RESEARCH ON SOIL FERTILITY IN SUGARCANE PRODUTION

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Summary

Field trials were conducted in 2023 to evaluate cane and sugar yield response to different sulfur (S) rates and source, potassium (K)-based starter and spring fertilization, and (inter) cover cropping. For the S study, the treatments included three sources (K-thiosulfate [0-0-25-16 S], ammonium (NH_4) thiosulfate [12-0-0-26 S], and elemental sulfur [90% S] pellets) applied at 0, 20, 40, and 60 lbs/acre. For the K study, the treatments included two rates (15 and 30 lbs/ac) of K starter, applied in fall 2020, with spring K application using MOP (80 lbs/acre) and Nachurs® high K additives as sources. The contribution of (inter) cover cropping, drilled-seeded and broadcast planted, at 25%, 50%, and 100% seeding rate based on Natural Resources Conservation Service (NRCS) recommendation on sugarcane productivity and nutrient cycling was also evaluated. Cane tonnage and sugar yield were optimized with 20 lbs S/acre application using elemental S and NH_4-thiosulfate but was further increased to 37 tons/acre and 8900 lbs/acre, respectively with 60 lbs S/acre application using K-thiosulfate. Only cane tonnage responded to K fertilizer and additives application. The limited response may be partly due to extreme heat and drought stress in summer 2023. Cover cropping had no impact on sugarcane productivity and nutrient buildup in the soil. While it expected that cover cropping requires long-term implementation for the benefits to take effect, the semi-perennial nature of sugarcane limits the planting of cover crops annually as opposed to summer crops and for this reason, the benefits from cover cropping may take longer to attain in sugarcane production systems.

Objective

This research was designed to evaluate the effect of K and S on sugarcane yield and quality components with factors including rate, sources, and application timing. In addition, multiple field trials were established to document the impact of cover crop planting rate and method on nutrient turnover and sugarcane productivity. This annual progress report is presented to provide the latest available data on certain nutrient management practices and not as a final recommendation for growers to use.

Results

Sugarcane Response to Different Sulfur Sources and Rates

The cane tonnage and sugar yield across S source x rate combinations were significantly different ($p<0.10$; Figures 1 and 2). The highest cane tonnage was 37 tons/acre from sugarcane treated with 60 lbs S/acre as K-thiosulfate; this however was not significantly different from the tonnage of sugarcane treated with 20-60 lbs/acre as elemental S and NH_4-thiosulfate (Figure 1). Similar pattern of response was observed for sugar yield (Figure 2). The K contribution from K-thiosulfate application was accounted and corrected by applying K as muriate of potash (0-0-60) at corresponding rates to all plots to match the highest K rate added to soil as K-thiosulfate. In another trial, while the addition of 25 lbs S/acre significantly increased soil S content, the increased in cane and sugar yield was not statistically significant (p<0.10; Figure 3). Also, the sugarcane treated with S tended to have higher stalk S content and removal rate. The untreated plot had 14.7 mg S/kg in the soil; this soil test value is above the critical S level (10 mg/kg). The application of 25 lbs/acre raised soil S to 30.1 mg.kg but appeared to be not enough to bring significant increase in S uptake and subsequent yield. Considering the mobile nature of S in the soil and S response trials in the past years, there is a need to revisit the current S fertilization guidelines. The results in the past years, just like in 2023, demonstrate that higher than 25 lbs/acre application rate can extend the productivity of sugarcane.

Effect of Potassium Starter and Spring Fertilization

Cane tonnage was significantly affected by the treatments (Table 1). This difference was mainly between the check and the treated plots with the exception of the plot under Treatment 4. The sugarcane planted with K-starter at the rate of 30 lbs/ac had lower sugar yield than those which received 15 lbs K/acre. There were no significant differences in TRS, %Brix, %sucrose, and stalk K content between treatments. The potential benefit from K fertilizer and additives application may have been limited by the extreme heat and lack of moisture stress in summer 2023 bringing only minimal and not significant increases in K uptake and sugar yield.

