THE RESPONSE OF SUGARCANE TO FERTILIZERS

I. THE ARECIBO CYCLE, 1944–1950

George Samuels and Pablo Landrau, Jr.[1]

INTRODUCTION

PURPOSE

The annual import of fertilizers and fertilizer material into Puerto Rico amounts to over 100,000 tons[2], of which over 70 percent[3] is used for the fertilizing of sugarcane. The fertilizer imports rose from 43,260 tons in 1922–23 to 191,714 in 1949–50. Over four times as much fertilizer material is being applied to sugarcane fields today as 30 years ago. This increased use of fertilizer for sugarcane clearly indicates the importance placed by the growers on fertilizing this crop.

The increased use of sugarcane fertilizers has not been accompanied by as great an increase in knowledge of how to use it. Although advances have been made in our knowledge about fertilizing sugarcane, they have been in rather general terms. Information is lacking on the fertilizer elements and the quantities needed of each for specific sugarcane varieties and soils. It was the object of the Agronomy Department of the Agricultural Experiment Station of the University of Puerto Rico to gain more precise information on the fertilizer needs of sugarcane.

The experiments undertaken here were designed to test various levels of nitrogen, phosphorus, and potassium on leading cane varieties. The sites selected were on the important sugarcane soils of the Island. The experiments were to be continued not merely for a plant-cane and a ratoon crop, as in previous work, but for a long period of time covering several cycles of plant cane and many ratoons, the ultimate purpose being to obtain a complete picture of the influence of the fertilizers on sugarcane, the soil, and the variety over a long period under the controlled conditions of a field experiment.

[1] Plant Physiologist and Assistant Agronomist, respectively, of the Agricultural Experiment Station of the University of Puerto Rico, Río Piedras, P. R. The authors wish to express their appreciation to the following for their fine cooperation in the field and the laboratory: O. Reyes, R. Irizarry, S. Gaztambide, F. Aróstebui, P. Richardson, F. Rochet, C. Rivera, J. A. Bonnet, A. Riera, F. J. Ascorbe, G. N. Calcaño, and Hipólito Monserrate. They also wish to thank the Land Authority of Puerto Rico for its fine cooperation, and B. G. Capó, Assistant Director for Research of the Agricultural Experiment Station of the University of Puerto Rico, for his guiding effort in this work.

[2] Mean of period 1921–1950 compiled from data taken from (4).[4]

[3] Mean of period 1942–1949 compiled from data taken from (7).

[4] Numerals in parentheses refer to Literature Cited, pp. 228–29.

This paper reports the first cycle of a plant cane and four ratoons of the Arecibo experiment on Coloso silty clay.

PROCEDURES

A sugarcane fertilizer-variety experiment was begun on September 18, 1944, on the San Francisco farm of the Land Authority of Puerto Rico at Arecibo. The experiment consisted of growing four sugarcane varieties (P.O.J. 2878, P.R. 903, M. 275, and M. 317) at seven different fertilizer levels of nitrogen, phosphorus, and potassium, on a Coloso silty clay. The harvesting dates for the plant-cane and ratoon crops and the age of the cane at harvest are given in table 1.

TABLE 1.—*Harvesting dates for 4 sugarcane varieties planted September 18 to 20, 1944, and age of the cane when harvested*

Crop	Harvesting date	Age of cane
		Months
Plant cane	February 25–March 4, 1946	17
First ratoon	April 6–8, 1947	13
Second ratoon	April 6–8, 1948	12
Third ratoon	April 18–23, 1949	13
Fourth ratoon	May 10-13, 1950	12

TABLE 2.—*Fertilizer treatments used (rates of application per acre) for 4 sugarcane varieties planted September 18 to 20, 1944*

Treatment No.	Fertilizer applied per acre		
	N	P_2O_5	K_2O
	Pounds	*Pounds*	*Pounds*
1	0	300	300
2	125	300	300
3	250	0	300
4	250	150	300
5	250	300	0
6	250	300	150
7	250	300	300

The design of the experiment was a split-plot one in which varieties were considered as the whole-plot effect and the various levels of the fertilizer were regarded as the sub-or split-plot effect. The plots were 30 feet long, 18 feet wide, or 540 square feet. In other words, each plot of the four varieties tested was subdivided into 7 parts on which various levels of fertilizer were used as shown in table 2. There were four cane furrows to each plot. The actual field design of the experiment is shown in figure 1.

241 C-5	242 B-7	243 D-4	244 A-1
229 C-6	230 B-3	231 D-1	232 A-4
217 C-4	218 B-2	219 D-5	220 A-7
205 C-7	206 B-1	207 D-7	208 A-3
193 C-3	194 B-5	195 D-6	196 A-2
181 C-1	182 B-4	183 D-2	184 A-6
169 C-2	170 B-6	171 D-3	172 A-5

Block 7

245 D-6	246 C-3	247 A-7	248 B-5
233 D-5	234 C-4	235 A-6	236 B-2
221 D-4	222 C-6	223 A-2	224 B-3
209 D-2	210 C-1	211 A-4	212 B-1
197 D-7	198 C-5	199 A-1	200 B-4
185 D-3	186 C-7	187 A-5	188 B-6
173 D-1	174 C-2	175 A-3	176 B-7

Block 8

249 D-3	250 A-1	251 C-2	252 B-5
237 D-1	238 A-4	239 C-3	240 B-2
225 D-7	226 A-5	227 C-4	228 B-1
213 D-5	214 A-7	215 C-5	216 B-6
201 D-4	202 A-2	203 C-6	204 B-7
189 D-2	190 A-6	191 C-1	192 B-3
177 D-6	178 A-3	179 C-7	180 B-4

Block 9

157 D-3	158 C-4	159 A-7	160 B-6
145 D-7	146 C-6	147 A-1	148 B-4
133 D-6	134 C-3	135 A-4	136 B-7
121 D-2	122 C-7	123 A-5	124 B-1
109 D-5	110 C-2	111 A-6	112 B-5
97 D-1	98 C-5	99 A-3	100 B-2
85 D-4	86 C-1	87 A-2	88 B-3

Block 4

161 C-5	162 A-3	163 B-2	164 D-6
149 C-4	150 A-6	151 B-3	152 D-2
137 C-1	138 A-4	139 B-7	140 D-3
125 C-2	126 A-7	127 B-5	128 D-4
113 C-3	114 A-2	115 B-1	116 D-7
101 C-6	102 A-1	103 B-4	104 D-5
89 C-7	90 A-5	91 B-6	92 D-1

Block 5

165 C-1	166 D-5	167 B-2	168 A-3
153 C-4	154 D-6	155 B-5	156 A-7
141 C-2	142 D-1	143 B-6	144 A-4
129 C-6	130 D-7	131 B-3	132 A-1
117 C-5	118 D-3	119 B-4	120 A-2
105 C-3	106 D-2	107 B-7	108 A-6
93 C-7	94 D-4	95 B-1	96 A-5

