

## A PINEAPPLE FERTILIZER EXPERIMENT.

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Full credit should be given our former plant breeder, Mr. H. B. Cowgill, for the fertilizer trial about to be reported on. The first crop was beginning to be harvested when Mr. Cowgill resigned. After his departure, the task of completing the harvest has devolved upon us and the making of a preliminary report based on the notes so obtained and on such data as were found available in the files of the Division of Agronomy and Horticulture.

The field selected for this experiment occupies an area of 0.67 acre and is situated on the slope of a hill facing northeast, and about 8 meters higher than the surrounding valley land. The approximate altitude of this level land being 80 feet above the level of the sea, the altitude of the field above that level can be taken to be about 106 feet. The angle of inclination of the slope is about 13.76 and the grade 22 per cent per meter.

### SOIL.

Conditions of drainage, although not uniform, are fairly good. The soil is a stiff clay derived from the decomposition of the layer of shale upon which it rests. At the northwestern corner of the field the shale fragments can be seen at the surface mixed with the top soil. Analyses of this soil will be available for report of the 1919 crop. For the present an analysis<sup>1</sup> is given below of the soil and subsoil of a hill close to it, and of the same formation and physical characteristics.

	Sample No. 24. (Soil)	Sample No. 25. (Subsoil)
Insoluble residue-----	55.89	53.30
Volatile matter-----	14.48	11.60
Fe <sub>2</sub> O <sub>3</sub> -----	11.40	12.88
Al <sub>2</sub> O <sub>3</sub> -----	17.40	21.24
CaO -----	0.17	0.17
MgO -----	0.56	0.65
K <sub>2</sub> O -----	0.22	0.27
P <sub>2</sub> O <sub>5</sub> -----	0.10	.07
Total nitrogen-----	0.30	0.14
H <sub>2</sub> O (air dry)-----	5.76	5.70

<sup>1</sup>Thanks are due the Director for his assistance in preparing the manuscript.

<sup>2</sup>These analyses were found on file in the records of the Division of Chemistry of the Insular Experiment Station, Río Piedras, P. R.

