SOIL FERTILITY RESEARCH IN SUGARCANE IN 2002

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SUMMARY:

Four field experiments were conducted in 2002 to test the effects of rates of fertilizers on the yield components of current sugarcane varieties. The effect of starter fertilizer on LCP85-384 was marginal, and there was no residual effect of starter fertilizer application at planting on subsequent second-stubble yield of HoCP85-845.

Results of a multi-location outfield test to determine the optimum rate of N fertilizer for LCP 85-384 continued to indicate the optimum rate was on the low end of present recommendations. This variety may have higher N use efficiency than other varieties at lower N application rates, but the effect is lost and possibly reversed at higher application rates.

OBJECTIVES:

This research was designed to provide information on soil fertility in an effort to help cane growers to produce maximum economic yields and to increase profitability in sugarcane production. This annual progress report is presented to provide the latest available data on certain practices and not as a final recommendation for growers to use all of these practices. Recommendations are based on several years of research data.

RESULTS AND DISCUSSION:

Starter fertilizers in fallow planted cane:

Averaged across two planting dates, the use of some complete starter fertilizers on billet-planted LCP 85-384 improved cane yield by 10% above the check (Table 2). Use of orthogonal contrasts indicated complete (N-P-K) starter fertilizer applications had higher cane and sugar yield than partial fertilizers from the September planting but not the August planting. The positive effect of starter fertilizer in plant cane diminshed in subsequent ratoon crops, and no consistent residual effect was found in second stubble HoCP85-845 from starter fertilizers applied to plant cane at planting (Table 1) .

Rates of spring-applied N fertilizer:

The effect of N fertilizer rate on yield of LCP 85-384 was tested at four large outfield locations. Stalk population response to N application rate generally plateaued by 80 lb N / a. However, population tended to increase slightly beyond that rate in heavy soil (Fig. 1). Nitrogen concentration of first leaf below top visible dewlap sampled in early August reflected relative yields among locations. Lowest N percent in these leaves ranged from 1.27% to 1.5%, with an application rate of 40 lb N/a . Highest N percent ranged from 1.66% to 1.86% and did not always result from the highest N application rate. Leaf N response to N application rate was generally not linear (Fig. 2). Cane yield response to N rate varied with location (Fig. 3). Stubble crops tended to have more response to N input than plant cane. Lower yield at Alma indicated other factors may have been limiting and therefore lowered the response to N but could also have been related to the generally unresponsive characteristic of plant cane to N applications. Where there was a response, the N rate for optimum yield ($\geq$ 90% of maximum yield and not statistically different) was at the lower end of the recommended range or slightly below it. Mill-core CRS was not affected by N rate, but whole-stalk CRS indicated a decline in stubble crops with increasing N rate(Fig. 4). The response of CRS varied with location. Sugar yield response reflected that of tonnage with stubble crops responding to N rate (Fig. 5).

The variety LCP85-384 produced numerically to significantly higher cane and sugar yield than CP70-321 and HoCP91-555 at 50 lb/a N but not at 100 and 150 lb/a N (table 3). This indicated a trend for greater N use efficiency at the lowest N rate relative to the other two varieties (Fig.6). More precise measurements of growth rate and N use efficiency throughout the growing season are being determined.

Table 1. Effect of fall and spring applied fertilizer on the yield of second-stubble cane HoCP 85-845 planted after a fallow year on Commerce soil on the St. Gabriel Research Station, 2002.

Fertilizer applied $N-P_2O_5-K_2O$		Second Stubble Cane - Fallow Planted					
		Cane	Stalk		Normal Juice		Sugar
Fall	Spring	Yield	No.	Wt.	Brix	Sucrose	Yield
lbs/A	lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
0-0-0	0-0-0	16.2	24.2	1.53	14.9	12.5	2815
	160-0-0	25.9	30.2	1.74	15.5	13.0	4716
	160-40-80	22.0	30.7	1.51	15.9	13.4	4167
15-45-45	0-0-0	13.8	25.3	1.24	15.5	13.1	2515
	160-0-0	24.4	31.3	1.54	15.5	13.2	4490
	160-40-80	22.6	32.6	1.49	15.2	12.8	4034
45-45-45	0-0-0	17.6	25.8	1.56	15.3	12.9	3158
	160-0-0	23.9	29.9	1.64	15.2	12.5	4140
	160-40-80	24.2	31.3	1.72	15.8	13.4	4550
30-30-90	0-0-0	17.0	24.7	1.40	14.8	12.3	2886
	160-0-0	22.0	30.7	1.58	15.4	12.8	3942
	160-40-80	22.7	31.2	1.82	15.2	12.9	4069
LSD .05 Treatments		6.4	4.1	0.31	NS	NS	1267
			Mean Effect				
0-0-0		21.4	28.3	1.59	15.4	13.0	3899
15-45-45		20.3	29.7	1.42	15.4	13.0	3680
45-45-45		21.9	29.0	1.64	15.4	12.9	3949
30-90-90		20.5	28.9	1.60	15.1	12.6	3632
	0-0-0	16.1	25.0	1.43	15.1	12.7	2843
	160-0-0	24.0	30.5	1.62	15.4	12.9	4322
	160-40-80	22.9	31.4	1.63	15.5	13.1	4205
LSD .05 Fall		NS	1.2	0.19	NS	NS	NS
LSD .05 Spring		1.6	1.1	0.16	0.4	NS	323

The fall fertilizer was applied in the planting furrow as a starter fertilizer in 1999 and spring fertilizer was applied in the off-bar furrow in the spring of each year.

Table 2. The effect of starter fertilizers on yield and quality of LCP85-384.

