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## Effect of Harvesting Sugarcane at 12, 14, and 16 Months of Age Upon Yields at Isabela, P.R.<sup>1</sup>

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### INTRODUCTION

It was stated in a previous paper (2) that improved crop management practices might be determinant factors in any effort to substantially increase sugarcane yields. A comparison was made of sugarcane production under the conditions prevailing at the time in Puerto Rico, with the varieties then available, and under typical current soil and crop management practices. The comparison revealed that 12- and 18-month canes were more efficient producers of sugar than 24-month canes. More cane tonnage and more total sugar per acre were obtained during shorter cycles than the 24-month cycle.

This report further elaborates the aspect of age at harvest as related to yields.

### MATERIALS AND METHODS

A field experiment was established at the Isabela Agricultural Experiment Substation farm, in northwestern Puerto Rico. The soil at the experimental site has been classified as Coto clay (4). Coto clay has a pH of around 5.2, a cation exchange capacity of around 6 meq. per 100g. of soil or less in the subsoil, and the sum of exchangeable bases drops from 6.3 meq. in the topsoil to 1.3 meq. in the subsoil. Aluminum ranges from 0.2 to 0.8 meq. and Mg. from 1.8 to 0.8 meq. Mean infiltration at the eighth hour is 3.83 inches per hour (3).

The experiment was laid out following a split-plot design with four replications. The subplots were 20 by 22 feet. Each subplot was separated from the adjacent one by an empty furrow. Eight varieties were included in the experiment: P.R. 980, P.R. 1117, P.R. 1140, P.R. 1166, P.R. 1148, P.R.

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1152, P.R. 1165, and P.R. 1158. These varieties constituted subplots. The three harvest ages tested in the main plots were 12, 14, and 16 months. Thirty three-eye seed pieces were planted per furrow for a total of 120 per plot, i.e., 12,000 to the acre. The cane was planted on February 2, 1968 and harvested in 1969 at 12, 14, and 16 months of age. All plots received a 15-10-5 fertilizer at the rates of 10, 12 and 14 hundredweights to the acre for the 12-, 14- and 16-month canes, respectively. The fertilizer was split into two applications, one half at time of planting and the other half 2 months later for the 12-month cane, and 4 months later for the 14- and 16-month canes. Irrigation, weeding and other cultural practices were performed in accordance with the conventional practices used in the north-western region. The succeeding ratoon crop received the same cultural treatment as the plant crop. It was harvested in 1970 at 12, 14, or 16 months of age following the treatment differentials.

The cane was weighed at harvest time from each plot and a 15-cane

TABLE 1.—*Effect of age at harvest on yields of sugarcane*<sup>1</sup>

Age at harvest	Sucrose	Cane/A	Sugar/A	Cane/A/month	Sugar/A/month
<i>Months</i>	<i>Percent/cane</i>	<i>Tons</i>	<i>Hundredweights</i>	<i>Tons</i>	<i>Hundredweights</i>
12	9.86 a	42.37	80.92 a	3.53 a	6.74 a
14	10.41 b	52.21 a	107.48 b	3.72 a	7.67 a
16	10.89 c	56.06 a	120.92 c	3.50 a	7.55 a

<sup>1</sup> Means with letters in common do not differ significantly ( $P = 0.01$ ).

sample from each plot was taken to determine sucrose percent cane. Based on tonnage and sucrose yields, sugar yield per acre, as well as tons of cane and hundredweights of sugar per acre per month were calculated. Combined yields for a plant cane and a ratoon crop were calculated at the end of the crop cycle. The cropping cycle extended for 24, 28, and 32 months in each respective age at harvest treatment. All the data were statistically analyzed.

## RESULTS AND DISCUSSION

Tables 1, 2, and 3 summarize data on mean production in terms of tons of cane per acre, tons of cane per acre per month, sucrose percent cane, hundredweights of sugar per acre and hundredweights of sugar per acre per month. Letters are used to indicate significant differences between means. Means with letters in common do not differ significantly.