# Topographical Map —x— of the —x— Pineapple Experimental field

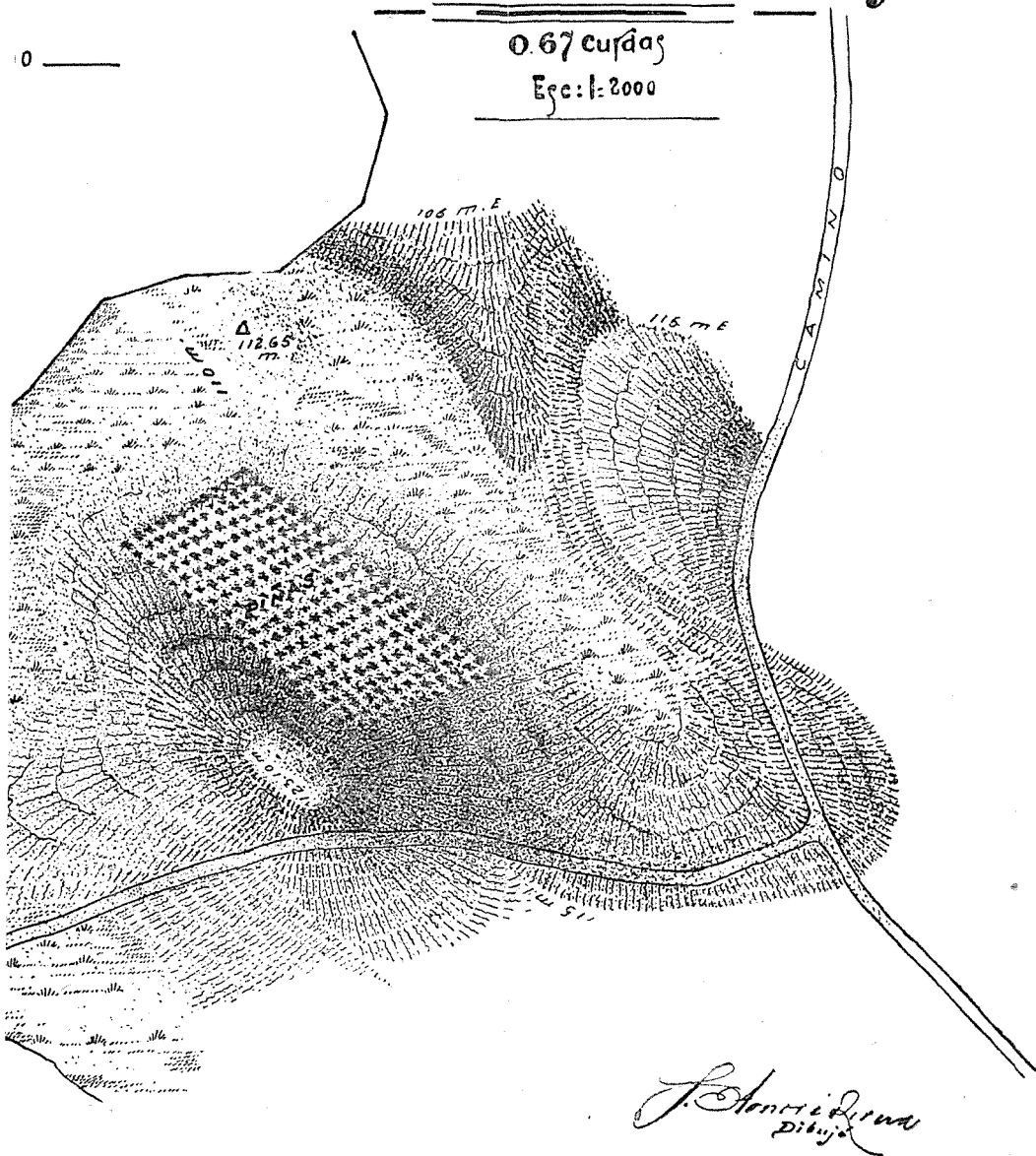


FIG. 1.—A Pineapple Fertilizer Experiment.

## PLAN OF EXPERIMENTAL PLOT.

The plan of the experiment is clearly shown in Fig. 2. The field was equally subdivided (see Fig. 2) into (1) an upper lot to be fertilized with a complete fertilizer prepared from dried blood, bone meal and sulphate of potash, and (2) a lower lot to be fertilized with a complete fertilizer prepared from ammonium sulphate, acid phosphate and sulphate of potash. Of the first 36 plots, those which received the same treatment were:

Plots 1, 7, 13, 19, 25, 31—which were not fertilized.

Plots 2, 8, 14, 20, 26, 32—which received a full dose of each ingredient.

Plots 3, 9, 15, 21, 27, 33—whose dose of potash was reduced by two thirds, as compared with Plots 2, etc.

Plots 4, 10, 16, 22, 28, 34—which were not fertilized.

Plots 5, 11, 17, 23, 29, 35—Whose dose of phosphate acid was reduced by two thirds, as compared with Plot 2, etc.

Plots 6, 12, 18, 24, 30, 36—whose dose of ammonium was reduced by two thirds, as compared with Plots 2, etc.

## ADDITIONAL PLOTS 37-41.

The phosphoric acid used in all the plots planned heretofore was to be derived from acid phosphate. It must have seemed desirable to try the effect of the same application of phosphoric acid derived from double super-phosphate. The latter would not carry any calcium sulphate along with it, as in the case of the acid phosphate. Accordingly, the field was further planned to include another plot, plot No. 39, identical with Nos. 2, 8, 14, 20, 26 and 32, except for the use of double super-phosphate instead of acid phosphate. Plot 39 duplicated 2, 8, 14, 20, 26 and 32 except that in the lower half dried blood was used instead of ammonium sulphate. The plan of the upper half of plots 2, 8, 14, 20, 26 and 31 was again repeated in an additional plot, plot 40. The latter differed from them, however, in that it was made 120 feet long, so that it occupied the upper as well as the lower portion of the field. The principal function of this plot 40 was a comparison of the relative efficiency of applying the fertilizer directly to the soil or in the axils of the leaves. It would also act as a check on the application of organic nitrogen and phosphorous on the upper portion of the slope by having an identical plot extending also into the lower slope. Finally the broader check plot was provided in plot No. 41.<sup>1</sup>

<sup>1</sup> NOTE.—Although plot 41 is supposed to be a check plot, a note has been found in the records of the Division of Agronomy to the effect that the plot had been fertilized with dried blood.