Cover Cropping Impact on Sugarcane Productivity and Nutrient Cycling

The planting method nor the seeding rate had no significant effect on cover crops biomass production (data not shown), perhaps explaining the lack of sugarcane yield response and soil nutrient buildup (Table 2). Cover crops were intercropped with the newly planted cane crop in 2021 and terminated in early spring 2022. Cover cropping requires long-term implementation for the benefits to take effect specifically in nutrient cycling and organic matter accumulation. The semi-perennial nature of sugarcane limits the planting of cover crops annually as opposed to summer crops and for this reason, the benefits from cover cropping may take longer to attain in sugarcane production systems.

Acknowledgement

The authors wish to express appreciation for the financial support of American Sugar Cane League and Nachurs.

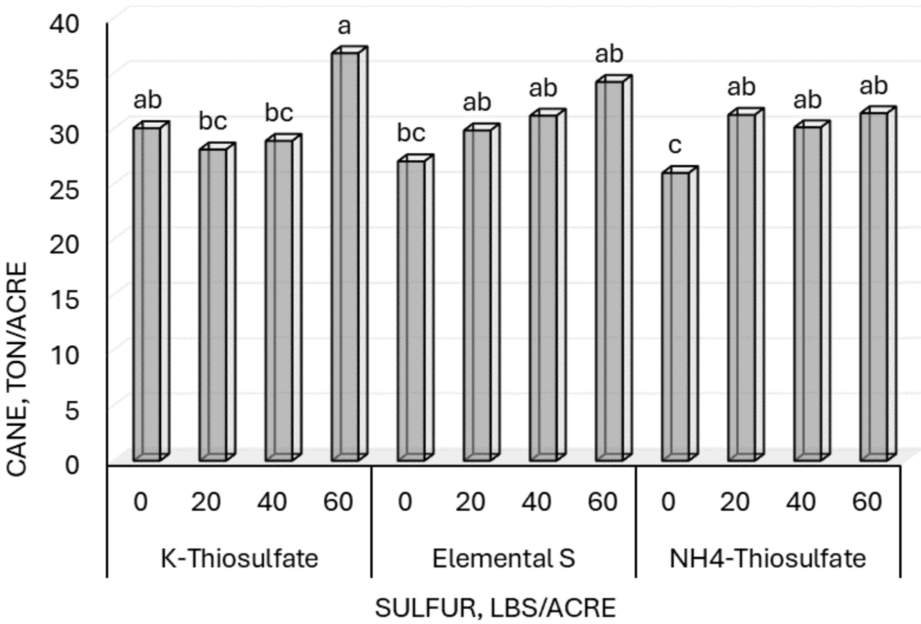

Figure 1. Cane tonnage of L01-299 fourth ratoon in response to sulfur source and rate, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023. Bars with the same lower-case letters are not significantly different at $p<0.10$.

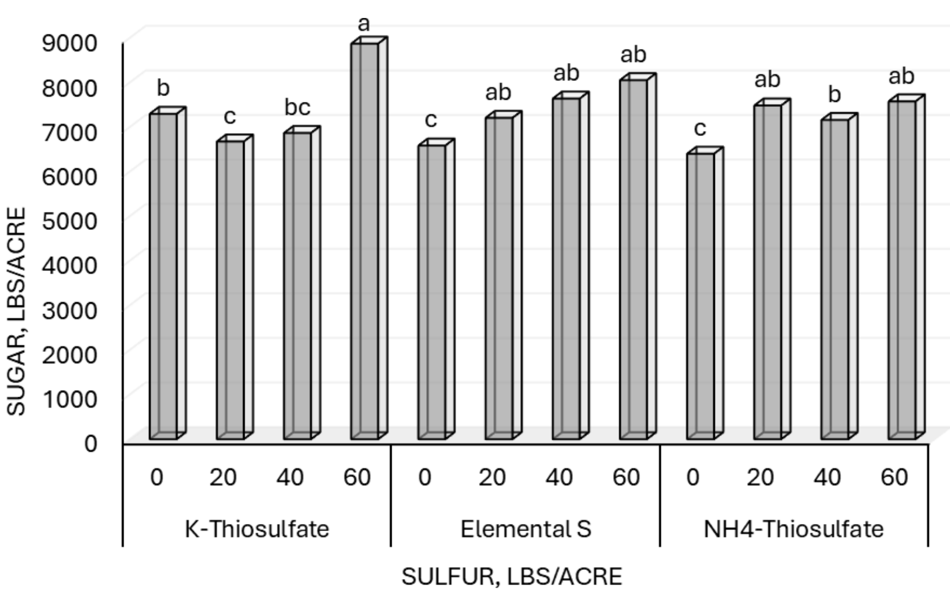

Figure 2. Sugar yield of L01-299 fourth ratoon in response to sulfur source and rate, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023. Bars with the same lower-case letters are not significantly different at $p<0.10$.