Block 6

73 C-6	74 A-3	75 B-7	76 D-4
61 C-7	62 A-1	63 B-2	64 D-1
49 C-2	50 A-6	51 B-1	52 D-3
37 C-1	38 A-5	39 B-4	40 D-2
25 C-4	26 A-2	27 B-6	28 D-7
13 C-3	14 A-4	15 B-5	16 D-6
1 C-5	2 A-7	3 B-3	4 D-5

Block 1

77 B-1	78 C-2	79 D-4	80 A-5
65 B-5	66 C-6	67 D-7	68 A-3
53 B-7	54 C-4	55 D-2	56 A-1
41 B-3	42 C-7	43 D-5	44 A-4
29 B-2	30 C-5	31 D-6	32 A-2
17 B-4	18 C-3	19 D-1	20 A-6
5 B-6	6 C-1	7 D-3	8 A-7

Block 2

81 D-3	82 B-6	83 A-7	84 C-2
69 D-4	70 B-2	71 A-1	72 C-3
57 D-6	58 B-5	59 A-4	60 C-7
45 D-7	46 B-3	47 A-2	48 C-1
33 D-1	34 B-7	35 A-5	36 C-6
21 D-5	22 B-4	23 A-3	24 C-4
9 D-2	10 B-1	11 A-6	12 C-5

Block 3

FIG. 1.—Field design of the experiment.

The analysis of variance was calculated as described by Cochran and Cox (3). The crop was planted September 18–20, 1944, 32 seed pieces to the furrow or 10,325 to the acre.

The fertilizer for each treatment was compounded from ammonium sulfate (20-percent N), superphosphate (20-percent P_2O_5), and potassium chloride (60-percent K_2O). The mixed fertilizer for each plot was applied by hand in the row under the seed piece before planting and at the base of the stools for the ratoons. All fertilizer was applied at once for each crop, and as soon after cutting the ratoon as conditions would permit.

The cane was cut as in commercial practice. The cane from each plot was weighed separately in the field using a portable crane and weighing baskets. Ten whole stalks of cane minus the tops were taken at random from each plot at the time of cutting. These canes were tagged as to origin and brought to the hydraulic mill at the Agricultural Experiment Station at Río Piedras for the determination of the sucrose content. All canes sampled were milled not later than 24 hours after cutting.

Beginning with the second ratoon, leaf samples to be used for foliar diagnosis were taken from the cane in each plot at a cane age of 3 months. The leaves selected were the four nearest the last emerged unopened leaf. They were obtained from 12 sugarcane shoots, 3 shoots being selected at random from each row of the four rows of the cane plot. Thus, 48 elongating leaf blades were cut at the collar joint of cane from each plot.

These leaf samples were then taken to the laboratory where they were cut with a knife-board paper trimmer, so that a 1-inch section was obtained from the basal, middle, and terminal portion of each. This gave 144 approximately 1-inch-square leaf sections per plot for analysis. The cut samples were oven-dried at 70°C, ground to 60-mesh, digested with acid, and analyzed for nitrogen, phosphorus, and potassium by the Soils Department (1).

The Area

TOPOGRAPHY

The Arecibo area is located on the northwestern coast of Puerto Rico. The experimental area is located at the mouth of a large, level valley through which the Río Grande de Arecibo flows. The valley, which is about 15 feet above sea level, is surrounded by high limestone hills. The site of the experiment is 8 kilometer from the city of Arecibo on the road to Utuado. The level land of the valley is devoted almost 100 percent to the growing of sugarcane. The cane land is mainly owned and managed by the Land Authority of Puerto Rico. The sugar centrals Cambalache and Los Caños are located in this fertile valley.

RAINFALL

The mean annual rainfall of this area, as recorded for a 26-year period, was 60.56 inches (5). The rainfall for the period 1944 to 1950, in which the experiment was conducted, is given in table 3. The mean for this period was 53.68 inches annually, 6.88 inches below the mean of the 26-year period for which rainfall records were available. No severe deficiencies nor excesses of rainfall which might be considered as a limiting factor in the experiment were encountered in the 1944 to 1950 period. The monthly rainfall records show a rather even distribution throughout the year.

SUGARCANE RESPONSE TO DIFFERENT FERTILIZER LEVELS

HUNDREDWEIGHTS OF 96° AVAILABLE SUGAR PER ACRE

Nitrogen

The use of nitrogen produced yield increases for every crop (see table 4). The use of 125 pounds of nitrogen per acre gave a highly significant

TABLE 3.—*Record of rainfall for Arecibo during period 1944–1950*[1]

Year	Inches of rain per month												Total for year
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1944	2.70	1.02	1.09	1.45	8.85	6.82	4.28	4.28	5.31	10.16	4.79	5.32	56.70
1945	1.68	3.15	1.65	2.99	11.09	3.49	4.06	4.42	5.56	6.96	6.14	.77	51.96
1946	4.26	1.02	3.32	5.76	4.45	6.40	1.38	3.63	3.07	4.94	3.23	9.33	50.79
1947	3.28	3.35	.48	2.30	6.41	3.24	0	6.26	3.95	8.29	2.52	7.58	46.64
1948	3.48	4.15	1.17	3.09	10.28	2.54	2.45	5.06	2.70	3.58	5.74	2.72	46.96
1949	5.63	2.40	7.65	0	5.09	2.37	5.07	4.23	6.44	6.57	6.58	4.35	56.38
1950	9.00	13.49	2.79	5.36	3.31	.56	3.29	6.46	3.13	6.36	9.60	2.96	66.31
Mean......	4.29	4.08	2.59	2.99	7.07	3.63	2.93	4.91	4.31	6.69	5.51	4.72	53.68
Mean of 26 years[2]	5.44	4.07	4.05	4.50	5.50	3.32	5.01	4.52	4.83	4.73	8.52	6.07	60.56

[1] Prepared from the Climatological Data, West Indies and Caribbean, U. S. Department of Commerce, Weather Bureau, 1944 to 1950.

[2] Data derived from table 3, page 48 (5).

increase in sugar per acre; this amounted to 69 hundredweights of sugar for the plant cane and averaged 34 hundredweights for the ratoons.

The use of an additional 125 pounds of nitrogen per acre did not give as great an increase in yield as did the first 125 pounds. For the plant cane, 250 pounds of nitrogen per acre gave 29 hundredweights more sugar per acre than 125 pounds; for the ratoons the average increase was only 6 hundredweights. In fact, the response to 250 pounds of nitrogen over 125 pounds decreased with the number of ratoons. From plant cane to fourth ratoon, the increase or decrease in hundredweights of sugar for 250 pounds of nitrogen over 125 pounds (treatment 7 minus treatment 2) was 29, 15, 6, 2, and −1. It seems evident from this that in this experiment, higher nitrogen applications were not as beneficial for older ratoons as for plant cane or new ratoons.