TREAT.	POP	STALK WT.	YIELD	BRIX	SUCROSE	CRS	SUGAR PER ACRE
AUG. Lb / a	1000/A	LBS.	TONS/A	%	%	LBS/T	LBS/A
0-0-0	40.7	1.77	31.9	16.5	14.0	199.9	6383
0-0-45	40.3	1.84	33.1	16.4	14.2	202.5	6679
0-45-45	39.6	1.82	32.0	16.3	14.1	201.6	6448
0-45-45	41.3	1.90	35.0	17.0	14.7	210.6	7382
45-0-45	41.3	1.74	32.4	16.5	14.2	202.5	6569
45-45-0	41.0	1.83	34.5	17.0	14.7	211.4	7294
45-45-45	40.5	1.77	34.2	17.0	14.7	211.0	7226
15-45-45	40.3	1.91	33.4	16.8	14.4	206.7	6905
30-90-90	38.1	2.05	32.4	16.4	14.1	200.8	6494
90-90-90	40.2	1.83	35.0	16.3	13.8	195.3	6852
LSD .05	2.9	0.30	4.9	1.0	1.0	17.2	1495
			NS	NS	NS	NS	NS
SEPT. Lbs./ a							
0-0-0	38.2	2.00	31.0	16.8	14.4	205.9	6378
0-0-45	39.3	1.77	33.8	16.4	14.1	200.4	6766
0-45-0	38.8	1.80	31.6	16.6	14.4	205.9	6497
0-45-45	37.3	1.95	31.4	16.5	14.2	202.9	6367
45-0-45	37.4	1.89	31.9	16.9	14.8	212.7	6773
45-45-0	37.0	1.91	31.4	16.4	13.9	197.8	6214
45-45-45	37.6	1.99	34.2	16.7	14.3	204.2	7010
15-45-45	37.8	1.97	32.3	16.6	14.2	202.1	6542
30-90-90	40.9	1.77	34.8	16.5	14.2	202.1	7025
90-90-90	41.1	1.71	34.0	17.0	14.6	209.3	7102
LSD .05	2.5	0.29	4.2	0.9	0.9	15.6	1009
		NS	NS	NS	NS	NS	NS
DATE				MEAN	EFFECT		
AUG.	40.3	1.84	33.4	16.6	14.3	204.2	6823
SEPT.	38.5	1.88	32.6	16.6	14.3	204.3	6667
LSD .05	0.8	NS	NS	NS	NS	NS	NS

FERT.							
0-0-0	39.5	1.88	31.4	16.6	14.2	202.9	6380
0-0-45	39.8	1.81	33.5	16.4	14.1	201.4	6723
0-45-0	39.2	1.81	31.8	16.5	14.3	203.8	6473
0-45-45	39.3	1.92	33.2	16.8	14.4	206.7	6874
45-0-45	39.4	1.81	32.1	16.7	14.5	207.6	6671
45-45-0	39.0	1.87	33.0	16.7	14.3	204.6	6754
45-45-45	39.0	1.88	34.2	16.8	14.5	207.6	7118
15-45-45	39.0	1.94	32.9	16.7	14.3	204.4	6723
30-90-90	39.5	1.91	33.6	16.4	14.1	201.4	6759
90-90-90	40.7	1.77	34.5	16.6	14.2	202.3	6977
LSD .05	NS	NS	3.1	NS	NS	NS	NS

Table 3. Effect of nitrogen fertilizer on the yield of plant cane of three varieties on Commerce soil on the St. Gabriel Research Station, 2002.

		Plant Cane				
Fertilizer applied	Cane	Stalk		Normal Juice		Sugar
N-P_2O_5-K_2O	Yield	No.	Wt.	Brix	Sucrose	Yield
lbs/A	T/A	1000/A	lbs.	%	%	lbs/A
		CP 70-321				
50-0-0	33.3	53.2	2.89	15.0	11.8	5333
100-0-0	40.8	55.7	2.92	14.7	11.7	6521
150-0-0	40.5	53.2	2.80	15.3	12.3	6922
		LCP 85-384				
50-0-0	36.2	69.0	1.88	15.4	12.6	6347
100-0-0	38.6	67.7	1.90	15.0	12.1	6447
150-0-0	36.1	71.5	1.86	15.6	12.9	6496
		HoCP 91-555				
50-0-0	34.5	66.1	2.08	15.4	12.2	5825
100-0-0	37.6	69.0	2.02	16.1	12.4	6418
150-0-0	43.8	77.5	1.89	15.3	12.2	7380
		Mean Effect				
50-0-0	34.6	62.7	2.28	15.2	12.2	5837
100-0-0	39.0	64.1	2.28	15.3	12.0	6462
150-0-0	40.1	67.4	2.18	15.4	12.4	6933
LSD .05	2.3	NS	NS	NS	NS	759

The nitrogen fertilizer was applied in the off-bar furrow in the spring of 2002.

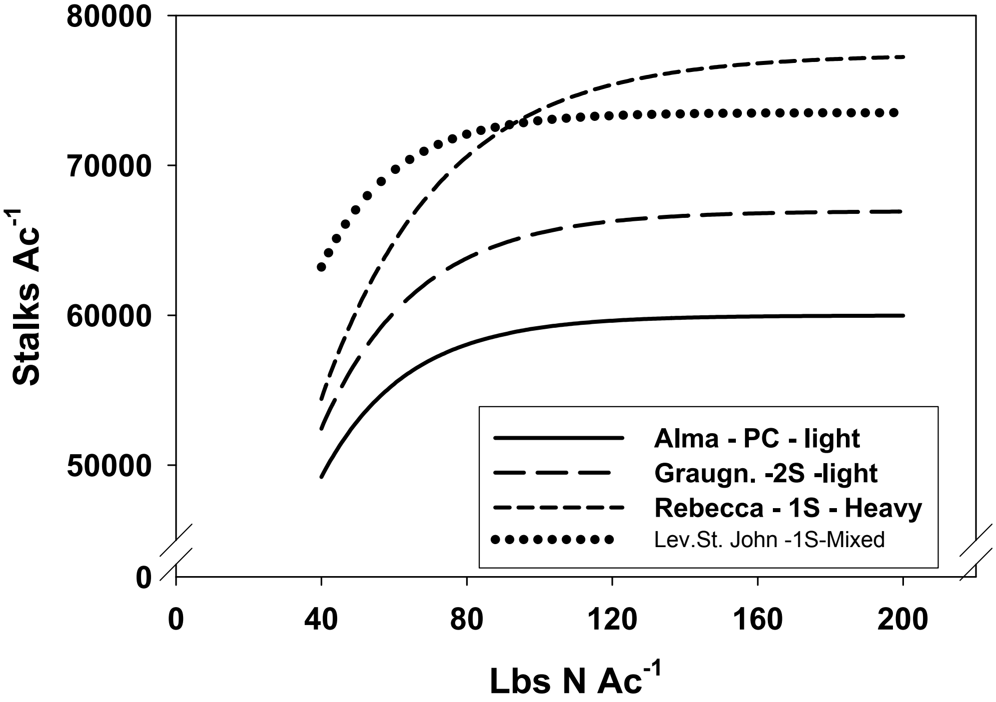

Fig. 1. Response of stalk population of cv 'LCP 85-384' to N fertilizer application. Exponential curve fit was used to smooth data.

