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STORAGE OF MILL CANE
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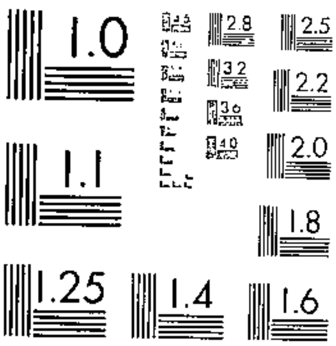
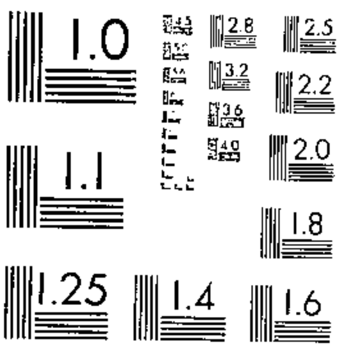


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A



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STORAGE OF MILL CANE

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INTRODUCTION

Rainy weather always has been a limiting factor in the harvesting of sugarcane in Louisiana. The gummy clay soils, when wet, make the passage of wagons and cane loaders in the fields difficult and sometimes impossible. During rainy weather the roads in the fields are soon cut into deep ruts and mudholes, making transportation of cane laborious and often impracticable for days at a time. Any prolonged interruption of harvesting and transportation of cane leads to the operation of mills at reduced capacity or to actual suspension of mill operations, resulting in prolonging the grinding season and increasing the cost of production of sugar.

The data [1] in table 1 give the percentage loss of factory time during the grinding season, resulting from a shortage of cane, due to rain, in 11 factories distributed over the Cane Belt, for the year 1932, and in addition, for 5 of these factories for 1931, and for 1 of them for 1930, 1931, and 1932. It is believed that these percentages are fairly representative of the normal loss of factory time in Louisiana. One factory reported that the loss during 1932 was less than normal. Another factory reported an average loss of 18 percent for 30 years.

[1] Furnished by officials of the various cane-sugar factories.

TABLE 1.—*Loss of factory time resulting from the shortage of cane due to rain*

Factory	Year	Loss of time	Factory	Year	Loss of time	Factory	Year	Loss of time
		Percent			*Percent*			*Percent*
A	1930	18	D	1932	29	I	1931	12
	1931	21	E	1932	15		1932	4
	1932	16	F	1932	18	J	1931	17
B	1932	31	G	1932	13		1932	7
C	1932	12	H	1931	18	K	1931	15
				1932	9		1932	7

The economic importance of this loss in time becomes evident when the following facts are considered: (1) The percentages given in table 1 represent over a million tons of cane; (2) the cane must be ground in a limited grinding season from about October 10 to 20 to January 1 to 10 (usually from 60 to 90 days), the beginning of the season being determined by the maturity of the cane and the end by the increasing freezing hazard with the advance of the season; (3) any prolongation of the grinding season, aside from increasing the cost of sugar manufacture, directly increases the freezing risk.

Considering the expensive equipment, the large personnel required for the milling of cane, the relatively short time during the year that cane can be ground, and the possible loss of cane due to freezing, the loss of time becomes the source of enormous yearly financial losses. A single example of the cost of such loss of time to a factory with an annual crop of about 120,000 tons will serve to make these losses more concrete. On the basis of an average yearly loss of time of 18 percent it was estimated by the management of this factory that by providing facilities for properly storing sufficient cane to insure continuous milling a saving of over $100,000 a year would be realized from factory and field operations.

As a result of the adverse economic conditions of recent years considerable interest has been stimulated among planters in the devising of means to reduce the cost of field and factory operations. This interest has extended to the possibility of developing methods of storing cane economically during fair weather to insure continuous factory operations. Because of the cheapness of cane and the enormous volume required for mill operations any system of storing mill cane must be, of necessity, relatively simple and cheap. A number of methods of storing cane have been under consideration, but the one which appeared to be the most practical from the standpoint of costs and effectiveness was that of sprinkling the cane after it had been accumulated in large piles placed in the open or under shade.

REVIEW OF THE LITERATURE

There has been an enormous amount of experimental work done on loss of sucrose in harvested cane. The environmental conditions under which these experiments were conducted, the methods of approach, the varieties, character, and amount of cane used, the time interval between analyses, the total duration of the experiments, and the avowed objective to be attained varied greatly. In some cases (*6, 11, 15, 18, 20*)[2] an attempt has been made to state definitely some of the environmental conditions of the experiments, but in those cases the information given is inadequate to an effective analysis of the part a particular phase (temperature, humidity, air movement, etc.) of environment plays in the loss of sucrose. In no case have the environmental factors been controlled and definitely isolated. Some of the experiments (*4, 10, 11, 12*) have been directed toward practical methods of preventing deterioration, but storage experiments have not been carried to a successful practical conclusion on a large scale. In most cases when cane has been kept wet by sprinkling or other means there is general agreement (*4, 10, 11, 12, 22*) that deterioration is retarded, but there are exceptions (*12, 20*). There is general agreement that cane stored in the shade shows less deterioration than cane stored in the sun (*12, 16, 17, 18, 19, 20*), although again there are exceptions (*16*). Some attempts have been made to study the effect of temperature on the rate of deterioration, but the simultaneous effect of air humidity was not taken into consideration (*6, 20*). It has been quite clearly shown that there are varietal differences in susceptibility to deterioration (*5, 7, 10, 15, 16, 17*), although the varieties studied differed and were limited to commercial varieties grown in the country in which the work was done. A recent paper (*14*) reports that under the same conditions varieties showing the greater loss of moisture show the greater rate of deterioration, but neither earlier work (*11*) nor that of the writers supports this claim.

PLAN OF EXPERIMENTS

Because of the apparently conflicting views held by previous investigators and the absence of more exact knowledge regarding the causes of deterioration, it has been found necessary by the writers to undertake a systematic study of the factors involved in deterioration.[3] As a result of this study, it is believed that a practical method of storing mill cane in Louisiana has been found that should insure more continuous factory operation. The phase of this study to be reported in this bulletin deals principally with the effect of sprinkling and of the absence of sprinkling on the composition of (1) mill cane stored in small piles of varying sizes in the shade as well as in the open, and (2) mill cane stored in large piles (7 to 260 tons) in the open, but consideration is also given to the weather conditions prevailing during the experiments and the temperatures existing in piled cane. Some data showing the relationship between weight changes (moisture change) and deterioration in stripped and unstripped cane are presented, since, too, such a relationship has a very important bearing on the problem of handling and storing sugarcane.

VARIETIES OF SUGARCANE USED

The following varieties of sugarcane were used: During 1930, P.O.J. 36–M, P.O.J. 213, and Co. 281; during 1931, P.O.J. 234, P.O.J. 213, P.O.J. 36–M, Co. 281, and C.P. 807; during 1932, P.O.J.

[2] Italic numbers in parentheses refer to Literature Cited, p. 28.

[3] Deterioration as used in this bulletin refers to the loss of sucrose by inversion, as it will be shown that inversion is the primary chemical change taking place in sound harvested cane.

213, P.O.J. 36–M, and Co. 290; and during 1933, P.O.J. 36–M, Co. 281, and C.P. 28/19.

STORAGE FACILITIES

To provide shade a shed 10 by 20 feet and 8 feet high in front and 6 feet high in the rear was erected, facing north. The roof proper extended 8 inches beyond the limits of the building in all directions. Further to protect the cane against rain and sun there was an extension of the roof in the front and back of 3.5 feet. These extensions had considerable slope downward. The shed was divided in half by a solid lumber partition. The ends of the shed were boarded up. Each half of the shed was divided into three 35-inch sections separated by 2- by 4-inch studdings set 2 feet apart. The sections were provided with a false floor made from 2- by 4-inch lumber, 2 feet apart, and 6 to 8 inches above the ground.

For the storage in the open, six racks were constructed of 2- by 4-inch lumber. The racks were of the same dimensions as the sections in the shed and were similarly constructed. The racks were so placed in a field south of the shed that the sun had full play on each of them. These facilities were used in connection with the storage of cane in small piles.

When larger piles of cane were used, the cane was stored in the mill yard of a plantation adjacent to the United States Sugar Plant Field Station. The piles were sufficiently far apart so that the shade of one pile did not fall on the other.

SAMPLING

SMALL PILES

In all the experiments except one conducted during 1933, to be discussed later, the cane of a given variety from a plot of cane of fairly uniform composition was transported to the shed promptly after cutting and placed in a large pile. In order to insure comparable composition of the cane in all lots stored, units of 4 or 5 stalks of cane were taken from the pile at one time and placed successively in a section (or rack) of each half of the shed and in two racks in the open [4] (when cane was simultaneously stored in the open), until about 1,500 to 1,800 pounds were stored in each rack. The cane was piled with the butts in the same direction in all cases. Five 30- to 40-stalk samples were used for each analysis. In the case of the original or check samples each sample was selected at random from the entire lot of cane. In each successive sampling five samples were selected from each rack by taking stalks at random over the entire pile. The surface moisture on the samples of sprinkled cane was allowed to dry off spontaneously before the cane was ground and analyzed.

LARGE PILES

Four experiments were conducted during three seasons (1930, 1931, and 1932) in which piles of cane (P.O.J. 213) ranged from 7 to 70 tons. Two piles were used in each experiment, one of which was sprinkled and one left unsprinkled. An effort was made to make the cane of the two piles as comparable as possible in sucrose content and purity. A given area of cane was selected in the field, cut, and hauled to the mill yard in trucks containing from 5,000 to 7,000 pounds each.

[4] During the season of 1931 and in one experiment during 1932 and 1933 cane was stored in the open.

The cane taken from the trucks was alternately placed on the sprinkled and unsprinkled piles. As long as the piles are relatively small it is possible to obtain cane of fairly uniform composition. As the size of the pile increases the uniformity decreases because of the variability in composition of the cane from a larger area.[5] This method of sampling not only involves the uncertainty of obtaining similar cane in the two piles, but affords no opportunity of knowing the condition of the cane when stored.

In one of the experiments, factory-mill analysis alone was employed; in two other experiments, the factory-mill analysis was supplemented by hand-mill samples of known composition which were placed at the center and on the top of the piles, and in the fourth experiment hand-mill samples only were used. These hand-mill samples were selected at the time the piles were being made from a given quantity of uniform cane and consisted of 30 to 50 stalks which were drawn at random from a given portion of a heap row. The number of samples used in a given analysis varied from 2 to 5. When the smaller number was used the samples consisted of 50 stalks. Analyses were made at the beginning of storage; at intervals, in the case of samples stored on top of the piles; and at the end of storage, in the case of samples stored on top and at the center of the piles. This method of sampling made it possible to determine the amount and the progress of deterioration.

During 1933 a single pile of 260 tons of cane was stored in a mill yard and sprinkled during 10 days. No effort was made to control the composition of the pile. Hand-mill samples of P.O.J. 36 M, selected in the same fashion as in the preceding experiments, were used to study the course of deterioration.

SPRINKLING

In the small-pile experiments the cane in one half of the shed was sprinkled and in the other half left dry, and when cane was stored in racks in the open, one lot of each variety was sprinkled and the other left unsprinkled. During 1930, the sprinkling of small piles was continuous. In the one experiment conducted during 1930 with large piles, sprinkling was continuous during the daytime, there being no sprinkling done at night. During 1931, the cane in small and large piles was sprinkled during the daytime at 7, 9, and 11 a.m. and 1, 3, and 5 p.m. The cane was sprinkled only long enough each time to insure wetting all of it. The sprinkling schedule during 1932 was the same as in 1931, except that the 7 a.m. sprinkling was omitted. The sprinkling schedule for the small piles was the same in 1933 as in 1931, and in the case of the large pile it was 8:30 and 10:30 a.m. and 1:30 and 4:30 p.m. daily.

METHODS OF ANALYSIS

In this study, in which it was desired to follow the principal chemical changes which take place in sugarcane stored under various conditions, the analyses were confined to the juice which was expressed by a motor-driven three-roller mill adjusted to give an extraction of approximately 60 percent. It is realized that further tests should be

[5] Factory-mill analyses were made of the entire pile at the end of the storage period in most instances; that is, a continuous fraction of the juice was taken from below the first crusher throughout the grinding of the pile from which the final sample of juice for analyses was taken.

made to determine the composition of the whole cane in order that the actual quantity of sugars lost by respiration and other causes may be calculated.

