THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, for the publication of articles by members of its personnel, or others, dealing with any of the more technical aspects of scientific agriculture in Puerto Rico or the Caribbean Area.

Vol. XLIII April 1959 No. 2

The Response of Two Sugarcane Varieties to Fertilizers at Río Piedras, 1954–57

P. Landrau, Jr., G. Samuels, and S. Alers-Alers[1]

INTRODUCTION

The first experiments on sugarcane fertilizers conducted by the Agricultural Experiment Station of the University of Puerto Rico, in 1911, were on a Vega Baja silty clay at Río Piedras (*8*).[2] This soil type occupies about 4,000 acres occurring in a number of widely separated parts of the river flood plains in the humid sections of northern Puerto Rico. From 80 to 85 percent of this area is used for sugarcane production, and most of the remaining 15 to 20 percent is devoted to pasture for dairy cattle.

Crawley and Cowgill (*8*) found that, when used for growing sugarcane, the Vega Baja silty clay responded to lime, nitrogen, and phosphorus. Chardón (*5*) showed that one fertilizer application to sugarcane on this soil was as good as the same amount divided into two applications. Chardón and Méndez (*6*) encountered no difference in yields of cane attributable to the use of such nitrogen sources as ammonium sulfate, sodium nitrate, or cyanamide. Bonnet, *et al.*, (*1*) found no difference in yields of cane due to the method of phosphate placement. In 1945–48, Capó, as reported by Samuels, *et al.* (*11*) conducted a fertilizer-variety experiment on a Vega Baja silty clay using sugarcane varieties P.R. 903, P.R. 904, M. 275, and P.O.J. 2878, grown at seven fertilizer levels. There was a significant response to nitrogen and a limited response to potash. This was the first experiment in Puerto Rico in which leaf samples of the sugarcane were taken for correlation with yields of sugar.

OBJECTIVES

Since the work of Capó and associates, in 1945–48, the sugarcane varietal picture has changed. With this change has come also increasing knowledge

[1] Former Associate Agronomist, Agronomist, and Research Assistant II in Agronomy, respectively, Agricultural Experiment Station, University of Puerto Rico, Río Piedras, P.R.

[2] Italic numbers in parentheses refer to Literature Cited, p. 87–8.

of foliar diagnostic technique (*4*). The experiments described herein were designed to test the effect of various levels of nitrogen, phosphorus, and potassium on new leading cane varieties growing in a Vega Baja silty clay. This paper also reports on the use of foliar diagnosis to determine the fertilizer needs of the sugarcane varieties tested on this soil type.

THE SOIL

The Vega Baja silty clay is one of the more important of the poorly drained soils of the river flood plains. It is associated with the Coloso, Fortuna, and Martín Peña series which occur in the humid and subhumid sections along the western, northern, and northeastern coasts.

All the soils in this group have an elevation only a few feet above sea level, and in many of them the water table is constantly at a depth averaging less than 24 inches from the surface. Most of the areas are subject to frequent inundations and sedimentations. Most of the soil occurs as low, imperfectly or poorly drained flat areas between the well-drained soils of the river flood plains and the soils of the coastal lowlands. It lies slightly above normal river overflow, but during exceptionally high water it is flooded.

TABLE 1.—*The dates of planting and harvesting, age of crop, and rainfall for the 3 experiments at Río Piedras, 1954–57*

Experiment No.	Type of crop	Date of planting or or ratooning	Date of cutting	Age of crop	Total rainfall
				Months	*Inches*
1	Summer planting	June 18, 1954	May 9, 1955	10.7	58
	First ratoon	May 9, 1955	June 4, 1956	12.9	101
2	Fall planting	Nov. 26, 1954	Jan. 23, 1956	14.0	116
	First ratoon	Jan. 23, 1956	Jan. 28, 1957	12.2	98
3	Spring planting	Mar. 11, 1955	Apr. 17, 1956	13.2	85

The surface soil of the Vega Baja silty clay to a depth of 8 or 10 inches is friable light-brown or grayish-brown granular acid silty clay or silty clay loam. This layer changes abruptly to a plastic medium-compact mottled yellowish-brown, gray, and red silty clay or clay subsoil, which continues to considerable depth and becomes slightly more mottled and more acid with depth. This compact subsoil prevents easy root penetration and thus plant-nutrient and moisture supplies are difficult to obtain.

