SUGAR CROPS PRODUCTION MANAGEMENT RESEARCH AT THE IBERIA AND SUGAR RESEARCH STATIONS

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SUMMARY:

Field trials consisted of **1)** continuing evaluation of the long-term effects of post-harvest residue management on sugarcane; **2)** assessing the efficacy of the nutritional product, HM-0938-A, a Helena® Chemical foliar-applied product, and **3)** AgriCal® and IgniteS^{2}®, soil-applied nutritional products from AgriGro; **4)** a continuation of the evaluation of iron clay cow pea as fallow period cover crop; and **5)** assessing the influence of source of trash on sweet sorghum juice quality.

The long-term residue management study was in the fallow period between the fourth and fifth production cycles, and, therefore, yield data are not available. Helena® Chemical’s foliar-applied nutritional product, HM-0938-A, produced higher tonnage than the check at the 1 pint/acre application made in June, whereas, neither of AgriGro’s products were efficacious in producing enhanced yields compared to the check. Iron clay cowpea grown during the fallow period of the sugarcane production cycle provided the equivalent of 40 lb N/A to the subsequent plant cane crop, but there were no differences in yield among treatments when first stubble plots were harvested the following year. Fermentable sugar yields were equivalent among sweet sorghum treatments varying in source of vegetative material (whole plant, stripped stalks and stalks with just leaves or panicles). Comparing these treatments for sugar content on a dry weight basis, however, revealed that stripped stalks contained the greatest amounts of sucrose, glucose and fructose compared to the treatments with different sources of trash.

I. LONG-TERM RESIDUE MANAGEMENT STUDY:

A post-harvest residue management study was initiated in 1997 and has continued through the second-stubble crop of production cycle number four. The study has clearly confirmed what other investigations have found, that post-harvest residue generated from green cane harvesting under Louisiana conditions has a negative effect on the cane and sugar yield of ratoon crops within a production cycle.

Generally, burning produces higher cane yield than retaining the residue, with sweeping the residue to the middles producing intermediate yields. What was known only anecdotally was that the negative effects of residue retention did not carry over to the plant-cane crop of subsequent cycles of production. This study consistently demonstrates yield recovery with the initiation of the plant-cane crop of each production cycle. While burning does not always produce superior yields, for the second-stubble crop in 2014 the burn treatment produced over 1,400 lb of sugar per acre more than the other two residue management treatments. In 2015, the field was fallow and no yield data are available.

Efficacy of Helena® Chemical Co. Product HM-0938-A on Cultivar L01-299:

Helena® Chemical Co. bio-nutritional product HM-0938-A is a foliar-applied experimental compound that is not commercially available. A field trial was conducted in 2014 on plant cane and 2015 on first stubble to evaluate the efficacy of HM-0938-A foliar applied at three rates (1.0, 1.5 and 2.0 pt/A) and two timings (May and June applications) . Each year cultivar L01-299 was fertilized with 120 lb N per acre (32% UAN) prior to the applications of the product. Plots were 3-rows wide and 50 ft in length and replicated four times in a randomized complete block design. The soil type was an Iberia silty clay. Data were recorded for biomass weight, juice quality, and leaf N percentage. As an average of both years, the only significant difference (P=.10) among all variables was the higher tonnage, compared to the check, achieved for the cane that received the 1.0 pint per acre rate in June (see table below). This same treatment was numerically the highest for pounds of sugar per acre. Nitrogen content of leaves did not reveal any meaningful disparities among the treatments, though average leaf N content was relatively low according to established critical values. Treatments will be applied again next year in second stubble.

Application rate pint/A	Application timing	Tons/A	TRS	Sugar/A lb	Leaf % N for 2015
0	0	40.0 b	234 a	9,339 a	1.08
1.0	May	40.8 b	232 a	9,484 a	1.15
1.5	May	44.0 ab	234 a	10,304 a	1.05
2.0	May	40.5 b	242 a	9,825 a	1.04
1.0	June	46.0 a	233 a	10,723 a	1.14
1.5	June	40.2 b	243 a	9,762 a	1.17
2.0	June	39.1 b	244 a	9,332 a	1.11
Means in a column followed by a common letter are not significantly different at P = .10					

Efficacy of AgriGro® Products, AgriCal and IgniteS^2, on Plant Cane L 01-299:

AgriCal is a liquid calcium formulation and IgniteS^2 is a bio-stimulant marketed by AgriGro®. They were applied together to plant cane L 01-299 in 32% UAN and in spring-applied preemergence herbicides and in the layby application of herbicide. IgniteS^2 was also applied alone in the layby application of herbicides. Treatments were replicated 8 times in a Randomized Block Design using plot dimensions of 18 x 50 ft. Shown in the table below, the products were not effective in boosting either cane or sugar yields in plant cane. Treatments are scheduled to be imposed in both first and second-stubble crops of the production cycle.

Treatment	Time of application	Rate applied	TRS	Tons cane/A	Sugar/A, pounds
No products			240	43.3	10,382
AgriCal plus IgniteS[2]	With preemergence herbicides applied in winter/spring	2 gal/A plus 1 pt/A	245	40.6	9,924
IgniteS[2]	With layby herbicides in May	1 pt/A			
AgriCal plus IgniteS[2]	With 32% UAN in April	1 gal/A plus 1 pt/A	237	38.3	9,086
AgriCal plus IgniteS[2]	With layby herbicides in May	1 gal/A plus 1 pt/A			
P =			0.24	0.41	0.28

Evaluation of Ironclay Cowpea as a Cover Crop for Sugarcane:

Iron clay cowpea, a mixture of two formerly separate cultivars, is a widely grown legume cover crop that is adapted to the climatic conditions of the Southeast. A field trial was conducted in 2013-14 to evaluate its suitability as a N-fixing cover crop for production during the fallow period prior to plant cane establishment. Cowpea seed was double drilled on sugarcane rows at the rate of 10 seed per linear foot of row on May 1, 2013. Peas were allowed to grow until July 31, when they were shredded. Sugarcane cultivar L01-299 was planted on September 7, 2013. Treatments compared were: 1) unfertilized plant-cane following a conventional fallow period; 2) plant-cane fertilized with 40 lb N per acre following fallow; 3) plant-cane fertilized with 80 lb N per acre following fallow; 4) unfertilized plant-cane following ploughed down cowpeas; 5) plant-cane fertilized with 40 lb N per acre following cowpeas; and 6) plant-cane fertilized with 80 lb N per acre following cowpeas. For the first stubble crop, all plots received the same amount of N fertilizer, 120 lb of N as UAN. Comparing fallow vs. cowpea for cane yield, TRS and sugar yield, there were no differences to detect in first stubble (see main effects below – interactions were not significant). This research is in cooperation with Drs. Paul White and Chuck Webber of the ARS-USDA Sugarcane Research Unit in Houma, LA.

