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9. ABSTRACT

This report presents the results of a study of irrigation-fertility relationships in sugar cane production in the Los Llanos area of Venezuela. Seed cane variety Puerto Rico 980 was used in two planting positions: furrow bottoms and ridge tops. The cane was planted with about 30 percent overlap in rows 1.4 meters wide. Four levels of N-P-K (2-1-2) fertilizer were used. Differential irrigation schedules were followed. The vegetation yield and sugar yield of cane in all of the experimental cells was analyzed. The fertilizer variable was found to be the only significant factor. Surprisingly, the yields of vegetation and sugar were not significantly affected by differences in planting method or irrigation schedule. However, considerable rain fell within ten weeks of harvest of this one-year cane, so this may have decreased the influence of differences in the irrigation schedules.

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INVESTIGATIONS OF SUGAR CANE GROWTH IN LAS MAJAGUAS, VENEZUELA

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INTRODUCTION

Sugar cane is a major crop in Venezuela. With the presentation of modern agriculture into the Los Llanos area (the interior plains) and the development of extensive and quality irrigation projects, technical knowledge is necessary to make the best use of the land. The construction of processing plants in the immediate area, a good climate, and the high value of sugar make the importance of sugar cane production in Los Llanos relatively secure for a long time. This study is one of many recently conducted in Venezuela. It was designed to study irrigation-fertility relations.

LITERATURE REVIEW

For purposes of this report, it seems most practical not to attempt a literature review. Rather, a statement of the experimental design will be given and justified with literature references.

Literature on sugar cane is extensive. The Ministerio de Agricultura y Cria (M.A.C.) has in Yaritagua, Estado Yaracuy, Venezuela, a sugar cane experimental station which has worked for at least 10 years with a number of intensive studies of various production aspects. Varieties, fertilization, herbicides, and other factors have been studied. A list of some of the more recent publications of this unit are in the Literature Cited.

Extensive use by the authors of this paper of the recent text by Humbert (1968) -- The Growing of Sugar Cane -- was the best single guide available, particularly on irrigation and ripening information. In addition, personal communication in Venezuela with local specialists in cane production (Ingenieros German Segura, Rigoberto Labrador) was also used to formulate the experimental plan.

Cane Variety

Variety Puerto Rico 980 was used because of its current popularity with specialists in the area. Other varieties have been studied in the area, but Puerto Rico 980 was still the recommended variety and one for which seed cane was available.

Planting Position

Two planting positions were used: (1) furrow bottoms and (2) ridge tops. The statement of local specialists is that cane losses are usually appreciable

as a result of poor drainage. Various investigators have observed a number of conditions attributable to poor drainage: (1) reduced transpiration, (2) inhibited root growth, (3) high non-protein nitrogen in the juice, and (4) reduced growth. Humbert quotes studies listing the following growth conditions:

(1) In fields with poor drainage, 97% of the roots were in banks bordering the cane furrows and in the upper few inches of soil. In areas over tile drains, only 75% of the roots were in similar positions.

(2) Poor drainage reduced total root weight by more than 50%.

(3) Internode lengths, normally expected to be 7 to 8 inches, were only one inch during the period of saturated soils and inadequate aeration.

In Louisiana, U.S., a "bank system" is used which involves hilling up the cane roots in a ridge above a drainage furrow. Several advantages result from this: (1) a root volume will exist above the saturated soil area, (2) weeds in the furrows are reduced, and (3) fertilizer can be applied and covered by this hilling process.

Planting Density and Spacing

Cane was planted with about 30% overlap in 1.4 meter-wide rows. As stated by Humbert, "The objective of all planting programs is to get a population of stalks that will effectively use all the sun light as quickly as is possible." He considers 1.4 to 1.8 m. as maximum for 2-year cane in Hawaii. However, spacing too narrow -- and this may include the 1.4 m. width -- results in more stalk mortality and depressed yields. The local specialist in Las Majaguas recommended row spacings of 1.4 m.

The final stalk density is a composite of several factors including thickness of planting, stooling characteristics, and length of time before harvest. Most producing areas plant an excess of seed, either end to end or with slight overlap, to ensure that no costly replanting is necessary. Established stools at 1.7 m. intervals have given adequate yields, but germination is not sure enough to gamble on such distances. Also, 12 or 15 month-old cane production is more sensi ive to the establishment of good early cane cover and development of an adequate stalk density.