PROCEDURES

Three experiments were utilized to study the response of sugarcane to fertilizers on Vega Baja silty clay. The experiments were planted at different seasons of the year so that information was obtained for a summer, fall, and spring planting, with a ratoon for each of the first two plantings. Two varieties, B. 41227 and M. 336, were used for each experiment. The former is a Barbados cane which has shown outstanding promise in this area (*10*) and the latter a cane noted for its high sucrose content and early maturing. The dates of planting or ratooning, dates of cutting, age of the crop, and rainfall during the crop, are given in table 1.

TABLE 2.—*The yields of available 96° sugar per acre, when 2 cane varieties were grown at different fertilizer levels at Rio Piedras, 1954–57*

Treatment No.	Treatments per acre of —			Yields of available 96° sugar per acre for —					Mean of all 5 crops, 1954–57
	N	P_2O_5	K_2O	Experiment 1, summer planting, plant crop, 1954–55	Experiment 1, summer planting, ratoon, 1955–56	Experiment 2, fall planting, plant crop 1954–56	Experiment 2, fall planting, ratoon, 1956–57	Experiment 3, spring planting, plant crop, 1955–56	
				B. 41227					
	Lb.	*Lb.*	*Lb.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*	*Cwt.*
B 1	0	300	300	40	130	90	66	141	93
B 2	150	300	300	88	169	149	119	179	141
B 3	300	0	300	100	179	139	121	177	143
B 4	300	150	300	104	159	136	124	171	139
B 5	300	300	0	92	151	141	113	156	131
B 6	300	300	150	105	171	137	114	154	136
B 7	300	300	300	108	172	167	130	177	151
Mean of all treatments				91	162	137	112	165	133
Least significant difference needed between treatments of same crop at:									
5-percent level				11.4	29.3	17.0	20.9	19.9	20.6
1-percent level				15.3	39.5	22.9	26.1	26.8	27.6
				M. 336					
M 1	0	300	300	38	81	76	67	73	67
M 2	150	300	300	70	117	127	98	89	100
M 3	300	0	300	76	123	133	102	108	108
M 4	300	150	300	88	121	134	105	103	110
M 5	300	300	0	85	105	127	103	88	102
M 6	300	300	150	86	118	131	113	103	110
M 7	300	300	300	92	117	142	116	104	114
Mean of all treatments				76	112	124	101	95	102
Least significant difference needed between treatments of same crop at:									
5-percent level				10.0	15.9	14.1	14.3	17.0	14.5
1-percent level				13.5	21.4	19.0	19.3	22.8	19.5

A randomized-block experimental design was used for each sugarcane variety with seven fertilizer levels. The various fertilizer treatments used are given in table 2. 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 was applied to each plot once for each crop. The fertilizer was applied to the plant crop just before planting in the furrow, and to the ratoon as soon after cutting as conditions would permit.

The plot size was 24 feet long and 18 feet wide, which gave an area of one one-hundredth of an acre per plot. The plots had four rows with the 3-eye sugarcane seed pieces laid on the bottom of the furrow at 1-foot intervals and covered with soil. This gave a rate of planting of about 9,600 seed pieces per acre.

The cane was cut by machete. That 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 different stools in each plot at the time of harvest. The 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.

Leaf samples for the foliar-diagnosis studies were taken every 15 days, beginning at an age of 2 and ending at 6 months. For the purpose of this study only the values at 3 months of age are reported, as they were the ones which showed the best correlation with fertilizer applications and cane yields. The leaf samples were obtained by taking 3 canes at random from each of the 4 rows in each plot; this provided 12 canes. Samples were then taken and analyzed as described in a previous publication (*13*).

RESULTS

YIELD OF 96° AVAILABLE SUGAR PER ACRE

In all the experiments, B. 41227 outyielded M. 336 in 96° available sugar per acre (table 2). The results of the individual treatments will be discussed by fertilizer elements to obtain a clearer picture of the fertilizer treatments on yields.

Nitrogen

There was a significant increase in yield from the use of a nitrogen fertilizer. The average of the five crops showed that 150 pounds of nitrogen per acre gave significantly large increases in yields of sugar for both varieties. As shown in table 3, the percentage increase for the first 150 pounds of nitrogen was 52 for B. 41227 and 49 for M. 336. The addition of another

150 pounds of nitrogen per acre to that already added again increased yields of sugar for both varieties.