The juice from each sample of cane was separately collected and weighed. One portion of juice was analyzed for its Brix reading, apparent sucrose, and apparent purity, by the customary methods.[6] Where a detailed analysis [7] was made, equal portions of juice (by volume) were taken from the 2 or 5 replicated samples of cane and combined. The composite samples of juice were centrifuged in a solid-wall basket under standardized conditions as regards speed and time and were then strained through a 200-mesh screen before the analysis was made. This operation removed such extraneous material as bits of cell tissues, wax, and soil particles, which it was believed should not be included in the samples when studying the composition of the juice phase.

The following determinations were made on the composite juice samples: Acidity, pH, sucrose, reducing sugars, dry substance, true purity, ash, and organic nonsugars.

Acidity.—The usual sugar-house method of determining acidity was employed in 1931 and 1932, namely, by titrating 10 cc of juice with 0.1 normal sodium hydroxide solution, with phenolphthalein as the indicator. The samples in 1933 were titrated electrometrically by means of the quinhydrone electrode: 50 cc of juice was titrated to a pH of 7.0 with 0.1 normal sodium hydroxide and the result was expressed as the number of cubic centimeters of alkali required for 10 cc of juice.

pH.—The pH of the juice was determined electrometrically by means of the quinhydrone electrode against a saturated calomel electrode (*13*).

Sucrose.—The double polarization method, with invertase as the hydrolytic agent, in accordance with the official method of the Association of Official Agricultural Chemists (*3, p. 370*), was used in determining sucrose. Initial solution contained 78 g of juice per 100 cc; dry basic lead acetate (Horne's) was used as the clarification agent and anhydrous Na_2CO_3 as the deleading agent. Deleading was controlled very satisfactorily by means of bromthymol-blue paper; the end reaction was taken at the approximate neutral point to this indicator paper. The data are expressed as percentage sucrose on dry substance, i.e., true purity.

Reducing sugars.—In the samples analyzed during the 1931 season, reducing sugars were determined by the Herzfeld method (*3, p. 382; 21, p. 240*) by means of the Meissl-Hiller factors; the samples during the 1932 and 1933 seasons were analyzed by the titration method of Lane and Eynon (*3, p. 377; 21, p. 250*). The latter method was found to be preferable. The burette was jacketed and equipped with an offset outlet, features which were found to be of great value in obviating heating of the reserve sugar solution during the titration. Clarification of the solutions of juice was effected in 1931 by filtration with the aid of diatomaceous earth, and in 1932 and 1933 by neutral lead acetate, while deleading with a dry mixture composed of 3 parts of sodium oxalate and 7 parts of potassium dihydrogen phosphate. A dry deleading agent of this character is to be preferred to a solution of an oxalate and phosphate, as is recommended by Cook and McAllep (*9*) and adopted officially by the Association of Hawaiian Sugar Technologists (*2*), as it obviates aliquoting and the introduction of a dilution factor. The results in this bulletin are expressed as percentage invert sugar based on dry substance.

Dry substance.—The dry substance of the juice was determined according to the official method of the Association of Official Agricultural Chemists (*3, p. 364*), by drying 8 g of juice (10 cc of a solution of juice containing 80 g of juice made to 100 cc) on silica sand at 70° C. in a vacuum (approximately 27 inches).

Ash.—The ash was determined in the 1931 and 1932 samples by direct incineration of 20 g of juice at low red heat; in the 1933 samples the sulphate ash was

[6] These analyses were performed by R. B. Bisland, of the Division of Sugar Plant Investigations, Bureau of Plant Industry, U.S. Department of Agriculture, at the Sugar Plant Field Station, Houma, La., to whom the writers are indebted.

[7] Detailed analyses were limited to the experiments conducted during 1931, 1932, and 1933. In some of the experiments during these years it was necessary to omit detailed analyses and in others to limit them to certain intervals of storage.

determined, but corrected by applying the usual factor of 10 percent. Results are based on dry substance.

Organic nonsugars.—The organic nonsugars were determined by subtracting the sum of the total sugars and ash (moisture-free percentage basis) from 100. Obviously this determination can be given but little emphasis, since it involves the accumulated errors of four other determinations.

EXPERIMENTAL DATA

STORAGE IN SMALL PILES

During 1930 two experiments, one following the other, were conducted in which three varieties (Co. 281, P.O.J. 213, and P.O.J. 36–M) were stored in the shade. One lot of each variety in each experiment was sprinkled and one lot left unsprinkled. Two experiments were run during 1931 in which cane of a given variety was stored in the open and in the shade. One lot in the shade and one in the open were sprinkled and one lot in each case left unsprinkled. Co. 281, C.P. 807, and P.O.J. 36–M were used in the first experiment and Co. 281, P.O.J. 234, and P.O.J. 36–M in the second. In 1 of the 2 experiments conducted during 1932, Co. 290 was stored in the shade and in the open and 1 lot in each case sprinkled and 1 left unsprinkled. In the second experiment sprinkled and unsprinkled cane of the varieties Co. 290 and P.O.J. 36–M were stored in the shade. One experiment was conducted during 1933 in which lots of sprinkled and unsprinkled P.O.J. 36–M were stored in the open and in the shade and lots of sprinkled and unsprinkled C.P. 28/19 were stored in the shade.

The Brix, apparent sucrose, and apparent purity obtained in these experiments after different intervals of storage are recorded in tables 2, 3, and 4, and the more detailed analyses in table 5.

TABLE 2.—*Brix, apparent sucrose, and apparent purity in sprinkled and unsprinkled cane stored in the shade for different periods during 1930*

Variety and experiment no.	Date of analysis	Duration of storage	Sprinkled cane				Unsprinkled cane			
			Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
Second-year stubble: Co. 281:		Days	°	Percent	Percent	Percent	°	Percent	Percent	Percent
1	Oct. 23	0	14.88	11.57	77.8		14.88	11.57	77.8	
	Oct. 27	4	14.68	11.38	77.5		14.94	11.40	76.3	
	Oct. 30	7	14.97	11.68	78.0	61	14.79	10.91	73.8	62
	Nov. 6	14	14.89	11.52	77.4	63	15.77	11.50	73.3	59
	Nov. 13	21	14.83	11.47	77.3	63	15.85	11.60	73.2	61
2	Nov. 19	0	16.94	14.21	83.9	64	16.94	14.21	83.9	64
	Nov. 26	7	16.68	14.09	84.5	63	17.35	14.53	83.7	62
	Dec. 3	14	16.69	14.07	84.3	62	17.65	14.20	80.5	62
	Dec. 10	21	16.59	14.03	84.6	62	18.15	14.73	81.2	58
First-year stubble: P.O.J. 213:										
1	Oct. 24	0	14.76	11.83	80.1		14.76	11.83	80.1	
	Oct. 27	3	14.07	10.99	78.1		14.88	11.85	79.6	
	Oct. 31	7	14.72	11.72	79.6	62	15.63	12.05	77.1	58
	Nov. 7	14	14.37	11.17	77.7	62	15.96	11.28	70.7	60
	Nov. 14	21	14.04	10.93	77.8	60	16.12	10.97	68.1	58
2	Nov. 19	0	16.11	13.27	82.4	65	16.11	13.27	82.4	65
	Nov. 26	7	15.69	13.01	82.9	63	16.76	13.97	83.4	60
	Dec. 3	14	15.70	13.08	83.3	62	17.34	13.38	77.2	60
	Dec. 10	21					17.40	12.90	73.6	58
P.O.J. 36-M:										
1	Oct. 24	0	14.26	10.44	73.2		14.26	10.44	73.2	
	Oct. 27	3	14.08	10.40	73.9		14.12	9.92	70.3	
	Oct. 31	7	14.10	10.53	74.7	61	14.91	9.68	64.9	62
	Nov. 7	14	14.00	10.30	73.6	64	15.40	7.36	47.8	61
	Nov. 14	21	13.82	10.03	72.6	62	15.63	7.12	45.6	58
2	Nov. 19	0	14.98	10.91	72.8	64	14.98	10.91	72.8	64
	Nov. 26	7	14.60	10.87	74.5	65	15.29	11.03	72.1	64
	Dec. 3	14	14.41	10.60	73.6	61	15.77	8.91	56.5	61
	Dec. 10	21	14.47	10.72	74.1	64	16.30	8.79	53.9	59

TABLE 3.—*Brix, apparent sucrose, and apparent purity in sprinkled and unsprinkled sugarcane (first-year stubble) stored in the shade and in the open for different periods during 1931*

Variety and experiment no.	Date of analysis	Duration of storage	Shade: Sprinkled cane				Shade: Unsprinkled cane			
			Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
		Days	°	*Percent*	*Percent*	*Percent*	°	*Percent*	*Percent*	*Percent*
Co. 281:										
1	Oct. 27	0	14.38	10.79	75.0	58	14.38	10.79	75.0	58
	Nov. 3	7	13.85	10.26	74.1	58	14.70	10.62	72.2	57
	Nov. 10	14	13.96	10.44	74.8	58	15.17	10.81	71.3	56
	Nov. 16	20	13.81	10.09	73.1	57	15.61	10.73	69.2	57
2	Nov. 17	0	16.64	13.49	81.1	59	16.64	13.49	81.1	59
	Nov. 27	10	16.09	13.22	82.2	62	16.88	13.67	81.0	61
	Dec. 4	17	15.99	13.14	82.2	60	16.84	13.57	80.6	59
	Dec. 11	24	15.83	12.98	82.0	60	16.85	13.47	79.9	59
C.P. 807:										
1	Oct. 24	0	13.42	10.21	76.1	57	13.42	10.21	76.1	57
	Oct. 27	3	13.45	10.35	77.0	60	13.69	10.32	75.4	58
	Oct. 30	6	13.68	10.47	76.5	56	13.78	9.88	71.7	57
	Nov. 5	12	13.35	9.98	74.8	55	14.61	9.36	64.1	63
	Nov. 13	20	13.69	10.40	76.0	56	15.20	9.65	63.2	59
P.O.J. 234:										
2	Nov. 16	0	16.70	13.86	83.0	55	16.70	13.86	83.0	55
	Nov. 25	9	16.39	13.67	83.4	62	16.72	13.39	80.1	59
	Dec. 2	16	16.13	13.45	83.4	53	17.01	13.23	77.8	55
	Dec. 9	23	16.68	13.85	83.2	58	17.03	12.71	74.6	59
P.O.J. 36-M:										
1	Oct. 26	0	14.37	11.03	76.8	59	14.37	11.03	76.8	59
	Oct. 29	3	14.75	11.27	76.4	59	15.03	11.14	74.1	59
	Nov. 4	9	14.30	10.98	76.8	59	15.18	10.82	71.3	59
	Nov. 10	15	14.06	10.59	75.3	57	15.55	9.39	60.4	57
	Nov. 18	23	13.82	10.28	74.4	59	15.62	9.05	57.9	56
2	Nov. 16	0	15.87	12.58	79.3	58	15.87	12.58	79.3	58
	Nov. 23	7	15.51	12.41	80.0	60	15.89	11.78	74.1	59
	Nov. 30	14	15.08	11.90	78.9	61	16.34	12.01	73.6	60
	Dec. 7	21	15.15	12.16	80.3	60	16.45	11.63	70.7	62