Phosphorus

There was no general significant response in yields of sugar per acre from the use of phosphorus fertilizer (see table 4). There was a difference of only 3 hundredweights of sugar per acre between no phosphorus and 300 pounds of P_2O_5 per acre (treatment 7 minus treatment 3) for the mean of the five crops. This difference was not significant statistically. This, of course, does not mean that phosphorus was not needed by the sugarcane. Although no responses occurred in the plant cane and first ratoon, there were responses to 150 pounds of P_2O_5 per acre in the second and fourth ratoons. After 3 years the plots that received 150 pounds of P_2O_5 per acre yielded 6 hundredweights of sugar more than those receiving no phosphorus. This difference was significant at the 5-percent level.

TABLE 4.—*Yields of the mean of 4 varieties of sugarcane in hundredweights of available 96° sugar when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre			Mean yields in hundredweights of available 96° sugar per acre					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
1	0	300	300	124	84	83	83	102	95
2	125	300	300	193	122	107	118	139	136
3	250	0	300	226	133	109	116	131	143
4	250	150	300	224	132	115	118	137	145
5	250	300	0	214	126	103	106	117	133
6	250	300	150	216	131	110	113	128	140
7	250	300	300	222	137	113	120	138	146
Mean for all treatments......				203	124	106	111	127	134
Least significant difference needed between treatments of same crop:									
5-percent level...............				10	6	5	5	5	4
1-percent level...............				14	8	6	6	7	5

The minimum P_2O_5 used was 150 pounds per acre. This was probably above a satisfactory minimum level. Consistent high yields have been obtained in long-range fertilizer trials (6) with the use of 20 pounds of P_2O_5 per acre yearly, as compared with 80 pounds. The use of from 40 to 50 pounds of P_2O_5 per acre per year would seem to be well above any deficiency level for sugarcane, except perhaps for soils with extreme phosphorus deficiency. Rates higher than 40 to 50 pounds per acre annually will not produce higher yields and only add to the cost of fertilizing the cane.

Potassium

The Coloso silt loam on which this experiment was performed shows need for potassium. The needs and responses from potassium fertilizers were not as great as for nitrogen, but significant increases in yields were realized when potash was used. The responses obtained were greater as the number of ratoons increased. No significant response was obtained in the plant cane (see table 4). The first ratoon did respond significantly to potassium up to levels of 300 pounds of K_2O per acre. Responses from potash were obtained for the second, third, and fourth ratoons, the response being greater for the fourth ratoon than for the first.

TABLE 5.—*Sucrose percent cane of the mean of 4 varieties of sugarcane when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre of—			Mean yield in sucrose percent cane					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
1	0	300	300	12.41	11.38	10.95	11.77	12.86	11.88
2	125	300	300	12.91	11.56	11.04	11.79	12.87	12.04
3	250	0	300	12.68	11.54	10.62	11.61	12.60	11.81
4	250	150	300	12.58	11.37	10.91	11.57	12.54	11.80
5	250	300	0	12.57	11.08	10.40	11.05	12.09	11.44
6	250	300	150	12.40	11.22	10.61	11.28	12.26	11.56
7	250	300	300	12.65	11.60	10.78	11.67	12.59	11.86
Mean for all treatments....				12.60	11.39	10.76	11.53	12.53	11.77
Least significant difference needed between treatments of same crop:									
5-percent level............				0.35	0.28	0.45	0.28	0.32	0.35
1-percent level............				.47	.37	.60	.37	.42	.46

The mean of the five crops showed an increase of 7 hundredweights of sugar per acre for 150 pounds of K_2O; when 300 pounds of K_2O per acre were used the increase was 13 hundredweights. From the data in table 4, it appears that, in this experiment, higher potassium rates were more beneficial to the ratoons than to the plant canes, the response being greater as the number of ratoons increased.

SUCROSE-PERCENT-CANE CONTENT

Nitrogen

Nitrogen had no significant influence on the sucrose content of the cane (see table 5). The use up to 250 pounds of nitrogen per acre neither increased nor decreased sucrose concentrations significantly; this was true of the plant cane and four ratoons.

Phosphorus

The use of phosphate fertilizers did not change sucrose concentrations appreciably (table 5). There was no response by any of the five crops grown.

Potassium

The omission of potash lowered the sucrose content of the sugarcane. There was no effect on the plant cane, but in the first ratoon a significant increase in sucrose concentration occurred when 300 pounds of K_2O per acre were used. For all the other ratoons except the second, there was a significant increase in sucrose from the use of 300 pounds of K_2O per acre

TABLE 6.—*Yields of the mean of 4 varieties of sugarcane in tons of cane per acre when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre of—			Mean yield in tons of cane per acre					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
1	0	300	300	50.0	36.9	37.9	35.3	39.7	40.0
2	125	300	300	74.7	52.7	48.5	50.0	54.0	56.0
3	250	0	300	89.1	57.6	51.3	50.0	52.0	60.0
4	250	150	300	89.0	58.0	52.7	51.0	54.6	61.1
5	250	300	0	85.1	56.9	49.5	48.0	48.4	57.6
6	250	300	150	87.1	58.4	51.8	50.1	52.2	59.9
7	250	300	300	87.7	59.1	52.4	51.4	54.8	61.1
Mean for all treatments........				80.4	54.2	49.2	48.0	50.8	56.5

over no potash. The use of 150 pounds of K_2O per acre produced no significant increase as compared with the no-potash treatment.

TONS OF CANE PER ACRE

As shown in table 6, the responses in tons of cane per acre were similar to those for hundredweights of sugar per acre shown in table 4. The greatest response was for nitrogen, then potassium, and last phosphorus.

VARIETY RESPONSES IN GENERAL

HUNDREDWEIGHTS OF 96° AVAILABLE SUGAR PER ACRE

The leading variety was P.R. 903, which gave significantly greater yields of sugar per acre than any of the other three varieties (see table 7). P.O.J. 2878 and M. 317 were second in yields, there being no significant yield difference between them. Variety M. 275 gave the lowest yields of sugar per acre. The increase in yields of sugar per acre for the mean of five crops from using P.R. 903 instead of M. 275 was 21 hundredweights, or 17 percent (see table 7).

