

## SUGARCANE YIELD LOSS DUE TO RATOON STUNT

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### ABSTRACT

The yield response of recently released CP-cultivars to ratoon stunt has not been determined. Cane and sugar yields of *Liefsonia xyli* subsp. *xyli* (Lxx)-infected and healthy sugarcane plants of cultivars that are currently major commercial cultivars that have not been in prior tests as well as former cultivars that have been included in previous tests were compared in three field experiments. Yield trials were established by planting either inoculated or Lxx-infected stalks and stalks from healthy plants for comparison in the plant and first ratoon crops. Plants infected with Lxx had fewer stalks, and reduced sugar and cane yields compared with healthy plants. Although the yield losses were not always significant, the trends were consistent among all three trials. The results indicate that ratoon stunt can cause cane and sugar losses in commercial cultivars currently grown in the Florida sugarcane industry, and control practices should be used. Although CP 72-2086 is considered resistant to spread and had fewer plants infected after inoculation than other cultivars, infected plants had significant losses in one trial.

### INTRODUCTION

Ratoon stunt is one of the most economically damaging diseases of sugarcane if not the most important disease (Davis and Bailey, 2000). The ratoon stunt pathogen *Liefsonia xyli* subsp. *xyli*, (Evtushenko et al., 2000) formerly named *Clavibacter xyli* subsp. *xyli* (Davis et al. 1984), is found in almost all sugarcane growing countries. Yield losses due to Lxx are well documented (Davis and Bailey, 2000). In South Africa, losses ranged from 19 to 41 % for rain-fed conditions (Bailey and Bechet, 1997). Losses in irrigated conditions were similar, 21 to 32 %, depending on cultivar. Stalk population and length were reduced due to the disease in both rain-fed and irrigated environments (Bailey and Bechet, 1997). In Louisiana, losses of cane in CP 65-357 ranged from 12 to 27 % in three tests, and there was an actual 7 % gain in infected plants in one test. Cane losses for CP 70-321 were 20 and 27 % in two tests. Sugar losses were similar for the two cultivars (Koike, 1982). There was slightly higher sugar per ton of cane in almost all the comparisons. Later in Louisiana, Grisham (1991) compared the yield of multiple cultivars in six, 3-year plantings and had significant yield losses on all but one cultivar, L 60-25, which is resistant to Lxx. In Florida, Irely (1985) compared the sugar yields of healthy and Lxx-infected plants and reported mostly non-significant, but consistent reductions due to Lxx. Generally, the infected treatments had fewer stalks, smaller diameter and reduced height. Dean and Davis (1990) reported a 5 % loss ( $P = 0.0001$ ) due to Lxx for four cultivars planted annually three times at four locations. Although a trend of losses was evident in the individual yield trials, only a few were statistically significant even with eight replications. The detection of 5 % yield losses as reported is extremely difficult because of the magnitude of the variance in the trials (Dean and Davis, 1990).

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All yield trials discussed above have been in plots at least 5 m long and several rows across. Dean (1983) used single-stool plots established by transplanting a single plant to the field to estimate yield and found yield differences between healthy and Lxx-infected treatments. Single-stool plots have been used to determine the yield losses caused by brown rust and sugarcane bacilliform virus (Comstock et al., 1992; Comstock and Lockhart, 1996). Sugarcane yellow leaf yield trials involving 1-m plots established from a single stalk of sugarcane have also been conducted (Comstock and Miller, 2004). The use of a single stool or 1-m plot size allows verification of the disease state of each individual stool or plot during the trial. Previously, yield trials were conducted with plants that were 100% healthy or 100 % Lxx-infected. Usually, Lxx-infected stalks are planted to ensure complete infection of all the plants in this treatment. The purpose of 100 % infection was primarily to maximize yield losses that are difficult to detect. However, in commercial fields, only a portion of the plants are infected. The actual losses that occur in growers' fields reflect the product of the percentage infection of Lxx and the loss in each Lxx-infected plant.

The yield trials previously conducted in Florida used primarily cultivars that are currently not major cultivars in the industry. The objective of this research was to conduct a series of yield trials using former and current cultivars to determine the effect of Lxx on yield.