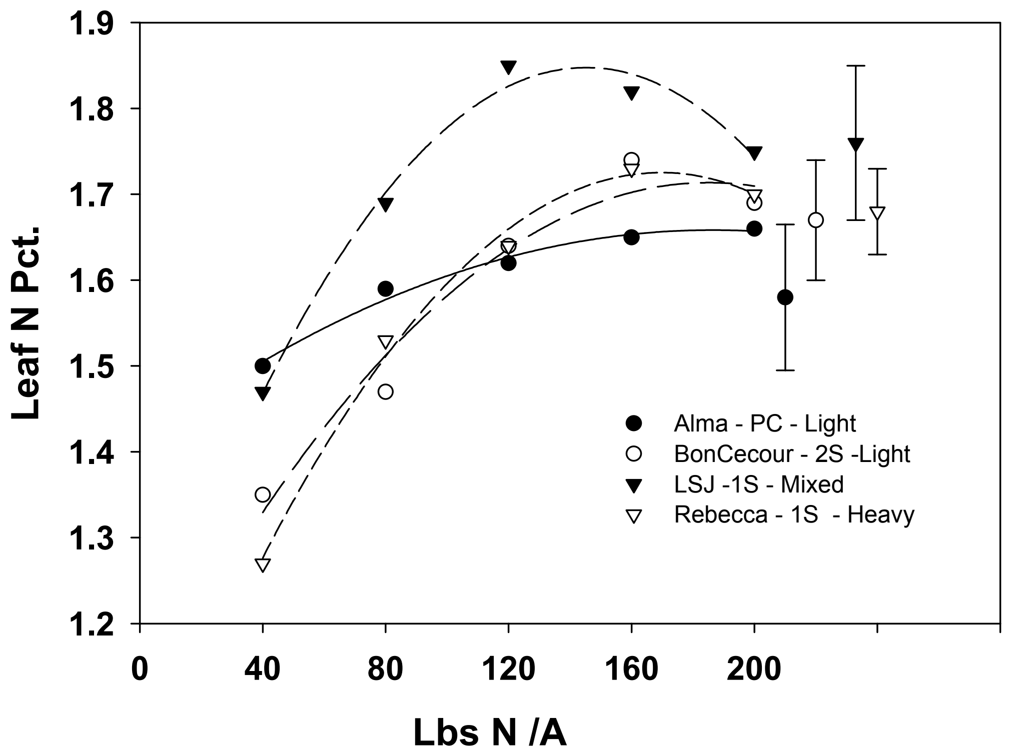

Fig. 2. N concentration of leaf below TVD for LCP85-384 as affected by N fertilizer rate and environment, Aug., 2002. Error bars represent $LSD_{0.05}$ for corresponding symbol.

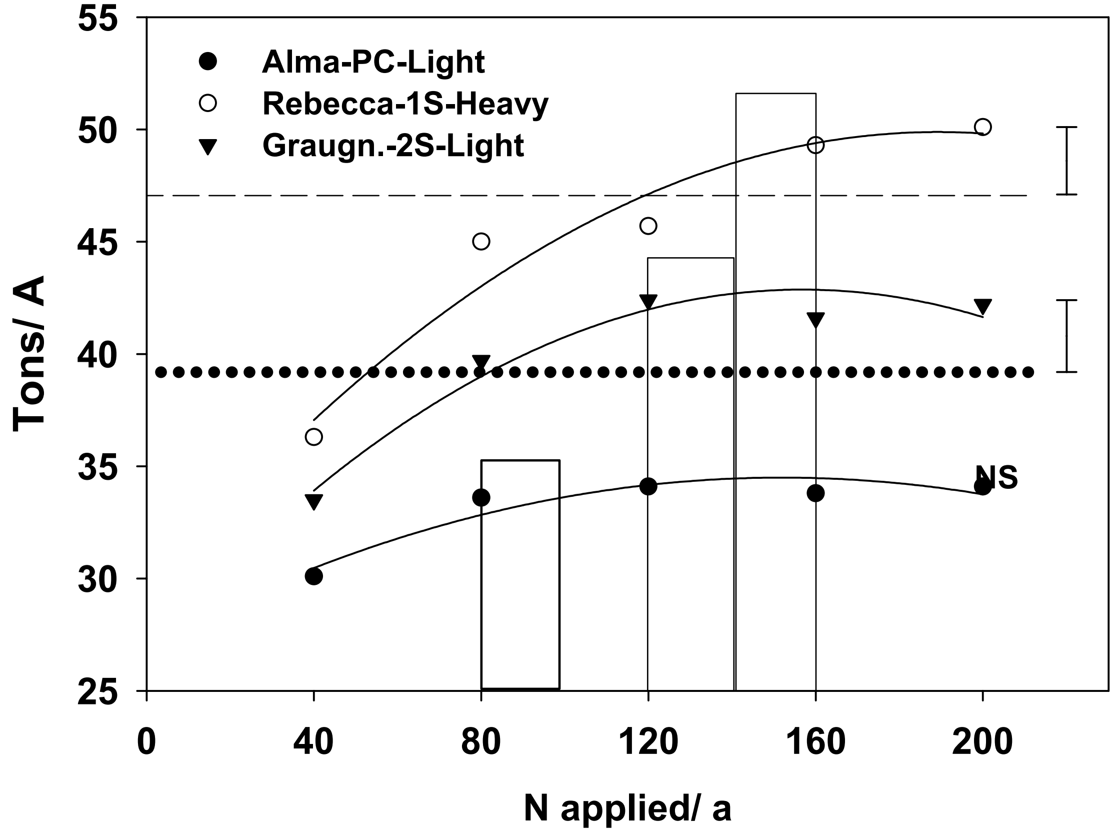

Fig. 3. The effect of N fertilizer rate, environment and crop stage on cane yield of LCP85-384. Error bars represent $LSD_{0.05}$ Rectangles represent present recommendations for N for corresponding crop stage and soil type.