TABLE 3.—*Relative increase in yield of available 96° sugar per acre (hundredweights) attributable to the addition of nitrogen, phosphorus, and potassium, from 2 cane varieties grown at Río Piedras, 1954–57*

Fertilizer element varied	Level[1] of fertilizer	Experiment 1, summer planting, plant crop, 1954–55	Experiment 1, summer planting, ratoon, 1955–56	Experiment 2, fall planting, plant crop, 1954–56	Experiment 2, fall planting, ratoon, 1956–57	Experiment 3, spring planting, plant crop, 1955–56	Average of 5 crops
			B. 41227				
N	0	0	0	0	0	0	0
	1	120	30	66	81	27	52
	2	170	32	86	98	26	62
P_2O_5	0	0	0	0	0	0	0
	1	4	−11	−2	3	−2	−4
	2	8	−4	20	8	−12	9
K_2O	0	0	0	0	0	0	0
	1	14	13	−3	1	1	4
	2	18	14	19	15	−14	15
			M. 336				
N	0	0	0	0	0	0	0
	1	89	45	67	46	22	49
	2	148	45	87	73	43	70
P_2O_5	0	0	0	0	0	0	0
	1	16	−2	1	3	−5	2
	2	21	−5	7	14	−4	5
K_2O	0	0	0	0	0	0	0
	1	1	12	3	10	17	8
	2	18	11	12	13	18	12

[1] The following quantities of fertilizer in pounds per acre were used for the indicated units:

Fertilizer units	Nitrogen treatments			Phosphorus treatments			Potassium treatments		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
0	0	300	300	300	0	300	300	300	0
1	150	300	300	300	150	300	300	300	150
2	300	300	300	300	300	300	300	300	300

The relative increase in yield from the nitrogen applied was not the same for all experiments. The highest percentage responses to the nitrogen additions were found in experiment 1, summer planting, plant crop (table 3).

Yields were more than doubled when nitrogen was added. Yet, on an actual yield basis of hundredweights of sugar, this crop was the poorest. The ratoon crop of this experiment actually outyielded the plant crop by far. The summer planting had less rainfall than usual for its growth and a shorter growing period, whereas the ratoon had a longer growing season and a normal rainfall.

Phosphorus

There was no significant response in yield of sugar to phosphate fertilizers for the average of five crops for either variety (table 2). There was a significant increase in the plant crop of experiment 1 for M. 336, but for no other crop. Even for rates up to 300 pounds of P_2O_5 per acre the general increase in yield of sugar per acre amounted to only 9 percent for B. 41227 and 5 for M. 336 (table 3).

Potassium

When the average of all five crops was considered there was no great response to potash, as there was to nitrogen. M. 336 showed no significant responses to either of the potash levels used. It required 300 pounds of K_2O per acre to produce a significant yield response in B. 41227 over its performance under the no-potash treatment (table 2). For B. 41227 the yield increase averaged only 4 percent for 150 pounds of K_2O per acre and 15 percent with 300 pounds (table 3). The use of 300 pounds of K_2O per acre increased yields of M. 336 by 12 percent, but this was 3 hundredweights per acre short of being significant (table 2).

TONS OF CANE PER ACRE

The response to the fertilizer treatments in tons of cane per acre followed very closely those obtained for sugar per acre. One hundred and fifty pounds per acre of nitrogen gave significantly increased yields of both varieties, but significant increases were obtained from an additional 150 pounds only with M. 336 (table 4). Phosphates produced no increase in cane tonnage of M. 336, except for the isolated case of the plant cane in experiment 1. Three hundred pounds of K_2O was needed to produce significant yield increases in B. 41227, but M. 336 showed no significant tonnage increase even from this amount.

SUCROSE-PERCENT-CANE

When we consider the average of the five crops, there was no significant influence on sucrose-percent-cane content for any fertilizer treatment (table 5). However, there were some differences for the individual crops. Nitrogen increased sucrose-percent-cane values significantly for the plant crops of

B. 41227 in experiments 1 and 2. In no case was there any appreciable decrease in sucrose for either variety when nitrogen was applied even up to 300 pounds per acre.

Both phosphate and potash fertilizers failed to increase sucrose-percent-cane values significantly.

