

◦

## **THE MYSTERY OF LOWERED PURITIES AND SUGAR YIELDS DURING THE 2014-2015 HARVEST SEASON**

**B. Legendre, H. Birkett and D. Day**

Audubon Sugar Institute, LSU Agricultural Center, St. Gabriel, LA.

Exposure of sugarcane to damaging frosts occurs in approximately 25% of the sugarcane producing countries of the world, but is most frequent on the mainland of the United States, especially in the state of Louisiana. The frequent winter freezes that occur in the sugarcane areas of Louisiana have forced the industry to adapt to a short growing season (about 7 months) and a short milling season (about 3 months). The nature and extent of damage to sugarcane by a freeze depends on the intensity and duration of the freeze, and the weather conditions after the freeze can control or accelerate deterioration. A series of freezes occurred in Louisiana on November 14-15 and November 18-19 where the temperatures at Ryan Airport in Baton Rouge were 29, 29 and 27°F, respectively. Then on November 16 and 17, 2.64 and 0.35 in, respectively, of rainfall were recorded. At this point in the harvest, approximately 50% of the 12.8-million ton Louisiana crop had been processed by the state's 11 factories.

Following the freezing conditions that occurred between November 14 and 19, there was a precipitous drop in brix and sucrose reported at most factories resulting in a significant drop in sugar recovery. In most instances, the drop in sucrose content was greater than the drop in brix resulting in a significant drop in syrup purity as well. Field conditions prior to November 16-17 were mostly dry with excellent cane and juice quality. The first freeze event on November 14-15 occurred with very dry field and soil conditions prior to the significant rainfall that occurred on November 16-17. It appeared that with the first freeze event, there was more damage to the canopy and stalk tissue than you would expect with a low temperature of 27-29°F (Table 1). Then with the significant rainfall event that occurred on November 16-17 there was, undoubtedly, a significant uptake of water which had the effect of diluting both brix and sucrose of juice. Prior to the rainfall, the sugarcane plant was possibly under limited water stress which added to the high brix and sucrose content of the juice. However, with the take up of water it is possible that the plant also absorbed various cations that would add to brix but not sucrose thus lowering purity.

Table 1. Effect of freezing temperatures on damage to the sugarcane stalk assuming freeze duration of 8-12 hr. hours.

<b>Temperature</b>	<b>General effect</b>	<b>Comments</b>
> -2.2 °C (> 28°F)	-Only slight damage to terminal buds and tender leaves. -Sucrose content continues to rise	-Can generally still plant the stalk with good germination
-2.8 to -3.9°C (25 to 27°F)	-Growing point and top third of the stalk is affected. -Most lateral (auxiliary) buds are killed. -Sucrose content and purity increase for a short time due to dehydration	-Minimal deterioration for 4-6 weeks assuming the top 6-12 in of stalk is removed.
-4.4 to -5.6°C (22 to 24°F)	-Most tissue is killed. -Lateral buds begin to weep and allow the entrance of bacteria into the tissue with associated mannitol and dextran.	-Expect some deterioration in 2-4 weeks depending on the sugarcane variety and post-freeze weather conditions. Removal of the top 12-18 in of the stalk is strongly recommended.
< -5.6°C (< 22°F)	-All tissue is killed. -The rind usually splits to produce freeze cracks that allow direct entrance of bacteria into tissue.	-Expect severe deterioration in 1-2 weeks. -Removal of the top 12-18 in of stalk is required; however, significant reduction in sugar yield will still occur.

Dr. Don Day theorized that the drop in purity might be the result of the action of a plant enzyme, namely invertase. He explained that sugarcane produces two types of invertase, an acid and an alkaline invertase, each characterized by the pH where they exhibit maximum activity. The enzyme is important to the plant for sucrose utilization. Given the low pH of juice, the acid invertase may be more important for this discussion. Acid invertase normally declines during maturation of the cane, and increases as growth starts, but it never completely disappears, as it has a role in maintaining cell turgor. It is normally found in vacuoles and apoplastic spaces of internodes. Slow maturing cane shows higher levels of this enzyme later in the cycle than earlier maturing varieties. This year we had both drought and freeze conditions. It is possible that drought slowed the decline in acid invertase levels in the plant as it would be required to help maintain osmotic pressure, which followed by freeze damage or harvest damage, would release the enzyme into the juice causing a decline in purity and an increase in invert levels.