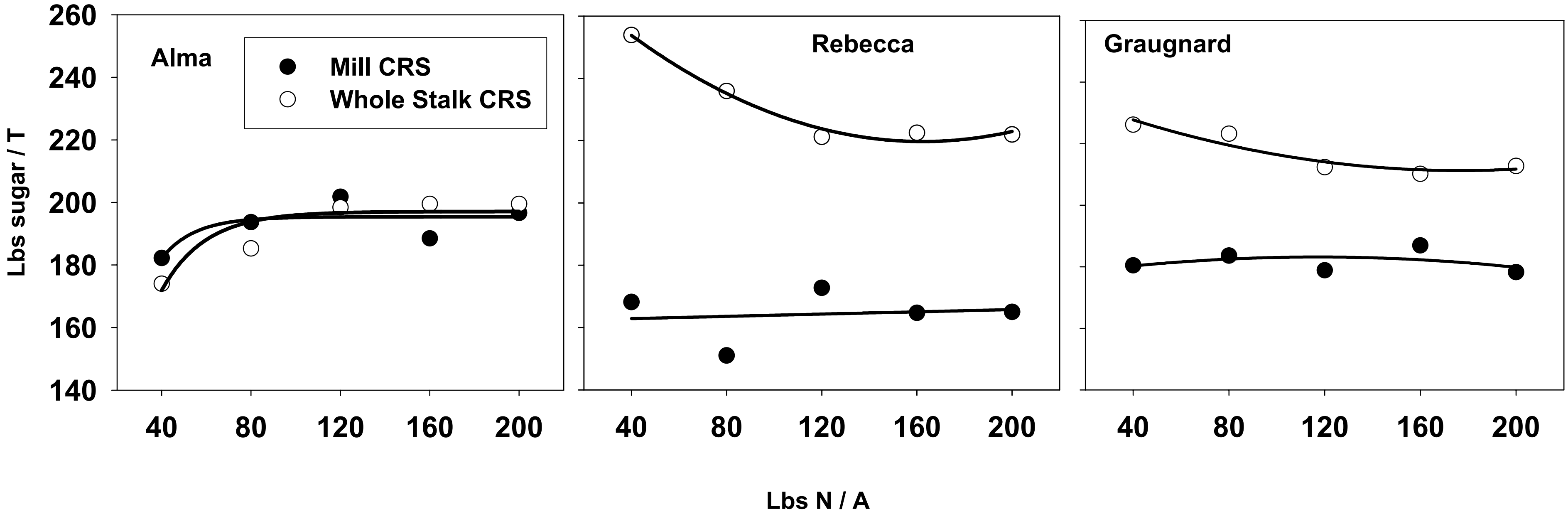

Fig. 4. The effect of N fertilizer rate, environment, and crop stage on CRS.

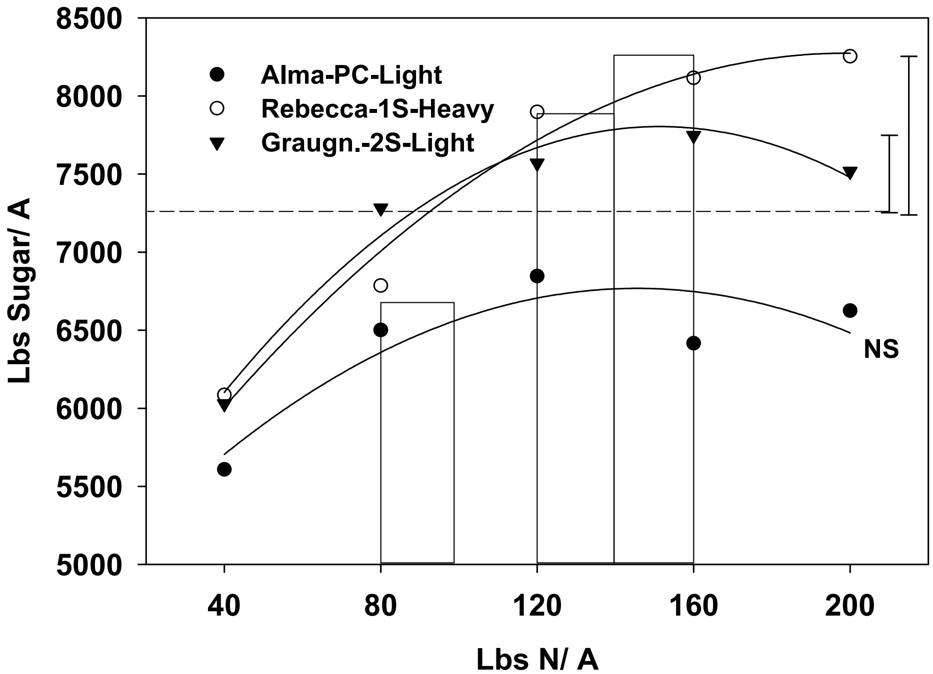

Fig. 5. The effect of N fertilizer rate, environment and crop stage on sugar yield of LCP85-384. Error bars represent $LSD_{0.05}$ Rectangles represent present recommendations for N for corresponding crop stage and soil type. Interception of dashed line and response curves represents area of curves that do not statistically from maximum response.

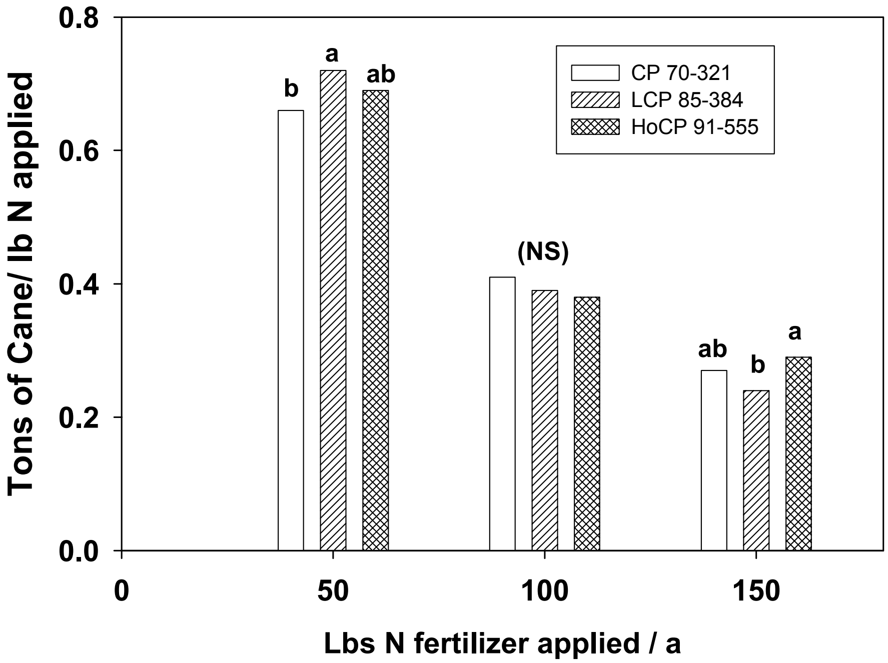

Fig. 6. The N -use efficiency differences among sugarcane varieties changes with with increasing N application rates.

EFFECT OF CALCITIC LIME AND CALCIUM SILICATE SLAG RATES AND PLACEMENT ON LCP 85-384 PLANT CANE AND FIRST-STUBBLE YIELD PARAMETERS ON A LIGHT-TEXTURED SOIL

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SUMMARY

Mixing 2 T/A of calcium silicate slag into the soil prior to planting produced significantly higher (P<.10) sugar/acre yields than all other treatments except where 1 T/A of slag was placed under the cane at planting. The failure of the 2 T/A calcitic lime treatment to produce comparable yields to the 2 T/A slag treatment suggests that the yield response to slag was due to silica and not calcium, though the disparity in yield between the 1 T/A application rates of slag and lime was not significant at the 10% probability level.