Treatment	Tons of cane/A	TRS	Pounds of sugar/A
Cane after Fallow	42.2 a	208 a	8,799 a
Cane after Cowpea	42.5 a	206 a	8,759 a
Means in a column followed by a common letter are not significantly different at P = 0.10			

Influence of Source of Trash on Sweet Sorghum Juice Quality:

Samples of sweet sorghum varying in amount and source of vegetative material (trash) were processed to determine juice yield, Brix, and fiber. Calculations were also made for total fermentable sugar on a wet weight basis and sugars in juice content on a dry matter basis (sucrose, glucose and fructose determined by HPLC). In general, as vegetative material content increased, fiber, dry weight and juice yield increased, while Brix and purity decreased. As shown in the table below, total fermentable sugar production was not affected by trash, which theoretically suggests processing on a whole-plant basis should be possible without affecting sugar recovery (please note that calculations for total fermentable sugar did not include an arbitrary milling extraction percentage). Harvesting, hauling and milling efficiencies, however, are favored by clean biomass represented by the stripped stalk data in this study, as trash is costly to separate and haul and interferes with recovery of sugars. Lower purity with additional trash also affects the quality end products at factories and refineries. On a dry weight basis, however, sugars in juice were affected by trash level, with whole-plant samples containing only 62% of the sugars in juice of stripped-stalk samples. Panicles contributed less to total biomass than leaves and, therefore, did not influence sugar recovery as adversely as leaves on a dry weight basis.

Trash treatment	Brix	Fiber	Purity	Dry weight	Juice yield	Total fermentable sugar	Sucrose	Glucose	Fructose
				Mg ha^{-1}			g g dry $weight^{-1}$		
Whole plant	13.6	24.9	77.56	9.4	28.9	3.2	0.248	0.048	0.032
Stalks + leaves	14.0	22.8	78.03	8.3	28.2	3.3	0.299	0.049	0.033
Stalks + panicles	14.1	20.9	83.06	6.7	25.8	3.1	0.369	0.053	0.033
Stripped stalks	14.3	19.1	83.07	5.9	25.0	3.2	0.435	0.059	0.034
P =	0.02	<.0001	<.0001	<.0001	<.0001	0.29	<.0001	<.0001	0.55

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NITROGEN MANAGEMENT RESEARCH IN LOUISIANA SUGARCANE PRODUCTION SYSTEMS

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SUMMARY

Three large-scale field demonstration plots were continued in 2015, one at the LSU AgCenter Sugar Research Station (Site A) and on two producers' fields in Donaldsonville, LA (Site B and C). The decision tools that were tested against the farmer's standard nitrogen (N) practice (T1) were: based on soil nitrate test + yield goal (T2), and based on optical sensor readings (T3). The trial on the effect of N source and rate on sugarcane yield using variety HoCP96-540 was continued using the following sources: urea (45% N), urea-ammonium nitrate solution (UAN-32% knife-in and dribble), and ammonium-nitrate (AN-34% N) applied at rates of 40, 80, and 120 lbs N/acre; a control plot (no N) was included. Treatments were replicated and arranged in a randomized complete block design. Nitrogen recommended by T2 was 69, 50, and 67 lbs N/ac while T2 recommended 62, 65, and 67 lbs N/acre for Sites A, B, and C, respectively. These were significantly lower than what applied to T1 plots (110-120 lbs N/ac). Remarkably, sugar yield were increased even with lesser amount of N applied to T2 and T3 plots. Thus with higher return from higher yield and savings made with applying lesser N, T2 had \$198, \$65, and \$372/acre and T3 had \$72, \$26, and \$143/acre higher return than T1 for Sites A, B, and C, respectively. Plots treated with 90 lbs N/ac obtained the highest sugar yield (P<0.05) and it appears that knife-in UAN remained the most appropriate source of N.

OBJECTIVES

This project intends to evaluate the performance of different decision tools for determining sugarcane N requirement and evaluate the effect of different N sources applied at varying rates on sugarcane productivity.

RESULTS

Performance Evaluation of Nitrogen Decision Tools

This study was continued in 2015 (2nd stubble) at the Sugar Research Station in St. Gabriel (plot size: 9000 ft^2, L01-299) and two locations in Donaldsonville, LA (plot size of Site B: 12,000 ft^2 with L01-299 and plot size of Site C: 33,000 ft^2 with HoCP96-540). The treatments included the current LSU AgCenter N recommendation/farmer's standard practice, N recommendation based on stalk N removal rate + soil nitrate, and optical sensor-based N recommendations. All treatments were replicated three times at each site.

The N rate recommended by T2 was 69, 50, and 67 lbs N/ac whereas similar recommendations were made by T3 (62, 65, and 67 lbs N/ac) for Site A, B, and C, respectively (Table 1). These application rates were significantly lower than what were applied to T1 plots (110-120 lbs N/ac). On average, the N recommended by T2 and T3 was lower by almost half the T1 application rate. Remarkably, sugar yield were increased even with lesser amount of N applied in these plots wherein the highest recorded was by as much as 1,500 lbs/ac at Site C. Combining the return from higher yield and savings made from applying lesser N fertilizer, the total net return from applying the rates recommended by T2 and T3 were noted as $198, $65, and $372/ac, and $72, $26, and $143/acre higher return than T1-treated plots for Sites A, B, and C, respectively. Unlike in 2014, it is notable that the performance of T2 and T3 was consistently better in terms of return that could perhaps explain by the absence of heavy rainfall in 2015 within a few days after fertilization. Overall, the demonstration study conducted in 2015 highlighted the potential of soil nitrate testing along with information of field yield average and optical sensor as N decision tools in sugarcane production.

Effect of Nitrogen Source Applied at Different Rates on Sugarcane Yield

Table 2 shows the response of yield and quality components of 1st stubble cane variety HoCP96-540 to different sources and rates of N. The highest cane tonnage (39 ton/ac) and sugar yield (9651 lbs/ac) was obtained from plots applied with 120 lbs N/ac but these increases were not significantly different from the increases obtained when 80 lbs N/ac was applied. Thus, by this standard, it can be inferred that the optimal N rate was 80 lbs/ac (P<0.01). While the use of knife-in UAN tended to increase sugar yield when compared with other sources, yield increases were not consistently significant (e.g. 9100 lbs/ac for urea vs. 9848 lbs/ac for UAN knife-in) and with a confident level of only 70%. Coated-urea had the lowest sugar yield among the sources used. In order to understand the cane response to sources and rate of N, the amount of inorganic N at the 0-6 inch depth of soil was monitored from 7, 14, 21, and 60 days after N fertilization (Figure 1). The effect of N rate was evident across sampling dates i.e., increasing N rate increased inorganic N (ammonium and nitrate). It is notable that the sources influence the time where the total inorganic N peaked out such that the highest inorganic N content for UAN-dribble was observed 14 days after N application. The inorganic N content peaked at 7 days after N application for urea and 21 days after for coated-urea. Overall, plots treated with 80 lbs N/ac obtained the highest sugar yield and knife-in UAN solution appeared to be the most appropriate source and method of N application in Louisiana sugarcane production system.

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Table 1. Nitrogen rate, sugar yield, and net return of sugarcane applied with N rate based on farmers' standard practice, stalk N removal rate + soil nitrate and optical sensor readings.