TABLE 4.—*The yields in tons of cane per acre produced by 2 cane varieties when grown at different fertilizer levels, at Río Piedras, 1954–57*

Treatment No.	Treatments per acre of —			Yields of cane per acre for —					Mean of all 5 crops, 1954–57
	N	P_2O_5	K_2O	Experiment 1, summer planting, plant crop, 1954–55	Experiment 1, summer planting, ratoon, 1955–56	Experiment 2, fall planting, plant crop, 1954–56	Experiment 2, fall planting, ratoon, 1956–57	Experiment 3, spring planting, plant crop, 1955–56	
				B. 41227					
	Lb.	*Lb.*	*Lb.*	*T.*	*T.*	*T.*	*T.*	*T.*	*T.*
B1	0	300	300	15.6	55.8	45.7	30.5	62.0	41.9
B2	150	300	300	32.1	71.1	66.7	56.9	76.3	60.5
B3	300	0	300	36.1	73.5	61.7	52.2	74.2	59.6
B4	300	150	300	35.9	67.1	63.2	57.5	72.7	59.3
B5	300	300	0	32.0	63.6	63.9	51.2	67.3	55.6
B6	300	300	150	37.1	72.4	67.5	56.8	67.1	60.2
B7	300	300	300	36.7	74.5	71.6	60.5	73.2	63.3
Mean of all treatments				32.1	68.3	62.9	52.2	70.4	57.2
Least significant difference needed between treatments of same crop at:									
5-percent level				3.7	9.9	6.1	6.4	5.7	6.7
1-percent level				5.0	13.4	8.2	8.7	7.7	9.0
				M. 336					
M1	0	300	300	12.8	29.9	31.5	25.7	28.3	25.6
M2	150	300	300	22.8	43.4	49.2	39.7	33.4	37.7
M3	300	0	300	24.8	44.2	52.4	41.8	40.4	40.7
M4	300	150	300	28.9	44.2	54.4	41.8	39.5	41.8
M5	300	300	0	28.4	39.7	52.4	43.1	34.3	39.6
M6	300	300	150	28.6	43.6	55.5	46.2	39.1	42.6
M7	300	300	300	29.6	43.3	57.3	47.6	39.1	43.4
Mean of all treatments				25.1	41.2	50.4	40.8	36.3	38.8
Least significant difference needed between treatments of same crop at:									
5-percent level				3.0	5.0	5.1	6.3	6.5	5.3
1-percent level				4.1	6.8	6.8	8.4	8.8	7.2

TABLE 5.—*The sucrose-percent-cane produced by 2 cane varieties when grown at different fertilizer levels, at Rio Piedras, 1954–57*

Treatment No.	Treatments per acre of —			Yield of sucrose-percent-cane for —					Mean of all 5 crops, 1954–57
	N	P_2O_5	K_2O	Experiment 1, summer planting, plant crop, 1954–55	Experiment 1, summer planting, ratoon, 1955–56	Experiment 2, fall planting, plant crop, 1954–46	Experiment 2, fall planting, ratoon, 1956–57	Experiment 3, spring planting, plant crop, 1954–56	
B. 41227									
	Lb.	*Lb.*	*Lb.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
B1	0	300	300	12.76	11.64	9.84	10.78	11.39	11.28
B2	150	300	300	13.70	11.90	11.17	10.53	11.76	11.81
B3	300	0	300	13.80	12.15	11.22	11.60	11.93	12.14
B4	300	150	300	14.43	11.83	10.78	10.76	11.75	11.90
B5	300	300	0	14.45	11.80	10.99	11.08	11.54	11.97
B6	300	300	150	14.20	11.74	10.17	9.92	11.50	11.51
B7	300	300	300	13.82	11.53	11.67	10.65	12.05	11.94
Mean of all treatments				13.88	11.80	10.83	10.76	11.70	11.79
Least significant difference needed between treatments of same crop at:									
5-percent level				0.66	0.78	0.97	1.19	0.88	0.92
1-percent level				.89	1.05	1.30	1.60	1.18	1.22
M. 336									
M1	0	300	300	14.69	13.69	12.14	13.01	12.87	13.28
M2	150	300	300	15.35	13.49	12.95	12.33	13.34	13.49
M3	300	0	300	15.24	13.89	12.75	12.23	13.42	13.51
M4	300	150	300	15.09	13.61	12.27	12.51	13.02	13.30
M5	300	300	0	15.11	13.18	12.19	11.99	12.87	13.07
M6	300	300	150	15.01	13.50	11.82	12.33	13.27	13.19
M7	300	300	300	15.54	13.51	12.45	12.23	13.40	13.43
Mean of all treatments				15.15	13.55	12.37	12.38	13.17	13.32
Least significant difference needed between treatments of same crop at:									
5-percent level				0.77	0.58	0.83	0.57	0.60	0.68
1-percent level				1.04	.78	1.12	.76	.81	.92

AGE OF CROP

Because the various plantings used differed in the number of months the cane was allowed to grow, the mean yield values for the various experiments were recalculated on a yearly basis and the results are given in table 6.

