

Strains of Sugarcane Mosaic Virus in Puerto Rico¹

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INTRODUCTION

Variations in type of mosaic symptoms on sugarcane varieties were observed by Edgerton and Taggart in 1924 (3) and Time and Edgerton in 1931 (9). These investigators, however, attributed the differences in symptoms to reactions of sugarcane clones rather than to the virus. Summers in Louisiana was first, 1934 (6), to differentiate strains of sugarcane mosaic virus, describing four strains principally by symptoms produced on the sugarcane variety C.P. 2860. In 1939 (7) he described seven strains, A, B, C, D, E, F, and G and three substrains of D on the basis of symptoms produced on C.P. 31294, C.P. 29291, and Co. 281.

In Puerto Rico, Bruehl in 1953 (1) pioneered in the identification of strains of the sugarcane mosaic virus, using the same differential hosts as those used by Summers. He was able at that time to identify the strains A, B, and D.

During the last decades, noble cane varieties, *Cristalina*, B.H. 10/12, and S.C. 12/4 have been replaced almost completely by locally-bred varieties. P.R. 980, a local variety now planted in more than 50 percent of our cultivated cane lands, was not included by Bruehl in his mosaic virus strain studies in 1954 (2). This variety, although highly resistant to the virus, occasionally has been found infected with mosaic under natural and greenhouse conditions. It is possible that change of varieties also has altered the occurrence and distribution of mosaic virus strains on the Island. Furthermore, new and more virulent strains might possibly occur under our conditions.

Investigations therefore were undertaken to determine: The occurrence and prevalence of the various mosaic virus strains on our cane plantations at the present time and their effect on growth and sucrose content of sugarcane; the relative susceptibility of our major varieties; and the susceptibility of several varieties of "recovered" canes.

MATERIALS AND METHODS

A total of 42 sugarcane mosaic diseased samples, obtained from various parts of the Island, were used as sources of inoculum for strain identifica-

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tion studies. Differential varieties, C.P. 31294, C.P. 29291, Co. 281, Louisiana Purple and C.P. 31588, were inoculated with juice expressed from mosaic-affected cane leaves using the Matz technique (5). Once expressed, the juices were immersed in a thermos container with ice cubes and used on the same day. The inoculated plants were left on benches under a cover of 75-percent Saran cloth. Recently, Liu (4) reported that 75°–85° F. was the optimum temperature range for sugarcane mosaic symptom expression. Accordingly, all the inoculated canes in the present study were kept within this temperature range. Symptoms were recorded approximately 8 weeks after inoculation.

For the trials on the effect of various strains on germination, growth and sucrose content, seedpieces of the sugarcane variety C.P. 31294, obtained from plants showing typical mosaic symptoms of strains A, B, and D, were planted 30 each in separate metal flats. Eight weeks after planting, germination was counted. Healthy seedpieces of the same variety were included as control. Growth of canes was measured when the plants were 2½ months old. The plants were then transferred from the metal flats to 50-gallon half drums. Plants were maintained in the drums until harvest. Mature cane stalks (10 for each sample) were obtained at 11 months of age for milling tests. The relative susceptibility of our commercial varieties of sugarcane to the various strains of mosaic virus was determined by inoculating separately 30 plants each of the same varieties with the various isolates of the virus. The number of plants showing mosaic symptom 8 weeks after inoculation was used to indicate the relative susceptibility of the variety to the virus.

RESULTS

DIFFERENTIATION OF STRAINS

On the basis of symptoms elicited on the five differential varieties of sugarcane, it is possible to classify the majority of the isolates into strains A, B, and D.

Strain A produces irregular but distinctive mottling on leaves of C.P. 31294 and does not cause noticeable stunting of C.P. 29291. As shown in figure 1, A, the irregular but distinctive mottling is not accompanied by necrosis on C.P. 31294. On varieties Co. 281 and Black Cheribon, this strain produces ordinary mosaic symptoms without discoloration of leaf sheath. On C.P. 31588, it produces numerous short stripes and flecks (fig. 2).