Variety and experiment no.	Date of analysis	Duration of storage	Open: Sprinkled cane				Open: Unsprinkled cane			
			Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
		Days	°	*Percent*	*Percent*	*Percent*	°	*Percent*	*Percent*	*Percent*
Co. 281:										
1	Oct. 27	0	14.38	10.79	75.0	58	14.38	10.79	75.0	58
	Nov. 3	7	14.01	10.48	74.6	60	14.50	10.43	71.6	59
	Nov. 10	14	14.14	10.47	74.0	56	15.18	10.49	69.1	57
	Nov. 16	20	13.90	10.24	73.7	58	15.49	10.44	67.4	57
2	Nov. 17	0	16.64	13.49	81.1	59	16.64	13.49	81.1	59
	Nov. 27	10	15.97	12.98	81.3	61	16.45	13.40	81.5	60
	Dec. 4	17	16.05	13.19	82.2	58	16.49	13.22	80.2	58
	Dec. 11	24	15.89	13.05	82.1	60	16.51	13.22	80.1	60
C.P. 807:										
1	Oct. 24	0	13.42	10.21	76.1	57	13.42	10.21	76.1	57
	Oct. 27	3	13.70	10.61	77.4	61	13.86	10.51	75.8	60
	Oct. 30	6	13.53	9.98	73.8	56	14.00	10.05	71.8	57
	Nov. 5	12	13.63	9.82	72.0	54	14.85	9.51	64.0	53
	Nov. 13	20	13.79	10.01	72.6	56	15.59	9.90	63.5	55
P.O.J. 234:										
2	Nov. 16	0	16.70	13.86	83.0	55	16.70	13.86	83.0	55
	Nov. 25	9	16.21	13.52	83.4	57	16.64	13.51	81.2	61
	Dec. 2	16	16.07	13.36	83.1	52	16.61	13.27	79.7	54
	Dec. 9	23	16.02	13.45	84.0	55	16.68	12.82	76.9	56
P.O.J. 36-M:										
1	Oct. 26	0	14.37	11.03	76.8	59	14.37	11.03	76.8	59
	Oct. 29	3	14.51	11.01	75.9	59	15.25	11.49	75.3	60
	Nov. 4	9	14.32	10.88	76.0	58	15.35	10.67	69.5	58
	Nov. 10	15	14.24	10.47	73.5	57	15.83	9.49	59.9	56
	Nov. 18	23	13.99	10.29	73.6	60	16.22	8.78	54.1	57
2	Nov. 16	0	15.87	12.58	79.3	58	15.87	12.58	79.3	58
	Nov. 23	7	16.48	12.29	79.4	60	15.65	12.57	80.3	60
	Nov. 30	14	15.24	11.88	78.0	63	15.57	11.73	75.3	60
	Dec. 7	21	15.20	12.22	80.4	61	15.90	12.12	75.9	61

TABLE 4.—*Brix, apparent sucrose, and apparent purity in sprinkled and unsprinkled sugarcane stored in the shade and in the open for different periods during 1932 and 1933*

Variety and experiment no.	Cane stored in—	Date of analysis	Duration of storage	Sprinkled cane				Unsprinkled cane			
				Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
Plant cane:											
Co. 290:		1932	Days	°	Pct.	Pct.	Pct.	°	Pct.	Pct.	Pct.
1	Shade	Nov. 4	0	15.46	11.94	77.2	65	15.46	11.94	77.2	65
		Nov. 11	7	15.47	11.93	77.1	65	15.94	12.00	75.3	64
		Nov. 18	14	15.40	11.80	76.6	66	16.37	11.85	72.4	65
	Open	Nov. 4	0	15.46	11.94	77.2	65	15.46	11.94	77.2	65
		Nov. 11	7	15.34	11.85	77.2	59	16.07	11.98	74.5	62
		Nov. 18	14	15.41	11.47	74.4	66	16.56	11.42	69.0	65
2	Shade	Nov. 18	0	15.83	12.46	78.7	65	15.83	12.46	78.7	65
		Nov. 25	7	15.58	12.16	78.0	66	16.17	12.52	77.4	68
		Dec. 3	15	15.62	12.32	78.9	67	16.60	12.41	74.8	64
		Dec. 9	21	15.71	12.42	79.1	64	16.74	11.99	71.6	68
		Dec. 16	28	15.47	12.48	80.7	68	16.90	12.47	73.8	69
P.O.J. 36-M:											
2	Shade	Nov. 18	0	15.14	12.08	79.8	61	15.14	12.08	79.8	61
		Nov. 25	7	14.67	11.57	78.9	62	16.00	12.72	79.5	63
		Dec. 3	15	14.81	11.59	78.3	61	16.43	12.74	77.5	60
		Dec. 9	21	14.64	11.43	78.1	59	16.75	12.27	73.3	60
		Dec. 16	28	14.47	11.46	79.2	63	16.80	12.13	72.2	61
First-year stubble:											
P.O.J. 36-M:		1933									
1	Shade	Oct. 18	0	14.23	10.92	76.7	55	14.23	10.92	76.7	55
		Oct. 25	7	13.96	10.81	77.4	58	15.04	10.03	66.7	58
		Nov. 1	14	13.52	10.32	76.3	62	15.25	9.15	60.0	60
		Nov. 10	23	13.42	10.39	77.4	60	15.74	8.90	56.5	57
	Open	Oct. 18	0	14.23	10.92	76.7	55	14.23	10.92	76.7	55
		Oct. 25	7	13.66	10.38	76.0	59	15.10	9.18	60.7	58
		Nov. 1	14	13.68	10.28	75.1	60	15.17	8.22	54.2	59
		Nov. 10	23	13.38	9.78	73.1	56	15.53	7.83	50.4	55
C.P. 28/19:											
1	Shade	Oct. 20	0	16.16	12.14	75.1	52	16.16	12.14	75.1	52
		Oct. 27	7	15.71	11.96	76.1	53	16.83	12.19	72.4	55
		Nov. 3	14	16.11	12.61	78.3	60	16.90	11.89	70.4	59
		Nov. 10	21	16.24	12.68	78.1	54	17.69	11.79	66.7	51

The results are conclusive in showing comparatively little loss of sucrose or drop in purity in sprinkled cane when stored in either the shade or in the open for 20 to 24 days. There was a tendency in most instances for the Brix, total solids, and sucrose to decrease with the continuation of storage. There may have been some dilution as a result of sprinkling, because in other experiments cane when kept wet sometimes increased in weight. Some loss in invert sugar and hence in total solids is to be expected as a result of respiration, especially if there is rooting and sprouting, which happened in certain instances. Whether or not this loss was partly or wholly at the expense of sucrose or of the starch in the starch zones [8] above the root bands is not known, as rooting and sprouting did not seem to affect the purity.

In the one experiment in which C.P. 28/19 (tables 4, 5) was used, there was a tendency for the purity to increase and the invert sugar to decrease in the sprinkled cane. Additional results will be required to determine whether or not this tendency is significant or characteristic of this variety when sprinkled.

[8] The starch deposits are in the growth regions or intercalary meristems above the root bands.

TABLE 5.—*Detailed analysis of sprinkled and unsprinkled sugarcane stored for different periods of time, in the shade and in the open, during 1931, and in the shade during 1932 and 1933*

Variety and experiment no.	Date of analysis	Duration of storage	Shade													
			Sprinkled cane							Unsprinkled cane						
			Acidity [1]	pH	Dry substance	True purity	Invert sugars [2]	Ash [2]	Organic nonsugars [2]	Acidity [1]	pH	Dry substance	True purity	Invert sugars [2]	Ash [2]	Organic nonsugars [2]
Co. 281 (first-year stubble):	1931	*Days*			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1	Oct. 27	0	2.85	......	13.68	80.77	10.57	4.41	4.25	2.85	......	13.68	80.77	10.57	4.41	4.25
	Nov. 3	7	2.70	......	13.22	80.79	10.14	4.46	4.61	2.70	......	13.97	77.74	11.78	4.22	6.26
	Nov. 10	14	2.80	......	13.35	79.78	10.56	4.54	5.52	3.00	......	14.50	77.38	13.23	4.20	5.19
	Nov. 16	20	3.10	5.24	13.10	79.54	10.64	4.43	5.39	3.20	5.28	14.72	76.47	13.82	4.44	5.27
2	Nov. 17	0	3.00	5.27	15.93	86.82	4.87	3.57	4.74	3.00	5.27	15.93	86.82	4.87	3.57	4.74
	Nov. 27	10	3.00	5.31	15.43	87.23	4.69	3.55	4.53	3.00	5.31	16.18	86.89	5.31	3.45	4.35
	Dec. 11	24	2.50	5.27	15.22	86.60	4.66	3.55	5.19	2.80	5.27	16.26	84.75	6.08	3.64	5.53
C.P. 807 (first-year stubble):																
	Oct. 24	0	......	......	12.60	83.81	10.29	......	......	......	......	12.60	83.81	10.29	......	......
	Oct. 27	3	2.40	......	13.02	81.57	10.15	......	......	2.30	......	13.13	79.89	11.67	3.69	4.75
	Oct. 30	6	2.30	......	12.80	81.25	10.45	3.62	4.68	2.30	......	13.55	75.57	14.26	3.51	6.66
	Nov. 5	12	2.55	......	12.85	80.16	11.78	3.67	4.39	2.75	......	13.96	71.78	19.26	3.42	5.54
	Nov. 13	20	2.45	......	13.05	81.14	10.69	3.60	5.17	2.80	......	14.55	71.00	21.18	3.58	4.24
P.O.J. 234 (first-year stubble):																
2	Nov. 16	0	......	5.35	16.18	87.21	4.80	2.90	5.09	......	5.35	16.18	87.21	4.80	2.90	5.09
	Nov. 25	9	2.40	5.30	15.82	88.50	4.20	2.69	4.61	2.40	5.30	16.43	83.75	8.27	2.89	5.09
	Dec. 2	16	2.20	5.35	15.66	88.05	4.10	2.90	4.95	2.40	5.30	16.62	82.37	9.98	2.66	4.99
	Dec. 9	23	2.20	5.28	15.23	87.46	4.37	2.82	5.35	2.50	5.15	16.64	81.79	9.86	2.74	5.61
P.O.J. 36-M (first-year stubble):																
1	Oct. 26	0	......	......	13.73	82.45	11.68	3.06	2.81	......	......	13.73	82.45	11.68	3.06	2.81
	Oct. 29	3	1.85	......	13.90	81.37	10.73	2.70	5.20	1.85	......	14.35	79.58	13.23	2.66	4.53
	Nov. 4	9	2.00	......	13.83	80.98	11.78	2.78	4.46	2.00	......	14.68	76.23	17.09	2.85	3.83
	Nov. 10	15	2.00	......	13.59	80.43	12.52	2.88	4.17	2.25	......	15.07	68.75	24.47	2.65	4.13
	Nov. 18	23	2.10	5.34	13.31	79.79	12.11	2.81	5.29	2.30	5.39	14.85	66.33	26.24	3.07	4.36
2	Nov. 16	0	......	5.39	15.33	84.34	9.13	2.50	4.03	......	5.39	15.33	84.34	9.13	2.50	4.03
	Nov. 23	7	1.90	5.40	15.05	85.32	8.15	2.59	3.93	2.00	5.39	15.44	80.18	12.88	2.66	4.28
	Nov. 30	14	1.85	5.42	14.49	85.02	8.72	2.87	3.39	2.30	5.43	15.85	77.35	13.64	2.66	6.35
	Dec. 7	21	1.80	5.32	14.71	85.52	8.19	2.56	3.73	2.00	5.25	16.06	77.83	15.21	2.51	4.45
Co. 290 (plant cane):	1932															
1	Nov. 4	0	2.90	5.23	14.77	83.07	8.87	4.14	3.92	2.90	5.23	14.77	83.07	8.87	4.14	3.92
	Nov. 11	7	2.85	5.20	14.88	83.80	8.44	3.51	4.25	2.95	5.20	15.31	82.30	10.67	3.55	3.48
	Nov. 18	14	2.85	5.26	14.83	82.60	9.08	3.48	4.84	3.05	5.24	15.78	79.18	12.26	3.56	5.00
2	do	0	2.85	5.28	15.19	84.53	7.37	3.67	4.43	3.85	5.28	15.19	84.53	7.37	3.67	4.43
	Dec. 3	15	......	5.35	15.05	83.32	8.23	3.68	4.77	2.90	5.33	16.01	80.51	10.90	3.64	4.95

P.O.J. 36-M (first-year stubble):																
2	Nov. 18	0	2.05	5.35	14.72	84.85	7.83	2.67	4.65	2.05	5.35	14.72	84.85	7.83	2.67	4.65
	Dec. 3	15	2.15	5.44	14.27	83.67	8.76	2.97	4.60	2.15	5.40	16.08	81.72	11.05	2.68	4.55
C.P. 28/19 (first-year stubble):	1933															
1	Oct. 20	0	2.20	5.18	15.63	81.13	8.86	4.13	5.88	2.20	5.18	15.63	81.13	8.86	4.13	5.88
	Oct. 27	7	1.99	5.24	14.99	81.45	8.64	4.38	5.53	2.13	5.26	16.18	77.94	11.85	4.18	6.03
	Nov. 3	14	1.89	5.25	15.49	82.44	7.33	4.15	6.08	2.16	5.25	16.45	74.77	14.67	4.44	6.12
	Nov. 10	21	1.85	5.34	15.57	83.88	7.13	4.05	4.90	2.04	5.31	16.97	74.60	16.67	4.15	4.58