The plant crop of the spring planting and the ratoon crop of the summer planting gave the best yields for B. 41227. The summer planting gave low yields. The spring planting outyielded the fall planting for this variety, but the reverse was true for M. 336. M. 336 also did better in the summer planting, the plant crop yielding about the same as the spring planting.

TABLE 6.—*The mean yields of 96° available sugar, tons of cane, and sucrose-percent-cane on an annual basis for the experiments with 2 cane varieties, at Río Piedras, 1954–57*

Item	Experiment 1, summer planting, plant crop, 1954–55	Experiment 1, summer planting, ratoon, 1955–56	Experiment 2, fall planting, plant crop, 1954–56	Experiment 2, fall planting, ratoon, 1956–57	Experiment 3, spring planting, plant crop, 1955–56
		B. 41227			
Hundredweights of sugar per acre	102	150	118	110	150
Tons of cane per acre	36.0	63.5	54.0	51.4	53.5
Sucrose-percent-cane	13.88	11.80	10.83	10.76	11.70
		M. 336			
Hundredweights of sugar per acre	86	104	106	100	87
Tons of cane per acre	28.2	38.2	43.2	40.2	33.1
Sucrose-percent-cane	15.15	13.55	12.37	12.38	13.17

FOLIAR DIAGNOSIS

The nutrient content of the sugarcane leaf blades, the moisture content of the sheath, and the relative yields of 96° available sugar per acre for the mean of the five crops are given in table 7.

The yield data were converted from tons of 96° available sugar to percentage relative yields of 96° available sugar per acre, so that the plant-crop and ratoon data could be properly combined, and comparisons could be made between varieties and various locations where other experiments have been performed. The relative yield was defined for this purpose as the percentage which the actual yield of sugar was of the yield obtained with the heaviest application of fertilizer. Before changing the actual to relative yields, however, all yield values for a given crop were fitted to a Mitscherlich equation for maximum yields (*2*), to determine whether the yields obtained for the heaviest fertilizer applications approached the theoretical maxima obtainable under the experimental conditions. If the maximum yield obtained from the Mitscherlich equation exceeded the actual yields of sugar under the heaviest fertilizer application by 0.1 ton per acre, it was used as a base in calculating relative yields.

The relative yields for each (table 7), calculated from the actual data, showed little difference from yields calculated using the Mitscherlich maximum—see table 7 wherein relative yield data are in parentheses. This implies that the fertilizer rates used in the experiment were sufficiently high

TABLE 7.—*The nutrient content of sugarcane leaf blades, sheath moistures, and relative yields of 96° available sugar per acre (percent) for the mean of 5 crops of 2 cane varieties grown at different fertilizer levels at Río Piedras, 1954–57*

Cane variety and fertilizer level[1]	Nutrient content of leaf blade, dry-weight basis, for treatments with —			Moisture content of leaf sheath, green-weight basis, for treatments with —			Relative yield[2] of 96° available sugar for treatments with —		
	N	P	K	N	P	K	N	P	K
B. 41227:									
0	1.28	0.16	0.67	81.2	83.5	82.7	61 (60)	95	86 (83)
1	1.63	.20	1.10	83.7	84.5	83.8	88 (90)	93	90 (87)
2	1.73	.21	1.40	83.7	84.0	84.0	100 (97)	100	100 (98)
M. 336:									
0	1.40	.16	.76	83.1	84.7	83.3	58 (56)	95	89 (85)
1	1.72	.19	1.40	85.0	84.9	84.5	87 (82)	96	97 (92)
2	1.81	.21	1.72	85.1	85.4	85.4	100 (93)	100	100 (96)

[1] The following quantities of fertilizer in pounds per acre were used for the indicated units:

Fertilizer units	Nitrogen treatments			Phosphorus treatments			Potassium treatments		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
0	0	300	300	300	0	300	300	300	0
1	150	300	300	300	150	300	300	300	150
2	300	300	300	300	300	300	300	300	300

[2] Numbers in parentheses refer to the relative yield recalculated using the maximum yield obtained with the Mitscherlich equation (*2*) as a base of 100.

to provide optimum yields in the Vega Baja silty clay. The relative yields for M. 336 were slightly lower than for B. 41227, when calculated under the Mitscherlich maximum, indicating that higher rates of nitrogen could have raised yields of sugar per acre even more for this variety.