Strain B causes severe mottling with fine, elongated chlorotic to white lesions, varying in the extent of necrosis in all stages, as shown in figure 1, B. Affected canes of variety C.P. 31294 show marked stunting and tiller excessively when compared with healthy ones of the same age. This strain causes only ordinary mosaic symptoms on Co. 281 and Black Cheribon. It has a higher level of infectivity than strain A.

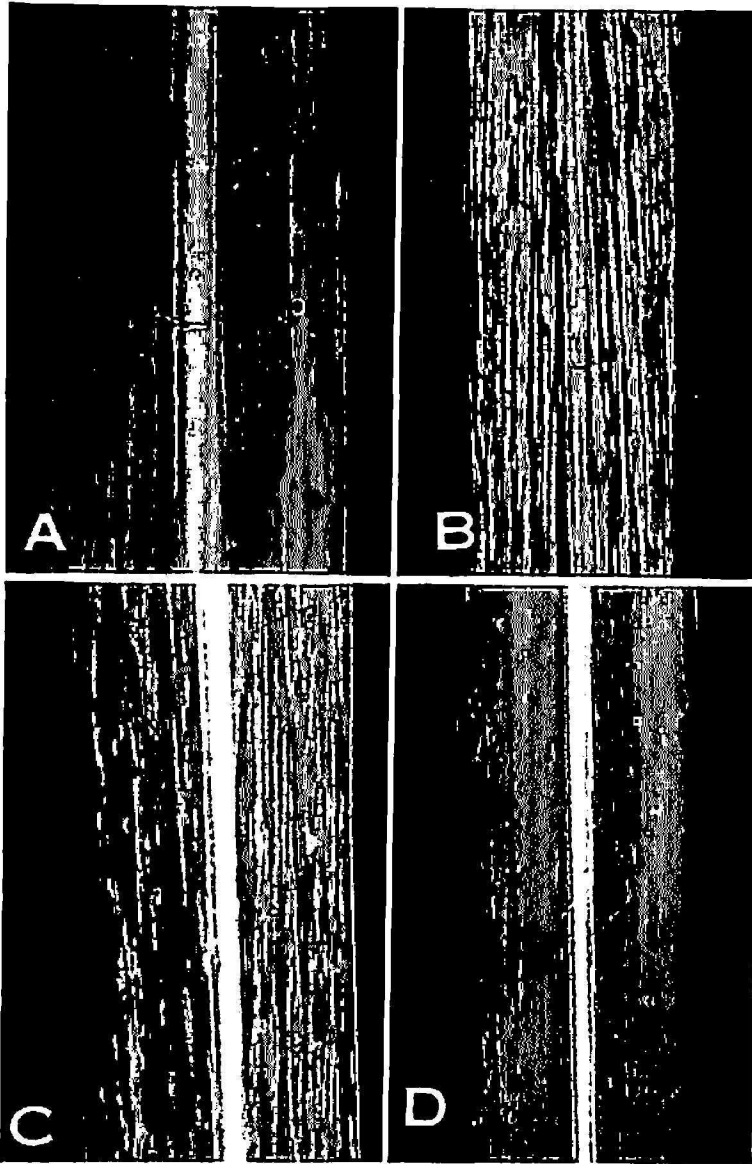


FIG. 1.—Symptoms of sugarcane mosaic virus on leaves of C.P. 31294 caused by strain A (A), strain B (B) and strain D (C); healthy leaf of the same variety (D).

Strain D produces white blotches or islands, some of which later coalesce to form long, yellowish white ribbons appearing frequently along the midrib or on one side of the leaf blade. The apparently unaffected leaf tissue is darker than in healthy plants, resulting in a strong contrast between the whitish lesions and the surrounding tissues. The number of lesions produced on the leaves is fewer than in the case of strain B (fig. 1, C).