## MATERIALS AND METHODS

### Experiment Layout

Three separate experiments were conducted to determine the effect of Lxx on the yield parameters of sugarcane. For the first and third trials, the treatments were Lxx-inoculated versus disease-free plots. In the second trial, Lxx-infected and healthy seedcane was planted, and the infected seedcane was inoculated again at planting. The following eight cultivars were included in all the yield trials: CP 70-1133, CP 72-1210, CP 72-2086, CP 80-1743, CP 80-1827, CP 84-1198, CP 85-1491, and CP 89-2143. All the tests were established in the following manner to maintain the disease-free status of the healthy check plots. Two rows of only healthy check plots were planted in adjacent rows with 1.5 m between rows. Next to these healthy rows there was a 3 m separation, then two rows of either all inoculated or infected stalks (depending on the test) were planted. This planning scheme minimized the spread of Lxx from plants in infected rows to plants in the healthy rows when the harvest machines went down the row. Individual plots were established by cutting a 2-m stalk section into two, 1-m sections and planting the two sections in a 1-m plot separated by a 2-m alley from the next plot. The plots of the eight cultivars were randomized in each replication, and plots of individual healthy cultivars were planted across from the same cultivar that was either Lxx inoculated or infected.

In the first (located in Pahokee, FL) and third (located in Belle Glade, FL) trials, the two treatments were disease-free (non-inoculated) and Lxx-inoculated. In the first test, the ends of the inoculated stalks were cut into two 1-m sections and the ends were immediately pressed onto a 2.5 cm spike that was immersed in cane juice expressed from Lxx-infected stalks of CP 53-1, a cultivar that supports high populations of Lxx. Non-inoculated stalks were treated similarly except that the stalks were pressed on the spike object immersed in water and not exposed to Lxx. Seedcane for the second trial (located 13 km southeast of Pahokee) was cut from healthy and infected plots of the first test at 10.5 months of age after diagnostic samples verified their

disease states. Furthermore, the infected stalks were inoculated at planting by cutting with knives dipped in juice expressed from Lxx-infected CP 53-1. The stalks in the third trial were also inoculated using knives in a similar fashion as the second trial. There were 52 replications in the first test, 40 replications in the second test and 44 replications in the third test. All three tests were evaluated in the plant and first-ratoon crops.

### **Yield Parameters**

The number of mature stalks per plot, cane weight per plot, kg sucrose per plot, stalk weight and sugar per ton of cane were determined. A sample of five stalks was cut from each plot to determine stalk weight and for juice analysis. Juice analysis was conducted at the sugar laboratory of the USDA-ARS Sugarcane Field Station, in Canal Point, FL. Plot weight was calculated by multiplying the stalk weight determined from the five-stalk bundles by the stalk number per plot. Kilograms sucrose per plot was determined by multiplying the theoretical recoverable sugar yields of the five-stalk bundles by the plot weights.

### **Disease States**

Disease state of each plot was determined by tissue-blot immunoassay using Lxx antisera provided by M. J. Davis, University of Florida, IFAS, Homestead (Comstock et al. 2001). From each of five stalks of a plant, a 10 to 15 cm section from the bottom of the stalk was cut, and a 1-cm-core of tissue was removed from the internode using a cork borer. In all three tests, Lxx-infected plots were defined as plots averaging more than zero Lxx-colonized vascular bundles for the five stalks sampled; indicating that the plot plants derived from a single inoculated stalk was infected; however, some Lxx was not detected in all stalks. Whereas healthy plots had all five stalks tested negative using the tissue-blot immunoassay. The number of Lxx-infected plots increased from the plant to first-ratoon crop. The actual number of replications used in the analysis is presented in the results tables. Analyses of variance were conducted using PROC GLM in SAS version 6.10 (SAS Institute Inc. Cary, NC 27513) on number of stalks per plot, plot weight, and kg sucrose per plot.