LOWER PLOT—INORGANIC NITROGEN AND PHOSPHORUS		UPPER PLOTS—ORGANIC NITROGEN AND PHOSPHORUS	
60 ft. 120 plants.		60 ft. 120 plants.	
1	UNFERTILIZED	UNFERTILIZED	UNFERTILIZED
2	36¾ lbs. { 12 lbs. Ammonium sulphate 18¾ lbs. Acid sulphate 6 lbs. Potassium sulphate	{ (Full dose) 47.9 lbs.	{ 13.9 lbs. Dried blood 28.05 lbs. Bone meal 6 lbs. Potassium sulphate
3	32 lbs. { 12 lbs. Ammonium sulphate 18¾ lbs. Acid phosphate 2 lbs. Potassium sulphate	{ (% less K <sub>2</sub> O) 43.9 lbs.	{ 13.9 lbs. Dried blood 28.05 lbs. Bone meal 2.00 lbs. Potassium sulphate
4	UNFERTILIZED	UNFERTILIZED	UNFERTILIZED
5	24¼ lbs. { 12 lbs. Ammonium sulphate 6¼ lbs. Acid phosphate 6 lbs. Potassium sulphate	{ (% less P <sub>2</sub> O <sub>5</sub> ) 29¼ lbs.	{ 13.9 lbs. Dried blood 9.35 lbs. Bone meal 6 lbs. Potassium sulphate
6	28¾ lbs. { 4 lbs. Ammonium sulphate 18¾ lbs. Acid phosphate 6 lbs. Potassium phosphate	{ (% less N) 38.6 lbs.	{ 4.64 lbs. Dried blood 28.05 lbs. Bone meal 6 lbs. Potassium sulphate
(These first 6 plots were repeated 5 additional times so that there resulted 36 plots, every consecutive 6 plots of which were treated identically with the first 6 shown in this plant.)			
37	UNFERTILIZED	UNFERTILIZED	UNFERTILIZED
38	25½ lbs. { 12 lbs. Ammonium sulphate 7½ lbs. Double superphosphate 6 lbs. Potassium sulphate	{ (Full dose) 27.4 lbs.	{ 13.9 lbs. Dried blood 7½ lbs. Double superphosphate 6 lbs. Potassium sulphate
39	38.6 lbs. { 13.9 lbs. Dried blood 18¾ lbs. Acid phosphate 6 lbs. Potassium sulphate	{ (Full dose) 49.9 lbs.	{ 13.9 lbs. Dried blood 28.05 lbs. Bone meal 6 lbs. Potassium sulphate
40	47.9 lbs. { 13.9 lbs. Dried blood 28.05 lbs. bone meal 6 lbs. Potassium sulphate	{ (Full dose) 47.9 lbs.	{ 13.9 lbs. Dried blood 28.05 lbs. Bone meal 6 lbs. Potassium sulphate
41	UNFERTILIZED	UNFERTILIZED	UNFERTILIZED

60 feet

60 feet

FIG. 2.—Plan of the Experimental Plots.



## PLANTING.

The slips were set in the field in 1917, in two-row beds, 5 feet apart. The plants were set 1 foot apart in the rows. Each plot contained 240 plants in two rows of 120 plants each. This allowed 60 plants to the row for the upper half of the plot and 60 for the lower half.

## APPLICATION OF FERTILIZER.

Application of fertilizers were made June 8, 1917; September 1, 1917; and January 22-24, 1918. In the case of plot 40, the fertilizer was applied to the soil in the lower half, and in the axils of the leaves in the upper half.

## EFFECT OF TREATMENT.

Notes taken by Mr. H. B. Cowgill, April 3, 1918, show that on this date—

“Chemical Plots No. 2 and its duplicates, having received a full dose of fertilizer, appear, in general, better than the rest.

“Chemical Plots No. 5 and its duplicates, having received two-thirds less phosphoric acid, appear almost as good as Plots No. 2 and duplicates.

“Chemical Plots No. 3, having received two-thirds less potash, appears third best.