TABLE 7.—*Mean yields of 4 varieties of sugarcane in hundredweights of available 96° sugar per acre*

Varieties	Mean yields in hundredweights of available 96° sugar per acre					Mean of 5 crops
	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
P.O.J. 2878	181	124	113	118	123	132
P.R. 903	232	136	108	117	137	146
M. 317	207	122	103	111	126	134
M. 275	191	113	99	97	122	125
Mean of all varieties	203	124	106	111	127	134
Least significant difference needed between varieties of same crop:						
5-percent level	12	8	6	8	7	6
1-percent level	17	11	8	11	9	9

TABLE 8.—*Mean sucrose percent cane for 4 varieties of sugarcane*

Variety	Mean yield in sucrose percent cane					Mean of 5 crops
	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
P.O.J. 2878	12.47	11.44	10.98	11.50	12.44	11.77
P.R. 903	12.70	11.54	10.78	11.77	12.73	11.91
M. 275	12.45	11.20	10.67	11.34	12.47	11.63
M. 317	12.78	11.39	10.60	11.53	12.53	11.77
Least significant difference needed between treatments of same crop:						
5-percent level	0.42	0.41	0.26	0.40	0.22	0.23
1-percent level	.57	.56	.35	.56	.31	.31

SUCROSE-PERCENT-CANE CONTENT

There was no appreciable difference in the sucrose content of the four varieties. For the plant cane and first ratoon there were no significant differences (see table 8). In the second ratoon P.O.J. 2878 contained the most sucrose, but P.R. 903 was highest in the third and fourth ratoons. M. 275 was the lowest in sucrose except in the fourth ratoon. For the mean of the five crops, P.R. 903 was significantly higher in sucrose than M. 275 only.

TONS OF CANE PER ACRE

Variety P.R. 903 gave the highest yield in tons of cane per acre with a mean of 60.8 tons. This was followed by M. 317, P.O.J. 2878, and M. 275, in order, the yields all being very similar and below that of P.R. 903 (see table 9). The plant cane P.R. 903 yielded 91.3 tons per acre; this was over 18 tons more cane per acre than P.O.J. 2878. For the mean of the five crops, P.R. 903 yielded 8.4 tons of cane more than M. 317, which had the lowest mean varietal yield.

VARIETY RESPONSES AT DIFFERENT FERTILIZER LEVELS

The response to a given fertilizer element at a given level need not necessarily be the same for different sugarcane varieties. Because of certain differences in vegetative structure one variety may be able to make more use of a given fertilizer element than another. One of the special objectives of this experiment was to note the behavior of different varieties at different fertilizer levels. If varieties do tend to behave differently at various fertility levels, the regular variety trial at one fertility level would seem to be invalid, or at least incomplete. However, if varieties compared in a field trial maintain their same rank at different fertilizer levels, the use of only one fertility level for varietal trials is valid. The results here presented show that varieties do tend to keep their rank when compared at different fertility levels, and that large, complex variety experiments at different fertility levels do not seem to be needed for general work with sugarcane.

TABLE 9.—*Mean yields of 4 varieties of sugarcane in tons of cane per acre*

Varieties	Mean yields in tons of cane per acre					Mean of 5 crops
	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
P.O.J. 2878	72.6	54.2	51.5	51.3	49.4	55.8
P.R. 903	91.3	58.9	50.1	49.7	53.8	60.8
M. 275	83.1	54.5	48.3	49.0	50.5	57.1
M. 317	74.7	49.6	46.7	42.1	48.7	52.4
Mean of all varieties	80.4	54.3	49.2	48.0	50.6	56.5

HUNDREDWEIGHTS OF AVAILABLE 96° SUGAR PER ACRE

Nitrogen

All varieties responded significantly to the use of 125 pounds of nitrogen per acre. P.R. 903 gave the highest yields when 125 and 250 pounds of nitrogen were used per acre. The mean of the five crops shows a significant increase in yield when 250 pounds of nitrogen per acre were used, as compared with 125 pounds (table 10). However, most of the increase was realized in the plant cane and first ratoon. The later ratoons did not show this significant increase. As presented in figure 2, the responses of the varieties to the nitrogen levels were very similar. The relative positions of the varieties were the same for the 0, 125, and 250 pounds of nitrogen per acre. Thus, P.R. 903 outyielded the other three varieties regardless of the fertility level.

Phosphorus

The response to phosphorus was slight, as was indicated before. Certain varieties responded more to phosphate fertilizers than others. P.R. 903 responded significantly to 300 pounds of P_2O_5 in the second ratoon (treatment 7 minus treatment 3) and 150 pounds in the third (treatment 4 minus treatment 3). P.O.J. 2878 and M. 317, however, showed no significant response to phosphorus applications. M. 275 showed a response to 150 pounds of P_2O_5 in the fourth ratoon only (treatment 4 minus treatment 3). However, the relative responses to P_2O_5 by the four varieties at various P_2O_5 levels were approximately the same as shown in figure 2.

Potassium

Variety P.R. 903 had the highest yields under 0, 150, and 300 pounds of K_2O per acre. None of the varieties treated responded significantly to potassium in the plant cane (table 10). P.O.J. 2878 gave significant yield increases with the use of 150 pounds of K_2O (treatment 4 minus treatment 3) for all ratoons except the fourth, where 300 pounds of K_2O were required. All ratoons of P.R. 903 gave significant increases in yields when 150 pounds of K_2O were applied, as compared to no potash, except for the second ratoon where 300 pounds of K_2O were needed. Varieties M. 275 and M. 317 did not respond to 150 pounds of K_2O per acre; 300 pounds per acre were needed for any significant yield increases. It would be more economical, therefore, to use P.R. 903, which needs only 150 pounds of K_2O per acre to obtain yields better than M. 317 with 300 pounds. As shown in figure 2, P.R. 903 gave higher yield responses at all potassium levels. Of the remaining three varieties, none was consistently in the lead at all potassium levels.

SUCROSE-PERCENT-CANE CONTENT

The use of nitrogen fertilizers did not significantly influence the sucrose content of any of the four varieties (table 11). The use of 300 pounds of nitrogen per acre (treatment 7) did not cause any significant decrease in the sucrose content of any of the varieties.

The application of phosphate fertilizers (treatments 3, 4, and 7) did not

TABLE 10.—*Mean yields in hundredweights of available 96° sugar for 4 varieties of sugarcane when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre of—			Mean yields in hundredweights of available 96° sugar per acre					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
P.O.J. 2878									
1	0	300	300	125	84	92	92	110	101
2	125	300	300	178	116	112	125	137	134
3	250	0	300	194	133	119	124	126	139
4	250	150	300	200	134	123	121	131	142
5	250	300	0	188	123	104	112	108	126
6	250	300	150	190	138	121	125	119	139
7	250	300	300	194	136	117	126	131	141
Mean for all treatments......				181	124	113	118	123	132
Significant difference needed between treatments of same crop:									
5-percent level................				21	13	10	9	13	7
1-percent level................				27	17	13	12	18	10
P.R. 903									
1	0	300	300	133	90	82	86	96	98
2	125	300	300	209	137	106	127	150	146
3	250	0	300	273	146	108	119	148	159
4	250	150	300	256	146	117	132	146	159
5	250	300	0	242	137	110	104	124	143
6	250	300	150	256	150	113	125	144	158
7	250	300	300	252	147	121	128	153	160
Mean for all treatments......				232	136	108	117	137	146
Significant difference needed between treatments of same crop:									
5-percent level...............				21	13	10	9	13	7
1-percent level...............				27	17	13	12	18	10
M. 275									
1	0	300	300	118	79	79	74	104	91
2	125	300	300	181	117	102	102	138	128
3	250	0	300	202	122	100	101	118	128
4	250	150	300	207	115	109	104	131	133
5	250	300	0	210	116	95	100	116	127
6	250	300	150	202	115	100	95	119	126
7	250	300	300	216	128	108	106	131	138
Mean for all treatments......				191	113	99	97	122	125