## **RESULTS**

Combining the yield data of all the cultivars, most yield parameters were reduced in the Lxx- infected plants compared with the healthy plants (Table 1). The number of stalks per plot were consistently lower in Lxx-infected plants compared to healthy plants in all trials when data were combined. However, only the ratoon of trial 1 and the plant and ratoon in trial 2 were statistically significant. There was not a significant loss of sugar per plot due to ratoon stunt infection in the plant crop of the first yield trial in which stalks were inoculated at planting. In the first-ratoon crop of trial 1, there was a 12.5% loss of sugar per plot in the Lxx- infected plots. The reduced sugar per plot in the other two tests ranged from 8.3 to 15.8 % using the combined yield data of all cultivars. The loss of plot weight in the experiments ranged from 3.4 (not significant) to 16.4% in the Lxx-infected plots. The loss of sugar per ton was not consistent (data not shown) due to ratoon stunt. Only in the ratoon crop for the first and second experiments were there significant losses; the other experiments were variable and not significant. In individual cultivars, only two had consistent patterns due to ratoon stunt: CP 70-1133 had higher sugar per ton while CP 89-2143 had lower sugar per ton due to Lxx in all six comparisons. The stalk weights were lower but not statistically significant in second and third

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**Table 1. Stalk counts, cane yields, and sugar yields of healthy (-) and ratoon-stunt infected (+) plants in three trials with data combined for seven sugarcane cultivars**

Trial and disease state	No. of samples	Plant <sup>a</sup> Stalks/ # plot <sup>-1</sup>	Cane kg plot <sup>-1</sup>	Sugar kg plot <sup>-1</sup>	No. of samples	Ratoon <sup>a</sup> Stalks/ # plot <sup>-1</sup>	Cane kg plot <sup>-1</sup>	Sugar kg plot <sup>-1</sup>
Trial 1								
-	363	16.2	26.3	2.8	324	23.6	40.2	4.8
+	169	15.5	25.4	2.7	240	22.4	35.9	4.2
% change		-6.2	-3.4	-3.6		-4.2	-10.7	-12.5
LSD 0.05		0.92	1.64	0.19		<b>1.05</b>	<b>2.07</b>	<b>0.26</b>
LSD 0.10		0.77	1.38	0.16		<b>0.88</b>	<b>1.74</b>	<b>0.22</b>
Trial 2								
-	248	22.5	43.2	5.7	223	26.5	39.5	5.5
+	211	19.5	36.1	4.8	199	23.9	34.2	4.7
% change		-13.3	-16.4	-15.8		-9.8	-13.4	-14.5
LSD 0.05		<b>0.72</b>	<b>1.60</b>	<b>0.22</b>		<b>1.00</b>	<b>1.77</b>	<b>0.25</b>
LSD 0.10		<b>0.61</b>	<b>1.35</b>	<b>0.19</b>		<b>0.84</b>	<b>1.48</b>	<b>0.21</b>
Trial 3								
-	336	17.5	29.0	3.6	253	23.0	30.2	3.9
+	202	17.3	26.4	3.3	161	22.3	27.0	3.4
% change		-1.1	-9.0	-8.3		-3.0	-10.5	-12.8
LSD 0.05		0.88	<b>1.66</b>	<b>0.21</b>		0.94	<b>1.57</b>	<b>0.21</b>
LSD 0.10		0.74	<b>1.40</b>	<b>0.18</b>		0.79	<b>1.31</b>	<b>0.17</b>

<sup>a</sup> Bold indicates statistically significant differences for the indicated probability level.

experiments in the plant crop; however, they were significantly lower in all experiments in the ratoon crop in the analysis of all data combined (data not shown). The stalks weight data was more variable with the individual cultivars with only CP 70-1133, CP 80-1743 and CP 89-2143 having lower stalk weights in all plant and ratoon comparisons and they were not always statistically significant.

In trial 1, the number of stalks per plot due to ratoon stunt were variable in this trial with ratoon stunt infected plots have more stalks in 4 of 8 cultivars in the plant crop and 3 of 8 cultivars in the ratoon crop. Only CP 89-2143 had a significant loss at  $P \leq 0.05$  of sugar per plot in both the plant and first-ratoon crop in the Lxx-infected plants (Table 2). There was a significant loss of sugar per plot at  $P \leq 0.05$  in the first-ratoon crop in the Lxx-infected plants of CP 80-1743. Also, CP 70-1133 had a 10.6% loss of sugar per plot at  $P \leq 0.10$  in the Lxx-infected plants of the first ratoon crop. Yield differences were not significant for the other cultivars in trial 1 between the Lxx-infected and healthy plants. The level of Lxx infection was low for several cultivars in the plant crop. Only four plots were Lxx infected for both resistant cultivar, CP 72-2086 and susceptible cultivar, CP 70-1133 (Table 2). Generally, the number of infected plots increased in the first-ratoon crop, but remained low for resistant, CP 72-2086.