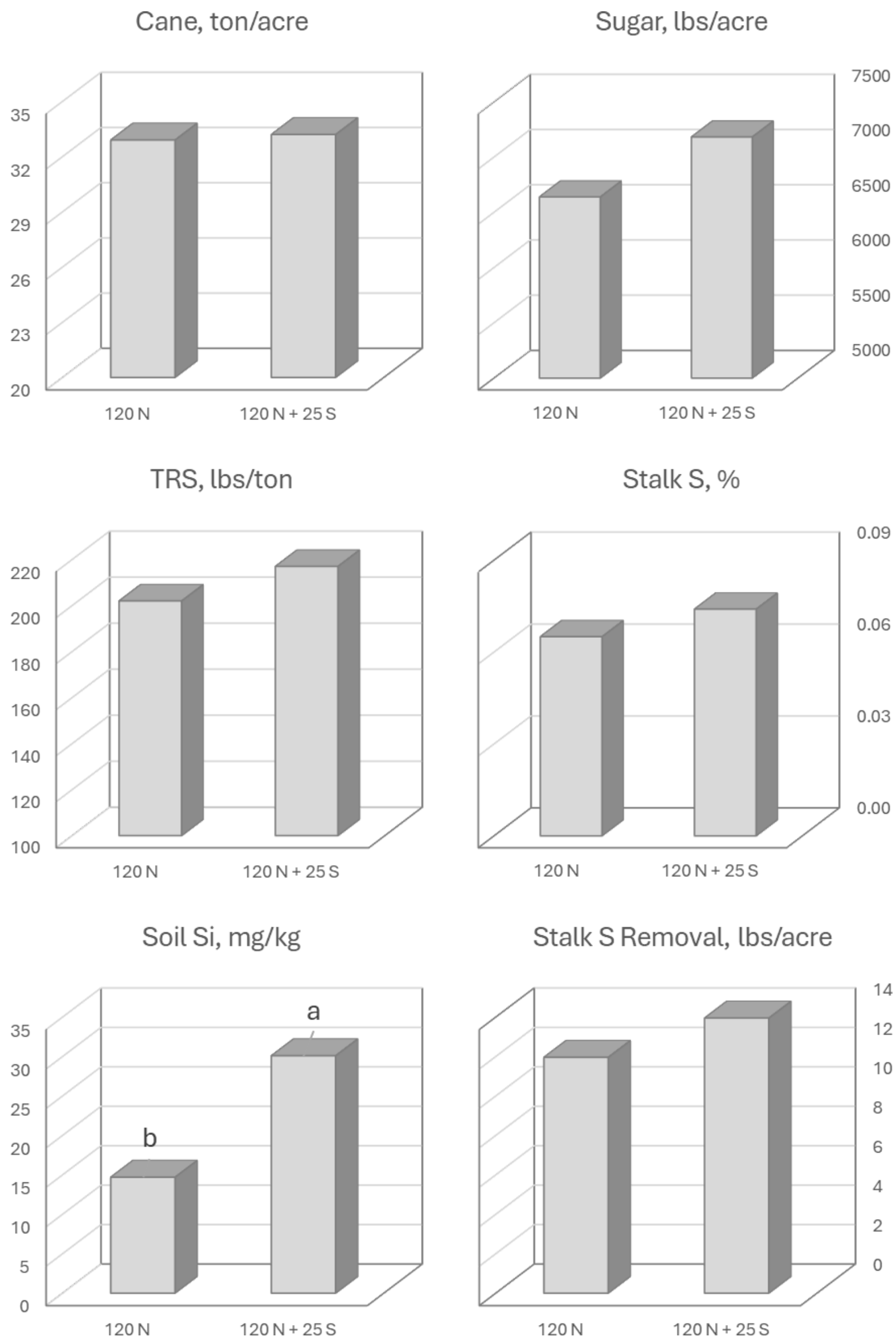

Figure 3. Yield, theoretical recoverable sugar, stalk S content and removal rate, and soil S with and without sulfur fertilizer, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023. 120 N = 120 lbs N/acre; 25 S = 25 lbs S/acre.