“Chemical Plots No. 6 and duplicates, having received two-thirds less nitrogen, appear fourth best. They are poor, but are better than the unfertilized Plots Nos. 1 and 4.

“There appears to have been, at this stage of development, no uniform difference between the plots in the mineral fertilizer series and the corresponding plots in the organic fertilizer series.

“Nos. 38 and 39, in the lower series, appeared about equal.

“No. 39, upper series, appears to be the best of all.

“No. 40, upper and lower series, poor and both about the same.”

## THE HARVEST.

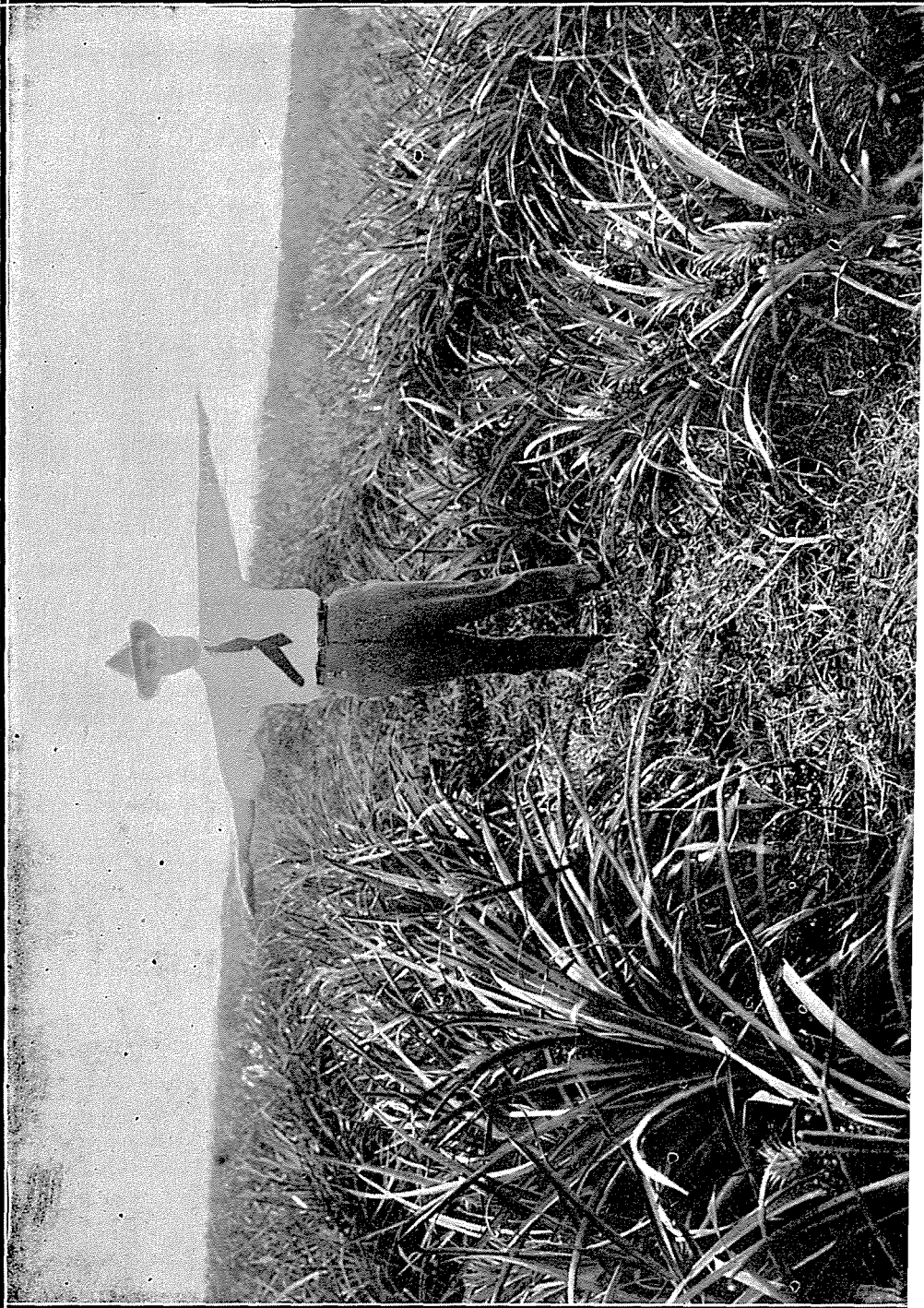
The picking and grading of pineapples extended from June 19 to October 8. A good number of pineapples were produced after October 8. These have not been included in this report. The number of fruits harvested per plot and their individual sizes will be found in the adjoining tables.