DISTRIBUTION OF STRAINS

As shown in table 1, strain A was isolated most frequently from mosaic-affected plants of the variety B. 34104 obtained from the Central Rufina area. Strain D was obtained most frequently from the Central Aguirre area

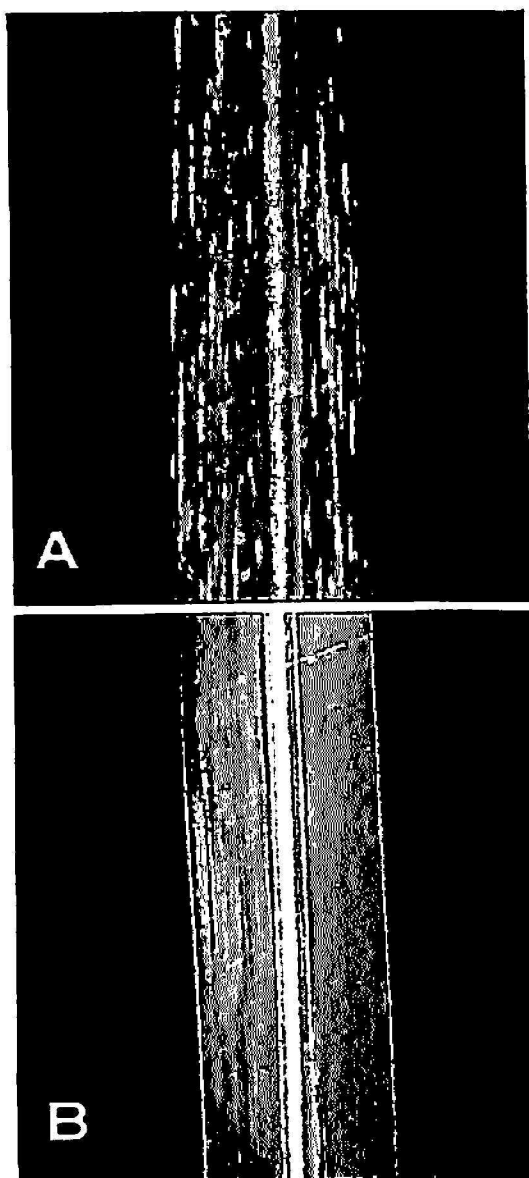


FIG. 2.—Mosaic virus symptoms on leaves of C.P. 31588 caused by strain A (A); healthy leaf of the same variety (B).

where B. 37161 was planted. Strain B appeared to be the most prevalent strain occurring in the Río Piedras, Central Rufina, Fajardo, and Central Aquirre areas.

EFFECT OF STRAINS ON GERMINATION, GROWTH, AND SUCROSE CONTENT

The results obtained to date indicate that mosaic virus strains A, B, and D have no appreciable effect on germination of sugarcane variety C.P. 31294. However, they reduced both growth and sucrose content greatly. As shown in table 2, strain D appreciably reduced cane growth of variety C.P. 31294; strain A did not. Strain D greatly reduced sucrose content; strain A very little.

TABLE 1.—*Strains of sugarcane mosaic virus identified on C.P. 31-294, C.P. 29-291, Co. 281, Black Cheribon and C.P. 31588 approximately 8 weeks after artificial inoculation with virus isolates from several sources*

Origin of collection by—		Strain identification			
Area	Variety	A	B	D	Unidentified
Río Piedras	C.P. 31-294	x			
Río Piedras	C.P. 31-294		x		
Río Piedras	Q. 50	x			
(Solís Farm)	C.P. 29-291				x
Fajardo	H. 48-4899			x	
Fajardo	H. 50-2542		x		
Fajardo	H. 50-7209		x		
Fajardo	B. 49-119		x		
Fajardo	H. 49-5			x	
Fajardo	H. 49-5				x
Humacao	B. 37-161			x	
Humacao	B. 37-161	x			
Humacao	B. 37-161				x
Central Aguirre	B. 37-161		x		
Central Aguirre	B. 37-161		x		
Central Aguirre	B. 37-161	x			
Central Aguirre	B. 37-161			x	
Central Aguirre	B. 37-161			x	
Central Aguirre	B. 37-161			x	
Central Aguirre	B. 37-161			x	
Central Aguirre	B. 37-161			x	
Central Aguirre	B. 34-104			x	
Central Aguirre	B. 34-104	x			
Central Aguirre	B. 34-104			x	
Central Aguirre	P.R. 980				x
Central Aguirre	P.R. 1013				x
Central Rufina	B. 34-104			x	
Central Rufina	B. 34-104	x			
Central Rufina	B. 34-104	x			
Central Rufina	B. 34-104		x		
Central Rufina	B. 34-104		x		
Central Rufina	B. 34-104	x			
Central Rufina	B. 34-104	x			
Santa Isabel	B. 37-161			x	
Fortuna	B. 34-104			x	
Hatillo	P.O.J. 36			x	
Camuy	P.O.J. 36			x	
Central Plata	M. 28				x
Central Plata	P.R. 980				x
Central Igualdad	Seedling JB ₃ X				x
	P.R. 1000				
Central Cambalache	M. 336				x
Cayey	H. 49-5				x
Fortuna	B. 37-161				x
Total		9	8	14	11