Variety and experiment no.	Date of analysis	Duration of storage	Open													
			Sprinkled cane							Unsprinkled cane						
			Acidity [1]	pH	Dry substance	True purity	Invert sugars [2]	Ash [2]	Organic nonsugars [2]	Acidity [1]	pH	Dry substance	True purity	Invert sugars [2]	Ash [2]	Organic nonsugars [2]
Co. 281 (first-year stubble):	1931	Days			Percent	Percent	Percent	Percent	Percent			Percent	Percent	Percent	Percent	Percent
1	Oct. 27	0	2.85	------	13.68	80.77	10.57	4.41	4.25	2.85	------	13.68	80.77	10.57	4.41	4.25
	Nov. 3	7	2.70	------	13.36	80.98	10.01	4.30	4.71	2.70	------	13.92	78.74	12.01	4.25	5.00
	Nov. 10	14	2.80	------	13.41	80.01	10.63	4.28	5.08	3.20	------	14.42	75.86	14.63	4.05	5.46
	Nov. 16	20	3.00	5.33	13.16	79.33	10.46	4.79	5.42	3.40	5.28	14.67	75.12	14.89	4.43	5.56
2	Nov. 17	0	3.00	5.27	15.93	86.82	4.87	3.57	4.74	3.00	5.27	15.93	86.82	4.87	3.52	4.74
	Nov. 27	10	3.00	5.31	15.38	86.80	4.79	3.56	4.85	3.00	5.31	15.91	86.11	5.32	3.58	4.99
	Dec. 11	24	2.50	5.29	15.48	86.50	4.72	3.55	5.23	2.70	5.26	15.87	84.88	5.96	3.73	5.43
C.P. 807 (first-year stubble):																
1	Oct. 24	0	------	------	12.60	83.81	10.29	------	------	------	------	12.60	83.81	10.29	------	------
	Oct. 27	3	2.30	------	13.11	82.53	9.90	3.55	4.02	2.45	------	13.50	78.59	12.08	3.27	6.06
	Oct. 30	6	2.30	------	13.00	80.08	10.88	3.69	5.35	2.30	------	13.97	77.52	14.22	3.44	4.92
	Nov. 5	12	2.55	------	13.28	77.03	12.85	3.63	6.49	2.75	------	14.37	71.19	21.11	3.31	4.39
	Nov. 13	20	2.55	------	13.16	78.27	13.06	3.72	4.95	2.80	------	14.95	69.90	21.99	3.37	4.74
P.O.J. 234 (first-year stubble):																
2	Nov. 16	0	------	5.35	16.18	87.21	4.80	2.90	5.09	------	5.35	16.18	87.21	4.80	2.90	5.00
	Nov. 25	9	2.35	5.30	15.80	87.78	4.51	2.77	4.91	2.40	5.30	16.16	86.76	5.63	2.81	4.80
	Dec. 2	16	2.20	5.35	15.63	87.78	4.40	2.94	4.88	2.40	5.30	16.16	84.53	8.20	2.64	4.63
	Dec. 9	23	2.20	5.28	15.64	87.85	4.03	2.92	5.20	2.40	5.17	16.32	82.72	8.55	2.80	5.93
P.O.J. 36-M (first-year stubble):																
1	Oct. 26	0	------	------	13.73	82.45	11.68	3.06	2.81	------	------	13.73	82.45	11.68	3.06	2.81
	Oct. 29	3	2.00	------	14.05	80.64	11.42	2.85	5.09	1.90	------	14.70	80.20	12.87	2.61	4.32
	Nov. 4	9	2.00	------	13.91	78.22	13.42	2.70	4.66	2.00	------	14.62	75.38	17.59	2.87	4.16
	Nov. 10	15	2.00	------	13.68	79.09	13.56	2.87	4.48	2.15	------	15.35	68.66	24.23	2.67	4.43
	Nov. 18	23	2.15	5.35	13.41	79.12	13.19	2.75	4.94	2.60	5.34	15.61	62.72	29.02	3.05	5.21
2	Nov. 16	0	------	5.39	15.33	84.34	9.13	2.50	4.03	------	5.39	15.33	84.34	9.13	2.50	4.03
	Nov. 23	7	1.90	5.40	15.03	84.96	8.32	2.66	4.06	2.00	5.39	15.13	83.81	9.19	2.57	4.43
	Nov. 30	14	1.85	5.44	14.67	83.16	8.83	2.79	5.22	2.25	5.40	15.07	81.75	11.96	2.87	3.42
	Dec. 7	21	1.75	5.32	15.01	84.41	8.09	2.52	4.98	2.00	5.23	15.50	81.29	12.26	2.51	3.94

[1] Determined by titrating 10 cc of juice with 0.1 N sodium hydroxide solution.

[2] Percentage based on dry substance.

The results obtained in connection with unsprinkled cane are in a number of ways in striking contrast to those obtained from sprinkled cane. Except in experiment 2, 1931 (tables 3 and 5), in cane stored in the open when there was considerable rain, the Brix and dry substance increased with the continuation of storage, showing the effect of drying. In the apparent-sucrose readings the effect of drying was obscured in most cases by rapid deterioration, especially when deterioration was marked. In some instances there was a large drop in sucrose. There was a drop in apparent and true purity in all the unsprinkled cane and in some cases it was very large. In most instances the drop in apparent purity was slightly greater than in true purity, indicating the influence of invert sugar on the apparent purity determination. The increase in invert sugar with the continuation of storage was definitely related to the loss of sucrose and drop in purity, indicating that deterioration is primarily a matter of inversion, especially as there was no significant change in acidity or pH and the organic nonsugars remained practically constant in both sprinkled and unsprinkled cane. The slight change in acidity that did occur in some cases, disregarding that accounted for by the effect of drying, does not signify that micro-organisms played any part in deterioration.

The data indicate that maturity as measured by apparent or true purity affects the rate of deterioration, for as the cane matures it seems to deteriorate less rapidly. The behavior of P.O.J. 36–M during 1930 (table 2) is an exception. It is possible that the cloudy and rainy weather of the first few days in experiment 2 dealing with P.O.J. 36–M, and absent in experiment 1 (fig. 1, 1930 data), may have had a relation to the difference in the amount of deterioration. However, it may also be possible that other unknown factors play a part in the varying behavior of different lots of cane of a given variety.

That there is a varietal factor affecting deterioration is very evident from the data presented. Although all varieties show little inversion when kept wet by sprinkling there is a pronounced difference in the behavior of the different varieties when stored under conditions that favor the drying out of the cane, as found in this and other studies. Co. 281 is very resistant, while P.O.J. 36–M and C.P. 807 appear to be the most susceptible to deterioration. The results with the other varieties are too meager to establish the relationship toward one another, but it can be concluded that their susceptibility is intermediate between Co. 281 and P.O.J. 36–M.

TEMPERATURE AND MOISTURE RELATIONS IN SMALL PILES

The effect of temperature and moisture on deterioration must be considered along with the effect of maturity. It will be noted that cane of a given variety in the second and later experiment in each of the first three seasons showed less deterioration than in the first,[9] and normally it would be expected that the cane in the second experiments would be subject to a lower temperature than in the first, but that is not always true. Figure 1 gives some of the weather records, including the mean of the daily maximum and minimum temperatures, rainfall, etc., for the periods during which the various experiments were run.

[9] Although two experiments involving P.O.J. 36–M were conducted during the early and latter part of the season of 1933, the conditions under which they were conducted were not entirely comparable. The results of the second experiment will be discussed later.

It will be noted that the temperatures during the first 15 to 18 days were fairly comparable during the two experiments in both 1930 and

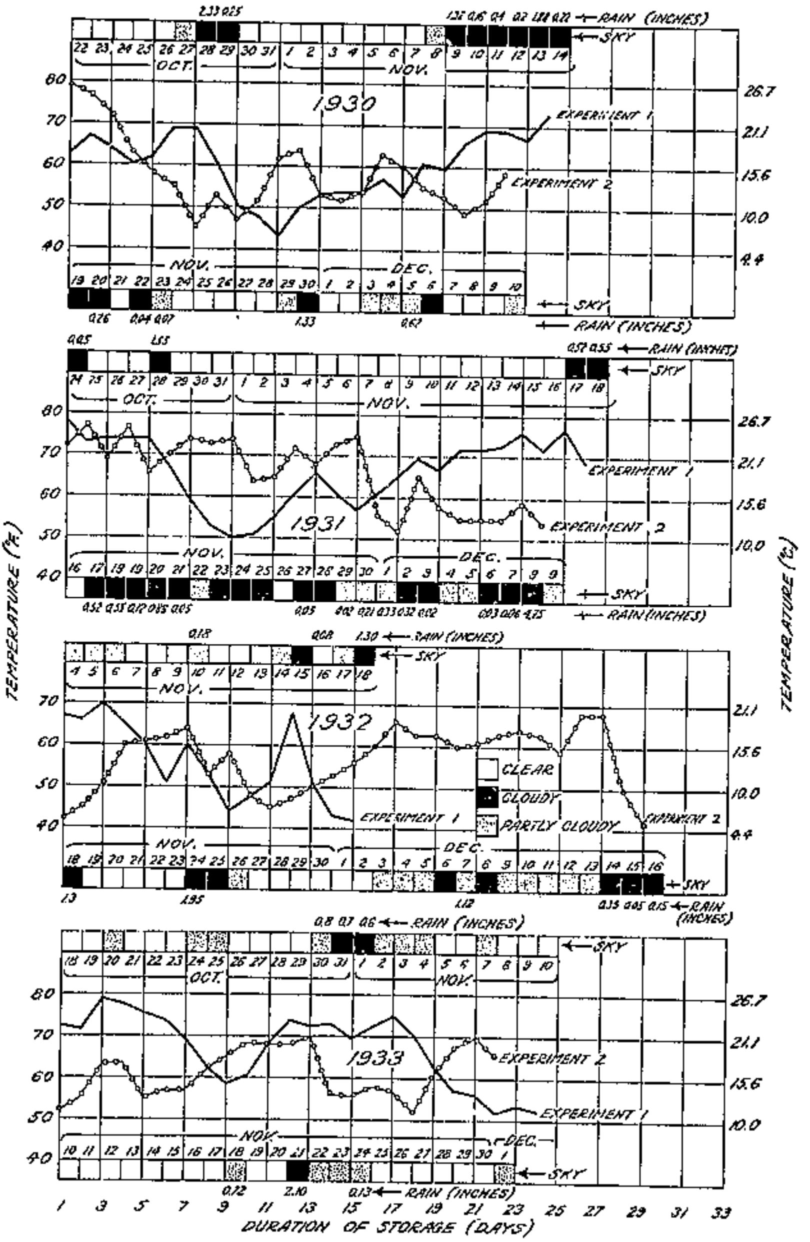

FIGURE 1.—Daily averages of maximum and minimum air temperatures, condition of sky as to cloudiness, etc., and rainfall during experiments with small piles in 1930, 1931, 1932, and 1933. The data regarding the condition of the sky are limited to the daytime.

1931. In 1930 there was considerable cloudiness and rainfall during the latter part of the first experiment. Cloudiness continued on into the second experiment and there was rain during 3 of the first 5 days. In 1931 the weather was predominantly clear during the first experiment and predominantly cloudy and rainy during the second. On examination of the comparable data on unsprinkled cane of the varieties Co. 281 and P.O.J. 36–M during 1931 (table 3) it will be found that there was greater deterioration in both varieties when stored in the open than when stored in the shade in experiment 1. In the second experiment the reverse was true of P.O.J. 36–M, and there was little difference in Co. 281 stored in the open and in the shade. It would seem that the cloudy and wet weather prevalent during the second experiment played a part in keeping down deterioration. Although no record was made of the wind, undoubtedly it also plays an important role in drying out cane and in that way affects the loss of sucrose.