**Table 2. Yield parameters per plot of Lxx-infected and healthy plants at Pahokee, Florida**

Cultivar and disease state	No. of samples	Plant <sup>a</sup>			Ratoon <sup>a</sup>			
		Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot	No. of samples	Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot
CP 70-1133 –	52	19.6	30.8	3.0	38	27.5	41.9	4.7
+	4	17.5	26.8	2.8	26	26.0	36.8	4.2
% difference		-10.7	-13.0	-6.7		-5.5	-12.2	-10.6
LSD 0.05		6.49	11.4	1.22		3.15	<b>4.73</b>	0.53
LSD 0.10		5.30	9.33	1.00		2.59	<b>3.90</b>	<b>0.43</b>
CP 72-1210 –	50	16.5	24.4	2.5	47	28.1	43.2	5.3
+	12	19.3	26.3	2.9	21	27.7	43.9	5.3
% difference		+17.0	+7.8	+16.0		-1.4	+1.6	0.0
LSD 0.05		3.99	5.54	0.59		3.91	7.60	1.02
LSD 0.10		3.29	4.57	0.49		3.23	6.29	0.84
CP 72-2086 –	54	15.9	26.4	2.8	52	23.6	39.9	5.0
+	4	13.8	19.3	2.2	9	30.8	43.6	5.1
% difference		-13.2	-26.9	-21.4		+30.5	+9.3	+2.0
LSD 0.05		6.2	12.22	1.49		<b>3.43</b>	8.2	1.09
LSD 0.10		5.1	10.09	1.23		<b>2.83</b>	6.8	0.90
CP 80-1743 –	49	18.1	24.0	2.7	41	25.2	38.5	4.9
+	23	19.2	25.4	2.8	34	22.3	29.3	3.7
% difference		+6.1	+5.8	+3.7		-11.5	-23.9	-24.5
LSD 0.05		2.71	4.18	0.58		<b>2.52</b>	<b>4.48</b>	<b>0.58</b>
LSD 0.10		2.25	3.47	0.48		<b>2.09</b>	<b>3.71</b>	<b>0.48</b>
CP 80-1827 –	49	13.0	23.1	2.4	44	21.4	40.0	4.6
+	28	14.3	26.1	2.7	36	22.5	39.5	4.6
% difference		+10.0	+13.0	+12.5		+5.1	-1.3	0.0
LSD 0.05		1.76	3.52	0.43		2.78	6.01	0.72
LSD 0.10		1.46	<b>2.92</b>	0.36		2.31	5.00	0.60
CP 84-1198 –	35	15.8	24.3	2.7	34	22.0	37.6	4.7
+	42	17.6	28.1	3.1	41	24.7	38.6	4.8
% difference		+11.4	+15.6	+14.8		+12.3	+2.7	+2.1
LSD 0.05		2.59	4.57	0.53		2.84	5.36	0.75
LSD 0.10		2.15	<b>3.80</b>	0.44		<b>2.36</b>	4.45	0.62
CP 85-1491 –	39	16.5	34.3	3.3	35	18.7	42.4	4.7
+	23	14.3	29.4	3.0	43	18.4	37.6	4.3
% difference		-13.3	-14.3	-9.1		-1.6	-11.3	-8.5
LSD 0.05		2.48	5.4	0.55		2.52	6.44	0.78
LSD 0.10		<b>2.05</b>	<b>4.46</b>	0.46		2.09	5.35	0.65
CP 89-2143 –	35	12.8	23.0	2.6	33	20.0	37.5	4.6
+	33	10.7	19.0	2.0	30	15.4	24.7	2.8
% difference		-16.4	-17.4	-23.1		-23.0	-34.1	-39.1
LSD 0.05		2.63	4.41	<b>0.42</b>		<b>2.57</b>	<b>6.28</b>	<b>0.80</b>
LSD 0.10		2.18	<b>3.66</b>	<b>0.35</b>		<b>2.12</b>	<b>5.19</b>	<b>0.66</b>

<sup>a</sup> Bold indicates statistically significant differences for the indicated probability level.