Site	N Decision Tool	N Applied	Sugar Yield	Income: Sugar yield		Saving: N fertilizer		Net
		lbs/ac	lbs/ac	lbs/ac	$/ac	lbs/ac	$/ac	$/ac
Site A	Current/Farmer's Std Practice	120	8252					
	Stalk N removal + Soil nitrate	69	9000	748	164.56	-51	33.15	**198**
	Optical Sensor-Based	62	8407	155	34.10	-58	37.70	**72**
Site B	Current/Farmer's Std Practice	110	10122					
	Stalk N removal + Soil nitrate	50	10240	118	25.96	-60	39	**65**
	Optical Sensor-Based	65	10109	-13	-2.86	-45	29.25	**26**
Site C	Current/Farmer's Std Practice	110	6300					
	Stalk N removal + Soil nitrate	67	7864	1564	344	-43	27.95	**372**
	Optical Sensor-Based	67	6822	522	115	-43	27.95	**143**

Notes: SRS – LSU AgCenter Sugar Research Station; Raw sugar price - $0.22/lb; Price of N fertilizer - $0.65/lb; Current/Farmer's Standard Practice – reference to compute for economic return.

Table 2. Yield and quality components of cane treated with different sources and rates of N fertilizer.

Treatment	Cane yield, ton/ac	Sugar yield, lbs/ac	TRS, lbs/ton	Brix, %	Sucrose, %
N Rate, lbs/ac					
0	29 c	6999 c	244	19.6	17.0
40	34 b	8606 b	243	19.5	17.0
80	37 ab	9064 ab	245	19.6	17.1
120	39 a	9653 a	245	19.6	17.1
mean	***37***	***9001***	***245***	***19.6***	***17.1***
Pr>F	***0.006***	***0.006***			
Source					
Ammonium nitrate	37	8914 ab	244	19.4	17.0
Coated-urea	34 b	8547 b	247	19.6	17.2
UAN-Dribble	37 ab	9110 ab	244	19.5	17.0
UAN-Knife	40 a	9848 a	244	19.6	17.0
Urea	37 ab	9100 ab	245	19.6	17.1
mean	***37***	***9144***	***245***	***19.6***	***17.1***
Pr>F	***0.2373***	***0.3716***	**-**	**-**	**-**

Values within column with different letters are significantly different based on the Pr>F values given in each variable.

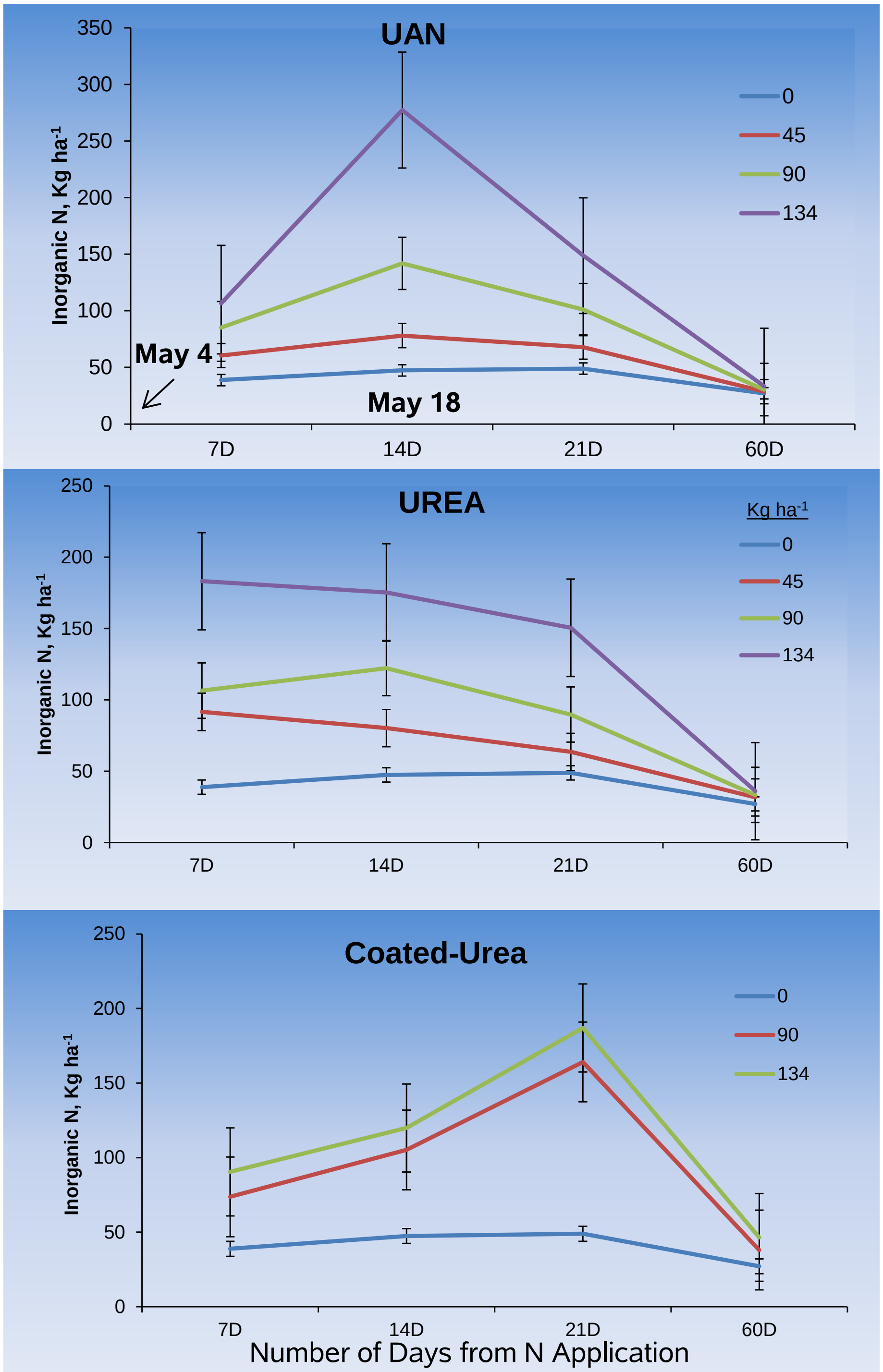

Figure 1. Inorganic N (ammonium and nitrate) content of soil at 0-6 inch depth applied with increasing rates of N as urea-ammonium-nitrate (dribble), urea, and coated urea.

RESEARCH ON SOIL FERTILITY AND CULTURAL MANAGEMENT PRACTICES IN SUGARCANE PRODUCTION

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SUMMARY

Multiple field trials were conducted in 2015 to evaluate cane tonnage and sugar yield responses to different rates and sources of phosphorus and potassium fertilizer, and silicon fertilization rate and timing. Yield and quality parameters of different cane varieties planted using whole stalks and billets were also evaluated. There was no yield response to P fertilization despite of significant increase in soil P level and stalk P uptake. The application of K resulted in significant increases in tonnage, theoretical recoverable sugar (TRS), sucrose, and sugar yield wherein the highest levels were from plots treated with 240 lbs/ac as muriate of potash (MOP). Based on mean separation procedure, the differences among these variables between plots treated with 60 and 240 lbs K/ac were not significant. Nevertheless, the application of 120 lbs K/ac as MOP still brought a positive net return. At the same rate of 120 lbs K/ac, Aspire (a source of K) tended to have the highest sugar yield compared to other sources of K (MOP and MOP+KMg). Annual application of silicate slag at 0.75 ton/ac returned the highest sugar yield. Silicate slag application was effective in raising soil Si and pH; even when applied one time at planting, the elevated level of soil Si and pH was maintained throughout the 3-year cropping cycle (3 harvests). Cane varieties for sugar production (L 01-299 and L 03-371) had higher tonnage, TRS, Brix, sucrose, and sugar yield ($P<0.001$) than the varieties for feedstock production (Ho 02-113, US 72-114, Ho 06-9001, and Ho 06-9002). Among cane varieties for biofuel/energy production, Ho 02-113 is the most promising because of its high yield potential (highest cane tonnage), high TRS, and low lignin content in fiber.