Fertilization

Four fertilizer levels were used, all with different amounts of the same mixture. The mixture was in the ratio 2-1-2 for N-P-K (all elemental) or 2-2.5-2.2 based on the older convention of N-P_2O_5-K_2O forms. The levels were:

Fo -Control, no fertilizer

F1 -75 Kg. N/hectarea

40 Kg. P/hectarea

75 Kg. K/hectarea

F2 -Double F1

F3 -Triple F1

The original plan was to have only 20 Kg. P/ha. for F1 and correspondingly double and triple this amount for F2 and F3, respectively. It was also intended to add 1/3 of the N and K plus total P at planting; the remaining N and K after 2 1/2 months. An error by the principal investigator (the writer) resulted in doubling the P added and in adding 2/3 of the N and K at planting. Therefore, the nutrient - balance and addition was different than originally planned.

Segura and Ortega (1964) recommended average values of N = 100-160 Kg/ha., P = 37 Kg. P/ha., and K = 160 Kg. K/ha. (Thus, values converted to element weights). Humbert says one should not exceed 250 Kg. N/ha. for 12-month cane (and all should be added within 4 months of planting), 200 Kg. P/ha. as rock phosphate (although recommendations vary enormously), and may need to add as much as 650 Kg. K/ha.

From this wide variation in data and recommendations, it was thought best to follow the guide of local workers. Many Venezuelan soils (recent soils) have large amounts of mica. This may account for the lower K recommendations than one might expect. The experiment was designed to approximate the recommendations of German Segura at Yaritagua, Venezuela, who used fertilizer levels approximately equal to the F2 used here. F1 would be less and F3 would be greater. The error in this study doubled the P level over the level that was planned. This may be just as well. Tests on this soil for P-deficiency are very low in P; in fact, tests were listed as "trace." There are evidences in past crops (corn particularly) that the soil may be quite low in its P-supplying power.

Irrigation

Irrigation was done uniformly to establish seedlings. Differential irrigation was applied in December and January before the harvest date of early March. These irrigations were to alter ripening (the development of sugar content in the plant).

W1 -Irrigate each 10-12 days; last irrigation 6 weeks before harvest.

W2 -Irrigate each 7-8 days; last irrigation 8 weeks before harvest.

W3 -Irrigate each 7-8 days; last irrigation 6 weeks before harvest.

As indicated by Humbert, "As the cane approaches maturity, extended irrigation intervals are schedules to reduce the rate of vegetative growth,

dehydrate the cane, and force the conversion of reducing sugars to recoverable sucrose." This is mostly a design for 2-year cane.

When to irrigate has been determined in some large plantations by placing tensiometers to a depth of 18 to 24 inches (45-60cm.). However, these are most useful on 2-year cane. Such irrometers are removed about 6 or 7 months prior to harvest and irrigation intervals are lengthened. Water is cut 84 days before the harvest after a "boom" growth season or kept on until 42 days before harvest after drier seasons.

A detailed moisture monitoring system was not used for various reasons. Personnel was fully occupied, the irrigation water was available only for a short 2-month period, and the use of instrument scheduling in the area is not realistic in the foreseeable future. Therefore, a set irrigation time schedule was established. It is believed that a longer ripening period should be considered in future work.