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In trial 2, the number of stalks per plot due to ratoon stunt was lower in 13 of the 16 comparisons and 8 were statistically significant. Significant losses at  $P \leq 0.05$  in sugar per plot were detected in four cultivars (CP 72-1210, CP 72-2086, CP 80-1743 and CP 84-1198) in the plant crop and three cultivars (CP 70-1133, CP 80-1743 and CP 85-1491) in the first ratoon crop in the Lxx-infected plants (Table 3). Additionally, losses in sugar per plot at  $P \leq 0.10$  were detected in two additional cultivars (CP 70-1133 and CP 89-2143) in the plant crop and CP 84-1198 in the first-ratoon crop in the Lxx-infected plants. The difference between Lxx-infected and healthy plots for sugar per plot ranged from a 2% gain (not statistically significant) for CP 80-1827 in the first-ratoon crop to a statistically significant 30% loss for CP 80-1743 in the first-ratoon crop. The losses of cane weight per plot were generally similar to the sugar loss.

In trial 3, sugar per plot losses in the Lxx-infected plants were detected at  $P \leq 0.10$  in CP 72-2086, CP 80-1743 and CP 85-1491 in the plant crop and in CP 72-1210 in the first-ratoon crop. CP 80-1827 and CP 84-1198 had significant sugar per plot losses in the Lxx-infected plants at  $P \leq 0.05$  in the first-ratoon crop (Table 4). The cane weight per plot generally paralleled the loss of sugar. Although most cultivars did not have significant differences, the sugar per plot was lower in the Lxx-infected plots except for two cultivars, CP 72-1210, where it was the same and CP 85-1491, where it was lower, in the plant crop. For all the comparisons, sugar per plot of infected vs. healthy treatments was lower, although not always significantly lower, in the first-ratoon crop.

## DISCUSSION

For each of the individual trials, the results clearly indicated that yield losses were caused by Lxx infection when all the cultivars are combined. Variability of losses for individual cultivars among the trials demonstrates the difficulty in conducting these tests. Previously, multiple yield trials in Florida were required to detect differences (Dean and Davis, 1990). Both Dean and Davis (1990) and Irey (1985) reported no statistical differences between infected and healthy treatments in the majority of individual trials although consistent trends were evident. The trends in these trials for the individual cultivars also indicated that Lxx-infected sugarcane plants yield less cane and sugar than healthy plants. Sugar per ton was not apparently affected since not consistent pattern was noted due to Lxx. Because of losses caused by Lxx, growers should continue to use healthy seedcane practices to control ratoon stunt. Either thermal treatment at 50 C for 2 hours or the use of disease-free seedcane derived via meristem culture will ensure stalks with minimal Lxx infection. Routine cultural practices of disinfecting cutting knives after planting and other sanitary practices should be practiced.

CP 72-2086, which is considered resistant to Lxx, had an incidence of infection of less than 2% in commercial fields which were not planted with meristem derived stalks and had no history of thermal treatment (Comstock et al., 1997). In these trials, there was an effort to infect the cane by inoculation at the time of planting in all trials. Trial 2 was established using seedcane that tested positive for Lxx prior to planting and was inoculated again at planting to ensure Lxx infected plants. However, only 23 of 40 CP 72-2086 plots tested positive at approximately 10 months after planting confirming the cultivar is resistant to infection. Interestingly, the yield of CP 72-2086 infected plants was lower than healthy plants in the plant crop in one trial at  $P \leq 0.05$  (Trial 2) and at  $P \leq 0.10$  level in another (Trial 3). Lower yields were consistent in infected

