Performance of Commercial Sugarcane Varieties in the Aguirre Clay Soil of the Lajas Valley[1]

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ABSTRACT

The data recorded during a plant cane crop and the first ratoon of an experiment established on Aguirre clay, a Vertisol of the Lajas Valley, indicate that NCo 310, PR 980 and PR 1013 performed better than the other commercial varieties based on sugar production. Agronomic characteristics, such as germination and ratooning ability, number of stalks per linear foot, and resistance to deterioration, were also determined.

INTRODUCTION

The main crop under cultivation in the Lajas Valley is sugarcane, covering approximately 16,000 out of the total of 20,000 acres. Most of the area is cultivated by the Sugarcane Corporation of Puerto Rico, but there are some private farmers who make a significant contribution to the total production of the valley. The average sugarcane production is about 29 tons/acre on the irrigated lands and 15 on nonirrigated.

The major soils of the valley exhibit certain common characteristics (2). They are deep soils with a high, almost uniform clay content with predominantly small pores and a very slow hydraulic conductivity in the subsoil. The depth of the top soil is ordinarily about one foot, but in a few cases it reaches two feet. These soils are high in soluble salts and exchangeable sodium, particularly below the upper 24-in depth. Topography favors the mechanization of all cultural and harvesting operations as well as the irrigation system.

The main commercial varieties of the zone are PR 980, B 49-119, PR 1028 and PR 1013 (3).

Rainfall is between 20 and 40 in/year (table 1), normally heavier between August and November. The prevailing moisture conditions of the Lajas Valley reduce productivity of sugarcane unless proper management is used. In most fields, ratoon deterioration is observed, which indicates the necessity of adopting special cultural practices. Appropriate varieties must be grown in order to obtain high productivity in the valley. Most of the present commercial varieties adapt well to other sugarcane areas of the Island, but not to the Lajas Valley. There are

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TABLE 1.—*Monthly distribution of rain in the Lajas Valley during years 1969, 1970, and 1971*

Month	1969	1970	1971
January	2.23	1.89	0.35
February	0.68	1.00	1.28
March	0.92	0.00	0.10
April	0.99	1.62	2.17
May	8.57	4.04	3.76
June	1.25	3.96	1.28
July	3.05	0.58	0.58
August	3.72	5.79	7.46
September	5.05	7.40	1.36
October	5.13	10.96	6.28
November	7.66	5.94	3.16
December	3.31	0.61	2.06
Total	42.56	43.79	29.84

only a few varieties that seem to be tolerant of the physical and chemical properties of the main soil series of the Lajas Valley.

The purpose of this experiment was to evaluate variety performance under the conditions prevailing in the valley and to determine how some agronomic characteristics affect variety productivity during the plant cane and the first ratoon crops.

MATERIALS AND METHODS

A variety experiment was established at the Lajas Valley in an Aguirre clay. This soil is typical of the lower parts of the Valley and is classified as a Vertisol, an Udic, Pellusterts, fine, mixed, isohyperthermic (5). It has a dark gray, black, or very dark brown clay surface layer and a light olive or olive gray subsoil. It is sticky and plastic when wet (4). When dried, it develops self-mulching characteristics in the surface layer and cracking down to the lower profile. It is of medium fertility and highly calcareous, and is occasionally high in salts.

Sixteen commercial sugarcane varieties were included in the experiment. A partially balanced incomplete block design replicated six times was used. Plot size consisted of four rows five feet apart and 20 feet long.

The experiment was planted on March 1969 and no replanting of gaps was practiced. A 14-4-10 fertilizer was applied previous to planting at a rate of 1000 lb/acre. Rainfall data were recorded. The field was irrigated once with one-half acre-foot of water. The plant cane was harvested in April 1970 at 13 months. The experimental data recorded were based on the following criteria:

Germination and erectness were graded on the basis of a scale of values from one to five, where one denotes superior germination and erect growth. The tillering capacity was determined by stalk counts on

the two center rows when the plants were ten months old. Stalk height and diameter were measured from random samples of ten canes/plot.