Table 1 summarizes all data without regard to differences between varieties. Production in terms of tons of cane harvested at 16 and 14 months was higher than that recorded at 12 months. The mean differences were highly significant. However, there were no differences as to the efficiency

TABLE 2.—Comparison of mean yields of each variety within each age at harvest<sup>1</sup>

Age at harvest Months	Varieties							
	P.R. 980	P.R. 1117	P.R. 1140	P.R. 1166	P.R. 1148	P.R. 1152	P.R. 1165	P.R. 1158
<i>Cane/A, tons</i>								
12	54.04 a	38.21 abc	41.31 abc	49.64 ab	36.96 bc	40.18 abc	47.96 ab	30.69 c
14	61.72 a	53.73 ab	50.53 abc	63.38 a	43.55 bc	49.41 abc	58.96 ab	36.37 c
16	62.74 ab	54.61 b	53.62 b	71.64 a	57.29 ab	53.68 b	63.34 ab	31.55 c
<i>Sucrose, percent</i>								
12	8.46 c	9.48 bc	11.34 a	9.76 bc	10.25 ab	10.41 ab	8.53 c	10.65 ab
14	9.22 b	10.15 ab	11.70 a	9.40 b	11.41 a	11.40 a	9.33 b	10.66 ab
16	10.13 bc	10.18 bc	11.97 a	10.22 bc	11.27 ab	12.22 a	9.59	11.50 ab
<i>Sugar/A, hundredweights</i>								
12	87.05 ab	70.40 ab	91.18 ab	97.39 a	76.75 ab	81.95 ab	78.91 ab	63.62 b
14	112.69 a	108.82 ab	118.96 a	118.73 a	100.02 ab	113.09 a	110.18 ab	77.38 b
16	128.52 ab	110.74 b	128.28 ab	146.27 a	128.60 ab	130.72 ab	120.36 ab	73.90 c
<i>Cane/A/mo., tons</i>								
12	4.50 a	3.18 bc	3.44 abc	4.13 a	3.08 bc	3.34 bc	3.99 ab	2.55 c
14	4.40 a	3.83 ab	3.60 abc	4.52 a	3.11 bc	3.52 abc	4.21 ab	2.59 c
16	3.92 a	3.41 a	3.35 a	4.47 a	3.58 a	3.35 a	3.95 a	1.97
<i>Sugar/A/mo., hundredweights</i>								
12	7.25 ab	5.87 ab	7.60 a	8.12 a	6.40 ab	6.83 ab	6.56 ab	5.30 b
14	8.05 a	7.77 b	8.50 a	8.48 a	7.16 b	8.08 a	7.87 a	5.53 b
16	8.03 a	6.92 b	8.02 a	9.14 a	8.04 a	8.18 a	7.52 a	4.65 b

<sup>1</sup> Means with letters in common do not differ significantly ( $P = 0.01$ ).

TABLE 3.—*Comparison of mean yields in terms of hundredweights of sugar per acre at each age at harvest, for individual varieties<sup>1</sup>*

Age at harvest	Yields for indicated varieties							
	P.R. 980	P.R. 1117	P.R. 1140	P.R. 1166	P.R. 1148	P.R. 1152	P.R. 1165	P.R. 1158
12 months	87.05 a	70.49	91.18 a	97.39 a	76.75 a	81.95 a	78.91 a	63.62 a
14 months	112.69 ab	108.82 a	118.96 ab	118.73 ab	100.02 ab	113.09 ab	110.18 ab	77.38 a
16 months	128.52 b	110.74 a	128.28 b	146.27 b	128.60 b	130.72 b	120.36 b	73.90 a

<sup>1</sup> Means with letters in common do not differ significantly ( $P = 0.01$ ).

of cane production as evidenced by the mean values of tons of cane per acre per month. In other words, pooling together the data obtained from the combined total yield of the plant and ratoon crops of the eight varieties under study, no significant differences were obtained as regard production of cane per acre per month, when harvested at 12, 14 and 16 months.

The mean differences as to sucrose percent cane were highly significant. Harvesting cane at 12 months of age early in February, resulted in the lowest sucrose yields, but a yield increase of 0.55 percent was registered by early April in the plant cane and in June in the ratoon crops at 14 months. A further increase of 0.48 was obtained when the cane was harvested at 16 months early in June in the plant cane and in August in the ratoon crop. Attention should be called to the fact that the 12-month cane was grown with an application of only 10 hundredweights of fertilizer per acre or  $\frac{5}{6}$  hundredweight per acre per month, whereas the 14- and 16-month old canes received 12 and 14 hundredweights per acre, corresponding to  $\frac{6}{7}$  and  $\frac{7}{8}$  hundredweight per acre per month. In terms of hundredweights of sugar per acre, the differences between means were highly significant, following the same trend as when sucrose percent cane was used as the criterion to evaluate the treatments. Irrespective of variety differences, when the cane was harvested at 16 months, about 13 hundredweights more sugar were produced than at 14 months and 40 hundredweights more than at 12 months. In terms of efficiency of sugar production, that is, based on the data on sugar per acre per month, there were no observable significant differences.