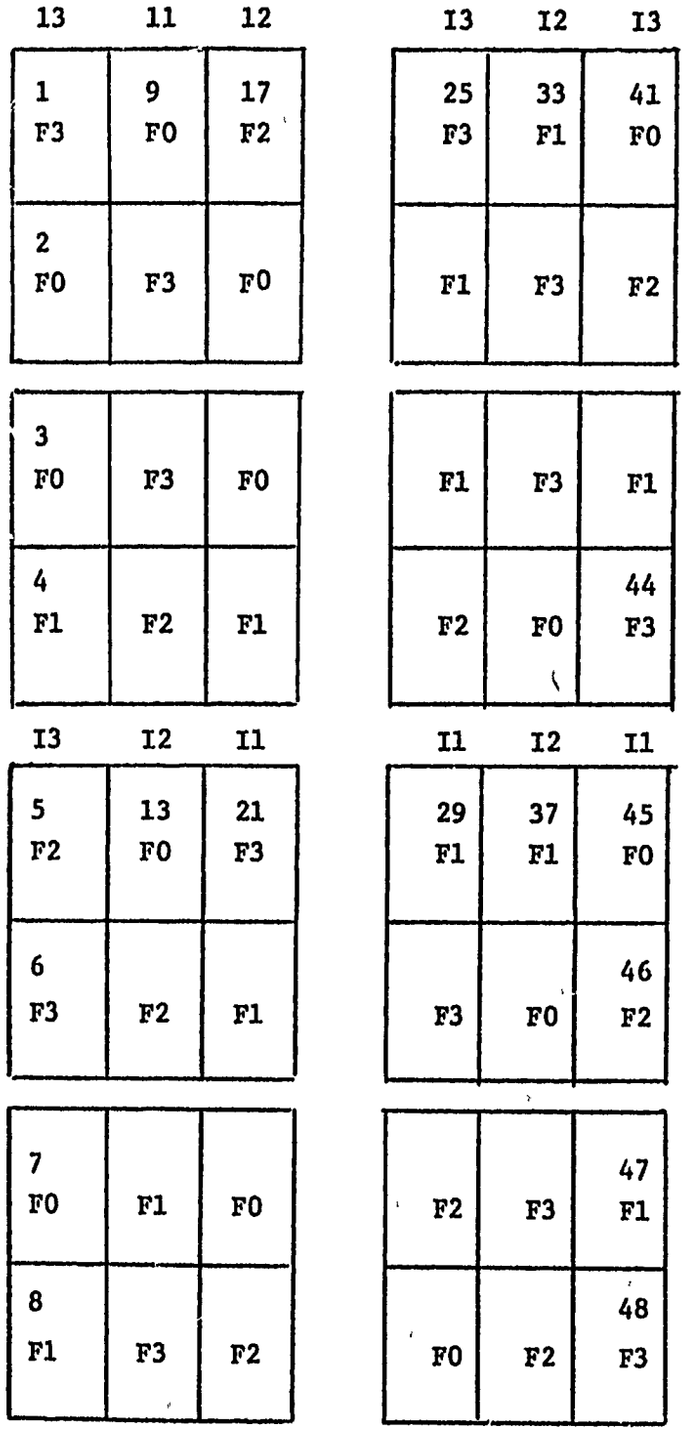
EXPERIMENTAL METHOD

Many of the details are given in a discussion in the Review of Literature. However, a concise and more comprehensive outline is presented here.

The Puerto Rico 980 variety cane was obtained from a grower in Las Majaguas upon recommendation of the local specialist, Ingeniero Rigoberto Labrador. It was planted within a couple of days of the cutting of the last crop, and with about 20% to 30% overlap. Rows were 1.4 m. wide, lots 5.6 m. x 20 m. long, and with a separating border row along the sides. Solid-cane blocks were 21 m. x 40 m. in size (6 lots plus border rows). See Figure 1.

One-half of the field was planted in the conventional form for the area, in the bottoms of the furrows. The other half was planted in the ridge area between furrows.

Fertilizer variables were repeated in each irrigation block of 4 lots.



Planted January 29, 30, 1970

Harvested March 9, 1971

Plot Size

Gross 7.0m. x 20 m.
Harvested 5.6m. x 20 m.

Fertility Added

F0 - Control, no fertilizer

F1 - 75 Kg N/ha.
40 Kg P/ha.
75 Kg K/ha.

F2 - Double F1

F3 - Triple F1

2/3 of N and K and all of the P added at planting. Remaining N and K added 75 days after planting.

I1 - Irrigate each 10-11 days up to 6 weeks before harvest.

I2 - Irrigate each 7-8 days up to 8 weeks before harvest.

I3 - Irrigate each 7 to 8 days up to 6 weeks before harvest.

1 ----Plot number

F3----Fertilizer treatment

Figure 1. Plot layout for sugar cane experimental study in Las Majaguas Irrigation System, Portuguesa State, Venezuela.

The levels used and located at random in each irrigation block were:

F0 -No fertilizer

F1 -75 Kg. N/ha.
40 Kg. P/ha.
75 Kg. K/ha.

2/3 of N and K and all P added at planting. Remaining N and K added at 75 days on the furrow bottom or ridge slope.