**Table 3. Yield parameters of Lxx-infected and healthy plants at 10 m SE of Pahokee**

Cultivar and disease state	Plant <sup>a</sup>				Ratoon <sup>a</sup>			
	No. of samples	Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot	No. of samples	Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot
CP 70-1133 –	33	22.0	41.8	5.4	30	30.8	46.7	6.4
+	21	19.9	37.5	4.8	22	25.8	36.4	5.0
% difference		–9.5	–10.3	–11.1		–16.2	–22.1	–21.9
LSD 0.05		<b>1.99</b>	<b>4.28</b>	0.59		<b>2.70</b>	<b>5.90</b>	<b>0.81</b>
LSD 0.10		<b>1.65</b>	<b>3.54</b>	<b>0.49</b>		<b>2.24</b>	<b>4.88</b>	<b>0.67</b>
CP 72-1210 –	30	26.6	40.5	5.4	30	31.0	37.9	5.3
+	27	21.0	33.3	4.4	19	27.2	33.5	4.7
% difference		–21.1	–17.8	–18.5		–12.3	–11.6	–11.3
LSD 0.05		<b>2.15</b>	<b>4.28</b>	<b>0.57</b>		<b>3.44</b>	5.49	0.82
LSD 0.10		<b>1.78</b>	<b>3.55</b>	<b>0.47</b>		<b>2.84</b>	4.53	0.67
CP 72-2086 –	39	21.2	44.8	6.1	36	24.8	36.6	5.2
+	23	22.0	35.7	4.9	25	27.2	33.0	4.6
% difference		+3.8	–20.3	–19.7		+9.7	–9.8	–11.5
LSD 0.05		2.49	<b>5.71</b>	<b>0.80</b>		3.55	4.94	0.72
LSD 0.10		2.07	<b>4.74</b>	<b>0.67</b>		2.94	4.10	0.60
CP 80-1743 –	28	29.1	53.6	7.6	22	32.0	44.1	6.4
+	30	22.6	39.1	5.5	31	24.5	31.4	4.5
% difference		–22.3	–27.1	–27.6		–23.4	–28.8	–29.7
LSD 0.05		<b>2.57</b>	<b>5.34</b>	<b>0.72</b>		<b>2.10</b>	<b>4.22</b>	<b>0.62</b>
LSD 0.10		<b>2.13</b>	<b>4.43</b>	<b>0.60</b>		<b>1.73</b>	<b>3.49</b>	<b>0.52</b>
CP 80-1827 –	30	20.2	36.9	4.62	25	23.5	36.4	4.9
+	28	18.3	35.4	4.61	27	23.2	36.4	5.0
% difference		–9.4	–4.1	–0.2		–1.3	0.0	+2.0
LSD 0.05		2.18	4.75	0.64		2.16	4.12	0.56
LSD 0.10		<b>1.81</b>	3.94	0.53		1.78	3.41	0.46
CP 84-1198 –	35	25.0	50.3	6.9	32	28.8	44.1	6.6
+	29	19.9	38.9	5.3	22	24.1	39.1	5.8
% difference		–20.4	–22.7	–23.2		–16.3	–11.3	–12.1
LSD 0.05		<b>1.79</b>	<b>4.81</b>	<b>0.69</b>		<b>2.36</b>	5.44	0.82
LSD 0.10		<b>1.49</b>	<b>4.00</b>	<b>0.57</b>		<b>1.95</b>	<b>4.50</b>	<b>0.68</b>
CP 85-1491 –	22	20.3	48.3	5.6	18	24.9	47.4	6.3
+	22	18.4	43.8	5.3	22	22.1	39.2	4.9
% difference		–9.4	–9.3	–5.4		–11.2	–17.3	–22.2
LSD 0.05		2.12	4.98	0.66		4.16	8.38	<b>1.25</b>
LSD 0.10		<b>1.72</b>	<b>4.10</b>	0.54		3.40	<b>6.84</b>	<b>1.02</b>
CP 89-2143 –	31	15.3	30.2	4.0	30	17.0	26.8	3.77
+	31	14.7	27.7	3.6	31	19.1	28.0	3.75
% difference		–3.9	–8.3	–10.0		–12.4	–4.5	–0.5
LSD 0.05		1.48	3.05	0.41		2.26	3.28	0.43
LSD 0.10		1.23	2.53	<b>0.34</b>		<b>1.87</b>	2.72	0.36

<sup>a</sup> Bold indicates statistically significant differences for the indicated probability level.

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**Table 4. Yield parameters comparing plot yields of Lxx-infected and healthy plants at Belle Glade, Florida**