TABLE 10.—*Continued*

Treatment No.	Treatments in pounds per acre of—			Mean yields in hundredweights of available 96° sugar per acre					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
Significant difference needed between treatments of same crop:									
5-percent level				21	13	10	9	13	7
1-percent level				27	17	13	12	18	10
M. 317									
1	0	300	300	118	83	78	81	98	92
2	125	300	300	207	119	107	118	129	136
3	250	0	300	236	130	108	120	133	145
4	250	150	300	230	134	111	117	139	146
5	250	300	0	216	130	102	108	119	135
6	250	300	150	216	122	106	109	129	137
7	250	300	300	226	137	107	121	135	145
Mean for all treatments				207	122	103	111	126	134
Significant difference needed between treatments of same crop:									
5-percent level				21	13	10	9	13	7
1-percent level				27	17	13	12	18	10

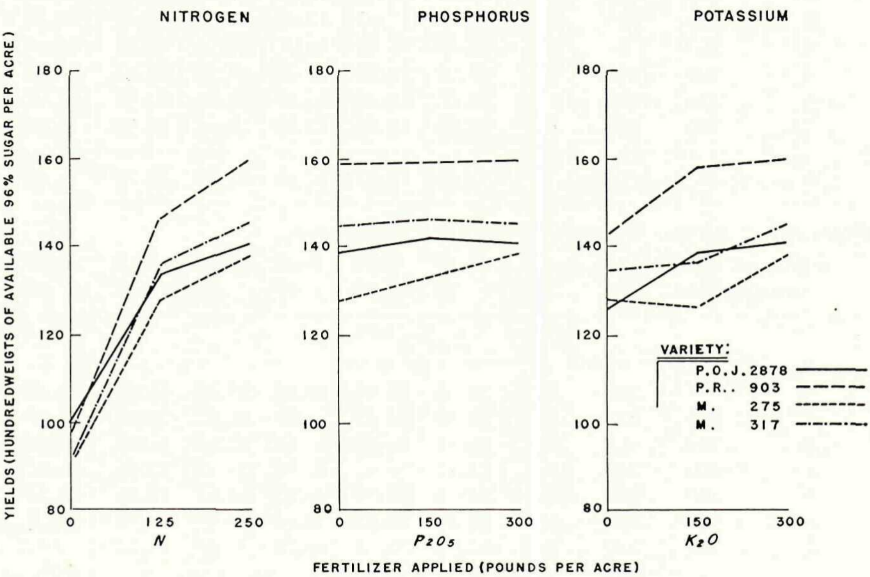

FIG. 2.—Yield response of the 4 sugarcane varieties to nitrogen, phosphorus, and potassium when used as fertilizers.

TABLE 11.—*Mean sucrose-percent-cane content for 4 varieties of sugarcane when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre of—			Mean sucrose-percent-cane content					Mean of 5 crops
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
				P.O.J. 2878					
1	0	300	300	12.63	11.29	11.11	11.78	12.90	11.94
2	125	300	300	12.89	11.27	11.24	11.80	12.82	12.01
3	250	0	300	12.16	11.51	11.05	11.46	12.40	11.71
4	250	150	300	12.60	11.66	11.22	11.32	12.36	11.83
5	250	300	0	12.20	11.21	10.31	10.31	12.07	11.34
6	250	300	150	12.42	11.31	10.91	11.54	12.11	11.66
7	250	300	300	12.42	11.83	11.02	11.67	12.41	11.87
Mean for all treatments......				12.47	11.44	10.98	11.50	12.44	11.77
Significant difference between treatments of same crop:									
5-percent level...............				0.71	0.64	0.90	0.56	0.65	0.70
1-percent level...............				.94	.85	1.19	.74	.86	.92
				P.R. 903					
1	0	300	300	12.37	11.28	10.88	11.88	12.88	11.86
2	125	300	300	12.73	11.78	11.18	12.07	13.19	12.19
3	250	0	300	13.25	11.41	10.30	11.78	12.88	11.92
4	250	150	300	12.98	11.62	10.94	12.04	12.72	12.06
5	250	300	0	12.69	11.26	10.72	11.15	12.05	11.57
6	250	300	150	12.53	11.75	10.59	11.54	12.45	11.77
7	250	300	300	12.36	11.71	10.86	11.94	12.94	11.96
Mean for all treatments......				12.70	11.54	10.78	11.77	12.73	11.91
Significant difference between treatments of same crop:									
5-percent level...............				0.71	0.64	0.90	0.56	0.65	0.70
1-percent level...............				.94	.85	1.19	.74	.86	.92
				M. 275					
1	0	300	300	12.15	11.44	10.80	11.39	12.87	11.73
2	125	300	300	12.80	11.47	10.98	11.51	12.91	11.94
3	250	0	300	12.41	11.56	10.63	11.34	12.29	11.65
4	250	150	300	12.27	10.89	10.79	11.43	12.49	11.57
5	250	300	0	12.70	10.90	10.34	11.31	12.35	11.52
6	250	300	150	11.97	10.85	10.40	10.97	12.17	11.27
7	250	300	300	12.86	11.31	10.76	11.43	12.22	11.72
Mean for all treatments......				12.45	11.20	10.67	11.34	12.47	11.63

TABLE 11.—*Continued*

Treatment No.	Treatments in pounds per acre of—			Mean sucrose-percent-cane content					Mean of 5 crops
	N	P_3O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	
Significant difference between treatments of same crop:									
5-percent level				0.71	0.64	0.90	0.56	0.65	0.70
1-percent level				.94	.85	1.19	.74	.86	.92
				M. 317					
1	0	300	300	12.51	11.50	11.02	12.04	12.78	11.97
2	125	300	300	13.23	11.71	10.77	11.78	12.55	12.01
3	250	0	300	12.71	11.69	10.48	11.88	12.81	11.95
4	250	150	300	12.47	11.32	10.71	11.47	12.59	11.72
5	250	300	0	12.69	10.96	10.21	10.85	11.90	11.32
6	250	300	150	12.71	10.98	10.53	11.06	12.32	11.52
7	250	300	300	12.96	11.53	10.47	11.64	12.79	11.88
Mean for all treatments				12.78	11.39	10.60	11.53	12.53	11.77
Significant difference between treatments of same crop:									
5-percent level				0.71	0.64	0.90	0.56	0.65	0.70
1-percent level				.94	.85	1.19	.74	.86	.92

influence significantly the sucrose content of the varieties tested. The varieties responded with different intensities to the application of potassium. M. 275 did not significantly change in sucrose content. There was a significant increase in the sucrose content of P.O.J. 2878 in the third ratoon only when 300 pounds of K_2O were applied. Beginning with the third ratoon, P.R. 903 and M. 317 significantly increased in sucrose content when 300 pounds of K_2O per acre were used (table 11, treatment 7 minus treatment 5).