This might explain some of the drop in sucrose content, purity and sugar recovery following what was thought as a minor freeze event. Every year is so different in Louisiana and the dry harvest conditions followed by a “dry” freeze and then followed by a significant rain event and subsequent freezing conditions triggered something in the cane not seen in recent years. Regardless, Louisiana still had record sugar yields of 232 lbs sugar/ton for the crop. However, for the week ending 11/15/14, sugar yields exceeded 258 lbs/ton at Alma Plantation

(Lakeland, LA) and 240 lbs/ton for the State as a whole (Table 2). After the first freeze and rainfall events, sugar yields dropped 15.3 lbs/ton at Alma Plantation and 5.9 lbs/ton for the State as a whole. But by the second week after the freeze sugar yields tumbled 23.8 lbs/ton at Alma Plantation but only 9.6 lbs/ton for the State when compared to the week ending 11/15/14. After the week ending 11/29/14, sugar recovery at Alma Plantation actually rebounded from the previous week while for the State as a whole sugar recoveries dropped another 1.7 lbs/ton. It is interesting to note that both absolute juice purities and syrup purities dropped significantly from week ending 11/15/14 through 11/29/14 (Table 2). However, after week ending 11/29/14 juice and syrup purities stabilized. One can't also overlook the fact that, in many cases, farmers were nearing the end of their ripener- treated cane by mid-November which might have had a negative impact on juice and syrup purities towards the end of November that coincided with the freeze and rainfall events. At the same time, it appeared that many farmers had started harvesting a significant amount of the variety L 01-299 which is known to have a lower sucrose content, purity and sugar yield in plant cane and stubble crops when compared to most of the other commercial varieties grown in the State with the possible exception of L 99-233.

Table 2. Pol % Cane, absolute juice purity, syrup purity, sugar yield and fiber content for the weeks ending 11/15/14, 11/22/14, 11/29/14 and 12/06/14 taken from the Weekly Comparative Manufacturing Report prepared by Dr. Harold Birkett.

Parameter	Week ending 11/15/14	Week ending 11/22/14	Week ending 11/29/14	Week ending 12/06/14
	Alma State	Alma State	Alma State	Alma State
Pol % Cane	14.30	13.53	12.97	13.13
	13.35	13.00	12.81	12.72
Juice Purity	86.22	85.70	84.85	84.44
	85.21	85.09	84.64	84.55
Syrup Purity	88.02	87.26	86.51	86.50
	87.30	87.20	86.83	86.65
Sugar Yield	258.8	243.5	235.0	240.3
	240.2	234.3	230.6	228.9
Fiber	12.91	13.25	13.53	13.44
	13.58	14.11	13.98	13.99

Each year the USDA-ARS, Sugarcane Research Unit in cooperation with the LSU AgCenter conducts field testing of commercial and candidate varieties for stalk cold tolerance at the Ardoyne Farm, Chacahoula, LA. The results of these tests help in the harvest management of varieties especially once a freeze event has occurred. The current reaction of Louisiana varieties to freezing temperatures of 24-26°F is found in Table 3. Also included in the tests is an Argentine variety, TucCP 77-42, which is known to have little or no tolerance to freeze events at the above stated temperatures and used as a check in these tests. During the 2014-2015 harvest season the temperature at the Ardoyne Farm never reached the threshold where significant deterioration occurred in standing cane.

Table 3. Stalk cold tolerance of Louisiana sugarcane varieties following a freeze event of below 26°F based on post-freeze deterioration.

<b>Sugarcane Variety Post-Freeze Deterioration</b>		
<b>Good</b>	<b>Moderate</b>	<b>Poor</b>
LCP 85-384	Ho 95-988	L 99-226
HoCP 85-845	L 97-128	L 99-233
CP 89-2143	HoCP 00-950	L 03-371
HoCP 96-540	Ho 05-961	TucCP 77-42
L 01-283		
L 01-299		
HoCP 04-838		

In summary, there was not any definitive research that could prove what exactly happened to reduce juice and syrup purities and sugar yield during the 2014-2015 harvest season; however, there are several possible explanations for the decline which include: 1) freeze events; 2) rainfall events; 3) invertase activity; 4) end of ripened cane; and, 5) change in varieties. This is by no means the only possible scenarios as to what happened during the harvest season. However, history will show that the 2014-2015 harvest season set a new record for sugar recovery.