RELATIVE SUSCEPTIBILITY OF COMMERCIAL VARIETIES TO STRAINS

A total of 18 commercial varieties of sugarcane were inoculated separately with strains A, B, and D. Varieties differed greatly in their susceptibility to the various mosaic virus strains, as shown in table 3. For instance, Co. 421 was highly susceptible to strain A but highly resistant to strain B. Percentage infection was relatively high when variety P.R. 980 was inoculated with strain A. This same variety however, developed no mosaic symptoms when inoculated with strain B. Most Puerto Rican varieties were highly

TABLE 2.—*Effect of mosaic virus on germination, growth and sucrose content of sugarcane variety C.P. 31294*

Strain	Germination	Growth	Sucrose content
	Percent	Inches	96° yield
A	90 ¹	7.10 ¹	16.5 ²
B	96	6.55	15.5
D	93	5.79	14.5
Control	96.6	9.70	16.6

¹ Average of 10 replications.

² Average of 3 replications.

TABLE 3.—*Relative susceptibility of 18 commercial varieties of sugarcane to local strains of mosaic virus*

Varieties	Strains		
	A	B	D
	Percent	Percent	Percent
P.R. 975	60 ¹	38	26
P.R. 980	41	0	20
P.R. 1013	38	0	19
P.R. 1016	0	0	0
P.R. 1028	0	0	0
P.R. 1048	0	0	10
P.R. 1059	0	0	0
P.R. 1085	0	0	0
P.R. 1116	0	0	0
P.R. 1117	33	33	0
B. 37172	40	6	0
B. 41-227	0	18	0
B. 4362	27	0	0
B. 49119	33	0	0
Co. 421	77	0	27
H. 32-8560	0	0	0
H. 44-3098	62	40	25
P.O.J. 2878	38	0	19

¹ Average of 3 replications.

resistant to all the strains. Strain A appeared capable of affecting the majority of our commercial varieties; strain D affected only a small number.

SUSCEPTIBILITY OF RECOVERED CANES TO THE VARIOUS STRAINS

Canes of the varieties P.R. 980, P.R. 1013, P.R. 1048, P.R. 1059, P.R. 1085, and P.R. 1117, recovered from mosaic virus strains A and B, were reinoculated separately with the same strains of the virus. The results (table 4) indicate that recovered canes from either strain A or strain B can be reinfected by the same strains of the virus. However, more canes, supposedly recovered from mosaic virus strain A, developed mosaic symptoms upon reinoculation with strains A and B.

DISCUSSION AND CONCLUSIONS

The results of these studies with differential varieties indicate that strains A, B, and D are the prevailing sugarcane mosaic virus strains in Puerto Rico. A small number of isolates could not be identified employing the key developed by Summers et al. (8). These may be minor variants of the principal strains. Summers also observed such abnormalities.

It is interesting to note that the same principal strains found in Puerto Rico by Bruehl in 1954 were also found in this study. The change of varieties during the last decade apparently has not altered the strain picture.

Local varieties differed greatly in their susceptibility to the three strains of mosaic virus. More than 40-percent infection was obtained when P.R. 980, a locally bred variety now being planted on more than 50 percent of our cane lands, was inoculated with mosaic virus strain A, but developed no mosaic symptoms when inoculated with strain B.

From a practical standpoint, the problem of mosaic is one simply of varietal resistance. Essentially, the only effective solution is the development of highly productive varieties of sugarcane resistant to the various strains of the virus and to plant such varieties exclusively.

The majority of mosaic collections identified as strain D came from sugarcane variety B. 37161, as noted by Bruehl (2). The instability of strain D was also observed, as he reported. In some cases, symptoms incited by strain D gradually changed until they could be confused with those elicited by strain A.