TONS OF CANE PER ACRE

Table 12 shows a variety response at different fertilizer levels similar to that observed for hundredweights of sugar per acre.

Relative Response to Fertilizers

REDUCTION IN YIELDS FROM OMISSION OF A FERTILIZER ELEMENT

The major fertilizer elements (nitrogen, phosphorus, and potassium) are necessary for maximum sugarcane yields. The response to these three elements varies, depending on the quantities already present in the soil, their form and availability. In table 13 the relative response to the ferti-

TABLE 12.—*Mean yields in tons of cane per acre for 4 varieties of sugarcane when grown at different fertilizer levels*

Treatment No.	Treatments in pounds per acre of—			Mean yields in tons of cane per acre					
	N	P_2O_5	K_2O	Plant cane	First ratoon	Second ratoon	Third ratoon	Fourth ratoon	Mean of 5 crops
				P.O.J. 2878					
1	0	300	300	49.5	37.5	41.4	39.1	42.6	42.3
2	125	300	300	69.1	51.5	49.9	53.0	53.4	56.0
3	250	0	300	79.8	57.8	53.8	54.1	51.0	59.4
4	250	150	300	79.4	57.5	54.8	53.4	53.0	60.0
5	250	300	0	77.1	54.9	50.4	51.4	45.0	56.0
6	250	300	150	76.5	60.1	55.5	54.2	49.1	59.6
7	250	300	300	78.1	57.5	53.1	54.0	52.8	59.4
Mean for all treatments...				72.6	54.2	51.5	51.3	49.4	56.1
				P.R. 903					
1	0	300	300	54.0	40.0	37.7	36.2	37.3	41.3
2	125	300	300	82.1	58.1	47.4	52.6	56.9	59.9
3	250	0	300	103.0	64.0	52.4	47.1	57.5	66.7
4	250	150	300	98.6	63.0	53.5	54.8	57.4	65.9
5	250	300	0	95.4	61.0	51.3	46.6	51.5	61.8
6	250	300	150	102.2	63.8	53.8	54.2	57.8	67.1
7	250	300	300	101.9	63.0	56.0	53.6	59.1	66.9
Mean for all treatments...				91.3	59.0	50.0	49.7	53.8	61.3
				M. 275					
1	0	300	300	48.6	34.5	36.6	32.5	40.4	39.0
2	125	300	300	70.7	51.0	46.4	44.3	53.5	53.6
3	250	0	300	81.4	53.0	47.0	44.5	48.0	55.0
4	250	150	300	84.4	53.0	51.0	45.5	52.4	57.5
5	250	300	0	82.7	52.2	46.0	44.2	47.0	55.1
6	250	300	150	84.4	53.0	48.1	43.3	49.0	55.9
7	250	300	300	84.0	56.6	50.1	46.4	53.6	59.0
Mean for all treatments...				77.0	50.5	45.1	43.0	48.9	54.0
				M. 317					
1	0	300	300	47.2	36.1	35.4	34.0	38.3	38.4
2	125	300	300	78.2	53.1	50.0	50.1	51.4	56.6
3	250	0	300	93.0	55.6	52.0	51.0	52.0	61.0
4	250	150	300	92.2	59.2	52.0	51.0	55.2	62.3
5	250	300	0	85.1	59.3	50.0	49.8	50.0	59.6
6	250	300	150	85.0	55.6	50.3	48.0	52.3	59.5
7	250	300	300	87.1	59.4	51.1	52.0	53.0	61.0
Mean for all treatments...				81.0	53.6	48.6	48.1	50.3	57.0

TABLE 13.—*The percentage reduction in yield of available 96° sugar per acre by 4 sugarcane varieties attributable to the omission of nitrogen, phosphorus, or potassium*

Variety and crop	Reduction in yield from omission of—		
	Nitrogen	Phosphorus	Potassium
	Percent	*Percent*	*Percent*
P.O.J. 2878:			
Plant cane	36	0	3
First ratoon	38	2	10
Second ratoon	21	2	11
Third ratoon	27	2	11
Fourth ratoon	16	4	18
Mean of 5 crops	28	1	11
P.R. 903:			
Plant cane	47	8	4
First ratoon	39	1	7
Second ratoon	32	11	9
Third ratoon	33	7	19
Fourth ratoon	37	3	19
Mean of 5 crops	38	3	12
M. 275:			
Plant cane	45	6	3
First ratoon	38	5	9
Second ratoon	27	7	12
Third ratoon	30	5	6
Fourth ratoon	21	10	11
Mean of 5 crops	32	7	8
M. 317:			
Plant cane	48	4	4
First ratoon	39	5	5
Second ratoon	27	1	5
Third ratoon	33	1	11
Fourth ratoon	27	1	12
Mean of 5 crops	35	1	7
Mean of four varieties:			
Plant cane	44	2	3
First ratoon	39	3	8
Second ratoon	27	4	9
Third ratoon	31	3	12
Fourth ratoon	26	5	15
Mean of 5 crops	33	3	9

lizer elements is presented in the form of the reduction in yields caused by omission of one of them. The reduction was calculated from the yield at the highest fertilizer levels, as compared with the no-fertilizer level.

As mentioned earlier, the greatest reduction in yield occurred when nitrogen was omitted. It is interesting to note that the reduction in yield decreased with the number of ratoons. The mean yield of the four varieties was reduced 44 percent in plant cane, 39 in first ratoon, and only 26 percent by the fourth ratoon. It appears that the greatest benefit is derived from high nitrogen applications in the plant cane and new ratoons, and less in the older ratoons.

The reduction in yield from the omission of phosphorus was only 3 percent for the whole experiment. The yield of M. 275 was reduced most when phosphorus was omitted.

When potassium was omitted there was a reduction in yield of 9 percent for the whole experiment. For the mean of the four varieties, the reduction for plant cane was 3 percent, which rose to 15 percent for the fourth ratoon. The fourth ratoon indicated more need for potash than did the plant cane.

PERCENTAGE OF MAXIMUM YIELDS

The concept of maximum yields is one closely associated with the work of Mitscherlich. The maximum yield represents the hypothetical yield obtainable with unlimited increases in the fertilizer nutrient. This concept has been both attacked and defended with much zeal. The use of maximum yields is debatable as an exact measure of crop yields; however, as a guide in indicating the relative increases to be obtained from fertilizer increments it has practical value. It is of particular value in indicating how useful heavy fertilizer applications are in increasing yields.