F2 -Doubled F1

F3 -Triple F1

Three irrigation schemes were imposed beginning in late November, the 10th month of growth, and each was duplicated in each planting scheme (furrow or ridge planting). The irrigation schemes used were:

I1 -Irrigate each 10-12 days; last irrigation 6 weeks before harvest.

I2 -Irrigate each 7-8 days; last irrigation 8 weeks before harvest.

I3 -Irrigate each 7-8 days; last irrigation 6 weeks before harvest.

The quantity of water applied was based on estimated needs which had to be determined for each soil and area. General statements suggested values of 0.5 to 0.7 cm. per day.

Christiansen and Hargreaves (1968) recommended maximum-use factors of 0.90-0.85 times the class A evaporation pan data for that month. Values for December are near 6.0 mm. per day and for January are 6.5 mm. per day. This would require 3.8 cm. each 7 days in December and 4.0 cm. weekly in January. It is common to require 40% to 80% more water than calculated to assure sufficient penetration over 90% to 95% of the area and take care of some runoff. Some parts (upper areas near the inflow source) will be wetted deeper than wanted. After estimating the limited runoff losses, from the first irrigations, a preset value of 1 cm. per day was decided on to be applied, the exact amount added to be measured.

Water measurement was done using siphons of known calibration. Head difference (ΔH) was measured by water level differences. Water levels were measured by

the depth from the water to the top of an iron rod fixed at the site. A rod was placed in the delivery ditch and one in the irrigation block reservoir for each irrigation block. The pairs of rods had their tops at equal elevation. Only water transferred from the delivery canal to the individual reservoirs was measured. Water from the reservoir to furrows of that block was also delivered by smaller siphons, but these flows were not individually measured.

Other measurements made included shoot counts at age three months for an estimate of uniformity of germination. Moisture content of the 8 to 10 node position of older stalks was taken during ripening to have some idea of how this crop compares with some recommendations regarding reducing moisture to approximately 73% for harvest.

Field weights during harvest were made using a platform balance. Sugar contents were done by the Ministerio de Agricultura y Cria (MAC) in Estacion Experimental de Occidente, Yaritagua, in Yaracuy State, Venezuela.

RESULTS AND DISCUSSION

The Data

The vegetation yields of sugar, percentage of sugar content, and sugar yield are given in Table 1. The data are given for the four fertilizer levels used, the three irrigation schemes, and the two planting positions -- furrow bottoms and ridge tops. The field was divided into left and right halves for planting, and into top and bottom halves for irrigation blocks five rows wide.

In Table 2 is plotted field position with yield, fertilizer and irrigation level indicated. An approximate yield-fertilizer curve was determined from data averages, then smoothed to provide a gradual increase in yield with increased fertilizer. Yield is shown in Table 2 as the difference in actual

Table 1. Vegetation yields, sugar percentage, sugar yields and added irrigation water for sugar cane plots in Las Majaguas Irrigation System, Venezuela. Four fertilizer treatments and two planting positions were used.

The Driest Plots (I1); Planting in Furrow Bottoms						
Fertilizer	Replicate 1-Block C8 Irrigation water added-29.7 cm.			Replicate 2-Block C12 Irrigation water added-41.0 cm.		
Treatment	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*
F0	79.7	11.8	9.37	58.8	12.4	7.28
F1	67.8	12.1	10.63	117.8	9.8	11.59
F2	94.1	12.2	11.45	64.9	10.6	6.86
F3	78.5	12.8	10.06	128.8	11.0	14.10

Intermediate Moisture (I2); Planting in Furrow Bottoms						
Fertilizer	Replicate 1-Block C9 Irrigation water added-58.5 cm.			Replicate 2-Block C10 Irrigation water added-60.4 cm.		
Treatment	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*
F0	88.3	11.8	10.42	76.1	10.8	8.18
F1	112.5	10.6	11.95	98.2	10.5	10.28
F2	107.7	11.5	12.38	66.6	10.8	7.18
F3	102.8	10.9	11.20	130.9	11.9	15.58

Highest Moisture (I3); Planting in Furrow Bottoms						
Fertilizer	Replicate 1-Block C7 Irrigation water added-61.1 cm.			Replicate 2-Block C11 Irrigation water added-68.1 cm.		
Treatment	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*	Yield ton/ha*	Sugar Percentage	Sugar ton/ha*
F0	67.2	12.8	8.56	69.1	11.9	8.23
F1	122.1	12.8	15.58	95.5	12.4	11.81
F2	107.1	12.6	13.48	95.9	12.6	12.06
F3	79.4	12.9	10.24	121.8	12.9	15.73

*Metric tons (toneladas) per hectarea. Yield is vegetation weight; Sugar is "yield" times "percentage sugar."