SUMMARY

The great majority of the sugarcane mosaic virus collections from Puerto Rican fields were identified as strain A, B, and D on the basis of symptoms induced on differential hosts C.P. 31294, C.P. 29291, Co. 281, Black Cherriton, and C.P. 31588.

Strain A caused little effect on growth and sucrose content of C.P. 31294 while strain D caused severe stunting and reduced sucrose content of the same variety. Strain A was most frequently obtained from sugarcane fields

TABLE 4.—Percentage injection of “recovered” sugarcane plants inoculated with various strains of sugarcane mosaic virus

Variety	Re- plica- tion	Inoculated with mosaic virus strain A, canes recovered from—						Inoculated with mosaic virus strain B, canes recovered from—					
		Strain A			Strain B			Strain A			Strain B		
		Plants inocu- lated	Plants showing mosaic		Plants inocu- lated	Plants showing mosaic		Plants inocu- lated	Plants showing mosaic		Plants inocu- lated	Plants showing mosaic	
	Number	Number	Percent	Number	Number	Percent	Number	Number	Percent	Number	Number	Percent	
P.R. 980	1	8	0	0	10	0	0	10	0	0	10	0	0
	2	8	0	0	6	0	0						
	3	7	1	14.2	6	0	0						
	4	10	3	30	8	0	0						
P.R. 1013	1	10	0	0	10	0	0	5	4	80	9	0	0
	2	10	0	0	10	0	0	5	3	60	10	1	10
P.R. 1048	1	7	1	14.2	10	1	10	5	4	80	8	5	62.5
P.R. 1059	1	7	4	57.1	6	0	0	7	2	28.8	4	1	25
	2	7	7	100	9	7	77.7	8	5	62.5	8	1	12.5
	3	7	4	57.1	9	3	33.3	4	1	25	10	0	0
	4	6	4	66.6	5	4	80	8	0	0	8	0	0
P.R. 1085	1	7	0	0	6	0	0	7	1	14.2	10	1	10
	2	8	0	0	5	0	0	7	2	28.5	5	0	0
	3							8	1	12.5	6	2	33.3
	4							5	1	20	6	0	0
P.R. 1117	1	8	0	0	7	0	0	10	0	0	10	0	0
Total		110	24	21.1	97	16	17.0	89	24	26.9	105	11	10.4

in the Central Rufina area where B. 34104 was planted. Strain D was most frequently obtained from fields in the Central Aguirre area where B. 37161 was planted.

Puerto Rican varieties differed greatly in their susceptibility to local mosaic virus strains. Forty-percent mosaic infection was obtained when variety P.R. 980 was inoculated with strain A. This same variety however, developed no mosaic symptoms when inoculated with strain B.

Canes recovered from either strain A or strain B can be reinfected in many cases by the same virus strains.

RESUMEN

La gran mayoría de las muestras de caña de azúcar infectadas con el virus del mosaico que se coleccionaron en Puerto Rico se identificaron como de las cepas A, B y D, basándose en los síntomas causados en las siguientes variedades de plantas-huéspedes: C.P. 31294, C.P. 29291, Co. 281, Black Cheribon y C.P. 31588.

La cepa A afectó poco el crecimiento y el contenido en sacarosa de la variedad C.P. 31294 mientras que la cepa D fue la causa de un serio enanismo y redujo el contenido en sacarosa de la misma variedad. La cepa A se consiguió con mayor frecuencia en las plantaciones de caña de la Central Rufina donde había siembras de la variedad B. 34104. La cepa D se obtuvo mayormente en las plantaciones de la Central Aguirre donde había siembras de la variedad B. 37161.

Las variedades de Puerto Rico (P.R.) difirieron mucho entre sí en cuanto a su susceptibilidad a las cepas nativas del mosaico. Al inocularse la P.R. 980 con la cepa A se obtuvo un 40 por ciento de infección. Sin embargo, esta misma variedad no desarrolló los síntomas del mosaico cuando se inoculó con la cepa B.

Algunas de las variedades ya recuperadas de la infección causada por las cepas A o B pueden, en muchos casos, reinfectarse con las mismas cepas del virus.

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