The maximum potential yields of the mean of the five crops for the four varieties were calculated, using the modified formula of Capó (2), and are presented in table 14. Certain entries under phosphorus and potassium were omitted because the yield data could not be applied to the modified equation used.

When no nitrogen was applied the yield of available 96° sugar was only 64 percent of the possible maximum yield for the mean of the four varieties. When 125 pounds of nitrogen per acre were used, the yield was 91 percent of the possible maximum yield for this experiment. From this it appears that the first 125 pounds of nitrogen are of decided value in increasing cane yields. However, the use of an additional 125 pounds of nitrogen gives an increase of only 7 percent, from 91 to 98 percent of the maximum. The decision as to whether an additional 7 percent of cane makes the use of 125 pounds of nitrogen per acre profitable is one for the individual grower to make. However, it is very clear that, under the conditions of the experiment, the use of over 250 pounds of nitrogen per acre would be of no value to the grower.

Yields were 98 percent of maximum when phosphorus was omitted from one fertilizer used. The use of 150 pounds of P_2O_5 gave an increase of 1 percent only, and 300 pounds of P_2O_5 produced maximum yields for the experiment. The use of even 150 pounds of P_2O_5 was unprofitable in this experiment.

TABLE 14.—*The percentage of maximum yields of available 96° sugar per acre obtained for 4 varieties of sugarcane when grown at different fertilizer levels*

Variety	Fertilizer element	Maximum yield in available 96° sugar	Fertilizer applied per acre		
			None	125 lbs. N and 150 lbs. of P_2O_5 and of K_2O	250 lbs. of N and 300 lbs. of P_2O_5 and of K_2O
		Hundredweights	*Percent*	*Percent*	*Percent*
P.O.J. 2878	Nitrogen	143	71	94	99
	Phosphorus	—	—	—	—
	Potassium	141	90	99	100
P.R. 903	Nitrogen	166	59	88	97
	Phosphorus	—	—	—	—
	Potassium	160	89	99	100
M. 275	Nitrogen	142	64	90	97
	Phosphorus	—	—	—	—
	Potassium	—	—	—	—
M. 317	Nitrogen	147	63	92	99
	Phosphorus	—	—	—	—
	Potassium	—	—	—	—
Mean of 4 varieties	Nitrogen	149	64	91	98
	Phosphorus	147	98	99	100
	Potassium	150	90	99	100

Ninety percent of the maximum yield was obtained when potassium was not applied (see table 14). The addition of 150 pounds of K_2O per acre produced 99 percent of the maximum yield. In practice the use of more than 150 pounds of K_2O per acre is neither warranted nor economical.

FOLIAR DIAGNOSIS

THE NUTRIENT CONTENT OF THE SUGARCANE LEAF

Beginning with second ratoon, leaf samples were taken at a cane age of 3 months. The analysis of the leaf samples is given in table 15.

and season. The no-potassium treatment for the mean of three crops resulted in a mean potassium content of the leaf of 1.63 percent; this increased to 1.95 percent with the addition of 300 pounds of K_2O per acre.

CORRECTION FACTORS

The accumulated data for the leaf analyses for 3 years (see table 15) show an appreciable yearly fluctuation. The third-ratoon levels of the no-nitrogen treatments are the highest, with the fourth ratoon having the lowest values. As the same fertilizer and cultural treatments were used for all crops, these fluctuations were for the most part caused climatically. This climatic factor can be divided into temperature, light, and rainfall. The seasonal variations in temperature and light were not recorded for this experiment and corrections could not be made for these.

The influence of rainfall on the variation of the nutrient in the leaf was determined using the rainfall data for the area. In figure 3, *A*, the rainfall for the period from time of cutting of the previous ratoon to the taking of the leaf sample was plotted against the percentage of nitrogen in the leaves. The regression values for the equations of the relationship were significant for the mean of the four varieties and for variety P.O.J. 2878. The equations obtained were:

Mean of 4 varieties	$Y = 0.96 + 0.021\,x$
M. 275	$Y = .95 + .021\,x$
P.O.J. 2878	$Y = .91 + .020\,x$
M. 317	$Y = 1.07 + .017\,x$
P.R. 903	$Y = .94 + .024\,x$

Thus, for every 10 inches of rain falling in the period from harvest to leaf-sampling time, there was a mean increase of 0.21 percent of nitrogen in the leaf sample.

To determine whether rainfall 1 week prior to leaf sampling influenced the leaf nitrogen these factors were plotted graphically (see figure 3, B). One inch of rain during the week prior to sampling increased the leaf nitrogen 0.33 percent.

This correction for rainfall permits the adjustment of the nutrient values of the leaf to the same basis, and allows a more accurate fit of leaf-nutrient values to yields. If we assume a basis of 20 inches of rain for the period from time of planting or cutting to taking the leaf sample, we can adjust the nitrogen values of table 15 to that basis regardless of rainfall variation. The adjusted data are given in table 16. When the data in these tables are compared it is seen that the correction for rainfall has adjusted the values for each year to about the same levels.

INTERPRETATION OF FOLIAR-ANALYSIS DATA

With increasing amounts of the fertilizer elements, the concentration of that fertilizer element in the sugarcane leaf increased (table 15). For nitrogen in almost all cases, the application of 125 and 250 pounds of nitrogen

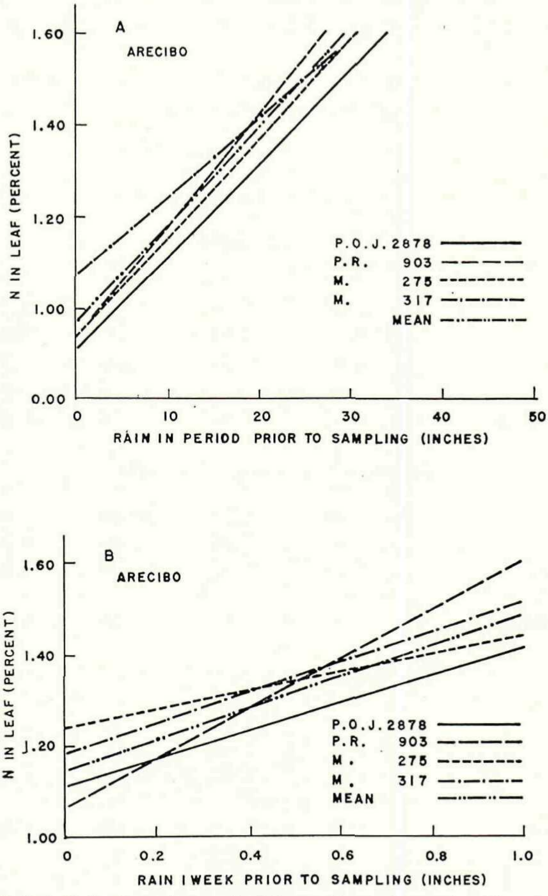

FIG. 3.—A, Rainfall during the period from time of cutting the previous ratoon to the taking of the leaf sample, as compared with percentage nitrogen in the leaf; B, rainfall during the period 1 week prior to taking the leaf sample as compared with percentage nitrogen in the leaf.

fertilizer per acre produced significant yield increases. Phosphorus applications produced no yield increases. Potassium fertilizers gave significant yield increases in some instances only. If we use the criteria of a significant increase in yield caused by a particular fertilizer application as a basis of selection, we can select leaf concentrations corresponding to these significant applications. Nutrient concentrations in the leaf corresponding to fertilizer applications which produced no significant increases in yields may be judged to indicate no response to fertilizers.