Table 1. Yield, theoretical recoverable sugar, and stalk K content and removal rate of L01-299 second ratoon in response to starter and spring K fertilizer treatments, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

Trt	K Rate, lbs/acre		Cane	Sugar yield	TRS	% Brix	%Sucrose	% Stalk K
	2020 Starter	Spring	ton/acre	lbs/acre	lbs/ton			
Control	0	0	33.7 b	7760	231	18.6	16.2	0.498
Farmer's Std	0	80	37.1 a	8240	226	18.1	15.6	0.512
1	15	Nachurs K-Additives 1	36.9 a	8559	232	18.9	16.3	0.482
2	15	Nachurs K-Additives 2	36.6 a	8646	236	18.9	16.5	0.464
3	15	80	34.6 ab	8094	234	19.2	16.5	0.496
4	30	Nachurs K-Additives 1	33.6 b	7803	233	18.6	16.3	0.526
5	30	Nachurs K-Additives 2	36.7 a	8545	234	18.9	16.4	0.482
6	30	80	34.9 ab	8191	235	18.6	16.4	0.492
		p<value	*	NS	NS	NS	NS	NS

*Significant at $p<0.10$; NS – not significant at $p<0.10$. TRS – theoretical recoverable sugar

Table 2. Effect of cover crop seeding rate and planting method on sugarcane yield and soil nutrient content averaged at three locations, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

Factor	Cane	Sugar	TRS	Soil N	Mehlich-3 Extracted Soil Nutrients, mg/kg						
	ton/acre	lbs/acre	lbs/ton	lbs/acre	Calcium	Copper	Magnesium	Phosphorus	Potassium	Sulfur	Zinc
Planting Method											
Broadcast	36.8	8189	221	16.8	1931	2.44	407	22.2	172	11.6	2.75
Drilled	36.4	8099	220	18.1	1930	2.62	410	22.0	171	11.6	2.88
p<value	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Seeding Rate, %											
0	36.4	8171	222	19.3	2041	2.55	432	21.9	182	11.9	2.96
25%	37.2	8073	216	16.7	1854	2.46	400	22.6	170	11.6	2.73
50%	36.4	8109	220	15.7	1917	2.60	401	21.9	169	11.6	2.87
100%	36.4	8222	224	18.1	1914	2.53	400	22.0	164	11.3	2.71
p<value	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

TRS – theoretical recoverable sugar, NS – not significant at $p<0.10$.
Soil N – plant available nitrogen

NITROGEN MANAGEMENT RESEARCH IN LOUISIANA SUGARCANE PRODUCTION SYSTEMS

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Summary

Field trials were conducted at the LSU AgCenter Sugar Research Station in St. Gabriel and on producer's fields in Napoleonville, LA to address the objectives of this project. The effect of N sources containing different N forms, *i.e.*, nitrate (NO_3), ammonium (NH_4), and urea (46% N) was evaluated. Also, the performance of sensor-based N recommendation + N-rich strip technology (Sensor+N-Rich) and best management practices (BMPs) was compared to a farmer's standard practice (FP) on a production field in Napoleonville. Sugarcane response to increasing N rate (0, 40, 80, and 120 lbs/acre) was also evaluated to validate the LSU AgCenter current N recommendation for sugarcane. Cane tonnage, quality components, sugar yield, N stalk removal rate, and soil nitrogen were determined at harvest. There were no significant differences on cane tonnage and sugar yield between N sources on both Commerce silt loam and Sharkey clay soil. Increase in sugar yield due to N application was only 25%. The results from the N validation trials showed optimization of yield at 40-80 lbs N/acre application rate. For the Sugar Model Farm, cane and sugar yield of both FP and BMPs were similar but BMPs blocks received, on average, 75 lbs N/acre compared to the 120 lbs/acre in FP blocks. The results on soil N analysis showed potential N loss when nitrate-N source was used on the light textured Commerce silt loam soil.