Maturity index was determined from Brix refractometric readings. Juice was sampled at the base and the top internodes of five canes of each plot taken at random every 15 days, starting in December. Maturity index was determined using the following formula:

$$\text{Maturity index} = \frac{\text{Brix top}}{\text{Brix base}} \times 100$$

At harvest, plots were hand-cut and individually weighed, and sucrose was determined by means of mill analysis. Crop deterioration was determined during the second ratoon by measuring the gaps per plot where varieties failed to ratoon. No further data were recorded from the second ratoon.

The first ratoon crop was harvested at 12 months. Data similar to that in the plant cane were recorded.

Statistical analyses for juice sucrose content, tons of cane, and tons of sugar per acre of the plant cane and a first ratoon crop were made.

RESULTS

Data on sucrose content, tons of cane, and tons of sugar per acre for the plant cane crop are given in table 2. Sucrose content of PR 1059 and

TABLE 2.—*Mean yields of sucrose, tons of cane and tons of sugar per acre of a plant cane crop in a variety experiment conducted at the Lajas Valley*

Variety	Sucrose content	TCA[1]	TSA[2]
	%		
PR 1059	13.85 a[3]	43.88 abcd	6.23 a
PR 1013	11.94 bc	48.88 ab	5.85 a
PR 980	12.24 bc	47.63 abc	5.77 a
NCo 310	12.00 bc	47.17 abcd	5.68 a
PR 1002	11.66 bc	49.10 ab	5.62 ab
B 49-119	11.07 a	50.34 a	5.60 ab
B 42-231	11.14 c	48.87 ab	5.42 abc
H 50-7209	10.86 c	47.48 abcd	5.15 abc
H 32-8560	12.91 ab	38.98 abcde	5.04 abc
CP 52-43	13.77 a	35.82 cde	4.97 abc
PR 1117	10.89 c	44.97 abcd	4.91 abc
PR 1028	12.49 abc	39.65 abcde	4.84 abc
PR 62-258	12.39 abc	36.10 bcde	4.39 abc
PR 1048	10.98 c	37.55 abcde	4.00 bcd
PR 1016	11.97 bc	33.40 de	3.92 cd
PR 1085	8.97 d	29.62 e	2.69 d

[1] Tons of cane per acre.

[2] Tons of sugar per acre.

[3] Values followed by the same letter are not significantly different at the 5% level.

CP 52-43 was significantly higher than that of eleven other varieties. PR 1085 was outyielded by all the varieties tested. B 49-119, PR 1002, PR 1013 and B 42-231 produced significantly higher tonnages of cane per acre than CP 52-43, PR 1016, and PR 1085. On the basis of tons of sugar per acre, PR 1059, PR 1013, PR 980, and NCo 310 were significantly higher than PR 1048, PR 1016, and PR 1085. No significant differences were observed among most of the varieties.

The results on sucrose content, tons of cane, and tons of sugar per acre for the first ratoon crop are given in table 3. NCo 310 and PR 1016 sucrose percentages were significantly higher than B 42-231, H 32-8560, PR 1013, B 49-119, and H 50-7209. No significant difference was observed in tonnage of cane per acre among fourteen varieties. NCo 310, PR 980, and PR 1013 produced the higher tonnages of cane but these were significantly higher than PR 1059 and PR 1048 only.

NCo 310, PR 980, PR 1013, and B 42-231 were the leading varieties on the basis of tonnage of sugar, with mean yields of 3.14, 2.77, 2.59, and 2.58 tons, respectively. NCo 310 was significantly higher than B 49-119, PR 1059, H 32-8560, PR 1048, and H 50-7209.