Table 1. (Continued) Vegetation yields, sugar percentage, sugar yields and added irrigation water for sugar cane plots in Las Majaguas Irrigation System, Venezuela. Four fertilizer treatments and two planting positions were used.

The Driest Plots (I1); Planting in Ridge Tops						
Fertilizer Treatment	Replicate 1-Block C6 Irrigation water added-44.0 cm.			Replicate 2-Block C3 Irrigation water added-59.7 cm.		
	Yield ton/ha.*	Sugar percentage	Sugar ton/ha.*	Sugar ton/ha.*	Sugar percentage	Sugar ton/ha.*
F0	75.8	14.4	10.89	94.4	11.6	10.93
F1	69.9	13.5	9.47	108.8	14.5	15.79
F2	104.7	12.9	13.49	86.3	11.4	9.80
F3	112.2	12.1	13.62	104.2	11.9	12.36
Intermediate Moisture (I2); Planting in Ridge Tops						
Fertilizer Treatment	Replicate 1-Block C4 Irrigation water added-64.4 cm.			Replicate 2-Block C5 Irrigation water added-72.1 cm.		
	Yield ton/ha.*	Sugar percentage	Sugar ton/ha.*	Yield ton/ha.*	Sugar percentage	Sugar ton/ha.*
F0	78.6	10.7	8.41	66.6	12.9	8.61
F1	86.3	13.1	11.32	89.2	13.8	12.28
F2	85.9	11.9	10.25	101.7	14.4	14.67
F3	104.7	12.6	13.14	136.6	13.7	18.66
Highest Moisture (I3); Planting in Ridge Tops						
Fertilizer Treatment	Replicate 1-Block C2 Irrigation water added-74.4 cm.			Replicate 2-Block C1 Irrigation water added-92.8 cm.		
	Yield ton/ha.*	Sugar percentage	Sugar ton/ha.*	Yield ton/ha.*	Sugar percentage	Sugar ton/ha.*
F0	91.2	13.5	10.14	89.4	11.3	12.29
F1	85.8	9.9	8.71	85.0	10.2	8.49
F2	120.0	11.9	14.38	127.7	11.3	13.36
F3	135.2	11.3	13.10	129.2	10.1	15.29

*Metric tons (toneladas) per hectares. Yield is vegetation weight; sugar is "yield" times "percentage sugar."

Table 2. Field layout of sugar cane plots in Las Majaguas, Venezuela. Yield values are "differences" between the estimated yield-fertilizer effects and actual yield values.

Irrigation Block Positions-Top Half of Field					
Planted in ridge tops on this half			Planted in furrow bottoms on this half.		
C1-I3	C3-I1	C5-I2	C7-I3	C9-I2	C11-I3
F3 +9	F0 +14	F2 -3	F3 -31	F1 +22	F0 -6
F0 +9	F1 +4	F3 +17	F0 -8	F2 +8	F2 -4
F2 +22	F3 -16	F0 -14	F1 +32	F3 -7	F1 +6
F1 -10	F2 -19	F1 -6	F2 +7	F0 +13	F3 +12
Irrigation Block Positions- Bottom Half of Field					
C2-I3	C4-I2	C6-I1	C8-I1	C10-I2	C12-I1
F2 +15	F0 -1	F3 -8	F1 -22	F1 +8	F0 -16
F3 +15	F2 -19	F1 -25	F3 -32	F0 +1	F2 -35
F0 -9	F1 -11	F0 -4	F2 -6	F3 -33	F1 +27
F1 +11	F3 -15	F2 -0-	F0 +4	F2 +21	F3 +19

Smoothed curved Fertilizer-yield estimates for ridge planting		Smoothed curved Fertilizer-yield estimates for furrow planting	
F0	80	F0	75
F1	95	F1	90
F2	105	F2	100
F3	120	F3	110

yield and the estimated smooth curve yield for that treatment.