Objectives

This project was designed to: 1) evaluate the potential of different N sources for sugarcane production in Louisiana, (2) evaluate the performance of Sensor+N-Rich as a N decision tool, and (3) validate the LSU AgCenter N recommendation for sugarcane.

<u>Effect of Nitrogen Sources on Sugarcane Productivity</u>

On average across N sources, the application of 80 lbs N/acre significantly increased cane yield by 29% or 8 tons/acre (Figure 1) and sugar yield by 25% or 1741 lbs/acre (Figure 2) ($p<0.05$). However, there were no differences on cane yield nor sugar yield between N sources. Both tonnage (35.2 vs. 32 ton/acre) and sugar yield (8582 vs. 6791 lbs/acre) were higher in cane grown on Commerce silt loam soil than in cane on Sharkey clay soil. Yield data tended to be lower in plots treated with UAN + nitrate compared to other N sources on Commerce silt loam. The light texture nature of Commerce silt loam has higher leaching potential and with nitrate being a mobile form of nitrogen and having a larger fraction in UAN + nitrate may have resulted in N loss that subsequently affected cane productivity. Like the previous years' results, there were no significant differences among the treatment means for all the quality components (Brix, TRS, polarity, purity, and sucrose; data not shown). The lack of response of quality components to treatments like N source is commonly observed in sugarcane. If there is any, the common trend is that TRS declines with fertilizer rate or the unfertilized sugarcane having the highest TRS.

The product of %N in stalk and cane tonnage estimates the annual N removal rate by sugarcane (Figure 3). The check recorded the lowest N removal rate for both soils at 50 lbs N/acre. The urea-coated treated sugarcane removed the lowest amount of N on Commerce silt loam utilizing only 5.2% of applied N followed by UAN + nitrate-treated sugarcane at 14.3%. On average the N use efficiency of sugarcane on Commerce silt loam was only 18.8% whereas it was 28.9% on Sharkey clay soil. On Sharkey clay soil, knife-in UAN treatment recorded the highest N removal rate at 75.3 lbs/acre and N use efficiency at 37.9%. The rest of the N sources on Sharkey clay soil had very similar N removal rate (66.3±1.7 lbs/acre) and N use efficiency (26.7±2.2 %).

Evaluation of Nitrogen Recommendation Approach

The treatments at the Sugar Model Farm in Napoleonville included the FP (farmer's standard; uniform application of N at 120 lbs/acre with burning as post-harvest residue) and the BMPs which constituted the sensor-based N recommendation in combination with N-rich strip technology (Sensor+N-Rich), sweep-residue, and cover cropping. The average cane and sugar yield levels of the BMP blocks and the Farmer's Standard were practically the same (Figure 4). However, on average, the BMPs blocks received, on average, 45 lbs lesser N than the FP blocks.

Validation of the LSU AgCenter Nitrogen Recommendation for Sugarcane

Two N response trials were conducted in 2023: one on a mixture of silty clay loam and silt loam soil, and one on silt loam soil using Ho12-615 and L01-299 cultivars, both first ratoon crop. The application of N at 40 lbs/acre maximized cane tonnage and sugar yield of Ho12-615 by 5.8 ton/acre and 1,463 lbs/acre, respectively (Table 1). Further increase in N application rate did not result in better yield than what was attained in plot treated with only 40 lbs N/acre. On the silt loam soil, L01-299 cultivar recorded a 11.7 ton/acre increase in cane yield and 2,672 lbs/acre increase in sugar yield at 80 lbs N/acre application rate. The current LSU AgCenter N recommendation for sugarcane remains valid. The quality components, including TRS, did not respond to N application rates. On the heavy-textured soil where Ho12-615 was planted, the total plant available N remained elevated as opposed to the light textured soil where L01-299 was grown. Even the untreated plot had a total of 26 lbs N/acre remaining after harvest while the N-treated plot had 64 lbs N/acre. The silt loam soil held only a total of 7 lbs N/acre with the check having similar values with the N-treated plots. However, the removal rates were comparable between these two soils, with both checks recording the lowest values (Table 1).