The relation of the sucrose content between the plant cane crop and the first ratoon showed a consistent reduction in the first ratoon for all varieties except for PR 1085. A similar pattern was observed in tonnage of cane with the greatest reductions observed in B 49-119, PR 1059, PR 1002, B 42-231, PR 1117, and H 50-7209, fluctuating from 21 to 27 tons of cane per acre. The relation of the sugar produced during the first ratoon

TABLE 3.—*Mean yields for sucrose, tons of cane and tons of sugar per acre in the first ratoon crop in a variety experiment conducted in the Lajas Valley*

Variety	Sucrose content	TCA	TSA
	%		
NCo 310	10.53 a[1]	30.10 a	3.14 a
PR 980	9.11 abc	29.60 a	2.77 ab
PR 1013	8.65 bcd	29.53 a	2.59 abc
B 42-231	8.94 bc	27.97 ab	2.58 abc
CP 52-43	9.95 ab	24.33 abc	2.49 abc
PR 1016	10.48 a	23.10 abc	2.44 abc
PR 1002	9.25 abc	25.82 abc	2.42 abc
PR 1117	9.70 abc	23.73 abc	2.36 abc
PR 62-258	9.82 abc	21.73 abc	2.25 abc
PR 1028	9.30 abc	23.77 abc	2.21 abc
PR 1085	10.00 ab	21.59 abc	2.14 abc
B 49-119	8.38 bcd	22.97 abc	1.97 bc
PR 1059	9.39 abc	20.01 bc	1.95 bc
H 32-8560	8.71 bcd	22.00 abc	1.91 bc
PR 1048	9.37 abc	17.84 c	1.74 bc
H 50-7209	7.50 d	21.68 abc	1.57 c

[1] See footnote 3, table 1.

and the plant crop indicated that PR 1059, B 49-119, H 50-7209, PR 1013, PR 1002, H 32-8560, and PR 980 had reductions of at least three tons per acre from plant crop to first ratoon.

The percentage of plantless areas or gaps after the first ratoon varied with different varieties as follows:

NCo 310	8.5
PR 1002	13.5
PR 1013	15.5
PR 980	18.7
B 42-231	20.1
CP 52-43	23.2
PR 1016	25.0
PR 1117	28.8
H 32-8560	30.8
H 50-7209	33.2
PR 62-258	33.6
PR 1048	34.3
PR 1028	37.2
PR 1059	39.1
B 49-119	40.1
PR 1085	54.2

Varieties less affected were NCo 310, PR 1002, PR 1013, PR 980, and B 42-231, with 8.5, 13.5, 15.5, 18.7, and 20.1% of gaps, respectively. PR 1059, B 49-119, and PR 1085 were severely affected, with 39.1, 40.1, and 54.1%, respectively.

Maturity indexes of the plant crop are presented in figures 1 and 2. Seven varieties attained 90% maturity during December or January. These varieties were cataloged as early. The others attained 90% maturity from February to April and were cataloged as intermediate to late.

Mean values for number of stalks per linear meter, stalk diameter, and height for both plant cane and first ratoon are presented in table 4. NCo 310 produced a significantly higher number of stalks per linear meter than the remaining varieties in both crops. B 49-119 was the second highest in stalk number in the plant cane, but this decreased significantly in the first ratoon. Stalk number for PR 980, PR 1013, CP 52-43, PR 1028, and PR 1059 did not reflect significant differences between plant cane and the first ratoon. Stalk diameter was not significantly affected by the crop cycle. However, plant height was severely reduced during the first ratoon as compared to the plant cane crop.