Using the corrected data of table 16, we see that, in general, values of approximately 1.40 percent nitrogen in the leaf or below are associated with the addition of no nitrogen, from 1.40 to 1.60 with applications of up to 125 pounds of nitrogen per acre, and from 1.60 to 1.70 percent leaf nitrogen with applications of 250 pounds. Therefore, it may be assumed that cane having leaf-nitrogen (when adjusted for rainfall) values below 1.40 percent would give significant higher yields of cane if fertilizer were applied. If leaf values are between 1.60 and 1.70 percent, it may be assumed that the addition of 125 pounds of nitrogen to the soil would give some

TABLE 16.—*Nitrogen content of dry leaf samples of 4 varieties of sugarcane corrected for rainfall differences*[1]

Crop	Content of leaf samples of—				Mean of 4 varieties
	P.O.J. 2878	P.R. 903	M. 275	M. 317	
No nitrogen[2]					
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Second ratoon	1.27	1.49	1.21	1.42	1.35
Third ratoon	1.31	1.40	1.44	1.35	1.38
Fourth ratoon	1.32	1.33	1.39	1.40	1.36
Mean of 3 crops	1.30	1.41	1.34	1.39	1.36
125 pounds of nitrogen per acre					
Second ratoon	1.42	1.76	1.44	1.60	1.56
Third ratoon	1.55	1.49	1.60	1.55	1.55
Fourth ratoon	1.54	1.58	1.60	1.60	1.58
Mean of 3 crops	1.50	1.61	1.55	1.58	1.56
250 pounds of nitrogen per acre					
Second ratoon	1.62	1.92	1.80	1.68	1.76
Third ratoon	1.63	1.60	1.70	1.54	1.62
Fourth ratoon	1.54	1.62	1.57	1.58	1.53
Mean of 3 crops	1.60	1.71	1.69	1.60	1.64

[1] All nitrogen values corrected to a basis of 20 inches of rainfall for period from cutting period of previous ratoon to time of leaf sampling. Original rainfall values in inches were 24, 30, and 13 for ratoons 2, 3, and 4, respectively.

[2] All treatments received 300 pounds of P_2O_5 and K_2O per acre, respectively.

increase in cane yield but not as great a one as for values below 1.60 percent. If the leaf nitrogen concentrations are above 1.70 percent it can be assumed that nitrogen fertilizers would produce no significant higher yields of sugarcane. Values below 1.40-percent leaf nitrogen indicate a more severe need of nitrogen, and 250 pounds would prove of more value than 125 pounds per acre.

As the annual fluctuation for phosphorus was not too great, we may then use values unadjusted for rainfall as a guide. If the leaf contains above 0.17 percent of phosphorus, this may be regarded as indicating that the cane would not respond appreciably to phosphorus fertilizers.

When leaf potassium values for sugarcane (adjusted for rainfall) are lower than 1.70 percent, this indicates that significantly greater cane yields can be expected if potash fertilizers are applied. If the leaf potassium values are above 1.90 percent no significant responses in yield of cane should be expected with potash applications.

The mathematical relationship between plant composition and crop as developed by Capó for hegari sorghum (2) was modified for sugarcane. The relationship was expressed by

$$Yr = A \text{ arc tan. percent } Nu + B$$

where Yr is the relative yield, *arc tan. per cent* Nu is the arc whose tangent has the same value as the percent nutrient content of the leaf on a dry-weight basis, and A and B are constants of the equation. This equation in its preliminary form has given significant relationships for the three ratoons samples. The details of this portion of the work and its results will be presented in a forthcoming publication.

Practical Recommendations

VARIETIES

Of the four sugarcane varieties tested, P.O.J. 2878, P.R. 903, M. 275, and M. 317, P.R. 903 was best, and yielded the most tons of cane per acre. There was no significant difference in sucrose percent cane between the four varieties. P.R. 903 gave the highest yields in hundredweights of 96° available sugar per acre and should be used in preference to the other three varieties.

FERTILIZERS

The response to fertilizer applications was greatest for nitrogen, less for potassium, and least for phosphorus. For sugarcane grown on Coloso silty clay and similar soils in the Arecibo area, the fertilizer recommendations are:

Plant cane

Nitrogen—125 to 250 pounds of N per acre
Phosphorus—40–50 pounds P_2O_5 per acre
Potassium—100 pounds of K_2O per acre

Ratoons

Nitrogen—125 pounds of N per acre
Phosphorus—40–50 pounds O_2O_5 per acre
Potassium—150 pounds of K_2O per acre

Summary

A variety-fertilizer experiment using four varieties at seven fertilizer levels was carried on for a plant sugarcane and four ratoons. The major results were:

1. Nitrogen gave the highest yield increases in hundredweights of 96° available sugar per acre.

2. Phosphate fertilizers did not increase the yields of sugar.

3. Potassium fertilizers did increase the yields of sugar per acre.

4. The application of nitrogen and phosphorus did not influence sucrose concentrations in the cane. The omission of potassium did decrease the sucrose content of the cane significantly.

5. Variety P.R. 903 gave the highest yields of sugar per acre as compared with P.O.J. 2878, M. 275, and M. 317. The yields of M. 317 and P.O.J. 2878 were about equal, and M. 275 gave the lowest yields.

6. The varieties maintained their relative yielding power when tested at various fertilizer levels. Except for the no-fertilizer level, P.R. 903 maintained its significant lead in yield at all levels of fertilizer application. There was no significant interaction between varieties and fertilizers.

7. The reductions in yields from the omission of a fertilizer element for the mean of five crops were 33, 3, and 9 percent for nitrogen, phosphorus, and potassium, respectively.

8. Analysis of leaf samples revealed that corrections must be made for rainfall to prevent a yearly variation in the data. When corrected for rainfall variations, values of 1.40 percent nitrogen (dry weight of the leaf) or below were associated with low cane yields, and values of 1.60 percent or over with high yields. For phosphorus, values above 0.17 percent phosphorus in the leaf at a cane age of 3 months may be regarded as indicating no appreciable need for phosphate fertilizers. Potassium values of 1.70 percent potassium in the leaf or less indicate a need for potash, and 1.90 percent or greater, none.

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