Inspection of the data suggests that a general pattern exists diagonally from lower left (sw) to upper right (ne). Lower than average yields occurred in a slender band across the top half of the field and in a wide band slightly inclined upward across the bottom half of the field. It is known that the field has two different soil series, Aqua Blanca and Algodonal, in irregular association. The variation may be partly soil variations. The pattern seems too regular to be easily explained on the basis of drainage differences or irrigation differences. However, the writers are unable to suggest any cause for the apparent variation-in-yield pattern or a basis of observed or measured characteristics.

Statistical Analysis

Analysis of variance of the sugar cane yields are given in Tables 3, 4, and 5. Both vegetation yield and sugar yield was affected by fertilizer additions. This was established statistically at a 99% confidence level.

Surprisingly, none of the other factors--planting method, irrigation and the interactions--significantly affected yield of vegetation or sugar. The percentage sugar was possibly affected by the planting--irrigation interaction (92% confidence level) and by the planting-irrigation-fertilizer interaction (94% confidence level). Because drying usually increases conversion to sugar, it is possible that differences in irrigation and root position the last three or four months during cane ripening might be related to an increase in sugar. The F-distribution value of 0.20 for irrigation and 0.21 for fertilizers indicates the expected negative relation between sugar percentage and higher levels of irrigation and fertilization. These generalities are well known.

Table 3. Analysis of variance for sugar cane grown in Las Majaguas, Portuguesa State, Venezuela. First crop, planted January 25, 1970, harvested March 8, 1971. Data for yield of cane in metric tons per hectarea.

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F-distribution Value
Planting	1	395.601	395.601	3.776 (less than 20% level)
Error (a)	2	209.553	104.777	
Irrigation	2	956.026	478.013	3.119
P x I	2	640.288	320.144	2.089
Error (b)	4	613.011	153.253	
Fertilizer	3	7,695.438	2,565.146	6.633 **(about(0.4%)
P x F	3	1,738.855	579 618	1.499
I x F	6	1,029.791	171.632	0.444
P x I x F	6	761.932	126.989	0.328
Error (c)	18	6,960.663	386.704	
Total	47	21,001.16	446.833	

Table 4. Analysis of variance for sugar cane grown in Las Majaguas Portuguesa State, Venezuela. First crop, planted January 25, 1970, harvested March 8, 1971. Data for sugar percentage in cane.

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F-distribution Value
Planting	1	2.8519	2.8519	2.640
Error (a)	2	2.1604	1.0802	
Irrigation	2	0.9179	0.4590	0.198
P x I	2	24.991	12.496	5.406 (signif at 8%)
Error (b)	4	9.2458	2.3115	
Fertilizer	3	0.3906	0.1302	0.209
P x F	3	2.3506	0.7835	1.257
I x F	6	4.7987	0.7998	1.283
P x I x F	6	9.5187	1.5865	2.545 (signif at 6%)
Error (c)	18	11.2184	0.6232	
Total	47	330.675	7.0356	

Table 5. Analysis of variance for sugar cane grown in Las Majaguas, Portuguesa State, Venezuela. First crop, planted January 25, 1970, harvested March 8, 1971. Data for sugar yield in metric tons per hectarea.

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F-distribution Value
Planting	1	13.283	13.283	2.236
Error (a)	2	11.881	5.9405	
Irrigation	2	5.9169	2.9585	1.457
P x I	2	7.2633	3.6317	1.789
Error (b)	4	8.1194	2.0299	
Fertilizer	3	103.315	34.4384	5.640**(about 0.8%)
P x F	3	16.851	5.6169	0.920
I x F	6	24.355	4.0592	0.663
P x I x F	6	29.785	4.9642	0.813
Error (c)	18	109.905	6.1058	
Total	47	330.674	7.0356	

The desirable effects of fertilizer in increasing vegetation growth is likely the major cause for a statistically highly significant F-distribution value for fertilizer effects on sugar yield.

Results of a Duncan multiple range test are given in Table 6. Statistically, only dry matter yield is altered by fertilizer treatments. Sugar yield is just barely less than statistically significant at the 95% confidence level. This indicates that fertilizer did increase dry matter content. Although it is less certain, fertilizer probably did increase the sugar yield. However, all three fertilizer levels used were about comparable on sugar yield--all better than the control (F0) but no one of them better than another. The dry vegetation yield was different depending on the amount of fertilizer added. For example, F3 produced significantly more yield than F1 or F2. Yet F2 did not produce more yield than F1. This indicates the probablility of some experimental error. Still, it seems evident that different fertilizer levels did alter yields.