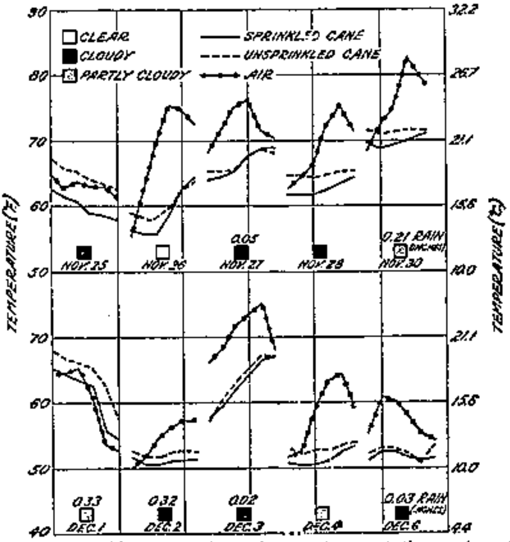

FIGURE 2.—Air temperature, temperatures at the center of sprinkled and unsprinkled small piles of cane stored in the shade, condition of sky as to cloudiness, etc., and rainfall. The temperature curves were plotted from readings taken at 7, 9, and 11 a.m. and 1, 3, and 5 p.m. on the days given. Experiment 2, 1931.

The effect of sprinkling on the temperatures within the piles of cane is of interest. In figures 2 and 3 are plotted curves for air temperature and temperatures at the center of sprinkled and unsprinkled piles stored in the shade and in the open, in experiment 2, 1931. Readings by means of resistance thermometers were taken at 7, 9, and 11 a.m. and 1, 3, and 5 p.m. just before sprinkling on different days, some of which were in succession. In figure 4 are plotted similar curves

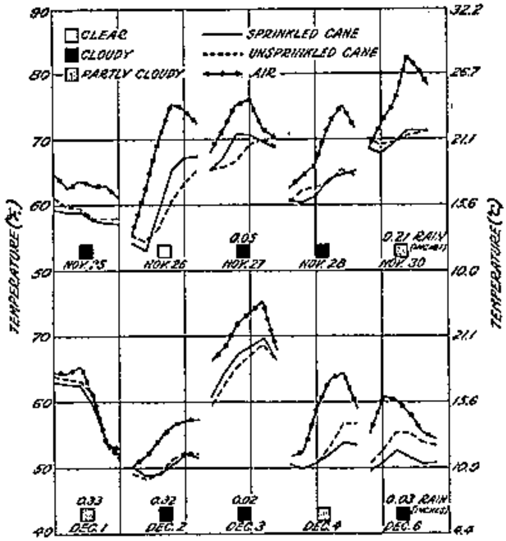

FIGURE 3.—Air temperature, temperatures at the center of sprinkled and unsprinkled small piles of cane stored in the open, condition of sky as to cloudiness, etc., and rainfall. The temperature curves were plotted from readings taken at 7, 9, and 11 a.m. and 1, 3, and 5 p.m. on the days given. Experiment 2, 1931.

in connection with cane stored in the shade during experiment 2, 1932.[10]

The temperature within the sprinkled piles was generally lower than in the unsprinkled piles, and the difference was generally greater in

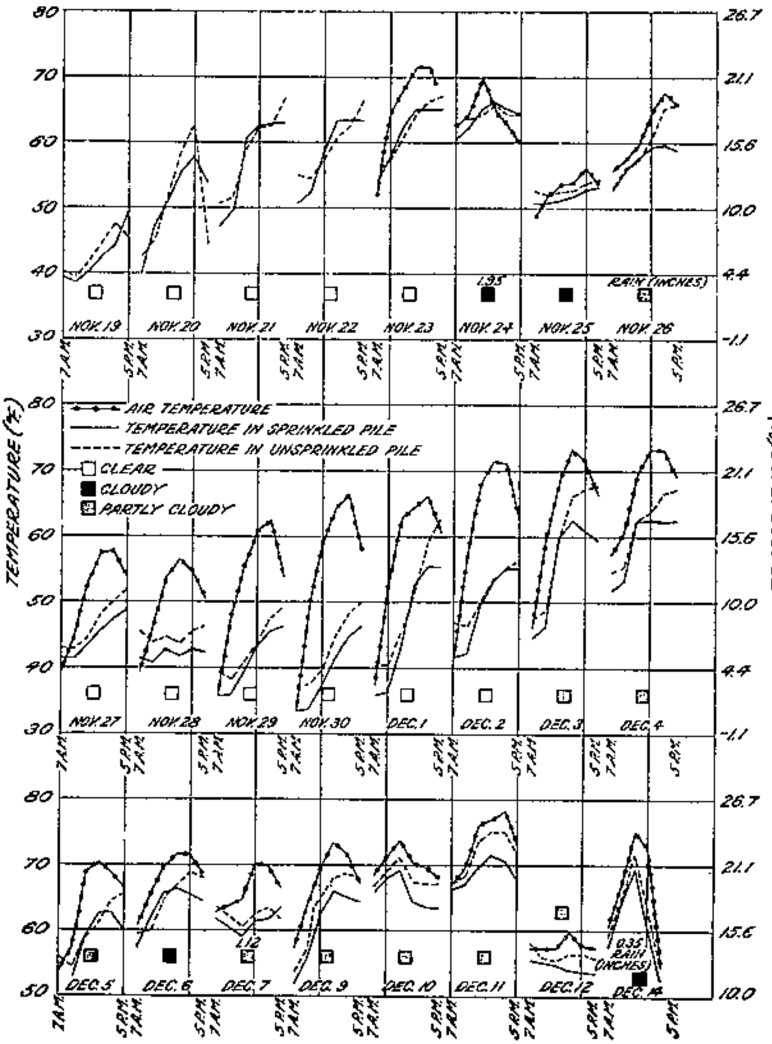

FIGURE 4.—Air temperature, temperatures at the center of sprinkled and unsprinkled small piles of cane stored in the shade, condition of sky as to cloudiness, etc., and rainfall. The temperature curves were plotted from daily readings (except Dec. 8 and 13) taken at 7, 9, and 11 a.m. and 1, 3, and 5 p.m. throughout the experiment. Experiment 2, 1932.

the shade than in the open. A lowering of the temperature in the sprinkled piles as a result of increased evaporation was expected. The actual differences in temperature between sprinkled and unsprinkled

[10] Temperature readings also were taken during 1933 in connection with sprinkled and unsprinkled cane stored in the shade and in the open. They were so similar to the foregoing records that they will not be presented.

cane or between cane stored in the shade and in the open, however, were not large. The temperature of the cane stored in the open tended to change more rapidly in response to a change in air temperature than did the cane stored in the shade and consequently showed a wider range of fluctuation. It is believed that the difference in temperature between the wet and dry pile is insufficient to account for the difference in deterioration, but rather that the difference in the water content of the cane cells resulting from sprinkling on the one hand and the absence of sprinkling on the other is of more importance. Other results obtained under controlled temperature and moisture conditions support this belief.

It will be seen from the difference between air temperature and that of the storage piles that small amounts of cane serve as a rather effective insulation against change in temperature, which is of practical importance in the storage of sugar cane.

STORAGE IN LARGE PILES

The analytical results obtained in connection with the storage of piles of cane of from 7 to 260 tons on the mill yard are given in tables 6 and 7.

In 2 out of 3 experiments in which factory-mill analyses were made (table 6) the unsprinkled cane showed a lower purity by the end of the storage period than the sprinkled cane. In the third experiment, 1932, in which there were 70 tons in each pile, the apparent purity (factory-mill analyses) of the sprinkled pile was slightly less than that of the unsprinkled pile. The difficulty in obtaining two piles of cane of 70 tons of comparable sucrose composition should be considered in evaluating these results. The results obtained from hand-mill samples in connection with this experiment, which were certain to be of rather uniform composition, show a greater drop in apparent and true purity in the dry pile than in the wet pile and a greater drop in the samples placed on top than in those at the center of the dry pile (tables 6 and 7). In one of the other two experiments (experiment 1, 1931), in which hand-mill samples were used, the same relation was found. In experiment 2, 1931, there was scarcely any difference between the results from the two piles, but since it rained on 5 out of the 6 storage days (from Dec. 15 to 21, 1931), was cloudy on 4 of these 6 days, and partly cloudy on the other 2 days (fig. 5, *A*) the unsprinkled pile was kept almost continuously wet. There was scarcely any significant change of purity in the hand-mill samples from either the top or the center of the 260-ton pile of cane sprinkled during 10 days' storage in 1933. In all these tests, whenever there was a drop in purity in the unsprinkled piles (such as in experiment 1, 1931, and the 1932 experiment) there was a corresponding increase in invert sugar. As in the tests conducted on small piles, this fact also indicates that the loss of sucrose was primarily due to inversion. The fact that there was no significant change in acidity or pH, nor any other sign of an abnormal condition in any of the piles, strongly indicates the feasibility of storing and sprinkling cane in large piles.

TABLE 6.—*Brix, apparent sucrose, apparent purity, and extraction in sprinkled and unsprinkled piles of sugarcane of 7 to 260 tons*

Variety and experiment no.	Sample	Position of sample	Size of pile	Date of analysis	Duration of storage	Sprinkled cane				Unsprinkled cane			
						Brix	Sucrose	Purity	Extraction	Brix	Sucrose	Purity	Extraction
			Tons		Days	°	Percent	Percent	Percent	°	Percent	Percent	Percent
P.O.J. 213 (first-year stubble)	Factory mill (normal juice)	Entire pile	7	1930 Nov. 6	3	13.58	10.45	77.0	....	16.05	11.98	74.6	....
P.O.J. 213:													
1 (second-year stubble)	Hand mill	Check	25	1931 Nov. 11[1]	0	16.11	13.38	82.9	55	16.14	13.38	82.9	55
	do	Top of pile	25	Nov. 16	4	15.64	12.65	80.0	55	16.66	12.55	75.3	56
	do	do	25	Nov. 18	6	15.47	12.52	80.9	60	16.60	11.98	71.8	57
	do	Center of pile	25	do	6	15.37	12.29	80.0	61	16.12	12.56	77.9	59
	Factory mill (normal juice)	Entire pile	25	do	6	12.58	9.06	72.0	....	13.75	9.59	69.8	....
2 (third-year stubble)	Hand mill	Check	30	Dec. 15	0	16.21	14.11	87.1	....	16.21	14.11	87.1	....
		Top of pile	30	Dec. 22	7	15.78	13.60	86.2	....	16.31	14.06	86.2	....
		Center of pile	30	do	7	15.69	13.43	85.6	....	16.11	13.85	86.0	....
P.O.J. 213 (third-year stubble)	Hand mill	Check	70	1932 Oct. 31	0	15.42	12.67	82.2	62	15.42	12.67	82.2	62
		Top of pile	70	Nov. 3	1	15.17	12.74	82.4	61	15.66	12.83	81.9	65
		do	70	Nov. 7	7	15.71	12.69	80.6	61	16.27	12.50	76.8	63
		Center of pile	70	do	7	15.58	12.69	81.5	63	15.80	12.55	79.4	64
	Factory mill (normal juice)	Entire pile	70	do	7	14.70	11.07	75.3	....	16.18	12.63	76.6	....
P.O.J. 36-M (first-year stubble)[2]	Hand mill	Check	260	1933 Nov. 27	0	14.81	11.44	77.3	59	....	....	....	....
		Top of pile	260	Dec. 7	10	14.38	11.15	77.5	60	....	....	....	....
		Center of pile	260	do	10	14.39	11.13	77.4	60	....	....	....	....

[1] The check sample was ground and analyzed Nov. 11, whereas the piles were not finished until Nov. 12.

[2] The pile consisted of a mixture of varieties.