## Pineapple Fertilizer Experiment.

TABLE I.

<i>Lower Series</i>			<i>Upper Series</i>	
Plots	Average size of fruits	Total number fruits harvested	Average size of fruits	Total number fruits harvested
1.....	40.85	20	43.02	47
2.....	32.19	51	32.73	57
3.....	33.66	54	35.48	58
4.....	38.07	52	37.75	82
5.....	32.22	45	29.66	53
6.....	34.37	37	37.31	58
7.....	42.48	39	38.89	58
8.....	33.55	59	34.87	64
9.....	28.82	48	34.94	76
10.....	44.21	46	37.85	71
11.....	31.52	75	31.70	81
12.....	30.74	57	36.16	71
13.....	45.05	53	40.42	56
14.....	30.15	78	42.10	56
15.....	31.52	55	35.66	84
16.....	36.30	60	47.29	51
17.....	36.32	74	39.52	75
18.....	34.22	54	38.46	56
19.....	39.94	38	41.80	31
20.....	33.05	61	40.40	60
21.....	36.85	40	39.29	51
22.....	42.75	14	41.18	37
23.....	30.36	51	32.45	54
24.....	38.19	21	37.53	47
25.....	44.40	10	27.02	29
26.....	31.57	40	36.00	72
27.....	32.57	28	38.82	34
28.....	47.40	10	43.20	10
29.....	30.87	55	33.60	50
30.....	39.37	16	39.20	15
31.....	44.50	12	44.30	13
32.....	46.12	38	37.93	29
33.....	37.44	34	38.59	21
34.....	45.47	19	43.38	13
35.....	34.00	49	35.45	44
36.....	39.39	33	40.71	14
37.....	46.68	23	42.00	14
38.....	33.82	69	31.78	37
39.....	29.39	49	36.80	45
40.....	37.30	46	37.50	16
41.....	46.21	37	46.04	46

In order to bring out more comprehensively the effect of each treatment, the following Table II has been prepared by condensing the data given in Table I:



Pineapple Fertilizer Experiment.

TABLE II.

UPPER SERIES.

Plots	Treatment	Total No. of fruits harvested	Average No. of fruits harvested	Average size of fruits
(1) 1, 7, 13, 19, 25, 31...	Not fertilized.....	234	39.0	39.24
(2) 2, 8, 14, 20, 26, 32...	Full dose.....	338	56.3	37.33
(3) 3, 9, 15, 21, 27, 33...	$\frac{3}{4}$ less P <sub>2</sub> O <sub>5</sub> .....	324	54.0	37.13
(4) 4, 10, 16, 22, 28, 34...	Not fertilized.....	264	44.0	41.77
(5) 5, 11, 17, 23, 29, 35...	$\frac{3}{4}$ less P <sub>2</sub> O <sub>5</sub> .....	357	59.5	33.73
(6) 6, 12, 18, 24, 30, 36...	$\frac{3}{4}$ less N.....	261	43.5	38.22
(Organic) Series average.....		296.33	49.38	37.9

LOWER SERIES.

(1) 1, 7, 13, 19, 25, 31...	Not fertilized.....	172	28.6	42.87
(2) 2, 8, 14, 20, 26, 32...	Full dose.....	325	54.5	34.43
(3) 3, 9, 15, 21, 27, 33...	$\frac{3}{4}$ less K <sub>2</sub> O.....	259	43.16	33.31
(4) 4, 10, 16, 22, 28, 34...	Not fertilized.....	201	33.5	42.38
(5) 5, 11, 17, 23, 29, 35...	$\frac{3}{4}$ less P <sub>2</sub> O <sub>5</sub> .....	349	58.16	32.54
(6) 6, 12, 18, 24, 30, 36...	$\frac{3}{4}$ less N.....	218	36.33	36.04
(Inorganic) Series average.....		254.33	42.37	36.9

The results obtained would seem to show that nitrogen is the element which most influences production; then, potash. The larger applications of acid phosphate may be interpreted as having been prejudicial. The data are brought together below:

NITROGEN.

