 | 0.06 | 3.6 | 4.3 | 83.5 |
| 14″—26″ | 5.6 | 0.11 | 0.01 | <0.001 | 0.003 | 0.006 | 0.05 | 1.0 | 1.7 | 59.9 |
| V. KRAMER ... ... 0″—18″ | 5.7 | — | 0.09 | 0.004 | 0.005 | 0.034 | 0.23 | — | — | — |
| 18″—30″ | 6.1 | — | 0.05 | <0.001 | 0.003 | 0.020 | 0.23 | — | — | — |

S = Sum of exchangeable bases. T = Total base exchange capacity. V = Degree of saturation, i.e. $\frac{S}{T} \times 100$.

**TABLE 3.—OXIDISABLE CARBON AND MINERAL NITROGEN.**

| | Field N as $NH_4-N$ $+NO_3-N$ p.p.m. N | After 24 days incubation at 29°C. p.p.m. C as $CO_2$ | p.p.m. N as $NH_4-N$ | p.p.m. N as $NO_3-N$ | Total Min. N p.p.m. N | N Formed p.p.m. N |
|---|---|---|---|---|---|---|
| I. U.L.O.A. ... ... ... ... 0″—12″ | 21 | 331 | 30 | 22 | 52 | 31 |
| II. REUNION ... ... ... ... 0″—11″ | 16 | 380 | 12 | 40 | 52 | 36 |
| III. REUNION ... ... ... ... 0″—11″ | 16 | 380 | 5 | 53 | 58 | 42 |
| IV. HAMMAR ... ... ... ... 0″—14″ | 16 | 218 | 2 | 27 | 29 | 13 |
| V. KRAMER ... ... ... ... 0″—18″ | 30 | 168 | 6 | 62 | 68 | 38 |

**Note.**—*N Formed* = (Total Mineral Nitrogen after incubation) − (Field Nitrogen).

*Field Nitrogen* is the mineral nitrogen (ammonia and nitrate) found in the soil when the samples were taken.

The carbon dioxide, ammonia and nitrate produced during incubation is a measure of the amount of organic matter broken down or oxidised by soil micro-organisms during the incubation period.

Mr. LINTNER explained that these experiments were the outcome of long discussions in Pretoria. It was decided to do something a little different to solve some of the soil problems in Natal. All were very enthusiastic but the experiments were put down at a very difficult time—in fact, we were on the verge of war. When war did break out soon after, everything seemed lost; but the Division of Chemical Services immediately offered their help and co-operation, and although subsequently various officers who took over were in their turn called away on active service, there remained an unbroken chain of co-operation right up to the completion of the experiment and the presentation of the paper. The author said that the paper was thus the result of the closest co-operation he had ever found in agriculture in this country.

Mr. DODDS said he welcomed these experiments which were so admirably designed and carried out all the more because they proved a rather extraordinary confirmation of some experiments at the Experiment Station. There were, however, some rather unexpected results, such as, for example, the lack of response to nitrogen in the sandy soils at Reunion, and the lack of response to all fertilizers at Umfolozi. It was found at the Experiment Station that some of the later ratoons at Umfolozi flats gave a distinct response to nitrogen. Dr. Orchard recommended that interactions in variety-fertilizer experiments should be studied more than had been the case up to the present. The few results we had were rather conflicting.

Mr. Dodds wanted to know how long the lands had been under sugarcane before these experiments were planted, and also whether lack of rainfall was a serious factor in causing the falling-off in ratoon crops in the Reunion experiment.

Mr. LINTNER, in reply, said that U.L.O.A. had been cultivated since 1932; Illovo A and B experiments had been fifteen years under cane; Mr. Kramer's fields had been under cane cultivation for twenty-eight years, and Mr. Hammars' for twenty-five years.

It was unfortunately not possible to collect rainfall data, but after the first harvesting at Reunion experiments, practically all the plots were completely under water.