INTRODUCTION

Silica (Si) is one of the most plentiful elements in the earth's crust. In the soil, Si is generally abundant as mineral quartz and clays, but its concentration in a soluble form is highly variable. Monosilicic acid is soluble in the soil and it influences the chemical, physical, and biological properties of soils and plants. Soluble Si (monosilicic acid) apparently increases the plants' resistance against attack by insects and diseases, and it enhances plant tolerance to cold and water stress. Increasing soil silica can result in increased phosphorus uptake by plants, while decreasing the soil concentration of some toxic elements. Depending on the crop, production responses to silicate fertilizers can improve from 10% to 100%. Substantial sugarcane yield responses to silica have been obtained in Florida and Hawaii. Agricultural activity removes large quantities of Si (over 100 lb/A each year) from soil. Monosilicic acid is rapidly used by the plant, and, unless replenished in the soil solution, plant available Si can be depleted. Crops under stress do not use Si efficiently, and Si deficient crops do not use other nutrients efficiently. Also, successive ratoon yields decrease more dramatically when plant available Si is low. Silica can also be used as a liming agent. Recent analysis of Si in 22 Louisiana soils show that all were deficient or very deficient in monosilic acid.

OBJECTIVE

To compare the effect of calcitic lime and calcium silicate slag rates and placement on soil and plant silica and sugarcane yields.

MATERIALS AND METHODS

A sugarcane study was planted in September 2000 with first progeny Kleentek variety LCP 85-384 billets. The six calcitic lime (Domino by-product) and calcium silicate slag (a by-product of the steel industry) treatments are given in Table 1. These treatments were replicated six times in a Latin square experimental design. Treatments 2, 3, 4, and 5 were incorporated into the rows before planting, and treatment 6 was placed under the cane at planting. Experimental plots consisted of three 5 foot 10 inch by 40 foot rows with a 10-foot alley at the ends of each plot. All experimental plots were separated by three border rows on each side of the plots.

The Domino lime and calcium silicate slag materials showed a calcium carbonate equivalent of 84.28% for the lime and 78.51% for the slag. The silicon content of the materials were 39,400 ppm for the lime, and 133,000 ppm for the slag. The respective analysis of the lime vs. slag were: 0.39 vs. 0.50 ppm for arsenic; 0 vs. 0 ppm for cadmium; 53,970 vs. 8,430 ppm for calcium; 0.16 vs. 0.33 ppm for nickel; 1.12 vs. 8.05 ppm for copper; 0.57 vs. 0.73 ppm for lead; 5.95 vs. 14.38 ppm for iron; 0.03 vs. 0.04 ppm for zinc; 1.21 vs. 4.53% for organic matter; 788 vs. 378 ppm for magnesium; 0.20 vs. 0.94 ppm for manganese; 12.05 vs. 8.38 for pH; 1.99 vs. 5.74 ppm for phosphate; 112 vs. 56 ppm for potassium; and 61 vs. 23 ppm for sodium. Soil samples were taken from each plot and analyzed for monosilic acid. Plant leaf tissue was taken in August 2001 and analyzed for silica concentration.

The experiment was grown to maturity using standard cultural practices. The plots were harvested using a combine harvester and a weigh rig. Ten stalks were taken from the middle row of each plot immediately before harvest for determination of stalk weights and CRS.

RESULTS AND DISCUSSION

Sugarcane benefiting from the incorporation of two T/A of silicate slag into the soil before planting produced significantly ($P<.10$) more sugar per acre, as an average of the plant cane and first stubble crops, than all treatments except where 1 T/A of slag was placed under the cane at planting. The significantly higher yields resulting from the application of 2 T/A of slag compared to the 2 T/A calcitic lime treatment is an indication that the yield response was silica induced and not calcium induced.

Table 1. The effects of treatments on sugar/acre yields averaged over both crops.

T#	Lime	Silica slag	Placement	Yield, lb sugar/acre
	T/A	T/A		
1	0	0	-	6,377
2	1	-	mixed into rows	6,194
3	2	-	mixed into rows	6,277
4	-	1	mixed into rows	6,446
5	-	2	mixed into rows	7,140
6	-	1	placed under cane	6,775
LSD 0.10				655

EFFECT OF HIGH GYPSUM APPLICATION RATES ON SUGARCANE YIELDS FOR A HEAVY-TEXTURED SOIL

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SUMMARY

As an average of plant cane and two stubble crops, sugar/acre yields of HoCP91-555 on Alligator clay were significantly (P<.10) increased with the application of 5 or 15 T/A of gypsum. The difference in sugar/acre between the check and the 20 T/A gypsum treatment (an application rate calculated to bring the Ca/Mg ration to approximately 7:1) was not significant. Gypsum lowered CRS but increased tonnage. The addition of compost and liquid biologicals was ineffectual in enhancing yield.

INTRODUCTION

Research in Louisiana shows that application of high amounts of gypsum (5-10 T/A) can result in significant (12%) yield responses in stubble crops on heavy-textured soils. There is also a school of thought that says, "Optimum crop yields cannot be obtained on heavy-textured soils unless the Ca/Mg ratio of soil (based on % CEC) is close to 7:1." We conducted our study to test this theory and to determine the effect of gypsum application rates on crop yields and soil moisture and physical properties.

MATERIALS AND METHODS

An Alligator clay soil was selected for use in this study. Initial soil analysis (3385 and 630 ppm Ca and Mg, respectively, with a CEC of 21.2) indicated that it would require 17.3 T/A of gypsum to bring the Ca/Mg ratio (based on % CEC) up to the desired 7:1 value. To achieve this goal 0, 1.5, 5, 10, 15, and 20 T/A of gypsum were broadcast applied to experimental plots on August 23, 1999, and incorporated into the soil. Prior to incorporation the 1.5 T/A gypsum treatment also received 1.5 T/A of by-product lime and 15 gallon/A of a liquid biological solution. In May of 2000 this treatment also received 1 T/A of UL-L bagasse compost.

A 6x6 Latin square experimental design was used in the experiment. All treatments were replicated six times. Plots consisted of three 5 foot 10 inch by 40 foot rows, with a 10-foot alley at the ends of all plots. All experimental plots were separated by three border rows on each side that did not receive gypsum. The experiment was planted in September 1999 with first progeny Kleentek variety HoCP 91-555 at four stalks and a lap of two joints.