The Duncan's test cannot be applied to irrigation or other treatments because the first requirement is that the analysis of variance of the item to be tested be significant. This did not occur.

Discussion

Several factors entered into the study that might help explain a lack of significance with some of the treatments applied.

1. Irrigation. It is known that in 2-year cane, the reduction of water begins 6 to 8 months before harvest. Obviously, a long "ripening" period results. In this study, irrigation was started only three and a half months before harvest. Considerable rain fell within ten

Table 6. Duncan multiple range tests for selected analyses of the Las Majaguas sugar cane study. Analysis for vegetation yield and sugar yield. Las Majaguas Irrigation System, Venezuela.*

1. Vegetation dry matter yield in the first 12 months

Fertilizer treatment

Code No.	Means	$\bar{X}i-\bar{X}1$	$\bar{X}i-\bar{X}2$	$\bar{X}4-\bar{X}3$	Range	5%	1%
F3	113.69	35.76**	18.78*	16.81*	4	18.1	24.7
F2	96.88	18.95*	1.97		3	17.6	24.0
F1	94.91	16.98*			2	16.8	23.0
F0	77.93						

Critical value=mean difference (dif. of error, range) $\sqrt{\frac{\text{Mean square of error}}{\text{number of observations}}}$

$$= Q\sqrt{\frac{386.70}{12}} = Q(5.66)$$

2. Sugar yield in the first 12 months

Fertilizer treatment

Code No.	Means	$\bar{X}i-\bar{X}1$	$\bar{X}i-\bar{X}2$	$\bar{X}4-\bar{X}3$	Range	5%	1%
F3	11.59	2.15	0.10	-0.02	4	2.28	3.10
F2	11.61	2.17	0.12		3	2.22	3.02
F1	11.49	2.05			2	2.12	2.89
F0	9.44						

Critical value=$Q\sqrt{\frac{6.10}{12}} = Q(0.711)$

*To read, $\bar{X}i-\bar{X}1$ is the fertilizer treatment opposite the number written minus the F0 value. Thus 35.76 is F3-F0; $\bar{X}i-\bar{X}2$ is the fertilizer treatment opposite the number minus the F2 value, thus 16.81 is F3-F2. The numerical limits for statistical significance are in the columns to the right. Range 2 difference between adjacent means, Range 3 difference between means two treatments apart, and Range 4 difference between means of F3 and F0. Reading diagonally lower left to upper right has mean differences at some range level.

weeks of harvest time. This would not permit a long enough dry period for irrigation differentials to be effective. Therefore, the normal season does not lend itself to variable length drying periods for "ripening." It is possible that harvest in April rather than in February or March might permit better ripening control by controlled irrigation to effect a higher sugar percentage.

It seems that for 12-month cane as grown here, the emphasis should be on (1) early growth irrigation to get a rapid start in growth and (2) on other management factors. Certainly, in the drier locations of Venezuela there is a need to still consider irrigation patterns the last six months before harvest.

2. Planting. Cane losses because of poor drainage were not evident. Two important factors were likely responsible for this result. First, the overall year of 1970 was not excessively wet; it was noticeably less wet in the normal wet period of June and July. Second, the area planted has been graded and leveled. Water accumulation was not likely to be extensive in the 100 meter-long runs. Small amounts of damage or growth reduction of furrow plantings may be counteracted by drought-caused losses in the ridge plantings. Losses in ridge plantings could result from excessive drying during the dry periods, and perhaps reduced root extension in the narrow ridge.

3. Fertilizer. Fertilizer treatments improved vegetation yields over those yields of control plots. The response would be lower than in some other soils that could have been selected because the area

used was in cane the year previous to planting and had received uniform fertilization. Unfertilized areas in this crop would likely respond more than expected because of residual fertilizer effects. Thus, differences between fertilizer treatments may be less than would be expected in some adjacent plots.

This cane study is continued into the second year for harvest in March 1972. It will be possible to compare these same treatments on the ratoon crop and through a second year.

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