

The Effect of Elevation on the Sucrose Content of Sugarcane

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INTRODUCTION

In Puerto Rico sugarcane is grown under a wide range of climatic conditions, rainfall being the main variable, in a large number of soil types with many extreme soil conditions, and at various altitudes ranging from almost sea level to over 1,500 feet. A large number of varieties are grown and there are differences in fertilization and other cultural practices. The variability in sucrose yields is rather large with many extremely low levels. Studies are under way with the objective of determining the fundamental reasons underlying those variations. In previous and forthcoming papers (2,3,6)² the influences of weather and climate, varieties, and fertilizer upon sucrose yields at harvesttime have been and will be reported and discussed.

It has been observed by many agriculturists that sugarcane grown at higher elevations yields juices richer in sucrose than when grown at lower altitudes. However, very little information is to be found in the available literature. Quintus (4) reported: "Besides rainfall, elevation above sea level affects the formation of saccharose. On estates situated at a high elevation, less cane is always produced, which disadvantage is partly or wholly made up by a greater sugar percent". In 1919, a report from Hawaii (5) recognized that, although there were differences in the behavior of cane varieties grown at different elevations, most varieties produced maximum sucrose at elevations of around 1,500 feet. The influence of elevation upon the sugarcane plant is, in all probability, closely related to climatic influences, particularly temperature. Geerligs (1) reported: "On plantations situated considerably above sea level the low night temperatures stop the growth and promote ripening".

This paper presents data to show the effect of elevation upon the sucrose content of sugarcane grown in Puerto Rico.

MATERIALS AND METHODS

Data covering the period 1939-49 were gathered from a large number of commercial fields of east-central Puerto Rico. Elevations were obtained for each field by superimposing topographic maps over field-distribution maps. They were subsequently spot-checked with a Short and Mason aneroid barometer. The data were classified and grouped by varieties and altitude

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² Numbers in parentheses refer to Literature Cited, p. 131.

intervals, disregarding climatic and edaphic differences. However, rainfall differences were not marked over most of the area studied and the differences in mean temperature were slight. Variations in soil types were numerous. Four sugarcane varieties were included in the study, namely, P.O.J. 2878, B.H. 10(12), P.R. 803, and F.C. 916. The study includes data from 695 crops harvested during the 10-year investigation period at the various altitude intervals in an attempt to explain at least some of the variability observed.

RESULTS AND DISCUSSION

Table 1 summarizes the study of the relation between sucrose content at harvesttime and field elevation. The over-all picture indicates that sugarcane grown at lower elevations tends to contain less sucrose than that grown at higher elevations. In general, the main differences occur in canes grown 1 to 10 m. above mean sea level and canes grown at the highest elevations studied. The differences among the other class intervals are negligible. A differential response among varieties can also be observed in table 1. Some varieties like P.O.J. 2878 and P.R. 803 yielded juices of very low sucrose content when grown at elevations ranging from 1 to 10 m. above mean sea

TABLE 1.—*Mean yields of available 96° sugar-percent-cane of 4 sugarcane varieties when grown at various elevations*

Variety and number of crops	Elevation (m.)	Available 96° sugar yields
		<i>Percent-cane</i>
Variety P.O.J. 2878:		
35	1-10	9.48
170	10-100	11.52
97	100-200	11.61
49	200-400	11.72
Variety B.H. 10(12):		
170	1-10	11.30
47	10-100	12.13
24	100-200	12.01
Variety P.R. 803:		
6	1-10	9.42
15	10-100	11.57
23	100-200	12.04
Variety F.C. 916:		
7	1-10	10.63
6	10-100	11.56
All varieties:		
242	1-10	10.94
259	10-100	11.62
144	100-200	11.79
50	200-400	11.78

TABLE 2.—*Monthly fluctuations in maximum, minimum, and mean temperature (°F.) at 2 selected stations located at different elevations*

Months	Temperature at indicated locations					
	Humacao (low elevation)			Cayey (high elevation)		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
January.....	83.2	59.8	72.3	85.0	51.0	68.4
February.....	84.7	58.3	72.4	85.2	50.0	68.2
March.....	87.0	59.0	74.3	86.8	50.7	70.6
April.....	87.8	61.3	76.1	88.2	53.4	72.0
May.....	88.5	66.3	78.7	90.5	56.5	74.2
June.....	88.8	69.7	79.9	88.8	61.8	75.6
July.....	89.7	69.5	79.8	89.4	62.5	75.5
August.....	91.5	70.2	80.2	90.4	60.6	75.3
September.....	90.6	69.2	78.9	88.8	60.3	75.2
October.....	90.0	68.2	78.4	88.8	60.0	75.0
November.....	87.2	64.2	75.9	88.2	59.7	73.4
December.....	84.0	60.8	73.6	87.0	54.8	70.9

level. Others produced juices of better quality. The differences in sucrose yields among the leading varieties commercially grown in Puerto Rico have already been discussed (3).

Table 2 gives the monthly temperatures at two selected stations representative of low and high sugarcane-producing areas: Humacao, on the east coast, and Cayey in the east-central mountains. In general, there is a difference in mean temperatures of about 4°F. between the two stations. Differences in maximum temperatures are negligible, but differences in minimum temperatures are of the order of 8°F. on the monthly basis. Thus the sugarcane planted at high altitudes enjoys about the same benefits from sunlight, as measured by "total day-degrees"³, with the added advantage of much cooler nights than the sugarcane planted on low sites. Hence, the beneficial effect of relatively high altitudes upon sucrose yields may reflect the influence of cool nights. There is also the possibility of some parallelism between the effects of elevation and soil conditions.

SUMMARY

Data are presented to show the influence of elevation on sucrose yields of four varieties of sugarcane: P.O.J. 2878, B.H. 10(12), P.R. 803, and F.C. 916. An over-all examination of the data from 695 crops harvested during a 10-year period, 1939-49, disclosed that elevations higher than 10 m. above mean sea level favor high sucrose accumulation in sugarcane. This effect

³ Degrees above 70°F. for a given period.

was more pronounced with some varieties than with others. This influence of altitude is probably a reflection of climatic effects. Data are presented to show that cane growing at high elevations within a given area, enjoys about the same benefits from sunlight, as measured by "total day-degrees", with the added advantage of cooler nights.

RESUMEN

En este trabajo se presentan datos que demuestran cómo influye la altitud a que se siembra la caña de azúcar sobre sus rendimientos de sacarosa. Cuando se hace un estudio de estos datos se percibe el hecho de que la caña que se siembra a más de 10 m. sobre el nivel del mar produce jugos más ricos en sacarosa que la de sitios más bajos. Este efecto de la altura sobre el mayor o menor contenido de sacarosa en la caña es con toda probabilidad una acción refleja de los efectos del clima.

Específicamente se aportan datos que señalan que la caña de azúcar en sitios altos, además de recibir los efectos beneficiosos de la radiación solar de igual manera que la que crece a menor altitud, también recibe los efectos de una temperatura más baja durante la noche.

LITERATURE CITED

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