Cane was grown to maturity each year using standard cultural practices. Plant populations were determined in September each year. The test was harvested (plant cane) in early December 2000 using a two-row soldier harvester, and plots were weighed with a weigh rig. In 2001 and 2002, stubble cane was harvested with a combine harvester. A 10-stalk sample was taken from each plot to determine average stalk weight and commercially recoverable sugar (CRS) per ton of harvested cane.

RESULTS AND DISCUSSION

Table 1 shows that the experimental treatments affected (P>0.10) all measured variables. Cane and sugar yields for the check were lower (P<.10) than for the 5 and 15 T/A gypsum treatments, as an average of three crop years. Sugar/acre treatment means for cane receiving gypsum in different amounts (treatments 2 through 6), however, did not differ significantly. Gypsum appeared to depress CRS but increase tonnage.

Our experiment was initiated to determine whether adjusting the % base saturation of Ca/Mg to 7.0 would result in increased sugarcane yields. It was also meant to test the effect of gypsum on soil moisture and physical properties, and their influence on crop yields. Data on the effects of our treatments on soil moisture and resistance to penetration by a soil penetrometer will be reported on at a later date.

Table 1. Effect of gypsum treatments on sugarcane yield variables averaged across three years.

T#	Gypsum	Stalk weight	Plant pop.	CRS	Cane yield	Sugar yield
	T/A	lb/stalk	1000/A	lb/T	T/A	lb/A
1	0	1.60	46.1	194.7	26.6	5090
2	5.0	1.62	48.3	184.2	30.0	5490
3	10.0	1.67	47.4	183.1	29.2	5350
4	15.0	1.65	47.7	184.3	30.1	5490
5	20.0	1.66	49.5	184.9	29.3	5300
6	1.5+	1.68	47.6	182.4	28.5	5200
LSD 0.10		0.08	1.8	5.1	1.2	320
LSD 0.25		0.06	1.2	3.5	0.8	220

%This treatment also received 1.5 T/A of Domino by-product lime when the gypsum was applied 15 G/A (on 8/23/99) of liquid biologicals, and 1 T/A of UL-L compost in April 2000.

EFFECT OF POWER PERK ON SUGARCANE YIELD VARIABLES AND SOIL WATER AND PENETRATION RESISTANCE

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SUMMARY

Sugarcane was indifferent to the application of Power Perk. Averaged over three crops, the application of up to 30 G/A of Power Perk did not increase sugar yield (P=.11). Furthermore, soil penetrometer resistance and soil moisture were not influenced significantly by this product.

INTRODUCTION

Power Perk is a liquid product produced by OrganiCal Inc., and is registered as an agricultural mineral and soil conditioner. This product has a pH of approximately 0.4 and is meant to be diluted at least 1:20 with water before application. It is currently used on construction sites and golf courses as a soil conditioner to correct and/or increase water percolation in clay and saline/sodic soils. Promoters of this product claim that it will reduce the expansion index of clay soils so that water can percolate through it and, thereby, reduce resistance to root growth. Since the heavy-textured soils used to grow sugarcane in south Louisiana are known to have drainage problems, we decided to test this product.

OBJECTIVES

To determine the effect of Power Perk application rates and methods of application on:

1) Soil water concentration and soil penetration resistance.
2) Sugarcane yield variables across a four-year cane cycle.

MATERIALS AND METHODS

An Alligator clay soil was selected for use in the study. First progeny Kleentek variety HoCP 91-555 was planted at three stalks and a lap of two joints in September of 1999. The experiment used a 6x6 Latin square design with six replications. Experimental plots consisted of three 5 foot 10 inch by 40 foot rows, with a 10-foot alley at the ends of the plots. All treatment plots were separated from adjacent treatments by three border rows.

Experimental treatments were applied immediately after planting. The Power Perk was diluted 1:10 with water before application. Treatments 2-4 were applied as a broadcast spray (from furrow-to-furrow). Treatments 5 and 6 had their Power Perk applied two ways: half in a narrow (one inch) band (in the furrow between the rows) and the other half in a 4-inch band on the row top.

Cane was grown to maturity using standard cultural practices, and plant populations were determined for each plot before harvest. The experiment was harvested in 2000 with a two-row soldier harvester and weighed with a weigh rig. In 2001 and 2002 the plots were harvested by a combine harvester and weighed with a portable weigh wagon. A 10-stalk sample was taken from each plot each year to determine average stalk weight and commercially recoverable sugar (CRS) per ton of harvested cane. Soil penetrometer resistance (using a soil pentrometer) and soil moisture (using dry weight differences) was measured down to 6 inches on August 28 and October 11 in 2001 and July 17 in 2002.

RESULTS AND DISCUSSION

Table 1 shows that the sugar/acre yield of sugarcane was not affected by any application rate of Power Perk, as an average of the three crops. Also, none of the components of yield, plant population, tonnage, and CRS responded to this product (data not shown). The data in Table 2 reveal that Power Perk treatments did not affect soil moisture or soil penetrometer resistance as an average of all samplings during the three crop years.

Table 1. The yield response of HoCP 91-555 to the application of Power Perk as an average of three crops.

T#	Power Perk	Sugar Yield
	G/A	lb/A
1	0 – furrow to furrow	5160
2	10 - “ “ “	5200
3	20 - “ “ “	5140
4	30 - “ “ “	4770
5	5 in furrow +5 over row top	4740
6	10 in furrow + 10 over row top	5210
LSD = .10		NS

Table 2. Effect of Power Perk treatments on soil penetrometer resistance and soil moisture as an average of samplings during three crops.

T#	Power Perk	Soil penetrometer resistance	Soil moisture
	G/A	lb/in^2	%
1	0	401	25.5
2	10 - furrow to furrow	382	25.7
3	20 - “ ” “	362	26.1
4	30 - “ ” “	389	26.0
5	5 in furrow +5 over row top	369	25.8
6	10 in furrow + 10 over row top	395	25.9
LSD 0.10		NS	NS

IMPACT OF PAPER MILL SLUDGE ON SUGAR CANE PRODUCTION AND YIELDS

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SUMMARY

The pH of soil increased from 7.1 to 7.4 at both the 10- and 20-ton sludge rates at approximately seven months following the application of the paper mill sludge. Further, there was an increase of over 35% (1365 to 1855 ppm) in the available calcium from the 0 to the 20-ton rate when sampled in April following the sludge application the previous October. There was also a 48% increase (25 to 37 ppm) in available sodium. The increase in available calcium and sodium for the 10-ton rate was intermediate between the 0 and 20-ton rate. There was little effect of paper mill sludge on the availability of K, Mg, and P at either the 10- or 20- ton rate. Further, there was no apparent increase in the organic matter content between the 0 and 20-ton rate. Paper mill sludge can increase soil pH and the availability of both calcium and sodium and could be considered for use in acid soils or where available calcium is low.