OBJECTIVE

This research was designed to provide information on phosphorus, potassium, and silicon fertilizer management to sugarcane to help growers maximize yields and profitability of sugarcane production. In addition, the performance of different cane varieties in response to planting method (whole stalk vs. billets) was also documented. This annual progress report is presented to provide the latest available data on certain practices and not as final recommendation for growers to use all of these practices.

RESULTS

Sugarcane Yield Response to Different Rate and Source of P Fertilizer

There was no significant effect of P application observed on cane tonnage, quality components, and sugar yield (*P*<0.1; Table 1). Except for S, nutrient composition of stalk was not affected by the treatments (Table 2). This was unexpected because the apparent increased in stalk S content was observed from plots that were treated with MES in 2013 (Table 2). No application was made in 2014 and 2015. This effect was carried and reflected to the total amount of S remove/acre attaining as much as 19.6 lbs/ac, the highest among the treatments (Table 3). Interestingly, the amount of P removed was significantly influenced by P application with the highest removal rate from plots treated with 45 and 65 lbs/ac annually using triple superphosphate (TSP). On these same treatments, evident increase in soil P based on Mehlich-3 procedure was observed which partially explained the significant increase in P uptake (Table 4). Sulfur content of soil was higher in MES and MESZ treated plots than the rest of the treatments; however the differences were not significant.

Sugarcane Yield Response to Different Rate and Source of K Fertilizer

The application of K resulted in significant differences in yield and primary quality components of cane (Table 5). Among the treatments, the application of 240 lbs K/ac as MOP significantly raised cane tonnage and sugar yield by as much as 5.3 tons/ac and 2260 lbs/ac, respectively in reference to check plot. The application of 120 lbs K/ac as Aspire resulted in similar cane and sugar yield as the MOP at 240 lbs K/ac. Among the three sources (MOP, Aspire, MOP+KMg) applied at 120 lbs K/ac, Aspire tended to have the highest sugar yield at 9466 lbs/ac compared to 8976 and 9044 lbs/ac of MOP and MOP+KMg, respectively. With 22 cents per lb of sugar, the application of K using these sources at 120 lbs K/ac resulted in $407, $299, and $314/ac gross income, respectively, using the check plot as reference. The price of K per lb in early 2015 was $1.48 and MOP as source, this translated to about $178 cost of K fertilizer which still brought a positive net return from applying K fertilizer at 120 lbs/ac.

There were significant differences in stalk nutrient content (Table 6). It is important to take note that the higher concentrations of nutrients were recorded for check plot especially for micronutrients. This could be partially explained by dilution effect. Among these nutrients, only the removal rate of K showed a positive relationship with K application rate (Table 7). There were also differences observed on Ca, Mg, S, and Cu content in soil based on Mehlich-3 procedure however, there was no clear pattern as to where the differences came from (source or rate) (Table 8). Soil Zn was markedly higher in plots that were treated with EM2 and EM4 in the previous year whereas soil K was increased with application of at least 120 lbs K/ac.

Effect of Silicon Rate and Time of Application on Sugarcane Yield

This study evaluated different application rates of silicate slag (Plant Tuff®, 12% Si) applied either once at planting, split (at planting and annual spring application), or only in spring (annually). Table 9 shows cane and sugar yield along with TRS and stalk Si uptake. Cane fertilized with 0.75 tons/ac of silicate slag obtained the highest tonnage however this increase was not significant when compared to most of the silicate slag-treated plots. This marginal improvement in cane tonnage did not translate to significant increases in sugar yield adding the lack of improvement in TRS with silicate slag application. While there were significant differences in stalk Si uptake, there was no clear pattern observed with rate and time of silicate slag application.

There was an evident increased in soil Si across rates and time of application of silicate slag; the highest soil Si recorded was from plots treated with the highest total silicate slag applied regardless of application time (Table 10). The amount of Si extracted from soil collected from plots which received 1.0 ton/ac annually (total of 3 tons/ac in 3 years) obtained the highest soil Si (141 mg/kg). The soil Si of plots which received 2 tons/ac in 2012 (before planting) remained elevated at 114 mg Si/kg even after three years of cropping. Similarly, the effect on pH was maintained at higher level compared to control plots. Among the plant-essential nutrients quantified in the soil, Ca was significantly increased ($P<0.1$) (Table 10). Soil S and Zn increased with increasing application rate (total) wherein higher levels were observed on plots which received 1 ton/ac annually. The enhanced level of these plant-essential nutrients was not related to changes in cane tonnage and sugar yield.

Yield and Quality Parameters of Different Varieties of Cane Planted as Whole Stalks and Billets

The treatments consisted of two planting methods (whole stalk vs. billets) and six different cane varieties (Ho 02-113, US 72-114, Ho 06-9001, Ho 06-9002, L01-299, and L03-371) factorial treatment structure arranged in split-plot in a randomized complete block design with four replications. Planting method was assigned as the main plot and variety as the sub-plot. This study was established at two locations at the Sugar Research Station in St. Gabriel, LA; one on a silt loam (2nd ratoon, Table 11) and one on silty clay soil (1st ratoon, Table 12). Based on the analysis of variance, planting method had no effect on both locations whereas variety showed significant influence on all measured variables (Tables 11 and 12). For the 2nd ratoon crop, cane varieties L01-299 and L03-371 obtained the highest tonnage, sucrose, Brix, and TRS whereas varieties Ho 02-113, US 72-114, Ho 06-9001, and Ho 06-9002 attained twice the amount of fiber (19-22.5%) as L01-299 and L03-371 produced. The lignin composition of fiber was highest in US 72-114 and lowest in Ho 06-9002, both cane varieties for feedstock production ($P<0.001$). Similar results were obtained from the 1st ratoon crop wherein cane varieties for sugar production (L01-299 and L03-371) had higher tonnage, TRS, Brix, sucrose, and sugar yield than the varieties for feedstock production (Ho 02-113, US 72-114, Ho 06-9001, and Ho 06-9002). Among the cane varieties for biofuel/energy production, Ho 02-113 is the most promising because of its high yield potential (highest cane tonnage), high TRS, and low lignin content in fiber. Planting method thus far has not shown any effect that would compromise the yield and quality of these cane varieties.