Table 2 summarizes the data for each individual variety in terms of all criteria for the combined data of a plant crop and a ratoon crop. Variety P.R. 1158 was inferior, under Isabela conditions, to all other varieties in terms of tons of cane and hundredweights of sugar per acre. It also was the least efficient of the eight varieties at all harvesting ages. In general terms, there were no differences among the other seven varieties. Any one of them could be suitable for efficient commercial production in the Isabela area, with mean sugar yields per acre ranging from 70 to 97 hundredweights at 12 months, 100 to 119 hundredweights at 14 months, and 111 to 146 hundredweights at 16 months. In terms of efficiency in sugar production (cwts./A/mo.), values ranged from 5.9 to 8.1 at 12 months, 7.2 to 8.5 at 14 months, and 6.9 to 9.1 at 16 months.

Table 3 shows the performance of individual varieties in terms of hundredweights of sugar per acre at each of the three harvesting ages. Varieties P.R. 980, P.R. 1140, P.R. 1166, P.R. 1148, P.R. 1152 and P.R. 1165 performed better when harvested at 16 than at 12 months of age. Mean differences were highly significant. No significant differences were observed between mean yields at either 12 or 14 months or at 14 and 16 months.

Variety P.R. 1117 performed better when harvested at both 14 or 16 than at 12 months of age. Age at harvest did not influence sugar yields of variety P.R. 1158.

Detailed data for each crop year, each cropping cycle, and each variety are given in tables 4, 5, 6, 7, and 8. Differences are not discussed in the text but may well be of value to those interested in sugarcane production in the Isabela area.

TABLE 4.—Tons of cane per acre from each crop for each age at harvest

Age at harvest	Yields for indicated varieties							
	P.R.980	P.R.1117	P.R.1140	P.R.1166	P.R.1148	P.R.1152	P.R.1165	P.R.1158
12 months								
Plant crop	65.32	45.82	49.79	55.90	36.04	45.84	57.25	36.29
First ratoon	42.77	30.61	32.82	43.39	37.89	34.52	38.68	25.10
14 months								
Plant crop	65.74	53.94	53.48	62.89	39.73	49.55	58.66	43.24
First ratoon	57.71	53.52	47.59	63.87	47.38	49.64	58.91	25.24
16 months								
Plant crop	70.45	45.82	55.60	74.29	55.45	56.72	62.07	47.51
First ratoon	55.05	52.13	53.10	65.14	54.39	59.36	56.34	26.58

TABLE 5.—Tons of cane per acre per month from each crop for each age at harvest

Age at harvest	Yields for indicated varieties							
	P.R.980	P.R.1117	P.R.1140	P.R.1166	P.R.1148	P.R.1152	P.R.1165	P.R.1158
12 months								
Plant crop	5.44	3.82	4.15	4.66	3.00	3.82	4.77	3.02
First ratoon	3.56	2.55	2.74	3.62	3.16	2.88	3.22	2.09
14 months								
Plant crop	4.70	3.85	3.82	4.49	2.84	3.54	4.19	3.39
First ratoon	4.12	3.82	3.40	4.56	3.38	3.55	4.21	1.80
16 months								
Plant crop	4.40	2.87	3.48	4.64	3.47	3.55	3.88	2.70
First ratoon	3.44	3.26	3.32	4.07	3.40	3.71	3.52	1.66

In general terms, the results of this experiment showed that in the Isabela area most sugarcane varieties increase in sucrose content up to 16 months of age, which was the maximum age of harvest in this study. Operations should not be scheduled to harvest cane too young in age. These results confirm those previously obtained by Capó<sup>3</sup> who demonstrated that harvesting variety P.R. 980 at 12 months deprived the crop of the most efficient and probably least expensive period of sugar production, a

<sup>3</sup> Personal communication to the senior author, May 1969.