The relationship between the nutrient content of the leaf and the relative yield of sugar per acre will be discussed for each fertilizer element separately.

Nitrogen

There was a highly significant linear correlation between leaf-nitrogen values and relative yields of sugar for both varieties. The equations obtained were:

Variety	Equations	Prediction value, percent
B. 41227	$Yr = 70.37\, Xn - 26.6$	70
M. 336	$Yr = 76.36\, Xn - 49.1$	79

where Yr = relative yield of available 96° sugar per acre and Xn = percent-leaf-nitrogen content on a dry-weight basis. The prediction values indicate what percentage of the variation in yield might be explained by the variation in leaf-nitrogen values. As cited, the prediction values indicate that 70 percent of the yield variation for B. 41227 was explained by the accompanying variation in its leaf-nitrogen values; for M. 336 it was 79 percent. Both values are high, indicating that the leaf-nitrogen value was a dominant factor in predicting sugar yield per acre.

The correlation between leaf nitrogen and sugar yields were also tested using the arc-tangent equation of Capó (*3*). The equations obtained were:

Variety	Equations	Prediction value, percent
B. 41227	$Yr = 4.06$ arc-tan $N - 147.5$	75
M. 336	$Yr = 3.60$ arc-tan $N - 132.7$	75

where Yr = relative yields of sugar per acre and arc-tan N = the arc-tangent value corresponding to the percent-leaf-nitrogen.

No significant change in the prediction values was obtained with the arc-tangent equation as compared to the linear equation using leaf nitrogen. However, this could be explained by the fact that the portion of the arc-tangent curve covered by the range of leaf-nitrogen values in the experiment were small and could be satisfactorily approximated by a straight-line or linear relationship.

There was a difference in sheath moisture content due to varieties—M. 336 being higher than B. 41227—and for nitrogen application—lower values being associated with no-nitrogen applications. Clements (*7*), Humbert and Howe (*9*), and Samuels, *et al.* (*12*) have shown that leaf nitrogen decreases as sheath moisture decreases.

To correct for the variation in moisture all leaf-nitrogen values were adjusted, using 83-percent sheath moisture as a standard. For every 1-percent change in sheath moisture a change of 0.061 percent-leaf-nitrogen was calculated. This value of 0.061 obtained from recent experimental work compared very closely to the value of 0.059 obtained by Clements for unirrigated cane in Hawaii.

The leaf-nitrogen values corrected for moisture variation in the sheath are given in table 8. Almost identical leaf values were obtained for both varieties when corrected for sheath moisture. The corrected leaf-nitrogen values were once again correlated with relative yields. The resulting equations were:

Variety	*Equations*	*Prediction value, percent*
B. 41227	$Yr = 79.16\,Xn - 41.0$	80
M. 336	$Yr = 70.10\,Xn - 35.3$	55

There was a gain of 10 percent in the prediction value for B. 41227, but a drop of 20 percent for M. 336 when the leaf-nitrogen values were corrected for moisture. A check of the individual moisture values for M. 336 revealed a high variability in the sheath-moisture values, with many running up to 88 percent—values never obtained heretofore with cane in the humid cane-growing area of Puerto Rico.

It is interesting to compare the leaf-nitrogen values now obtained for B. 41227 and M. 336 with those obtained 10 years ago by Capó on the very same Vega Baja silty clay with such sugarcane varieties as P.R. 903, P.R. 904, M. 275, and P.O.J. 2878. The linear equations and the leaf values for nitrogen associated with various relative yields of the varieties just mentioned are given in table 9. There are many similarities in the levels of leaf nitrogen for all the varieties. B. 41227 has values close to those for P.R. 903, P.R. 904, and M. 275. P.O.J. 2878, leaf nitrogen very slowly decreased with relative yield. M. 336 started out with a high level for nitrogen at 100-percent relative yield, but dropped rapidly to values comparable to the others at 70-percent relative yield.

Phosphorus

No significant correlation was obtained between leaf-phosphorus values and relative yields of 96° sugar per acre, using either a linear or an arc-tangent equation. Although there were definite increases in leaf phosphorus with increasing phosphate applications (table 7), there were no accompanying significant increases in yields of sugar per acre from these phosphate applications.

Capó, *et al.* (*11*) on the Vega Baja silty clay obtained no significant yield responses to phosphates, and probably because of this, no correlation could be established between leaf-phosphorus value and relative yield of cane growing in this soil.