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Table 1. Primary quality components, cane tonnage and sugar yield of variety L01-299 (2^{nd} ratoon) applied with different rates and sources of phosphate, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	Population 1000/ac	Brix %	TRS lbs/ton	Sucrose %	Cane Tonnage ton/ac	Sugar Yield lbs/ac
Check	0	41498	18.33	206	14.89	41.1	8455
TSP	10	51923	18.09	200	14.54	42.6	8514
	20	49735	18.28	197	14.47	41.1	8093
	45	55025	18.30	200	14.62	44.0	8826
	65	44605	18.28	206	14.88	42.4	8726
MAP	0	45573	18.50	204	14.68	41.9	8553
	20	48041	18.31	199	14.58	40.0	8002
MES	0	53167	18.50	203	14.83	42.0	8529
	20	45205	18.49	202	14.76	40.6	8204
MESZ	0	44957	18.71	211	14.74	40.9	8648
	20	50323	18.85	213	15.44	40.7	8674
Treatment effect (P-value)		0.1396	0.8628	0.2743	0.701	0.6923	0.7803

Table 2. Concentrations of select plant essential nutrients in stalk of cane variety L01-299 applied with different rates and sources of phosphate, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	Ca	Mg	P	K	S	Cu	Fe	Mn	Zn
		%					mg/kg			
Check	0	0.0928	0.0812	0.0805	0.3873	0.0642 bc	2.055	29.25	12.87	10.96
TSP	10	0.0855	0.0798	0.0820	0.4082	0.0585 bc	2.022	25.69	12.35	10.52
	20	0.0840	0.0802	0.0768	0.2962	0.0482 c	2.038	18.44	12.13	9.41
	45	0.0885	0.0805	0.0880	0.4243	0.0688 b	1.965	24.85	12.27	10.21
	65	0.0835	0.0748	0.0890	0.3790	0.0595 bc	1.895	23.51	12.61	9.61
MAP	0	0.0795	0.0770	0.0792	0.3270	0.0488 c	2.030	19.24	11.72	9.24
	20	0.0848	0.0790	0.0790	0.3588	0.0608 bc	2.005	22.69	11.47	9.51
MES	0	0.0965	0.0885	0.0815	0.4135	0.0855 a	2.080	20.48	15.89	11.15
	20	0.0810	0.0778	0.0842	0.3652	0.0685 b	1.980	18.68	12.96	10.35
MESZ	0	0.0910	0.0825	0.0768	0.3370	0.0735 ab	1.992	42.37	11.34	9.86
	20	0.0890	0.0838	0.0755	0.2767	0.0580 bc	1.925	23.24	12.85	8.67
Treatment effect (P-value)		0.1958	0.2388	0.4523	0.3950	**0.0275**	0.9536	0.3176	0.7926	0.3635

Table 3. Stalk nutrient uptake of cane variety L01-299 applied with different rates and sources of phosphate, 2015, St. Gabriel, LA.

Source	**Rate lbs/ac**	**Ca**	**Mg**	**P**	**K**	**S**	**Cu**	**Fe**	**Mn**	**Zn**
		lbs/acre								
Check	0	21.52	18.83	18.61 bcd	90.4	14.7 bcd	0.0476	6.90	2.96	2.553
TSP	10	20.18	18.73	19.23 abc	95.8	13.8 bcd	0.0475	6.09	2.89	2.468
	20	19.04	18.19	17.44 cd	67.0	11.02 d	0.0462	4.20	2.74	2.130
	45	21.52	19.64	21.51 a	103.2	16.55 abc	0.0479	6.21	2.99	2.496
	65	19.65	17.56	20.73 ab	88.2	14.04 bcd	0.0445	5.52	2.95	2.245
MAP	0	18.61	18.01	18.42 bcd	75.6	11.24 d	0.0476	4.51	2.76	2.154
	20	19.00	17.67	17.52 cd	79.9	13.48 bcd	0.0447	5.17	2.50	2.121
MES	0	22.15	20.23	18.74 bcd	95.6	19.63 a	0.0479	4.75	3.67	2.577
	20	18.35	17.71	19.06 bcd	82.3	15.60 bc	0.0448	4.24	2.93	2.335
MESZ	0	20.91	18.89	17.74 cd	77.4	16.93 ab	0.0456	10.39	2.62	2.243
	20	20.20	18.96	16.84 d	59.3	12.86 cd	0.0433	5.29	2.81	1.923
Treatment effect (P-value)		0.3714	0.6763	**0.0666**	0.1263	**0.0234**	0.8906	0.3928	0.6118	0.1158

Values followed by different letters within a column are significantly different at 0.10 level of confidence.

Table 4. Soil pH and Mehlich-3 extractable nutrients of soil samples collected post-harvest, 2015, St. Gabriel, LA.

Source	**Rate lbs/ac**	**pH**	**Mehlich-3 Extractable Nutrients, mg/kg**						
			P	**K**	**Ca**	**Mg**	**S**	**Zn**	**Cu**
Check	0	5.57	20.09 d	118	1501	332	8.140	1.894	1.909
TSP	10	5.62	29.02 cd	117	1514	344	8.479	1.994	1.890
	20	5.62	30.64 cd	109	1429	316	8.321	1.938	1.814
	45	5.45	55.19 b	146	1780	385	9.134	2.290	2.34
	65	5.45	73.00 a	145	1691	371	8.880	2.276	2.294
MAP	0	5.57	35.04 cd	117	1596	335	8.683	3.114	1.986
	20	5.79	29.54 cd	137	1714	395	8.612	2.168	2.397
MES	0	5.26	37.87 c	131	1605	352	9.406	2.303	2.160
	20	5.24	35.57 cd	124	1456	328	9.156	1.885	2.004
MESZ	0	5.35	35.08 cd	132	1620	356	9.411	2.765	2.438
	20	5.35	29.14 cd	134	1416	287	9.405	1.999	1.692
Treatment effect (P-value)		0.7969	**0.0004**	0.8728	0.3323	0.2888	0.8122	0.5160	0.1441

Values followed by different letters within a column are significantly different at 0.001 level of confidence.

Table 5. Primary quality components, cane tonnage and sugar yield of variety L01-299 (2nd ratoon) applied with different rates and sources of potash, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	Population count/ac	Brix %	TRS lbs/ton	Sucrose %	Cane Tonnage ton/ac	Sugar Yield lbs/ac
Check	0	49759	18.00 c	203 d	14.7 d	37.2 c	7617 d
MOP	30	46535	19.25 ab	219 bc	15.8 abc	42.0 ab	9261 abc
	60	46152	18.75 b	222 abc	15.8 abc	39.5 bc	8774 bc
	120	39857	19.25 ab	223 ab	16.0 ab	40.2 ab	8976 bc
	180	56767	19.00 ab	223 ab	15.9 abc	41.8 ab	9336 abc
	240	50507	19.25 ab	231 a	16.4 a	42.5 a	9877 a
Aspire	120	43492	19.25 ab	224 ab	16.0 ab	42.2 a	9466 ab
EM2	0	42536	18.75 b	218 bc	15.6 bc	40.2 ab	8768 c
EM4	0	47854	18.75 b	212 cd	15.2 cd	42.2 a	8916 bc
MOP+KMg	120	41589	19.50 a	223 ab	16.0 ab	40.2 ab	9044 bc
Treatment effect (P-value)		0.5936	**0.0457**	**0.0219**	**0.0308**	**0.0463**	**0.0017**

Values followed by different letters within a column are significantly different at 0.05 level of confidence.