For the plant-cane crop, there were no significant differences among treatments, including sludge rates at 0, 10, and 20 tons per acre, starter fertilizer rates at 0, and 15-45-45 or spring nitrogen rates at 0-0-0, 80-0-0, and 160-0-0, or combination of treatments (interactions) on the yield of sugar per acre (TRS/A), tons cane per acre (TC/A) or sugar per ton of cane (TRS/TC).

No significant differences were found in the yield of sugar per acre (TRS/A) and tons of cane per acre (TC/A) in the first-stubble crop. However, there was a significant interaction between sludge treatments and the yield of (TRS/TC). There were no differences in TRS/TC at either the 0 and 10-ton per acre sludge rate and the 0-0-0, 80-0-0, and 160-0-0 spring nitrogen rates; however, there was a significant reduction in TRS/TC at the 20-ton sludge rate where the 160-0-0 spring nitrogen rate was applied in 2001 and again in 2002. Although there were no differences in TRS/TC in 2001 at any of the sludge rates and spring nitrogen rates in the plant-cane crop, there was a significant difference in TRS/TC for the 20-ton sludge rate in the first-stubble crop. No significant differences were found in 2002 in the yield of TRS/A, TC/A, and TRS/TC at either starter fertilizer rates. However, there was a significant increase in both TRS/A and TC/A as the rate of nitrogen was increased in the spring of both 2001 and 2002.

INTRODUCTION

The organic matter content of most Louisiana soils is considered low by most standards. Generally speaking, increased organic matter in the soil will increase water- and nutrient-holding capacity, improve water percolation through the soil, improve tilth, and reduce erosion. These factors can improve plant survival and growth. The result can be increased yields with lowered fertilizer requirements and less soil, pesticide, and nutrient loss in runoff.

Paper mills collect large volumes of short fiber (sludge) in the paper-making process in their wastewater treatment plants. This material is primarily composed of partially digested cellulose and hemi-cellulose fibers and algae bodies with some residual lime. It is a convenient material to use and apply. The paper industry is seeking ways to use this material rather than landfill the large volumes it produces. Paper mill fiber residue has been used as a mulch, a lime source, and an amendment to increase soil organic matter content. The sludge material has a pH of 8.9 and is comprised of approximately 30% calcium and 0.5% sodium on a dry weight basis.

PROCEDURES

The overall experiment was arranged in a randomized complete block design with four replications. Sludge treatments (0, 10 and 20 tons per acre) were arranged in a split plot design with starter fertilizer treatments (0 and 15-45-45) and spring N treatments (0-0-0, 80-0-0, and 160-0-0) arranged in a factorial design. Each of the 18 plots per replication was two rows wide (12 feet) by 24 feet long with a 4-foot buffer between plots. Sludge and starter fertilizer treatments were applied in the furrow at planting on October 16, 2000, while spring N treatments were applied in April 2001 to the plant-cane crop and April 2002 to the first-stubble crop. Standard cultural practices were applied to the experimental area with respect to control of weeds and insect pests.

Ten-stalk samples, taken at random along the row, were removed from each plot on December 3, 2001, in the plant-cane crop and December 18, 2002, in the first-stubble crop. All stalks were stripped of all leaves and topped approximately 4-6 inches below the apical meristem (bud). Data collected and/or calculated included mean stalk weight, Brix by refractometer, sucrose by polarimetry, purity as the ratio of sucrose to Brix and the yield of theoretical recoverable sugar per ton of cane (TRS/TC). Plots then were harvested on the same dates by a cane combine (Cameco Model 2500) operating at approximately 3.5 mph and an extractor fan speed of 950 rpm. All cane from each plot was weighed in the wagon fitted with load cells and the weights recorded. From these data, the yield of tons cane per acre (TC/A) and yield of theoretical recoverable sugar per acre (TRS/A) were calculated for each plot. The data for TRS/A, TC/A, and TRS/TC were analyzed with a mixed model analysis (SAS 8.2 PROC MIXED). Least square means were calculated and separated using least square mean probability differences ($P = 0.05$).

Data were also collected before and after the application of paper mill sludge for various soil parameters including pH, macro and micro nutrient content as well as organic matter content.

RESULTS AND DISCUSSION

Soil test results just before and after the application of the paper mill sludge are shown in Table 1. It appeared that the pH of the soil showed a slight increase at the 20-ton sludge rate approximately seven months following the application. Further, there was an increase of over 35% (1365 to 1855 ppm) in the available calcium from the 0 to the 20-ton rate when sampled in April following the sludge application the previous October. There was also a 48% increase (25 to 37 ppm) in available sodium. The increase in available calcium and sodium for the 10-ton rate was intermediate between the 0 and 20-ton rate. There appeared to be no effect of paper mill sludge on the availability of K, Mg, and P at either the 10- or 20-ton rate. Further, there was no apparent increase in the organic matter content between the 0 and 20-ton rate. Paper mill sludge can increase soil pH and the availability of both calcium and sodium and could be considered for use in acid soils or where available calcium is low.

For the plant-cane crop, there were no significant differences among treatments, including sludge, starter fertilizer, or spring nitrogen applications, or combination of treatments (interactions) on the yield of sugar per acre (TRS/A), tons cane per acre (TC/A), or sugar per ton of cane (TRS/TC) cane, or sugar yield (Tables 2, 3, 4 and 5). However, it is interesting to note that there was no significant deleterious effect of the paper mill sludge on any of the yield components. This, in itself, is considered positive because many un-stabilized organic amendments can actually show a negative impact on crop yield the year of application. Research with compost applications on other crops does not generally show significant yield increases until the second year. It is for this reason that the experiment was kept for a second year to determine if the addition of the sludge treatments would have a positive impact on yield in the first-stubble crop.