TABLE 7.—*Detailed analysis of hand-mill samples stored on top and at the center of sprinkled and unsprinkled piles of sugarcane, ranging from 25 to 260 tons* [1]

Variety and experiment no.	Position of sample	Date of analysis	Duration of storage	Sprinkled cane: Acidity (0.1 N NaOH per 10 cc of juice)	Sprinkled cane: pH	Sprinkled cane: Dry substance	Sprinkled cane: True purity	Sprinkled cane: Invert sugars	Sprinkled cane: Ash	Sprinkled cane: Organic non-sugars	Unsprinkled cane: Acidity (0.1 N NaOH per 10 cc of juice)	Unsprinkled cane: pH	Unsprinkled cane: Dry substance	Unsprinkled cane: True purity	Unsprinkled cane: Invert sugars	Unsprinkled cane: Ash	Unsprinkled cane: Organic non-sugars
			Days			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
P.O.J. 213:		1931															
1 (second-year stubble).	Check	Nov. 11	0	1.55	----	15.78	87.57	6.95	1.82	3.66	1.55	----	15.78	87.57	6.95	1.82	3.66
	Top of pile	Nov. 18	7	1.85	5.39	15.12	85.58	8.51	1.48	4.07	1.95	5.39	16.39	78.04	16.08	1.90	3.98
	Center of pile	do	7	1.90	5.36	15.12	85.38	8.24	1.98	4.40	1.85	5.39	15.81	84.00	10.00	2.04	3.96
2 (third-year stubble).	Check	Dec. 15	0	2.00	5.26	15.84	89.84	2.61	2.49	5.06	2.00	5.26	15.84	89.84	2.61	2.49	5.06
	Top of pile	Dec. 22	7	1.90	5.36	15.20	90.89	2.72	2.62	3.77	1.90	5.36	15.88	90.49	2.48	2.58	4.41
	Center of pile	do	7	1.90	5.36	15.19	90.68	2.79	2.70	3.83	1.90	5.36	15.72	90.39	2.50	2.68	4.43
		1932															
P.O.J. 213 (third-year stubble).	Check	Oct. 31	0	1.20	5.42	15.19	86.37	7.56	2.06	4.01	1.20	5.42	15.19	86.37	7.56	2.06	4.01
	Top of pile	Nov. 7	7	1.15	5.40	15.18	86.80	7.38	2.14	3.59	1.20	5.42	16.01	81.83	10.41	2.06	5.70
	Center of pile	do	7	1.10	5.42	15.33	86.11	7.35	1.99	4.55	1.10	5.42	15.84	82.70	8.20	1.99	7.11
		1933															
P.O.J. 36-M (first-year stubble).[2]	Check	Nov. 27	0	1.47	5.34	14.15	82.76	9.24	3.49	4.51	----	----	----	----	----	----	----
	Top of pile	Dec. 7	10	1.44	5.41	13.92	82.26	9.20	3.63	4.91	----	----	----	----	----	----	----
	Center of pile	do	10	1.42	5.42	13.89	82.36	9.08	3.58	4.98	----	----	----	----	----	----	----

[1] Piles in experiment 1, 1931, contained 25 tons; in experiment 2, 1931, 30 tons; in the 1932 experiment 70 tons, and in the 1933 experiment 260 tons.
[2] The pile was a mixture of varieties.

TEMPERATURE AND MOISTURE RELATIONS IN LARGE PILES

In figure 5 a comparison is shown of (1) air temperature and temperatures at the center of the sprinkled and unsprinkled piles of cane (30 tons) in experiment 2, 1931, and in the 1932 experiment (70 tons), and (2) air temperature and temperatures at the center of the sprinkled pile (260 tons) in the 1933 experiment. The rainfall and the condition of the sky as to cloudiness are also given.

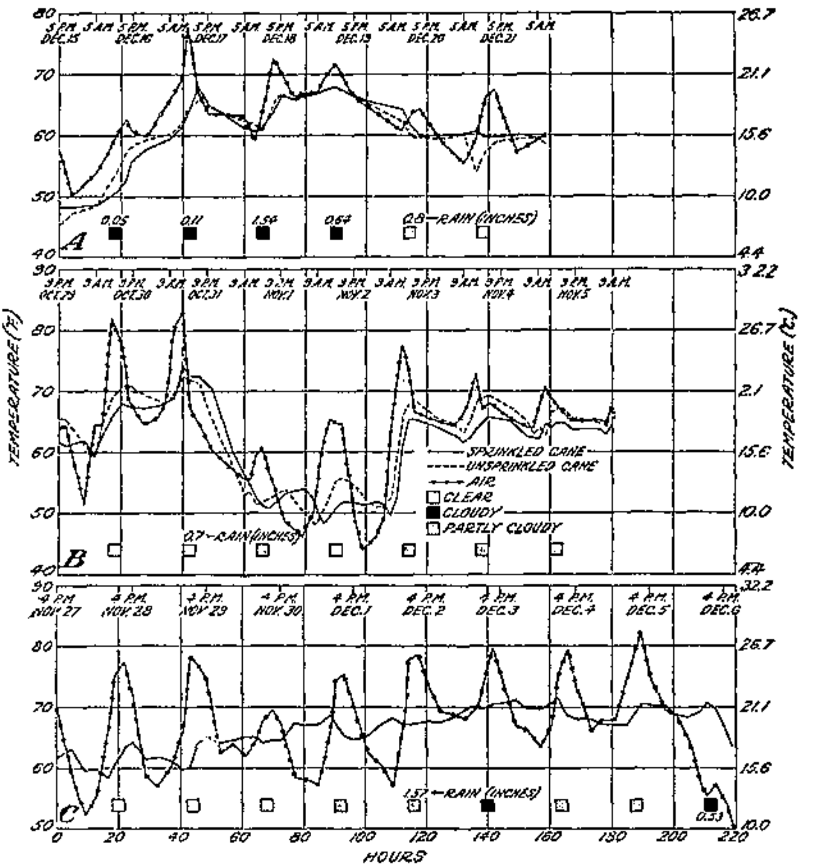

FIGURE 5.—Air temperature, temperatures at the center of sprinkled and unsprinkled piles of 30 tons (1931) and 70 tons (1932), and of a sprinkled pile of 260 tons (1933) of cane stored in the open; condition of sky as to cloudiness, etc., and rainfall. The temperature curves were plotted from readings taken frequently (usually every 2 hours) throughout each experiment: *A*, Experiment 2, 1931; *B*, 1932 experiment; *C*, 1933 experiment.

It will be seen that there was not much difference between the temperature of the sprinkled and unsprinkled piles, although it was generally slightly lower in the sprinkled piles even during the 1931 experiment, when the weather was predominantly cloudy and rainy. The difference in the 1932 experiment is not sufficient, it is believed, to account for the difference in deterioration. It is significant that although the temperatures of the pile lag behind that of the air, they tend to fluctuate with it. Even in the pile of 260 tons, when by the end of the storage period there was slight nodal root growth (1 to 1.5 inches long), the temperature of the pile laggingly fluctuated with that of the air. It shows that even in piles as large as 260 tons the heat of respiration is dissipated in a sufficiently rapid manner to be no source of hazard, at least as long as the duration of the storage period is not too great. It also signifies an absence of the action of micro-organisms.

The air temperature and the temperatures at the center of two mill-yard piles of cane of 800 tons are shown in figure 6. The piles joined each other and pile no. 2 was started when pile no. 1 was finished. The temperature of pile no. 1 laggingly fluctuated with the air temperature. The fluctuation in pile no. 2 was not so definite, but there was no tendency for an accumulation of heat. The direction of the wind as well as the time of piling may have had an influence on this difference.

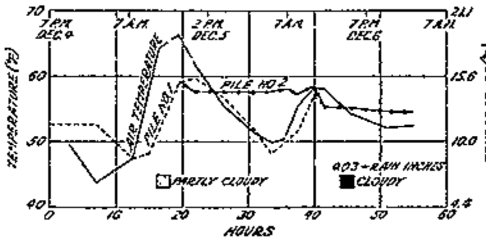

FIGURE 6.—Air temperature, temperatures at the center of two mill-yard piles of cane (unsprinkled) of about 800 tons each, condition of sky as to cloudiness, etc., and rainfall (Dec. 4 to 6, 1931). The temperature curves were plotted from readings taken approximately every 2 hours throughout the period of storage.

It has been shown in the storage tests, involving both small and large piles, that sprinkling reduces deterioration to a minimum, that there is no pronounced change in composition of the juice in cane stored wet, and that there is no accumulation of heat even in piles as large as 800 tons within the time limits given. It may be concluded, therefore, that cane if sprinkled may be safely and profitably stored for limited periods in Louisiana, thus insuring more or less continuous operation of the mills.

MISCELLANEOUS EXPERIMENTS BEARING ON DETERIORATION OF SUGARCANE

If sugar losses in harvested cane are to be kept at a minimum, it is essential to know what may be expected to occur in such cane in the interval between cutting and milling or placing in piles for sprinkling. This time interval may be only a few hours, but more frequently it may extend to a day or more. In some instances it is the practice to place the cane in small piles across the rows after topping. Then without further stripping the remaining leaves are allowed to dry sufficiently for burning.[11] Thus, a few experiments were conducted in which the rate of inversion of sucrose in stripped and unstripped cane, and of checking inversion by sprinkling, once it has started, were studied.

DETERIORATION IN STRIPPED AND UNSTRIPPED CANE

Three experiments were conducted in which the rate of inversion of sucrose in stripped and unstripped cane of two varieties (table 8) was studied. The method of sampling was the same in all three experiments. A plot of uniform cane from a limited area was cut off at the

[11] Although these experiments were not designed to cover this particular case, it is believed that they throw some light on it.

ground and placed in a long pile across the furrows without stripping. In each experiment twenty-five 30-stalk samples were selected by drawing stalks for each sample at random over the entire pile. After selection, 15 of these samples, taken at random from the lot, were stripped in the same manner that is used with mill cane. The leaves and trash were left on the remaining 10 samples. The stalks of each sample were bound together by wire fastened around the sample in 2 or 3 places. In each experiment five of these stripped samples were analyzed immediately as checks. The remaining samples were stored as follows: In the first experiment, 5 stripped and 5 unstripped samples were stored at 65° F. and 96 percent relative humidity and at 65° and 75 percent relative humidity on racks in storage rooms 10 by 12 feet by about 9 feet high. In the two other experiments, 5 stripped and 5 unstripped samples were stored on each of two racks (1.5 feet high and 16 feet long) in the open. The samples on the one rack were sprinkled and those on the other were left unsprinkled. The samples were spread out over the racks and all the wire bands were released except at the base of the sample. The upper parts of all samples were then spread out to afford ample opportunity for evaporation to take place. The tops (upper portion of stripped and unstripped cane) of the samples faced south and were fully exposed to the sun, when shining, throughout the day. The sky was clear throughout the duration of the first of these two experiments, the minimum temperature ranging from 36° to 53°, and the maximum from 65° to 80°. During the second experiment the sky was clear 3 days, partly cloudy 3 days, and cloudy 2 days (including the day of setting up and the day of taking down the experiment). The rainfall was 0.15 inch; the range of minimum temperatures from 40° to 65°; and that of maximum temperatures from 68° to 81°.

Weight [12] losses were not determined in the first of the three experiments. In the two other experiments, the weight losses were accurately determined in the stripped cane and an effort was made to determine indirectly some notion of the weight losses in the unstripped cane. An average weight was taken of the 15 stripped samples. The losses given were obtained by subtracting the average weight of the unstripped samples of a given treatment after stripping from the average original weight of the stripped samples. This method, when the samples are limited, naturally involves considerable error. When the loss in weight is considerable, it is possible to obtain a rough measurement of the relative loss in weight. A physical examination of P.O.J. 36-M stored in the open showed that the degree of shriveling of the top joints, in the order of the greatest to the least, was as follows: Unsprinkled unstripped, unsprinkled stripped, sprinkled unstripped, and sprinkled stripped. The loss in weight, the increase in Brix, and the drop in purity (table 8) follow the same order. The difference in shriveling was not as clearly defined in the case of Co. 281. The drop in purity increases in the following order: Sprinkled stripped, unsprinkled stripped, sprinkled unstripped, and unsprinkled unstripped. The increase in Brix, which is also a measure of the loss in weight (water), is in the same order as the drop in purity, but the weight losses do not entirely correspond. It is believed that this discrepancy is due to the method of obtaining weight losses in unstripped cane, which, as already pointed out, may be in considerable error.

[12] The major portion of the loss in weight is assumed to be due to the loss in moisture.