	Total No. of fruits (Average)	Average size (No. fruits per box)
<i>Upper series</i>		
Full dose of N.....	338	37.33
$\frac{3}{4}$ less of N.....	261	38.22
Difference.....	77	-0.89
<i>Lower Series</i>		
Full dose of N.....	327	34.43
$\frac{3}{4}$ less of N.....	218	36.04
Difference.....	109	-1.61

POTASH.

<i>Upper series</i>		
Full dose of K <sub>2</sub> O.....	338	37.33
$\frac{3}{4}$ less of K <sub>2</sub> O.....	324	37.13
Difference.....	14	+0.20
<i>Lower series</i>		
Full dose of K <sub>2</sub> O.....	327	34.43
$\frac{3}{4}$ less of K <sub>2</sub> O.....	259	33.31
Difference.....	82	+1.12

PHOSPHORIC ACID.

<i>Upper series</i>		
Full dose of P <sub>2</sub> O <sub>5</sub> .....	338	37.33
$\frac{3}{4}$ less of P <sub>2</sub> O <sub>5</sub> .....	357	33.73
Difference.....	-19	+3.60
<i>Lower series</i>		
Full dose of P <sub>2</sub> O <sub>5</sub> .....	327	34.43
$\frac{3}{4}$ less of P <sub>2</sub> O <sub>5</sub> .....	349	32.54
Difference.....	-22	+1.89



## CONCLUSIONS.

It would be premature to draw general conclusions based on the results obtained with one crop. However, the benefit derived from the application of fertilizers is illustrated strikingly by the appearance of the unfertilized plots in the field as compared with the fertilized ones as well as by the number and size of the fruits harvested. (See Fig. 3.) The average total number of fruits produced by the upper plots which received fertilizer in any way was 325 of an average size of 35.37 per box as compared with 249 of an average size of 40.5 per box in the unfertilized ones. The corresponding figures for the lower plots were 288.25 of an average size of 34.13 per box for the fertilized as compared with 186.5 of an average size of 42.63 per box for the unfertilized. In other words, the treatment increased the number of fruits by over 30 per cent and the size of fruits by over 12 per cent for the upper (organic) plots and over 54 per cent and 19 per cent, respectively, for the lower (inorganic) plots.

The results obtained might also indicate that the beneficial effect of the organic fertilizer has been greater than that of the inorganic fertilizer. However, after leaving out the checks, the differences established below do not warrant that conclusion, especially in view of the fact that the difference in number and size of the fruits in the check plots of the upper as compared with the lower suggests a difference in soil conditions.

	Total No. of fruits	
Average of plots fertilized with organic N & P <sub>2</sub> O <sub>5</sub> .....	320.	36.60
Average of plots fertilized with inorganic N & P <sub>2</sub> O <sub>5</sub> .....	288.75	34.08
Difference.....	31.75	+2.52

In Table V, given below, the results obtained in plots 39-40<sup>1</sup> are compared with the average figures from plots 2, 8, 14, 20, 26 and 32 and check plot 37.

<sup>1</sup> Plot 41 is omitted, since, as remarked above, it was fertilized presumably by mistake.

## Pineapple Fertilizer Experiment.

TABLE V.

## UPPER SERIES.

Plots	Treatment	Average No. of fruits	Average size of fruits
2, 8, 14, 20, 26, 32.	Full dose (bone meal).....	56.33	39.24
37.....	Not fertilized.....	37	31.78
38.....	Full dose (doble superphosphate).....	45	36.80
39.....	Full dose.....	16	37.50
40.....	Full dose (applied to plant).....	14	42.00

## LOWER SERIES.

2, 8, 14, 20, 26, 32.	Full dose (acid phosphate).....	56.3	36.24
37.....	Not fertilized.....	69	33.82
38.....	Full dose (double superphosphate).....	49	29.39
39.....	Full dose (dried blood).....	46	37.30
40.....	Full dose (applied to soil).....	23	46.68

Since the figures given in Table III have been obtained from single plots, comments on them are withheld until further data are available.