Table 6. Concentrations of select plant essential nutrients in stalk of cane variety L01-299 applied with different rates and sources of potash, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	Ca	Mg	P	K	S	Cu	Fe	Mn	Zn
		%					mg/kg			
Check	0	0.1029 a	0.0832	0.0821	0.475 abc	0.1036 ab	2.010 ab	30.4	9.321	12.85 a
MOP	30	0.0805 bcd	0.0764	0.0736	0.347 d	0.0392 d	2.046 a	25.7	10.344	10.14 c
	60	0.0744 cd	0.0681	0.0699	0.435 cd	0.0593 cd	1.736 c	35.7	8.071	9.41 c
	120	0.0807 bcd	0.0721	0.0768	0.459 bc	0.0649 cd	1.882 abc	31.3	9.475	10.74 bc
	180	0.0740 cd	0.0676	0.0739	0.546 ab	0.0650 cd	1.756 bc	44.8	8.652	9.99 c
	240	0.0712 d	0.0649	0.0781	0.565 a	0.0631 cd	1.729 c	56.1	9.394	9.52 c
Aspire	120	0.0793 bcd	0.0719	0.0758	0.470 abc	0.0662 cd	1.950 abc	26.0	9.911	9.85 c
EM2	0	0.0852 bc	0.0778	0.0798	0.449 bc	0.0751 bc	2.019 a	26.3	9.771	10.97 abc
EM4	0	0.0916 ab	0.0792	0.0814	0.495 abc	0.0738 c	2.143 a	26.1	12.485	12.30 ab
MOP+KMg	120	0.0781 cd	0.0768	0.0750	0.438 cd	0.1075 a	1.719 c	25.7	10.350	10.01 c
Treatment effect (P-value)		**0.0153**	**0.0093**	0.6072	**0.0681**	**0.0175**	**0.0727**	0.8239	0.6892	**0.0583**

Values followed by different letters within a column are significantly different at 0.05 level of confidence.

Table 7. Stalk nutrient uptake of cane variety L01-299 at different rates and sources of potash, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	Ca	Mg	P	K	S	Cu	Fe	Mn	Zn
		lbs/ac								
Check	0	20.7 ab	16.90 cde	16.72	96.3 cd	20.91 ab	0.0405	0.622	0.185	0.258 ab
MOP	30	19.3 abc	18.36 ab	17.58	82.2 d	9.22 d	0.0498	0.622	0.252	0.248 bc
	60	16.8 d	15.36 f	15.65	98.3 cd	13.44 cd	0.0390	0.795	0.180	0.212 c
	120	18.4 bcd	16.58 cdef	17.60	104.9 c	15.01 bcd	0.0432	0.720	0.218	0.248 bc
	180	17.5 cd	16.03 def	17.35	127.6 ab	15.33 bcd	0.0415	1.075	0.200	0.235 bc
	240	17.2 cd	15.77 ef	18.82	136.1 a	15.08 bcd	0.0420	1.342	0.230	0.230 bc
Aspire	120	18.9 bcd	17.26 bcd	18.12	112.2 bc	15.74 bc	0.0470	0.615	0.240	0.238 bc
EM2	0	19.3 abc	17.67 abc	17.88	101.4 cd	17.11 bc	0.0460	0.592	0.215	0.248 bc
EM4	0	21.4 a	18.66 a	19.00	115.3 bc	17.19 bc	0.0508	0.615	0.292	0.290 a
MOP+KMg	120	18.2 cd	17.89 abc	17.28	100.9 cd	24.98 a	0.0402	0.598	0.240	0.232 bc
Treatment effect (P-value)		**0.0495**	**0.0023**	0.2619	**0.0036**	**0.0306**	**0.0144**	0.7850	0.3514	0.1088

Values followed by different letters within a column are significantly different at 0.05 level of confidence.

Table 8. Soil pH and Mehlich-3 extractable nutrients of soil samples collected post-harvest, 2015, St. Gabriel, LA.

Source	Rate lbs/ac	pH	Mehlich-3 Extractable Nutrients, mg/kg						
			P	K	Ca	Mg	S	Zn	Cu
Check	0	5.8	18.03	87 e	1457 bc	308 cd	3.00 abc	1.74 c	2.24 bc
MOP	30	5.3	15.23	99 cde	1606 ab	340 abc	2.37 bcd	1.69 c	2.36 ab
	60	6.2	13.80	95 de	1706 a	364 a	1.67 cd	1.70 c	2.40 ab
	120	5.6	13.06	105 bcd	1480 bc	312 cd	2.40 bcd	1.68 c	2.31 bc
	180	5.9	9.86	123 ab	1580 ab	355 ab	1.19 d	1.67 c	2.39 ab
	240	5.5	13.07	127 a	1359 c	285 d	2.18 bcd	1.56 c	1.99 c
Aspire	120	5.4	20.95	114 abc	1422 c	284 d	3.12 abc	1.75 c	2.14 bc
EM2	0	5.6	13.70	99 cde	1475 bc	321 bcd	2.49 bcd	2.61 b	2.18 bc
EM4	0	5.4	19.38	115 abc	1641 a	344 abc	3.18 ab	2.95 a	2.64 a
MOP+KMg	120	5.4	15.78	103 cde	1376 c	327 abc	4.38 a	1.64 c	2.10 bc
Treatment effect (P-value)		0.5523	0.3626	**0.0165**	**0.0074**	**0.0214**	**0.0620**	**<0.001**	**0.0976**

Values followed by different letters within a column are significantly different at 0.10 level of confidence.

Table 9. Effect of rate and time of silicate slag application on cane yield, theoretical recoverable sugar, sugar yield, and stalk Si uptake of second ratoon cane variety L01-299, 2015, St. Gabriel, LA.

At Planting	Annual Spring	Total	Cane Tonnage	TRS	Sugar Yield	Si Uptake
-----------------ton/ac--------------------------			ton/ac	lbs/ton	lbs/ac	lbs/ac
0	0	0	38 ab	218 a	8306 a	85 cd
2	0	2.00	39 ab	206 a	8044 a	93 abc
1	0.5	2.50	38 ab	204 a	7729 a	97 ab
0.5	0.25	1.25	37 b	218 a	8059 a	80 d
0	0.25	0.75	40 ab	214 a	8467 a	90 abcd
0	0.5	1.50	38 ab	207 a	7868 a	86 bcd
0	0.75	2.25	41 a	205 a	8470 a	99 a
0	1	3.00	39 ab	203 a	7899 a	90 abcd

Values followed by different letters within a column are significantly different at 0.10 level of confidence.

Table 10. Effect of rate and time of silicate slag application on pH, Si content, and Mehlich-3 extractable nutrients of soils collected after the second ratoon cane variety L01-299, 2015, St. Gabriel, LA.

At Planting	Annual Spring	Total	pH	Si	P	K	Ca	Mg	S	Zn	Cu
-----------------ton/ac-------------------------				---mg/kg-----------------------------------							
0	0	0	5.78bc	61c	23.8ab	118a	1580b	319a	4.96b	2.06b	2.09a
2	0	2.00	6.62a	114ab	23.6ab	116a	1885ab	350a	5.38b	2.35b	2.22a
1	0.5	2.50	6.42a	107ab	24.7ab	117a	1844ab	349a	5.67ab	2.06b	2.03a
0.5	0.25	1.25	6.36ab	84bc	21.8ab	114a	1730ab	338a	4.63b	1.98b	2.08a
0	0.25	0.75	5.68c	77bc	28.9a	124a	1713b	331a	5.38b	1.93b	2.18a
0	0.5	1.50	6.25abc	101abc	20.5b	116a	1707b	337a	5.06b	2.14b	1.98a
0	0.75	2.25	6.19abc	110ab	25.1ab	111a	1739ab	333a	5.58ab	2.24b	1.95a
0	1	3.00	6.56a	141a	29.7ab	121a	2064a	389a	7.04a	3.33a	2.20a

Values followed by different letters within a column are significantly different at 0.10 level of confidence.