TABLE 8.—*Brix, apparent sucrose, apparent purity, weight loss, and extraction in stripped and unstripped sugarcane stored (1) under controlled temperature and relative humidity and (2) in the open, sprinkled and unsprinkled*

Kind of storage and variety	Date of analysis	Duration of storage	Temperature (° F.) and relative humidity (percent) or treatment	Stripped				
				Brix	Sucrose	Purity	Weight loss	Extraction
Cane stored under controlled temperature and relative humidity:	1932	*Days*		°	*Percent*	*Percent*	*Percent*	*Percent*
P.O.J. 36-M (second-year stubble).	Nov. 11	0	....	14.94	11.47	76.8	....	61
	Nov. 17	6	65°; 96 percent.	14.83	11.19	75.5	....	62
	..do.....	6	65°; 75 percent.	15.60	10.41	66.6	....	61
Cane stored on racks in the open:	1933							
P.O.J. 36-M (first-year stubble).	Nov. 10	0	....	15.57	12.21	78.4	....	58
	Nov. 17	7	Sprinkled....	15.70	11.83	75.1	2.1	53
	do....	7	Unsprinkled..	16.87	9.25	54.8	8.4	58
Co. 281 (first-year stubble).	Dec. 13	0	....	16.93	14.23	84.1	....	59
	Dec. 20	7	Sprinkled....	17.14	14.21	83.1	1.7	59
	..do....	7	Unsprinkled..	17.61	14.27	81.0	3.9	60

Kind of storage and variety	Date of analysis	Duration of storage	Temperature (° F.) and relative humidity (percent) or treatment	Unstripped				
				Brix	Sucrose	Purity	Weight loss	Extraction
Cane stored under controlled temperature and relative humidity:	1932	*Days*		°	*Percent*	*Percent*	*Percent*	*Percent*
P.O.J. 36-M (second-year stubble).	Nov. 11	0	....	14.94	11.47	76.8	......	61
	Nov. 17	6	65°; 96 percent.	15.12	11.43	75.6	......	59
	..do.....	6	65°; 75 percent.	15.50	10.45	67.4	....	60
Cane stored on racks in the open:	1933							
P.O.J. 36-M (first-year stubble).	Nov. 10	0	....	15.57	12.21	78.4	....	58
	Nov. 17	7	Sprinkled.....	16.57	10.23	61.7	6.2	57
	..do.....	7	Unsprinkled..	17.78	8.15	45.8	10.5	57
Co. 281 (first-year stubble).	Dec. 13	0	....	16.93	14.23	84.1	....	59
	Dec. 20	7	Sprinkled....	17.64	14.22	80.6	1.0	59
	..do....	7	Unsprinkled..	18.05	13.58	75.2	5.9	60

If the evaporation of moisture is held in check by storing the samples at 65° F. and 96 percent relative humidity, little inversion of sucrose in either stripped or unstripped cane occurs even in a susceptible variety like P.O.J. 36–M. If, however, the cane is stored under conditions (65° and 75 percent relative humidity) that favor evaporation, considerable inversion takes place. There was not much difference in the purity of stripped and unstripped cane at either condition of storage. This may be explained by the fact that evaporation was restricted from the tops, because in order to place the samples crosswise in the rooms it was necessary to bend the leaves somewhat and to pile the samples together, i.e., each lot of stripped and of unstripped cane. They were not spread out as were those stored in the open.

These results confirm those obtained by Browne and Blouin (*8*) in showing greater inversion in unstripped (or untopped) cane stored in the open. The cane in the present experiments was subjected to greater exposure, as Browne and Blouin were studying windrowed cane and the length of storage was different in the two cases (7 days in these experiments, a month in those of Browne and Blouin).

Alvarez (*1*) claims that this relation does not hold for P.O.J. 36 and P.O.J. 213. The discrepancy in results may be due to difference in the varieties used, as well as the difference in the environmental conditions under which the experiments were conducted, and from the fact that in the experiment conducted by Alvarez the unstripped cane was cleaned of all the leaves except the tops. The environmental conditions under which these workers (*1*, *8*) conducted their experiments are not given. However, it is believed that the loss in moisture, rather than the movement of invertase from the leaves down into the stalks, brings about a physiological condition within the stalks themselves that is responsible for the greater inversion of sucrose in unstripped than in stripped cane. When stripped and unstripped canes are stored in the open under conditions favoring rapid loss of moisture, it is to be expected that there would be more rapid loss of moisture from the unstripped than from the stripped cane, because of the greater evaporating surface of the leaves of unstripped cane, which would draw heavily on water in the stalks.

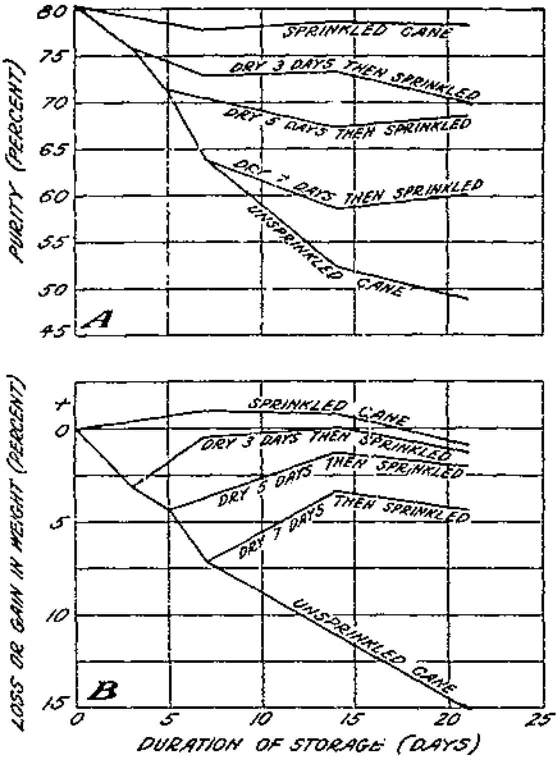

FIGURE 7.—Periodic change in purity (*A*), as related to gain and loss of weight (*B*), in 5 lots of cane (P.O.J. 36-M, first-year stubble) stored in the shade, 1 lot sprinkled, 1 unsprinkled, and the 3 others stored dry 3, 5, and 7 days, respectively, and then sprinkled.

INFLUENCE OF SPRINKLING ON CHECKING DETERIORATION RESULTING FROM PRELIMINARY DRYING OF MILL CANE

An experiment was conducted in which 30-stalk samples of P.O.J. 36-M were selected by drawing stalks at random from a large pile of uniform, freshly harvested cane. All samples were stored in the shade. One lot of samples was sprinkled, one left unsprinkled, and one each of three lots stored dry for 3, 5, and 7 days, respectively, and then sprinkled. The sprinkling was done at 7, 9, and 11 a.m. and at 1, 3, and 5 p.m. daily. The samples were weighed before storing and at intervals thereafter, in order to study the weight losses and gains. Periodic analyses were made to study the course of inversion and other changes (table 9; fig. 7). Five 30-stalk samples were used as a unit for analysis for each treatment and period of storage. The weather conditions during the period in which the

TABLE 9.—*Periodic analysis and weight gains and losses in sprinkled and unsprinkled sugarcane (P.O.J. 36–M, first-year stubble) stored for 21 days in the shade and in sugarcane stored in the shade for 3, 5, and 7 days and then sprinkled 18, 16, and 14 days, respectively, 1933*

Date of analysis	Duration of storage	Treatment of cane	Brix	Apparent sucrose	Apparent purity	Gain (+) or loss (−) in weight	Extraction	pH	Acidity [1] (0.1 N NaOH per 10 cc of juice)	Dry substance	True purity	Invert sugars	Ash	Organic non-sugars
	Days		°	*Percent*	*Percent*	*Percent*	*Percent*		*Cc*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Nov. 10	0	Check	15.77	12.68	80.4		55	5.30	1.28	15.24	85.58	8.06	2.85	3.53
Nov. 17	7	Sprinkled	15.31	11.98	78.3	+0.99	52							
Nov. 21	14	do	15.14	11.91	78.7	+.75	61							
Dec. 1	21	do	15.21	11.89	78.2	−.71	60	5.37	1.18	14.67	84.12	8.47	3.12	4.20
Nov. 10	0	Check	15.77	12.68	80.4		55	5.30	1.28	15.24	85.58	8.06	2.85	3.53
Nov. 13	3	Stored dry 3 days	16.15	12.29	75.9	−3.21	57	5.28	1.33	15.67	81.94	11.08	2.87	4.11
Nov. 17	7	Stored dry 3 days, then sprinkled 4 days	15.67	11.43	72.9	−.48	53							
Nov. 21	14	Stored dry 3 days, then sprinkled 11 days	15.22	11.16	73.3	+.04	61							
Dec. 1	21	Stored dry 3 days, then sprinkled 18 days	15.04	10.51	69.9	−1.29	60	5.37	1.24	14.55	77.46	14.36	3.23	4.95
Nov. 10	0	Check	15.77	12.68	80.4		55							
Nov. 15	5	Stored dry 5 days	16.41	11.69	71.2	−4.42	56							
Nov. 24	14	Stored dry 5 days, then sprinkled 9 days	15.53	10.45	67.3	−1.28	61							
Dec. 1	21	Stored dry 5 days, then sprinkled 16 days	15.25	10.45	68.5	−2.11	60							
Nov. 10	0	Check	15.77	12.68	80.4		55	5.30	1.28	15.24	85.58	8.06	2.85	3.53
Nov. 17	7	Stored dry 7 days	16.59	10.58	63.8	−6.95	59	5.32	1.34	16.18	71.45	21.27	3.01	4.27
Nov. 24	14	Stored dry 7 days, then sprinkled 7 days	15.80	9.26	58.6	−3.48	59							
Dec. 1	21	Stored dry 7 days, then sprinkled 14 days	15.52	9.33	60.1	−4.46	60	5.32	1.33	14.99	69.51	22.56	3.29	4.64
Nov. 10	0	Check	15.77	12.68	80.4		55	5.30	1.28	15.24	85.58	8.06	2.85	3.53
Nov. 13	3	Stored dry	16.49	12.29	75.9	−3.20	57	5.28	1.33	15.67	81.94	11.08	2.87	4.11
Nov. 15	5	do	16.41	11.69	71.2	−4.42	56							
Nov. 17	7	do	16.59	10.58	63.8	−6.95	59	5.32	1.34	16.18	71.45	21.27	3.01	4.27
Nov. 24	14	do	17.21	8.99	52.2	−11.16	58							
Dec. 1	21	do	17.66	8.62	48.8	−15.12	56	5.24	1.52	17.23	59.95	31.95	3.07	5.03

[1] Acidity determined electrometrically, employing quinhydrone electrode and titrating 50 cc juice to a pH of 7.0.

experiment was conducted are shown in figure 1 (experiment 2, 1933).

The apparent and true purity of the sprinkled cane were maintained at a high level, whereas in the unsprinkled cane they dropped rapidly with the continuation of storage. The rate in drop in purity is very definitely correlated with the increased loss in weight. The Brix of the juice from the sprinkled cane decreased gradually during the first 14 days, apparently, in response to the increased weight or absorption of moisture and then increased with the loss in weight that followed. The Brix of the juice increased in cane stored in the absence of sprinkling, but decreased when moisture was added, as did the weight loss. The invert sugar increased with the drop in purity, and there was no significant change in pH or acidity. The results in tables 8 and 9 show that the loss of moisture is an important factor in bringing about inversion in sugarcane. Taken together with unpublished data, they show it is usually more important than temperature under Louisiana conditions, at least within certain time limits.

The foregoing results indicate that inversion of sucrose in harvested cane can be checked by sprinkling after it has started, but there is a suggestion in the data that by delaying the sprinkling inversion is not quite so effectively checked as when sprinkled at the start. The results from two other experiments (not published) also confirm these in showing that sprinkling will check inversion once it has started. There can be no possible advantage, however, in delaying sprinkling, since sprinkling at the start conserves more sugar. It should be emphasized that in order to preserve the greatest possible amount of sugar, the cane should be brought promptly to the mill or the storage pile after cutting.

TESTS BY FACTORY MANAGERS

During the grinding season of 1933 all the cane (about 20,000 tons) that was transported by truck to one factory for week-end grinding was sprinkled once or twice a day. The piles varied from 200 or 300 to 2,000 tons. In some instances the cane was in the yard as long as 2 weeks. A record of the regular mill analysis in which the stored cane was compared with the analysis of the cane that was ground as it was brought to the factory indicates that there was little deterioration in the stored cane.

A rather satisfactory test involving about 1,000 tons of cane, sprinkled at 10 a.m. and 2 p.m. each day of storage, was carried out at one factory [13] from which the results given in table 10 were obtained. The cane was transported to the factory in barges within 24 hours after it was loaded, and it is estimated that all the cane was placed in the barge within 48 hours after it was cut. A barge contains about 100 tons of cane. As the cane was piled in the mill yard, three grabs of about 2,400 pounds each, one from each end and one from the center of each barge, were taken from the top, middle, and bottom portions of the barge and analyzed as a check. The percentage of sucrose given for each date of piling is the average obtained from these barge samples. The final analyses were taken from juice obtained during the grinding of the pile. The time the cane was in the pile varied

[13] Frank L. Barker, of the Valentine Sugars, Inc., Lockport, La., conducted the test and kindly furnished the data given in table 10 and the other information relating to this test.

from 4 to 10 days. The results show that there was no significant change in the sucrose content of the cane during storage.