Potassium

The linear correlation between leaf-potassium values and relative yields of 96° available sugar for the mean of the five crops was not significant for B. 41227, and was just barely significant at the 5-percent level for M. 336.

TABLE 8.—*Leaf-nitrogen values (percent) before and after correction for sheath moisture, for 2 cane varieties grown at Rio Piedras, 1954–57, as affected by fertilizer levels*

Cane variety and fertilizer level[1]	Uncorrected for sheath moisture		Corrected for sheath moisture	
	Leaf nitrogen, dry-weight basis	Sheath moisture, green-weight basis	Leaf-nitrogen, dry-weight basis	Sheath moisture, green-weight basis
B. 41227:				
0	1.28	81.2	1.39	83.0
1	1.63	83.7	1.59	83.0
2	1.73	83.7	1.69	83.0
M. 336:				
0	1.40	83.1	1.39	83.0
1	1.72	85.0	1.60	83.0
2	1.81	85.1	1.69	83.0

[1] See footnote 1 of table 7.

TABLE 9.—*Leaf-nitrogen values (percent) associated with various relative yields of 96° sugar per acre for several sugarcane varieties*[1]

Variety	Leaf-nitrogen value needed for a relative yield of —					
	100	90	80	70	60	50
P.R. 903	1.68	1.60	1.52	1.44	1.36	1.28
P.R. 904	1.84	1.73	1.62	1.51	1.40	1.29
M. 275	1.75	1.66	1.57	1.48	1.39	1.30
P.O.J. 2878	1.78	1.72	1.66	1.60	1.54	1.48
M. 336	1.93	1.79	1.65	1.41	1.27	1.13
B. 41227	1.78	1.66	1.54	1.42	1.30	1.18
Average	1.80	1.69	1.59	1.48	1.34	1.28

The prediction values for the varieties were 11 percent for B. 41227 and 26 for M. 336.

The reason for this poor correlation between leaf potassium and relative yields of 96° sugar may be that the response of the leaf potassium to potash applications was great; yet where yields of sugar were concerned, the response was moderate to poor and irregular. Where no potash was applied, leaf-potassium values were 0.67 and 0.76 percent for the two varieties. These leaf-potassium values are lower than any the authors have encountered before. Yet, despite these extremely low leaf-potassium values, relative yields of sugar per acre were not severely depressed. Sheath-moisture values were normal to high, indicating that the roots were functioning normally. It appears that at 3 months of age, the soil potassium was not readily available to the cane, as indicated by the leaf values. However, during the ensuing period of growth of about 9 months, sufficient potash seems to become available to the cane to satisfy a major part of its needs. The relationship between leaf potassium and relative yields of sugar have not been well-defined for the Vega Baja silty clay.

SUMMARY

A series of foliar-diagnosis-fertilizer experiments with five crops of two sugarcane varieties, B. 41227 and M. 336, were made on a Vega Baja silty clay at Río Piedras. The experimental results may be summarized as follows:

1. In all experiments B. 41227 outyielded M. 336 in available 96° sugar per acre.
2. There was a significant increase in yield of sugar per acre from the use of nitrogen fertilizer at the rate of 150 pounds of nitrogen per acre, and in some cases from 300 pounds of nitrogen per acre.
3. There was no significant response in yield of sugar per acre from the use of phosphate fertilizers, except for the plant cane of a summer planting of M. 336.
4. Response in yields of sugar per acre to potash fertilizers was erratic, and limited to B. 41227.
5. The response to the fertilizer treatments in tons of cane per acre followed very closely that obtained for sugar per acre.
6. For the average of the five crops, there was no significant influence on sucrose-percent-cane content for any of the fertilizer treatments.
7. When allowances were made for the age of the crop, it was found that the plant crop of the spring planting and the ratoon crop of the summer planting of B. 41227 were tied as the highest yielders of sugar per acre. For M. 336, the plant crop of the fall planting was highest.
8. There was a highly significant linear correlation between relative yields of sugar and percent-leaf-nitrogen for both sugarcane varieties.
9. No significant correlation was obtained for relative yields of sugar and leaf-phosphorus values.
10. The relationship between relative yield of sugar per acre and leaf-potassium values was not too clear. Linear-correlation studies showed none to little significance for the varieties.
11. Some comparisons are given with leaf-nitrogen values obtained 10 years ago by Capó, using varieties P.R. 903, P.R. 904, M. 275, and P.O.J. 2878.