Table 11. Effect of planting method on yield and primary components of different cane varieties, 2nd ratoon, 2015, St. Gabriel, LA.

Variety	Tonnage ton/ac	TRS lbs/ton	Brix %	Fiber %	Sucrose %	Lignin %	Sugar lbs/ac
Ho 02-113	28.8 b	164 b	16.2 b	19.0 c	12.3 b	19.8 b	4828 b
US 72-114	23.1 c	119 d	14.4 d	20.6 bc	9.7 d	20.7 a	2842 c
Ho 06-9001	19.9 c	140 c	15.6 c	21.9 ab	11.0 c	18.6 cd	2861 c
Ho 06-9002	18.0 c	137 c	15.5 c	22.5 a	10.9 c	18.2 d	2400 c
L 01-299	37.0 a	207 a	17.9 a	11.8 d	14.8 a	18.8 c	7684 a
L 03-371	40.0 a	213 a	18. a	10.2 d	15.2 a	19.1 c	8560 a
Analysis of variance							
Planting method (P)	NS	NS	NS	NS	NS	NS	NS
Varieties (V)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P x V	NS	NS	NS	NS	NS	NS	NS

Values followed by different letters within a column are significantly different at 0.001 level of confidence.

Table 12. Effect of planting method on yield and primary components of different cane varieties, 1st ratoon, 2015, St. Gabriel, LA.

Variety	Tonnage ton/ac	TRS lbs/ton	Brix %	Fiber %	Sucrose %	Sugar lbs/ac
Ho 02-113	23.3 b	203 b	18.1 c	20.5 b	14.7 b	4742 b
US 72-114	22.6 b	180 d	16.9 d	20.6 b	13.3 c	4056 c
Ho 06-9001	19.7 c	200 bc	17.8 c	23.6 a	14.5 b	3942 c
Ho 06-9002	19.3 c	194 c	17.8 c	24.0 a	14.2 b	3733 c
L 01-299	29.4 a	260 a	21.1 b	13.2 c	18.2 a	7646 a
L 03-371	28.4 a	268 a	21.6 a	10.0 d	18.8 a	7633 a
Analysis of variance						
Planting method (P)	NS	NS	NS	NS	NS	NS
Varieties (V)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P x V	NS	NS	NS	NS	NS	NS

Values followed by different letters within a column are significantly different at 0.001 level of confidence.

THE EFFECT OF SULFUR FERTILIZER ON SUGAR YIELD

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Two sulfur fertilizer trials were conducted at Blackberry Farms, LLC in Vacherie, LA, and one sulfur fertilizer trial was conducted in Kaplan, LA in 2015. At the Vacherie site, one test was with a first stubble crop of L 01-283 on Sharkey clay; the second site was with a second stubble crop of HoCP 96-540 on a Commerce silt loam. For the test at Kaplan, the test was with a first stubble crop of HoCP 04-838 on a Crowley silt loam. The Kaplan site included a third treatment of Cobalt. Prior to conducting the trials, the soil was sampled at each site. Two treatments were included: 1) 22 lbs S/acre, and 2) Control (no S fertilizer). The fertilizer source was 32% UAN and ammonium thiosulfate mixture 28-0-0-5 (N-P_2O_5-K_2O-S). The N rate was 120 lbs N/acre. Fertilizer was applied by tractor with a 5-row off-bar cultivator and injected into the furrow created by the off-bar. Application date was April 2, 2015 at Vacherie and May 11, 2015 at Kaplan. Each plot was 150 feet long and consisted of 5 rows – only the center three rows were harvested for the trial. The trial was replicated four times at Vacherie and six times at Kaplan.

Standard cultural practices were followed during the 2015 growing season. Leaf tissues were analyzed for nutrient content (Tables 4 & 5) and sampling was done in July. A total of 20 leaves were sampled from each plot and the leaf selected was from the second top visible dewlap. The soil was sampled from each plot after harvest was completed (Tables 4 & 5).

The two field trials in Vacherie was harvested on October 20, 2015; the Kaplan trial was harvested on November 6, 2015. Plots were combine-harvested and weighed to determine cane yield (tons/acre). A 10-stalk sample was hand-cut out of each plot for a quality analysis. Each sample was then sent to the laboratory to determine Brix by refractometer and pol (Zº) by saccharimeter (Gravois and Milligan, 1992).

Data were analyzed with SAS (v 9.4) software. Replication was considered a random effect; treatment was considered a fixed effect. Least square means were estimated and tested for statistical significance (P=0.05) with the Student’s t test using the PDIFF option of PROC MIXED.

Gravois, K.A. and S.B. Milligan. 1992. Genetic relationships between fiber and sugarcane yield components. Crop Sci. 32:62-67.

Table 1. First stubble data obtained on sugarcane variety L 01-283 from a sulfur field trial conducted at Blackberry Farms in Vacherie, LA during 2015. The soil type was a Sharkey clay.

Treatment	Sugar Yield		Cane Yield		TRS	
	lbs/ac		Tons/ac		lbs/ton	
No Sulfur	6805	A	27.5	A	247	B
22 lbs S/acre	5724	B	22.3	B	257	A
Pr>F	0.011		0.009		0.006	

Table 2. Second stubble data obtained on sugarcane variety HoCP 96-540 from a sulfur field trial conducted at Blackberry Farms in Vacherie, LA during 2015. The soil type was a Commerce silt loam.

Treatment	Sugar Yield		Cane Yield		TRS	
	lbs/ac		Tons/ac		lbs/ton	
No Sulfur	8720	B	37.7	A	232	A
22 lbs S/acre	9309	A	38.3	A	243	A
Pr>F	0.006		0.335		0.148	

Table 3. First stubble data obtained on sugarcane variety HoCP 04-838 from a field trial conducted at Joe Denais Farm in Kaplan, LA during 2015. Soil type was a Crowley silt loam.

Treatment	Sugar Yield		Cane Yield		TRS	
	lbs/ac		Tons/ac		lbs/ton	
No Sulfur	10444	AB	36.2	AB	289	A
22 lbs S/acre	11064	A	38.1	A	290	A
Cobalt	9672	B	33.6	B	287	A
Pr>F	0.022		0.012		0.766	

Table 4. Soil test and leaf tissue analyses for the silt loam (HoCP 96-540) and clay (L01-283) test sites at Vacherie. Brown headings are soil test values and green headings are leaf tissue values.