TABLE 6.—*Sucrose percent cane from each crop for each age at harvest*

Age at harvest	Yields for indicated varieties							
	P.R. 980	P.R. 1117	P.R. 1140	P.R. 1166	P.R. 1148	P.R. 1152	P.R. 1165	P.R. 1158
<b>12 months</b>								
Plant crop	6.68	8.20	9.63	8.79	8.07	8.80	6.91	8.32
First ratoon	9.62	11.05	11.31	10.62	11.69	12.03	9.40	11.12
<b>14 months</b>								
Plant crop	9.25	9.74	11.64	8.96	10.54	10.30	8.80	10.47
First ratoon	9.21	10.56	11.78	9.86	12.29	11.60	10.77	10.86
<b>16 months</b>								
Plant crop	10.64	9.33	12.39	10.13	11.46	11.45	10.19	11.78
First ratoon	10.26	10.77	13.06	10.74	12.43	12.01	10.16	12.99

TABLE 7.—*Hundredweights of sugar per acre from each crop for each age at harvest*

Crop cycle	Yields for indicated varieties							
	P.R. 980	P.R. 1117	P.R. 1140	P.R. 1166	P.R. 1148	P.R. 1152	P.R. 1165	P.R. 1158
<b>12 months</b>								
Plant crop	86.97	74.90	96.84	101.23	59.59	81.01	79.63	62.04
First ratoon	87.13	66.08	85.53	93.56	93.91	82.89	78.21	65.21
<b>14 months</b>								
Plant crop	121.36	105.41	124.62	112.76	83.34	102.79	103.17	100.12
First ratoon	104.03	112.22	113.31	124.71	116.71	114.91	125.69	54.64
<b>16 months</b>								
Plant crop	149.85	106.41	138.09	150.33	127.48	127.96	125.85	101.85
First ratoon	107.20	115.08	117.88	137.88	126.83	139.95	102.60	59.59

TABLE 8.—*Hundredweights of sugar per acre per month from each crop for each age at harvest*

Age at harvest	Yields for indicated varieties							
	P.R. 980	P.R. 1117	P.R. 1140	P.R. 1166	P.R. 1148	P.R. 1152	P.R. 1165	P.R. 1158
<b>12 months</b>								
Plant crop	7.25	6.24	8.07	8.43	4.97	6.75	6.64	5.17
First ratoon	7.26	5.51	7.13	7.80	7.83	6.91	6.52	5.43
<b>14 months</b>								
Plant crop	8.67	7.53	8.90	8.05	5.95	7.34	7.37	7.15
First ratoon	7.43	8.02	8.09	8.91	8.34	8.21	8.98	3.90
<b>16 months</b>								
Plant crop	9.37	6.65	8.63	9.40	7.97	8.00	7.87	6.37
First ratoon	6.70	7.19	7.37	8.62	7.93	8.75	6.41	3.72

period which may continue to 14 months or more in the north coast. According to Alers (1), the situation can be stated simply by saying that the greatest proportion of synthesized sugar is stored in the cane only after the main stalks have developed fully and the rate of stalk elongation decreases.

However, considering the conditions under which this experiment was conducted, it still remains to be determined if age at harvest is the determinant factor in sugar production, whether differences in production can be attributed to differences in fertilizer application, to weather conditions immediately prior to the time of harvesting, or possibly to influence of all these factors together.

#### SUMMARY

The data presented in this paper were obtained from a field experiment conducted at Isabela in northwestern Puerto Rico, employing a split plot design in which the age of the sugarcane at harvest (12, 14, and 16 months) was tested in the main plots and eight varieties in the subplots. The varieties were: P.R. 980, P.R. 1117, P.R. 1140, P.R. 1166, P.R. 1148, P.R. 1152, P.R. 1165, and P.R. 1158. Four replications were used.

A statistical analysis of the data revealed that higher sugar yields were obtained when the cane was harvested at 16 rather than at 14 or 12 months of age under the conditions prevailing at Isabela and irrespective of variety. Yields also were higher at 14 than at 12 months. These differences were highly significant.

#### RESUMEN

En este trabajo se presentan los datos obtenidos de un experimento de campo con caña de azúcar establecido en Isabela, en el noroeste de Puerto Rico. Se utilizó un diseño de parcelas divididas en el que la edad de la caña al cosecharse (12, 14 y 16 meses) constituía la variable en las parcelas principales, las cuales se subdividieron para acomodar la otra variable, variedades de caña. Se estudió el comportamiento de las siguientes variedades: P.R. 980, P.R. 1117, P.R. 1140, P.R. 1166, P.R. 1148, P.R. 1152, P.R. 1165 y P.R. 1158. Cada tratamiento se repitió cuatro veces. Los estudios estadísticos de los datos obtenidos revelaron que, bajo las condiciones que prevalecen en Isabela e independientemente de la variedad, los rendimientos de azúcar fueron más elevados cuando las cañas se cosecharon a los 16 meses de edad que a los 14 y 12 meses, e igualmente más elevados a los 14 meses que a los 12. Estas diferencias fueron altamente significativas.

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