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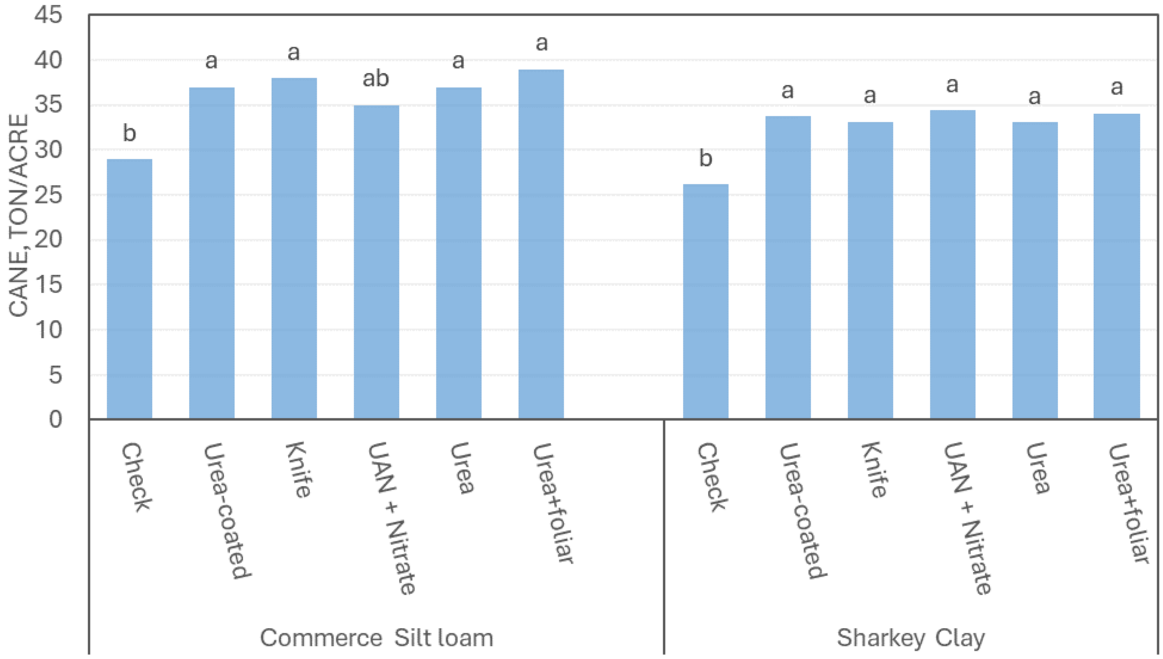

Figure 1. Effect of N source on cane tonnage of L01-299 second ratoon crop, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