Correlations studies on number of stalks per linear meter, stalk diameter, and height were significantly correlated between plant cane,

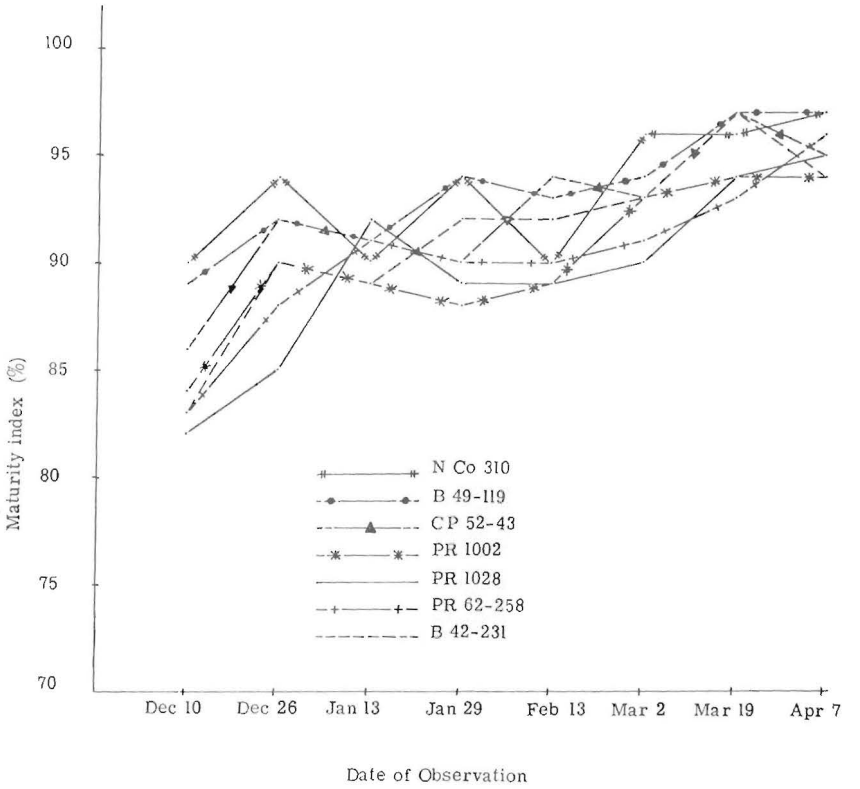

FIG. 1. – Maturity performance of early varieties.

and the first ratoon, with coefficients of 0.63, 0.34, and 0.49, respectively.

Data on germination, ratooning ability and erectness are presented in table 5.

DISCUSSION

Data reported in this paper indicate that most of the commercial sugarcane varieties grown in other ecological zones of the Island perform very poorly when grown under conditions prevailing in the Lajas Valley, when not complemented by adequate irrigation. Sweet varieties such as PR 1059, CP 52-43, H 32-8560, PR 1028, and PR 62-258 produced poor tonnages of sugar per acre, while high tonnage varieties were poor in sucrose content, as was observed in B 49-119, PR 1002, PR 1013, B 42-231, and PR 980. Using total sugar of the plant cane crop calculated on the basis of sucrose content and tonnage of cane, PR 1059 was the