RESUMEN

Una serie de experimentos sobre diagnóstico foliar y abonamiento se llevó a cabo con caña de azúcar en un suelo del tipo Vega Baja limo arcilloso en Río Piedras. Los resultados experimentales pueden resumirse como sigue:

1. En todos los experimentos, la variedad B. 41227 rindió más que la M. 336 en cuanto a azúcar 96° por acre.

2. Hubo un aumento significativo en rendimiento de azúcar por acre cuando se aplicó nitrógeno a razón de 150 libras por acre, y en algunos casos hasta 300 libras.

3. No hubo aumento significativo en el rendimiento de azúcar por acre del uso de abonos fosfatados con excepción de una siembra de plantilla primavera hecha con M. 336.

4. Los resultados fueron erráticos en cuanto al rendimiento de azúcar por acre cuando se aplicaron abonos fosfatados, y se limitaron sólo a la B. 41227.

5. La reacción a los tratamientos en cuanto al tonelaje de caña por acre, siguió muy de cerca a la que se obtuvo en cuanto al rendimiento de azúcar por acre.

6. Para el promedio de 5 cosechas, no hubo influencia significativa en cuanto al porcentaje de sacarosa en la caña en ninguno de los tratamientos con abono.

7. Cuando se tomó en cuanta la edad de la cosecha, se encontró que en cuanto a la B. 41227, la plantilla de primavera y el retoño de verano estuvieron a la par en lo que se refiere a los más altos rendimientos de azúcar por acre. En cuanto a la M. 336 fué la siembra de otoño la que produjo los mayores rendimientos.

8. Hubo una correlación lineal muy alta entre los rendimientos relativos de azúcar y el porcentaje de nitrógeno en la hoja en ambas variedades de caña (B. 41227 y M. 336).

9. No se obtuvo correlación significativa para los rendimientos relativos de azúcar y para los valores de fósforo en la hoja.

10. La relación entre el rendimiento relativo de azúcar por acre y los valores de potasio en la hoja no aparecieron muy claros. Los estudios de correlación lineal no demostraron gran significancia en cuanto a las variedades.

LITERATURE CITED

1. Bonnet, J. A., Capó, B. G., and Riera, A., Lack of response of sugarcane to applications of phosphorus in Puerto Rico, *J. Agr. Univ. P.R.* **30**(3) 186–95, 1946.

2. Capó B. G., A modification of Mitscherlich's method for the determination of the nutrient contents of the soil, *J. Agr. Univ. P.R.*, **22** (2) 137–72, 1938.

3. Capó, B. G., and Samuels, G., The development of a mathematical concept to in-

terpret the relations between plant composition and crop yield, *J. Agr. Univ. P.R.* **37** (4)249–64, 1953.

4. Capó, B. G., Samuels, G., Landrau, P. Jr., Alers-Alers, S., and Riera, A., The Method of Foliar Diagnosis as Applied to Sugarcane, Univ. P.R. Agr. Exp. Sta., Bul. 123, pp. 1–45, Feb. 1955.
5. Chardón, F., see reference (*10*) p. 54.
6. Chardón, F. and Méndez, F., see reference (*10*) p. 55.
7. Clements, H. F., Crop-Logging of Sugarcane: The Standard Nitrogen Index and the Normal Nitrogen Index, Hawaii Agr. Exp. Sta. Univ. Hawaii Tech. Bul. No. 35, pp. 1–56, Oct. 1957.
8. Crawley, J. T., and Cowgill, H. B., see reference (*10*) p. 36.
9. Humbert, R. P., and Howe, G. L., An examination of 6 year's crop-logging at Ewa, Exp. Sta. Haw. Plant. Assoc. Special Release 56, Feb. 1952.
10. Méndez-Roig, F., and Samuels, G., Sugarcane variety trials in Puerto Rico, 1951–55, *J. Agr. Univ. P.R.* **41** (3) 147–60, 1957.
11. Samuels, G., and Capó, B. G., Research with Sugarcane Fertilizers in Puerto Rico, 1910–54, Univ. P.R. Agr. Exp. Sta. Tech. Paper 16, pp. 68–9, March 1956.
12. Samuels, G., Capó, B. G., and Bangdiwala, I. S., The nitrogen content of sugarcane as influenced by moisture and age, *J. Agr. Exp. Sta. Univ. P.R.* **37** (1) 1–12, 1953.
13. Samuels, G., and Landrau, P. Jr., The response of sugarcane to fertilizers I, The Arecibo cycle, 1944–50, *J. Agr. Univ. P.R.* **36** (3) 203–29, 1952.