TABLE 10.—*Influence of sprinkling on the sucrose content in cane*[1] *stored in the mill yard in 1933*

Date of storing cane	Initial weight and analysis		Date of grinding cane	Final weight and analysis	
	Weight of cane	Sucrose (normal juice)		Weight of cane	Sucrose (normal juice)
	Tons	*Percent*		*Tons*	*Percent*
Dec. 16	[2] 107.600	12.57			
Dec. 17	400.100	12.08			
Dec. 18	381.250	12.79			
Dec. 19	52.800	13.25	Dec. 24	727.370	12.54
Dec. 20	51.180	12.40	Dec. 26	245.615	12.80
Total or average	973.080	12.72		972.985	12.61

[1] About 70 percent of the cane was P.O.J. 36-M, 20 percent P.O.J. 234, and 10 percent P.O.J. 213.
[2] The initial weights were obtained at the field derricks before the cane was loaded on the barges and the final weights were obtained at the factory just before grinding.

SOME PRACTICAL CONSIDERATIONS

The results from the experiments conducted by the writers, as well as the mill-yard tests made by the plantation managers, show that mill cane, if sprinkled, can be stored in piles of considerable size for limited periods, with profit. The length of time that cane can be stored in large piles will depend somewhat on the temperature prevailing at the time and the degree of sprinkling. If the temperatures are too high and prolonged (around 70° F. and above in the piles) and there is excessive sprinkling, the cane will tend to root and later sprout. Normally, however, such temperatures do not prevail much of the time in Louisiana during the grinding season. By comparing the temperature at the center of the piles with air temperatures (fig. 5) it will be seen that the air temperatures may go considerably higher than 70° during the daytime without raising the temperature within the pile to 70°. It is believed that piles of cane of considerable size can be stored successfully for a week to 10 days by sprinkling only 2 or 3 times a day. Once the pile is thoroughly wet it is believed that all that is necessary thereafter is to wet the surface cane occasionally. By means of fine spray from a nozzle or a sprinkling system, it would be possible to limit the amount of water used, thus reducing the hazard of oversprinkling and the consequent damage to the mill yard or other place of storage.

The sprinkling of cane brought to the mills in barges and standard-gage railroad cars would likewise conserve considerable sugar, especially when the cane is transported long distances or held at or near the factory for an appreciable period before being ground. In the case of the barges, a pump could be attached to a barge and the cane sprinkled from the bayou. An overhead sprinkling arrangement, under which the cars could be run, could be used to sprinkle cane held in railroad cars.

Aside from being stored in the mill yard, cane might profitably be stored at derricks in the fields, where water and the necessary transportation facilities are readily available. Such storage would have the advantage (1) of relieving congestion at the mill yard and (2) of enabling the plantations to store more cane when necessary to insure continuous mill operation. This cane could be picked up by grabs when railroad cars, of either narrow or standard gage, are used for transporting the cane or left in chains when the cane is transferred by trucks.

Aside from storing cane for grinding during rainy weather, it will be found profitable to sprinkle the cane now stored on the mill yard for normal week-end operations.

It should be emphasized that cane designated for storage should be stored and sprinkled as promptly as possible after it is cut, to avoid drying out and the consequent loss of sugar.

It may be possible, too, sometime in the future, to devise a simple and cheap means of providing shade and thus further protect against loss of sucrose in storage.

It is realized that in some instances the sprinkling of cane complicates the matter of obtaining the necessary weight values on which to base the pay of the grower for his cane. It is believed, however, that this question can be worked out satisfactorily between the mill manager and the grower.

Further tests will be required in connection with storage of cane in large piles to determine more accurately the frequency and amount of sprinkling required, the size of pile, and the length of time that cane can profitably be stored.

SUMMARY

The data presented deal with (1) inversion of sucrose and other chemical changes in small piles (about 1,500 to 1,800 pounds) of cane of different varieties, sprinkled and unsprinkled and stored in the shade and in the open; (2) inversion and other chemical changes in sprinkled and unsprinkled piles of cane from 7 to 70 tons, and a sprinkled pile of 260 tons, stored in the open in the mill yard; (3) the influence of weather on such deterioration; (4) temperatures in piles from 1,500 pounds to 800 tons; and (5) weight losses as related to inversion of sucrose.

The results show conclusively that the sprinkling of cane in small piles prevents heavy losses of sucrose in all varieties. The storage of unsprinkled cane may result in heavy losses of sucrose by inversion. Whether there is greater or less inversion in unsprinkled cane stored in the shade than in that stored in the open depends upon cloudiness and rainfall; wet weather tends to check inversion.

The results thus far obtained show that sprinkling retards inversion in piles ranging in size from 7 to 260 tons during 6 to 10 days' storage.

The deterioration in sprinkled and unsprinkled piles of cane is primarily due to inversion of sucrose.

There was no significant change in acidity, pH, or organic nonsugars nor any change that indicated the action of micro-organisms in sprinkled or unsprinkled piles.

Sprinkling tends to lower the temperature of cane in the piles; however, the difference in the temperature of sprinkled and unsprinkled piles is believed to be insufficient to account for the difference in deterioration, which seems to result rather from the difference in turgidity of the cane. The value of sprinkling, therefore, is believed

to depend on its effectiveness in maintaining the normal turgidity of the cane throughout the storage period.

The temperature at the center of the larger piles, although lagging behind, tends to fluctuate with the air temperature, indicating that there is no progressive accumulation of the heat of respiration and of that produced by micro-organisms.

The maturity of the cane, whether related to the sucrose content or some other physiological condition, seems to be a factor in the rate of deterioration; the more mature the cane the less rapid is the deterioration.

The inversion of sucrose is intimately associated with the loss of moisture and increases with the drying out of the cane.

Co. 281 deteriorates less rapidly under all conditions of storage than the other varieties studied. P.O.J. 36-M and C.P. 807 appear to be the most susceptible to deterioration. The position of the other varieties studied (C.P. 28/19, Co. 290, P.O.J. 213, and P.O.J. 234) seems to be between these two extremes. Their exact relation to each other has not been accurately determined. The maturity of these varieties probably plays a part in this relation.

The results presented in this bulletin show that very little deterioration occurred in stored sugarcane when it was kept thoroughly wet during the period of storage. They strongly suggest the practicability of storing mill cane, if sprinkled, in the mill yard or at the derricks during fair weather as a means for insuring more continuous operations during periods of rainy weather, which interfere with or temporarily stop, harvesting. The results also indicate that shading the stored cane, especially during dry weather, tends to furnish further protection against deterioration.

LITERATURE CITED

(1) Alvarez, A. S.
1933. ENSAYO SOBRE EL DETERIORO DE LA CAÑA CORTADA, DESPUNTADA Y NO DESPUNTADA. Rev. Indus. y Agr. Tucumán 23: 53-59, illus.

(2) Association of Hawaiian Sugar Technologists.
1931. METHODS OF CHEMICAL CONTROL FOR CANE-SUGAR FACTORIES. . . . Rev., 140 pp. Honolulu.

(3) Association of Official Agricultural Chemists.
1930. OFFICIAL AND TENTATIVE METHODS OF ANALYSIS . . . Compiled by the Committee on Editing Methods of Analysis . . . Ed. 3, 593 pp., illus. Washington, D.C.

(4) Barbados Department of Agriculture.
1914. THE DETERIORATION OF CUT CANE. Barbados Dept. Agr. Rept. Agr. Work 1910-12 (pt. III): 42-46.

(5) Balch, R. T., and Lauritzen, J. I.
1933. WINDROWING QUALITIES OF CO. 281 AND OTHER VARIETIES OF SUGARCANE UNDER LOUISIANA CONDITIONS. U.S. Dept. Agr. Circ. 304, 15 pp., illus.

(6) Barnes, J. H.
1917. THE AFTER-RIPENING OF CANE. CHEMICAL CHANGES WHICH TAKE PLACE AFTER CUTTING. Agr. Jour. India 12: 200-215.

(7) Blouin, R. E.
1913. UNA COMPARACIÓN DE LOS RESULTADOS DE LOS ENSAYOS CON LAS CAÑAS DE JAVA CON LOS DE LAS CAÑAS "KAVANGIRE", "ZWINGA", Y MORADA Y RAYADA DEL PAIS. Rev. Indus. y Agr. Tucumán 4: 141-150.

(8) Browne, C. A., Jr., and Blouin, R. E.
1907. THE CHEMISTRY OF THE SUGARCANE AND ITS PRODUCTS IN LOUISIANA. La. Agr. Expt. Sta. Bull. 91, 103 pp.

(9) Cook, H. A., and McAllep, W. R.
1928. GLUCOSE DETERMINATIONS; A SUMMARY OF WORK WITH THE METHYLENE BLUE METHOD PROPOSED FOR OFFICIAL ADOPTION IN HAWAII. Facts About Sugar 23: 782–784, 806–808.
(10) Cross, W. E., and Belile, J. A.
1914. LA DETERIORACIÓN DE CAÑAS CORTADAS. Rev. Indus. y Agr. Tucumán 5: [272]–290.
(11) ——— and Harris, W. G.
1916. DETERIORACIÓN DE LAS CAÑAS DE SEMILLERO DE JAVA DESPUES DE CORTADAS. Rev. Indus. y Agr. Tucumán 7: 219–250.
(12) Czernicki, O. F. Müller von.
1900. OORSPRONKELIJKE VERHANDELINGEN. HET LABORATORIUM TEN DIENSTE DER RIETEN SUIKERPRODUCTIE. Arch. Java-Suikerindus. Jaarg. 8: [597]–657, illus.
(13) Dawson, L. E.
1926. THE PH WITH QUINHYDRONE ELECTRODE; A RECORD OF EXPERIMENTS WHICH SEEMS TO COMMEND THE USE OF THIS METHOD ESPECIALLY FOR SUGAR-HOUSE PRODUCTS. Sugar 28: 211–214, 262–264, 310–312, 369–370, illus.
(14) Haldane, J. H.
1933. DRYAGE AND DETERIORATION OF CANE VARIETIES IN UPPER INDIA. Internatl. Sugar Jour. 35: 140–143.
(15) Hall, J. A.
1914. INVERSION IN CUT SUGAR CANE. La. Planter and Sugar Manufacturer 52: 233–234.
(16) Hommes, F.
1926. ACHTERUITGANG VAN RIET OP HET EMPLACEMENT. Arch. Suikerindus. Nederland. Indië 34: [545]–551.
(17) Kuyper, J.
1924. ACHTERUITGANG VAN RIET TUSSCHEN HET OOGENBLIK VAN SNIJDEN EN VAN VERMALEN. Arch. Suikerindus. Nederland. Indië, Meded. Proefsta. Java-Suikerindus. Jaarg. 32, deel. 3, pp. [25]–54.
(18) Lee, H. A.
1923. THE DETERIORATION OF CUT CANE IN PAMPANGA. Philippine Sugar News 4: 7.
(19) Lohman, C. de Savornin.
1900. IETS NADERS OVER DEN ACHTERUITGANG VAN GESNEDEN RIET. Arch. Java-Suikerindus. Jaarg. 8: 1171–1179.
(20) Sanyal, P. B.
1925. DETERIORATION OF SUGARCANE DURING ITS STORAGE BY WINDROWING. India Dept. Agr. Mem., Chem. Ser. 8: 105–126.
(21) Spencer, G. L. and Meade, G. P.
1929. A HANDBOOK FOR CANE-SUGAR MANUFACTURERS AND THEIR CHEMISTS. Ed. 7, rev., rewritten, and enl. by G. P. Meade. 560 pp., illus. New York and London.
(22) Went, F. A. F. C., and Geerligs, H. C. Prinsen.
1894. OVER DEN ACHTERUITGANG VAN HET SACCHAROSEGEHALTE VAN GESNEDEN SUIKERRIET. Arch. Java-Suikerindus. Jaarg. 2: 249–253.

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