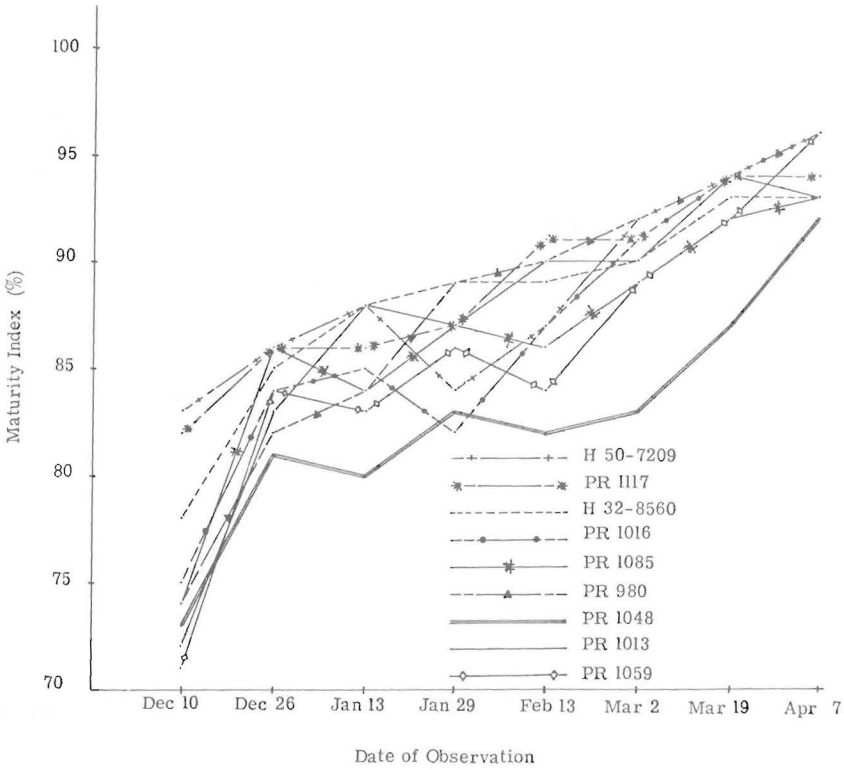

FIG. 2.—Maturity performance of intermediate and late varieties.

leading variety followed by PR 1013, PR 980, and NCo 310, but there were no significant differences among them. B 49-119 and B 42-231, two commercial varieties of the Valley, ranked sixth and seventh in the order of merit based on total sugar. PR 1048, PR 1016, and PR 1085 performed very poorly, producing less than 70% of the total sugar produced by PR 980.

During the first ratoon crop, NCo 310 produced the best juice quality and the highest tonnage of cane and of sugar per acre. In general, both sucrose content and tonnage of cane were sharply reduced during the first ratoon, probably due to unfavorable climatic conditions during the second year. However, a great variability among varieties was observed, indicating a well-defined variety-environment interaction. Although reduction of cane tonnage in successive crops is normally expected, the changes observed indicated that most of the varieties tested did not adapt well to the soil and climatic conditions prevailing in the Valley. NCo 310, PR 980, and PR 1013 were the least affected in their producing capacity during the first ratoon. This fact indicates that

TABLE 4.—*Mean values of three stalk characteristics in a plant cane crop and the first ratoon*

Variety	Stalk Characteristics					
	Plant cane			First ratoon		
	Stalks per linear meter	Diameter	Height	Stalks per linear meter	Diameter	Height
	No.	*Cm*	*M*	*No.*	*Cm*	*M*
PR 980	7.9 ab[1]	2.80 bc	2.62 abc	7.7 b	2.61 abc	1.64 abcd
PR 1013	7.2 abc	2.69 bc	2.68 abc	8.5 b	2.61 abc	1.69 ab
PR 1016	5.8 d	2.90 abc	2.34 bc	5.8 cd	2.88 a	1.54 bcd
PR 1028	6.9 bc	2.60 bc	2.37 bc	7.3 bc	2.86 a	1.62 abcd
PR 1048	5.9 d	2.86 abc	2.42 abc	5.8 cd	2.48 abc	1.41 cd
PR 1059	7.9 ab	2.58 c	2.41 bc	7.3 bc	2.28 c	1.40 d
PR 1117	6.2 c	3.22 a	2.81 a	5.3 d	2.83 a	1.70 ab
PR 1002	8.1 ab	3.05 ab	2.47 abc	6.0 cd	2.88 a	1.66 abcd
B 42-231	6.2 c	3.26 a	2.78 ab	5.3 d	2.72 ab	1.87 a
CP 52-43	8.1 ab	2.67 bc	2.47 abc	7.7 b	2.58 abc	1.50 bcd
B 49-119	9.1 a	2.85 abc	2.61 abc	7.1 bc	2.52 abc	1.56 bcd
H 32-8560	5.6 d	2.97 abc	2.54 abc	5.8 cd	2.81 a	1.68 abc
PR 62-258	6.2 c	2.84 abc	2.70 abc	7.3 bc	2.52 abc	1.62 abcd
NCo 310	9.4 a	2.65 bc	2.42 bc	10.0 a	2.33 bc	1.51 bcd
PR 1085	4.3 d	3.0 ab	2.30 c	4.7 e	2.90 a	1.66 abcd
H 50-7209	5.8 d	2.97 abc	2.68 abc	3.4 e	2.80 a	1.75 ab

[1] Mean values with one or more letters in common do not differ significantly at the 5% level.