Results for the first-stubble crop are shown in Tables 6, 7, 8, and 9. No significant differences were found in the yield of sugar per acre (TRS/A) and tons of cane per acre (TC/A) (Table 7). However, there was a significant interaction between sludge treatments and the yield of sugar per ton of cane (TRS/TC) (Table 6). There were no differences in TRS/TC at either the 0 and 10-ton per acre sludge rate and the 0-0-0, 80-0-0, and 160-0-0 spring nitrogen rates; however, there was a significant difference in TRS/TC at the 20-ton per acre sludge rate and the three spring nitrogen rates (Table 7). Although there were no differences in TRS/TC in 2001 at any of the sludge rates and spring nitrogen rates in the plant-cane crop, there was a significant difference in TRS/TC for the 20-ton sludge rate in the first-stubble crop. Previous experiments have shown that increased levels of nitrogen can cause a reduction in TRS/TC; however, this is the first evidence of an interaction between sludge and nitrogen rates. Where the rate of nitrogen was increased in both the spring of 2001 and 2002, there was a significant reduction in TRS/TC at harvest in 2002. No significant differences were found in 2002 in the yield of TRS/A, TC/A, and TRS/TC at either starter fertilizer rates (Table 8). However, there was a significant increase in both TRS/A and TC/A as the rate of nitrogen was increased in the spring of both 2001 and 2002 (Table 9). This is not unusual because LCP 85-384 does not apparently respond to high nitrogen rates in the plant-cane crop; however, in subsequent stubble crops, there is usually an increase in yield with increased nitrogen rates.

Because of the interaction that occurred between sludge rates and spring nitrogen rates, it is recommended that this experiment be harvested again in the second-stubble crop.

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Table 1. Soil test results conducted at the Louisiana State University Soil Testing Laboratory for the site where the paper mill sludge was applied at the St. Gabriel test site.

	Sludge		Ca	K	Mg	Na	P	Bases	OM
Sample date	Tons/ac	pH			Ppm			meq/100g	%
Sept. 2000	0	7.1	1455	94	317	26	349	10.2	1.21
April 2001	0	7.3	1365	95	315	25	324	9.8	0.97
April 2001	10	7.4	1510	91	307	33	326	10.4	1.13
April 2001	20	7.4	1855	108	347	37	333	12.6	1.22

Table 2. Mixed model analysis of fixed effect terms for the Paper Mill Sludge test harvested on December 3, 2001, in the plant-cane crop of the sugarcane variety, LCP 85-384, conducted at the St. Gabriel Research Station.

			Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
Source	Num df	Den df		Pr > F	
Sludge	2	9	0.28	0.68	0.32
Starter	1	45	0.32	0.83	0.11
Spring	2	45	0.54	0.45	0.12
Sludge*Starter	2	45	0.47	0.09	0.03
Sludge*Spring	4	45	0.24	0.47	0.37
Starter*Spring	2	45	0.63	0.98	0.57
Sludge*Starter*Spring	4	45	0.20	0.20	0.01

Table 3. Means of sludge treatments for yields of sugar per acre, tons cane per acre, and sugar per ton in the plant-cane crop of LCP 85-384 harvested on December 3, 2001, at the St. Gabriel Research Station.

Sludge	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
tons/ac	lbs/ac	tons/ac	lbs/ton
0	8684	44.0	197
10	8210	43.2	190
20	8457	44.1	192
Significance (0.05)	NS	NS	NS

Table 4. Means of starter fertilizer treatments for yields of sugar per acre, tons cane per acre, and sugar per ton in the plant-cane crop of LCP 85-384 harvested on December 3, 2001, at the St. Gabriel Research Station.

Starter Fertilizer	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
	lbs/ac	tons/ac	lbs/ton
0-0-0	8380	43.9	191
15-45-45	8521	43.7	195
Significance (0.05)	NS	NS	NS

Table 5. Means of spring nitrogen rate treatments for yields of sugar per acre, tons cane per acre, and sugar per ton in the plant-cane crop of LCP 85-384 harvested on December 3, 2001, at the St. Gabriel Research Station.

Nitrogen rate	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
	lbs/ac	tons/ac	lbs/ton
0-0-0	8549	44.1	194
80-0-0	8358	44.1	190
160-0-0	8445	43.2	196
Significance (0.05)	NS	NS	NS

Table 6. Mixed model analysis of fixed effect terms for the Paper Mill Sludge test harvested on December 18, 2002 in the first-stubble crop of the sugarcane variety, LCP 85-384, conducted at the St. Gabriel Research Station.

Source	Num df	Den df	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
				Pr > F	
Sludge	2	9	0.91	0.81	0.29
Starter	1	45	0.96	0.88	0.54
Spring	2	45	0.04	0.01	0.01
Sludge*Starter	2	45	0.65	0.76	0.32
Sludge*Spring	4	45	0.47	0.36	0.03
Starter*Spring	2	45	0.57	0.45	0.99
Sludge*Starter*Spring	4	45	0.53	0.22	0.78

Table 7. Means for sludge and spring nitrogen treatments for yields of sugar per acre, tons cane per acre and sugar per ton in the first-stubble crop of LCP 85-384 harvested on December 18, 2002 at the St. Gabriel Research Station[1].

Sludge	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC) lbs/ton						
Tons/ac	lbs/ac	tons/ac	Spring nitrogen rate						Significance
			0-0-0		80-0-0		160-0-0		
0	8343	31.7	267		256		266		NS
10	8545	32.2	270		268		259		NS
20	8429	32.7	271	A	260	AB	243	B	P < 0.05
Significance (P=0.05)	NS	NS							

[1] Nitrogen (32%) and potassium applied in the spring of 2002 at the rate of 120 pounds per acre and 80 pounds per acre, respectively. Means in a row followed by the same letter are non significant at P < 0.05.

Table 8. Means of starter fertilizer treatments for yields of sugar per acre, tons cane per acre and sugar per ton in the first-stubble crop of LCP 85-384 harvested on December 18, 2002 at the St. Gabriel Research Station[1].

Starter Fertilizer	Sugar per acre (TRS/A)	Tons per acre (TC/A)	Sugar per ton (TRS/TC)
	lbs/ac	tons/ac	lbs/ton
0-0-0	8445	32.2	263
15-45-45	8432	32.3	261
Significance (P=0.05)	NS	NS	NS

[1] Nitrogen (32%) and potassium applied in the spring of 2002 at the rate of 120 pounds per acre and 80 pounds per acre, respectively.

Table 9. Means of spring nitrogen rate treatments for yields of sugar per acre, tons cane per acre and sugar per ton in the first-stubble crop of LCP 85-384 harvested on December 18, 2002 at the St. Gabriel Research Station[1].

Nitrogen rate	Sugar per acre (TRS/A)		Tons per acre (TC/A)	
	lbs/ac		tons/ac	
0-0-0	7982	B	29.7	B
80-0-0	8584	AB	32.8	A
160-0-0	8750	A	34.2	A
Significance (0.05)	P < 0.05		P < 0.05	

1 Nitrogen (32%) and potassium applied in the spring of 2002 at the rate of 120 pounds per acre and 80 pounds per acre, respectively. Means in a column followed by the same letter are non significant at P < 0.05.