Cultivar and disease state	Plant <sup>a</sup>				Ratoon <sup>a</sup>			
	No. of samples	Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot	No. of samples	Stalks #/ plot	Cane kg/ plot	Sugar kg/ plot
CP 70-1133 –	44	17.7	28.2	3.3	30	25.1	29.7	3.6
+	26	15.4	23.5	2.8	14	24.9	27.6	3.4
% difference		-13.0	-16.7	-15.2		-0.8	-7.1	-5.6
LSD 0.05		2.54	5.36	0.64		2.47	4.59	0.59
LSD 0.10		<b>2.10</b>	<b>4.44</b>	0.53		1.98	3.68	0.47
CP 72-1210 –	42	18.2	27.5	3.4	36	27.3	34.0	4.4
+	34	19.3	27.0	3.4	29	27.4	31.7	4.0
% difference		+6.0	-1.8	0.0		+0.4	-6.8	-9.1
LSD 0.05		2.17	4.06	0.50		1.72	3.29	0.43
LSD 0.10		1.80	3.38	0.42		1.43	2.72	<b>0.36</b>
CP 72-2086 –	51	16.8	29.7	3.8	32	21.8	27.8	3.6
+	12	14.9	24.3	3.1	13	19.2	25.8	3.3
% difference		-11.3	-18.2	-18.4		-11.9	-7.2	-8.3
LSD 0.05		2.98	6.15	0.83		2.68	5.28	0.66
LSD 0.10		2.47	<b>5.08</b>	<b>0.68</b>		<b>2.15</b>	4.23	0.53
CP 80-1743 –	45	24.6	35.2	4.7	22	23.1	24.4	3.1
+	19	24.3	29.3	4.0	11	24.6	22.9	3.0
% difference		-1.2	-16.8	-14.9		6.5	-6.1	-3.2
LSD 0.05		3.28	6.16	0.82		4.80	8.19	1.04
LSD 0.10		2.71	<b>5.10</b>	<b>0.68</b>		3.55	6.06	0.77
CP 80-1827 –	44	15.8	29.3	3.6	38	21.9	32.2	4.1
+	29	15.4	26.4	3.2	25	20.6	28.5	3.6
% difference		-2.5	-9.9	-11.1		-5.9	-11.5	-12.2
LSD 0.05		2.10	5.11	0.62		1.92	3.76	<b>0.46</b>
LSD 0.10		1.75	4.24	0.52		1.59	<b>3.11</b>	<b>0.38</b>
CP 84-1198 –	44	18.9	31.0	4.0	40	25.6	33.3	4.5
+	43	18.5	28.0	3.6	31	22.5	24.8	3.3
% difference		-2.1	-9.7	-10.0		-12.1	-25.5	-26.7
LSD 0.05		2.46	4.26	0.57		<b>1.72</b>	<b>2.71</b>	<b>0.37</b>
LSD 0.10		2.05	3.55	0.48		<b>1.43</b>	<b>2.25</b>	<b>0.31</b>
CP 85-1491 –	21	13.0	26.8	3.0	20	21.3	34.2	3.9
+	17	14.9	31.0	3.5	15	21.5	32.7	3.7
% difference		+14.6	+15.7	+16.7		+0.9	-4.4	-5.1
LSD 0.05		2.07	4.47	0.52		2.62	7.22	0.79
LSD 0.10		<b>1.69</b>	<b>3.64</b>	<b>0.42</b>		2.13	5.87	0.64
CP 89-2143 –	45	12.8	23.4	3.0	35	17.1	24.2	3.3
+	22	13.3	20.9	2.7	23	17.0	20.7	2.7
% difference		+3.9	-10.7	-10.0		-0.6	-14.5	-18.2
LSD 0.05		2.67	4.40	0.58		3.99	5.79	0.76
LSD 0.10		2.21	3.65	0.48		3.30	4.78	0.62

<sup>a</sup> Bold indicates statistically significant differences for the indicated probability level.

plants of CP 72-2086 in all three plant crops and two of three first ratoon crops. Another cultivar, LCP 85-384, has been reported to have a slow rate of Lxx spread but when infected, had yield losses (Hoy et al., 1999). Indicating that resistance to infection and disease spread is different from resistance to yield losses.

The use of small plots had several advantages. A primary advantage was that the disease state of all plots could be verified. Also, in the small plots, a five-stalk bundle usually represented more than 10 % of the total stalks in the plot. This was a much larger sample percentage than if a larger plot was used and a 10 stalk sample was taken. The smaller plot size allowed much easier access to the plots and easier sampling.

### CONCLUSIONS

Losses to ratoon stunt were demonstrated for current sugarcane cultivars in three multiple-year experiments. Yield reductions associated with ratoon stunt have now been demonstrated in sugarcane in Florida for more than 25 years. The demonstration of on-going loss potential clearly indicates that control practices are required. For this reason a healthy seedcane program is recommended.