TABLE 5.—*Variety performance on germination, ratooning, and erectness during the plant cane crop and the first ratoon*

Variety	Plant Cane		First ratoon	
	Germination[1]	Erectness[2]	Ratooning	Erectness
PR 980	2	2	2	2
PR 1013	2	2	2	2
PR 1016	4	2	3	2
PR 1028	4	2	4	2
PR 1048	4	1	4	1
PR 1059	2	1	4	1
PR 1117	3	2	3	2
PR 1002	2	3	2	3
B 42-231	2	3	3	4
CP 52-43	2	1	3	1
B 49-119	2	2	5	1
H 32-8560	4	3	4	3
PR 62-258	4	2	4	1
NCo 310	1	2	1	2
PR 1085	5	2	5	3
H 50-7209	3	5	4	5

[1] 1 denotes superior germination; 5 very poor.

[2] 1 denotes erect stalks; 5 recumbent.

apparently they are more tolerant of the ecological conditions of the Valley than are the rest of the varieties tested.

Poor adaptability of varieties was well detected in their germination and ratooning ability. Germination percentages of PR 1085, PR 62-258, H 32-8560, PR 1048, PR 1028, and PR 1016 were very low. The failure of these varieties to produce a uniform stand of canes was also responsible for their poor performance. NCo 310, PR 980, and PR 1013 exhibited a superior germination and tillering capacity during the first crop, producing from 47 to 50 tons of cane per acre. Germination and ratooning ability were apparently affected by the prevailing conditions of the zone, since the varieties tested, when they grow in other ecological zones, exhibit good agronomic characteristics.

The failure of some varieties to ratoon was evident in PR 1059 and B 49-119 which had good germination during the plant cane but deteriorated during ratoon crops, as evidenced by 40% of plantless, bare plot area. Varieties NCo 310, PR 980 and PR 1013 produced the highest cane tonnage and also exhibited the best ratooning ability. Ratoon deterioration is indicative of the poor adaptability of most of the commercial varieties tested. In general, those varieties having the best germination and ratooning ability were the best performers on the basis of sugar production.

Differences in stalk number per plot (tillering) between plant cane and first ratoon were observed. However, the highly significant correlation coefficients obtained, indicated that tillering capacity of varieties was uniformly affected by the conditions prevailing during both crop years.

The number of internodes per stalk, in general, was uniformly reduced during the ratoon crop at a rate of approximately 25%. Stalk diameter was also reduced during the ratoon crop, but changes were less than 10%.

No appreciable difference in stalk height was observed between plant cane and first ratoon. PR 1028, B 42-231, CP 52-43, and PR 1085 had a slight increase in height during the ratoon, but in general, most of the varieties reflected a reduction of about 0.1 to 0.2 meter.

The differences observed in agronomic characteristics between successive crops were very close to what was expected. Maturity did not account for the differences observed in juice quality or in total sugar produced. Determinations of maturity indexes during harvesting time indicate that all the varieties were at their optimum maturity (93 to 97%) when harvested. Nor was sucrose deterioration observed in the early varieties. Based on maturity indexes, varieties were grouped in two classes: Those attaining 90% maturity in early December or in January were classified as early maturing. Those which attained 90%

maturity during February, March, or April were classified as intermediate to late maturing.