Soil			pH	PSoil	KSoil	CaSoil	MgSoil	SSoil	CuSoil	ZnSoil	NaSoil	NLf	PLf	KLf	SLf	CaLf	MgLf	BLf	CuLf	MnLf	MoLf	ZnLf
Type	Treatment	Rep		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Silt loam	21.5 S	1	7.09	19.47	155.9	2113	243.6	0.85	3.01	2.50	41.84	1.79	0.24	1.20	0.16	0.22	0.20	4.96	7.37	51.53	2.05	24.35
Silt loam	21.5 S	2	6.65	19.15	158.0	2118	292.4	4.04	3.24	1.62	15.33	1.77	0.23	1.29	0.15	0.17	0.18	2.74	6.38	47.62	1.57	22.54
Silt loam	0 S	1	7.32	19.94	215.7	2416	234.6	3.88	3.90	2.40	19.95	2.05	0.24	1.10	0.13	0.25	0.18	4.05	7.07	42.09	5.73	22.56
Silt loam	0 S	2	6.95	14.22	170.4	1867	230.2	4.36	3.28	1.66	10.40	1.79	0.24	1.28	0.12	0.21	0.18	3.68	6.81	50.19	4.48	22.78
Silt loam	21.5 S	3	7.38	12.76	175.7	1859	177.9	3.95	2.61	1.78	7.46	1.53	0.24	1.35	0.15	0.17	0.18	3.73	6.24	43.43	2.14	20.92
Silt loam	21.5 S	4	6.74	11.87	168.2	1537	193.2	3.34	2.46	1.32	11.41	1.45	0.22	1.26	0.13	0.16	0.16	3.44	5.69	44.76	1.41	19.92
Silt loam	0 S	3	7.04	14.03	185.1	1981	181.8	4.23	2.75	1.60	13.97	2.17	0.25	0.97	0.14	0.29	0.21	4.78	8.42	39.18	6.27	24.68
Silt loam	0 S	4	7.13	45.67	215.4	1372	164.1	10.00	1.96	1.31	34.46	1.51	0.22	1.32	0.10	0.15	0.16	2.89	5.74	43.15	4.17	20.34
Clay	0 S	1	6.42	32.73	279.3	3084	649.4	2.92	6.27	2.80	20.96	1.67	0.27	1.66	0.10	0.19	0.18	10.22	5.58	96.75	3.31	22.08
Clay	0 S	2	6.53	63.99	282.2	3704	793.8	2.30	7.14	3.18	25.57	1.60	0.27	1.94	0.11	0.16	0.17	7.80	5.68	107.02	2.81	22.95
Clay	0 S	3	6.48	48.36	280.8	3394	721.6	2.61	6.71	2.99	23.27	1.82	0.25	1.41	0.10	0.18	0.18	8.71	5.48	96.88	3.02	20.71
Clay	21.5 S	1	6.52	35.64	270.3	3597	727.6	2.50	7.27	3.68	26.47	1.46	0.22	1.52	0.14	0.17	0.16	8.84	4.51	81.70	1.88	18.85
Clay	21.5 S	2	6.47	36.61	306.5	4014	807.4	3.86	7.07	3.30	25.52	1.56	0.24	1.59	0.15	0.18	0.18	9.54	5.08	85.61	1.73	18.60
Clay	21.5 S	3	6.50	36.13	288.4	3806	767.5	3.18	7.17	3.49	25.99	1.40	0.25	2.02	0.16	0.17	0.17	8.62	4.90	103.26	1.74	18.41

Table 5. Soil test and leaf tissue analyses for the Crowley silt loam (HoCP 04-838) test site at Kaplan. Brown headings are soil test values and green headings are leaf tissue values.

Treatment	Plot	Rep	pH	P, ppm	K, ppm	Ca, ppm	Mg, ppm	Na, ppm	S, ppm	Cu, ppm	Zn, ppm	N, %	P, %	K, %	S, ppm	Ca, ppm	Mg, ppm	Cu, ppm	Zn, ppm
120 N Cobalt	101	1	8.18	6.81	71.06	1710.33	464.79	208.34	22.47	2.35	2.23	1.37	0.16	1.33	0.15	0.13	0.20	4.70	26.09
120 N Cobalt	102	2	8.18	6.81	71.06	1710.33	464.79	208.34	22.47	2.35	2.23	1.49	0.18	1.03	0.17	0.17	0.31	5.30	33.82
120 N Cobalt	103	3	8.18	6.81	71.06	1710.33	464.79	208.34	22.47	2.35	2.23	1.39	0.16	0.92	0.18	0.17	0.31	5.30	33.13
120 N Cobalt	104	4	7.90	3.59	70.38	1603.37	496.87	181.87	22.84	2.02	1.38	1.20	0.10	1.10	0.17	0.13	0.21	4.44	31.30
120 N Cobalt	105	5	7.90	3.59	70.38	1603.37	496.87	181.87	22.84	2.02	1.38	1.52	0.13	1.13	0.18	0.16	0.20	5.35	26.70
120 N Cobalt	106	6	7.90	3.59	70.38	1603.37	496.87	181.87	22.84	2.02	1.38	1.37	0.09	0.95	0.17	0.24	0.15	4.19	20.66
120-0-0-0	201	1	7.81	6.45	86.17	2022.29	455.76	178.40	27.33	3.01	2.74	1.22	0.14	1.05	0.15	0.26	0.22	4.47	22.44
120-0-0-0	202	2	7.81	6.45	86.17	2022.29	455.76	178.40	27.33	3.01	2.74	1.31	0.16	1.07	0.18	0.25	0.24	4.96	25.11
120-0-0-0	203	3	7.81	6.45	86.17	2022.29	455.76	178.40	27.33	3.01	2.74	1.63	0.17	0.84	0.19	0.35	0.31	5.46	28.99
120-0-0-0	204	4	7.69	3.68	65.04	1450.68	384.31	134.70	21.70	1.83	1.30	1.13	0.09	1.00	0.16	0.21	0.18	3.97	21.78
120-0-0-0	205	5	7.69	3.68	65.04	1450.68	384.31	134.70	21.70	1.83	1.30	1.11	0.08	1.10	0.17	0.20	0.16	4.11	20.79
120-0-0-0	206	6	7.69	3.68	65.04	1450.68	384.31	134.70	21.70	1.83	1.30	1.60	0.11	1.05	0.18	0.27	0.16	5.02	22.62
120-0-0-21.5	301	1	7.81	12.48	71.18	2030.11	398.01	75.84	26.14	2.32	2.31	1.37	0.19	1.08	0.18	0.33	0.20	4.39	19.71
120-0-0-21.5	302	2	7.81	12.48	71.18	2030.11	398.01	75.84	26.14	2.32	2.31	1.11	0.18	1.10	0.22	0.28	0.24	3.93	20.79
120-0-0-21.5	303	3	7.81	12.48	71.18	2030.11	398.01	75.84	26.14	2.32	2.31	1.03	0.16	0.98	0.20	0.24	0.24	4.19	21.57
120-0-0-21.5	304	4	7.86	3.11	59.05	1540.37	375.47	112.19	20.40	1.87	1.29	1.15	0.15	1.00	0.19	0.27	0.22	4.03	18.55
120-0-0-21.5	305	5	7.86	3.11	59.05	1540.37	375.47	112.19	20.40	1.87	1.29	1.04	0.14	1.07	0.17	0.25	0.24	3.69	16.85
120-0-0-21.5	306	6	7.86	3.11	59.05	1540.37	375.47	112.19	20.40	1.87	1.29	1.21	0.16	1.12	0.20	0.32	0.22	4.33	19.30