### REFERENCES CITED

- Bailey, R.A. and G.R. Bechet. 1997. Further evidence of the effects of ratoon stunting disease on production under irrigated and rainfed conditions. Proc. South African Sugar Technol. Assoc. 71: 97-101.
- Comstock, J.C. and B.E.L. Lockhart. 1996. Effect of sugarcane bacilliform virus on biomass production of three sugarcane cultivars. Sugar Cane 4:12-15.
- Comstock, J.C. and J.D. Miller. 2004. Yield comparisons: Disease-free tissue-culture versus bud-propagated sugarcane plants and healthy versus yellow leaf infected plants. J. Amer. Society Sugar Cane Technol. 24:31-40.
- Comstock, J.C., R. Perdomo, G. Powell, and Z. Wang. 1997. Ratoon stunting disease in Florida sugarcane fields: Relationship between disease incidence and cultivar resistance. J. Am. Soc. Sugar Cane Technol. 17:95-101.
- Comstock, J.C., J.M. Shine, Jr., P.Y.P. Tai, and J.D. Miller. (2001). Breeding for ratoon stunting disease resistance: Is it both possible and effective? Proc. Int. Soc. Sugar Cane Technol. 24:471-476.
- Comstock, J.C., J.M. Shine, Jr., M.J. Davis, and J.L. Dean. 1996. Relationship between resistance to *Clavibacter xyli subsp. xyli* colonization in sugarcane and spread of ratoon stunting disease in the field. Plant Dis. 80:704-708.
- Comstock, J.C., J.M. Shine, Jr., and R.N. Raid. 1992. Effect of rust on sugarcane growth and biomass. Plant Disease 76:175-177.

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- Davis, M.J. and R.A. Bailey. 2000. Ratoon Stunting. *In*: Rott, P., R.A. Bailey, J.C. Comstock, B.J. Croft, and A.S. Saumtally (Eds). A guide to sugarcane diseases, Centre de cooperation internationale en recherche agronomique pour le developpment (CIRAD) and International Society of Sugar Cane Technologists (ISSCT) Montpellier, France. pp. 49-54.
- Davis, M.J., A.G. Gillaspie, Jr., A.K. Vidaver, and R.W. Harris. 1984. *Clavibacter*: a new genus containing some phytopathogenic coryneform bacteria, including *Clavibacter xyli* subsp. nov. and *Clavibacter xyli* subsp. *cynodonis* subsp. nov., pathogens that cause ratoon stunting disease of sugarcane and Bermudagrass stunting disease. *Int. J. Systematic Bacteriology* 34:107-117.
- Dean, J.L. 1983. Single-stool plots for estimating relative yield losses caused by ratoon stunting disease of sugarcane. *Plant Dis.* 67:47-49.
- Dean, J.L. and M. J. Davis. 1990. Yield loss caused by ratoon stunting disease of sugarcane in Florida. *J. Am. Soc. Sugar Cane Technol.* 10:66-72.
- Evtushenko, L.I., L.V. Dorofeeva, S.A. Subbotin, J.R. Cole, and J.M. Tiedje. 2000. *Leifsonia poae* gen. nov., sp. nov., isolated from nematode galls on *Poa annua*, and reclassification of '*Corynebacterium aquaticum*' Leifson 1962 as *Leifsonia aquatica* (ex Leifson 1962) gen. nov., nom. rev., comb. nov. and *Clavibacter xyli* Davis et al. 1984 with two subspecies as *Leifsonia xyli* (Davis et al. 1984) gen. nov., comb. Nov. *Int. J. Syst. Evol. Microbiol.* 50:371-380.
- Grisham, M. P. 1991. Effect of ratoon stunting disease on yield of sugarcane grown in multiple three-year plantings. *Phytopathology* 81:337-340.
- Hoy, J.W., M. P. Grisham, and K.E. Damann. 1999. Spread and increase of ratoon stunting disease of sugarcane and comparison of disease detection methods. *Plant Dis.* 83:1170-1175.
- Irey, M.S. 1985. Detection and incidence of ratoon stunting disease in commercial sugarcane planting in Florida. *J. Amer. Soc. Sugar Cane Technol.* 4:10-12.
- Koike, H. 1982. Yield effects of ratoon stunting and sugarcane mosaic diseases of some sugarcane varieties in Louisiana. *J. Amer. Soc. Sugar Cane Technol.* 1:47-51.