Under Lajas conditions, varieties do not flower profusely. Even those varieties that tassel in other areas, such as NCo 310, CP 52-43, PR 1028, and PR 1002, produced only a few tassels. This might be an explanation for the keeping quality of the juice of early varieties which did not show deterioration even when they were harvested in April.

Considering total sugar per acre, the best performing varieties were NCo 310, PR 980, PR 1013, PR 1059, and PR 1002. It has been demonstrated that PR 1059 performed well during plant cane, but its first ratoon is very poor, exhibiting a fast deterioration which disqualifies it as a commercial variety for the Valley. PR 1002 ranked fifth, but since it exhibited undesirable growth habits, it is unsuitable for mechanical harvesting. Most of the cane in this zone is harvested with "soldier type" machines.

The data reported from this experiment indicate that only a few of the commercial varieties grown in the Island perform well in the ecological conditions prevailing in an extensive area of the Lajas Valley, when not adequately irrigated. A large number of clones have been tested during the last years[3, 4] (1) under similar conditions, but they have not outyielded varieties NCo 310, PR 980, and PR 1013.

RESUMEN

En un experimento realizado en un suelo de la serie Aguirre en el Valle de Lajas, se evaluó el comportamiento agronómico de 16 variedades comerciales de caña de azúcar con el propósito de determinar la adaptabilidad de dichas variedades a las condiciones ecológicas que prevalecen en gran parte del Valle. El suelo Aguirre arcilloso se caracteriza por un desagüe interno defectuoso y muchas veces presenta problemas de altas concentraciones de sales.

Las cañas se cosecharon durante dos años, obteniendo datos de una plantilla de 13 meses y un primer retoño de 12, cosechado en abril. Se recopiló información sobre rendimiento, toneladas de caña y de azúcar por acre, germinación, retoñamiento, características del tallo (grueso, altura), hábito de crecimiento, índice de madurez, número de cañas y deterioro del retoño.

Las variedades NCo 310, PR 980 y PR 1013 produjeron mayor cantidad de azúcar por cuerda a base del promedio de producción de las cosechas de plantilla y del primer retoño. La PR 1059 se comportó muy bien en la plantilla tanto en toneladas de caña como de azúcar por cuerda, pero en el primer retoño su producción de azúcar disminuyó a aproximadamente un 31%.

La B 49-119, variedad sembrada en gran escala comercial en el Valle, por ser supuestamente tolerante a la salinidad, figuró la número ocho en la escala de mérito basada en azúcar por acre, pues produjo 14% menos azúcar que la NCo 310. Las variedades PR 1002 y B 42-231 figuraron en quinto y sexto lugar, respectivamente. El hábito de crecimiento reclinado de ambas variedades las descualifican para siembras comerciales en el Valle.

Los datos recopilados sobre el deterioro del retoño reflejan que las variedades de mayor producción fueron las menos afectadas, indicando ser más tolerantes a las

[3] Informe de Progreso, Programa de evaluación regional de variedades de caña, Est. Exp. Agr. Univ. P.R., 1973.

[4] Informe de Progreso, Programa de evaluación de variedades de caña, Est. Exp. Agr. Univ. P.R., 1974.

condiciones ecológicas del Valle. Otras características agronómicas estudiadas, tales como germinación, ahijamiento, retoñamiento y número de cañas por metro lineal indican que las variedades NCo 310, PR 980 y PR 1013 reflejaron un comportamiento superior sobre las demás variedades dentro de las condiciones existentes en el área experimental en el Valle.

Los índices de madurez obtenidos indican que siete variedades (NCo 310, B 42-231, B 49-119, CP 52-43, PR 1002, PR 1028 y PR 62-258) son de madurez temprana, las otras son intermedias o tardás. A base de la capacidad productiva de azúcar de cada variedad, su adaptabilidad a las condiciones ecológicas que prevalecen en el Valle cuando no se puede regar adecuadamente y a la cosecha mecanizada, debe de incrementarse la siembra comercial de las variedades NCo 310, PR 980 y PR 1013.

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