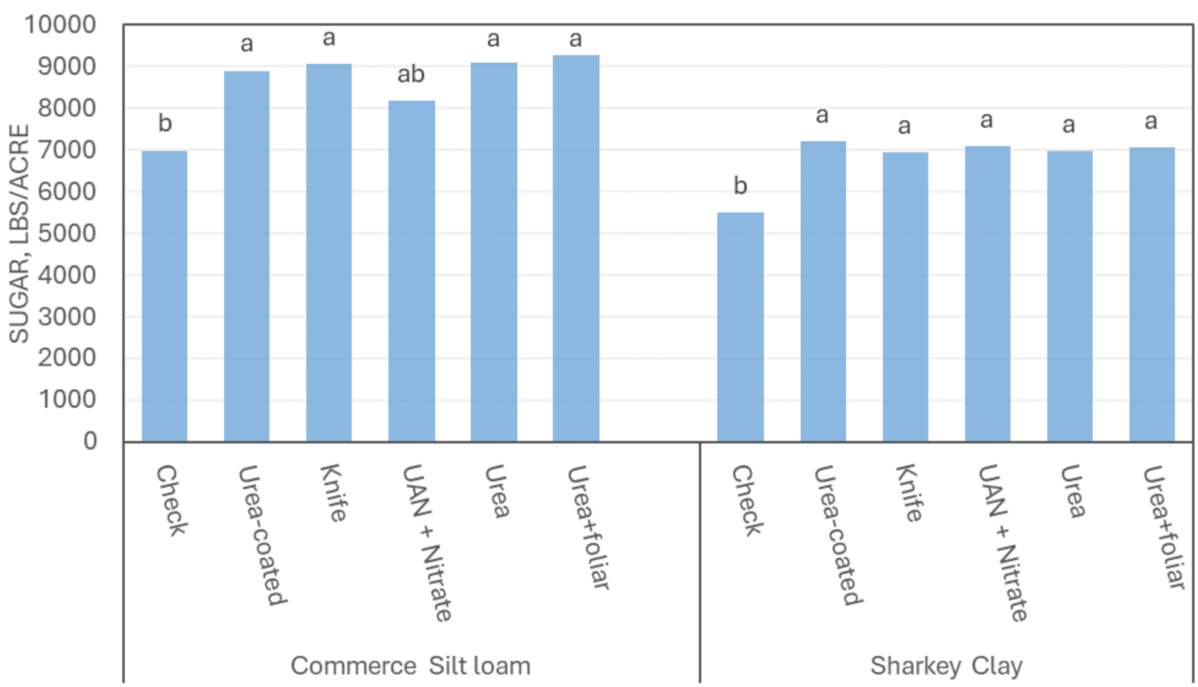

Figure 2. Effect of N source on sugar yield of L01-299 second ratoon crop, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

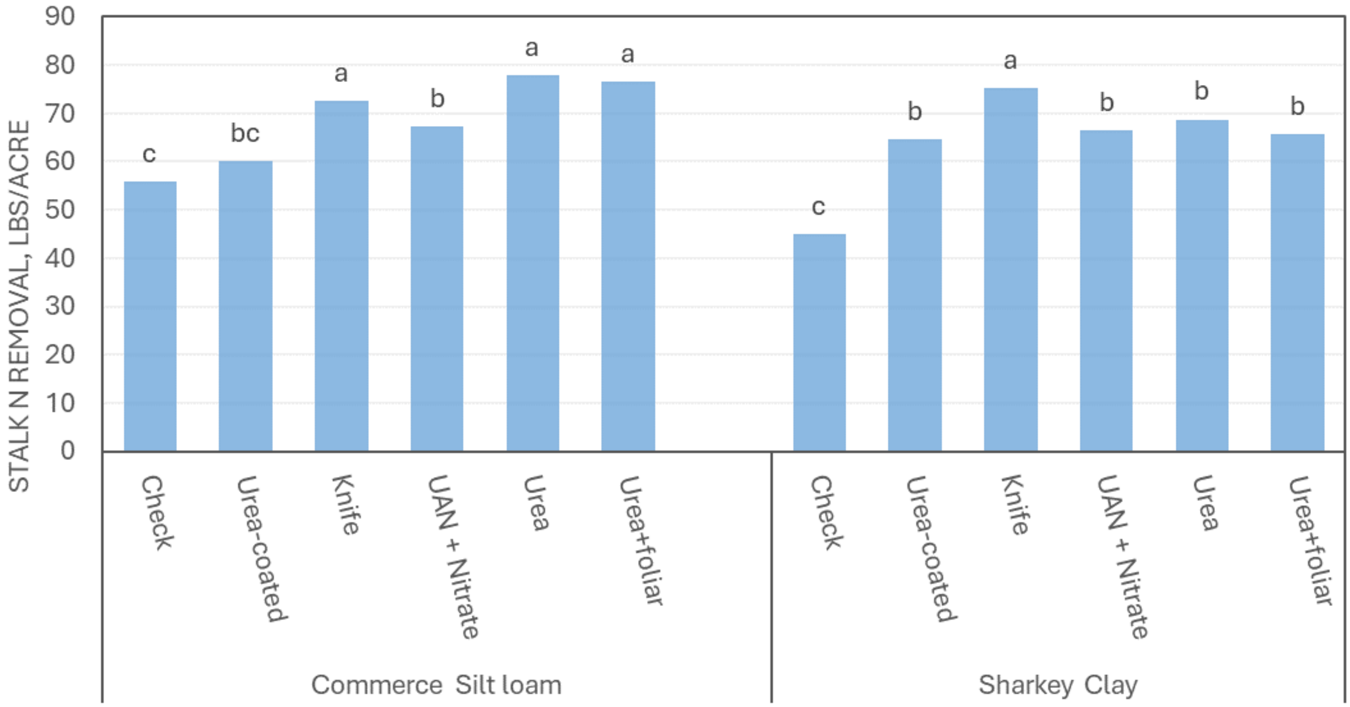

Figure 3. Effect of nitrogen source on sugar yield of L01-299 second ratoon crops, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

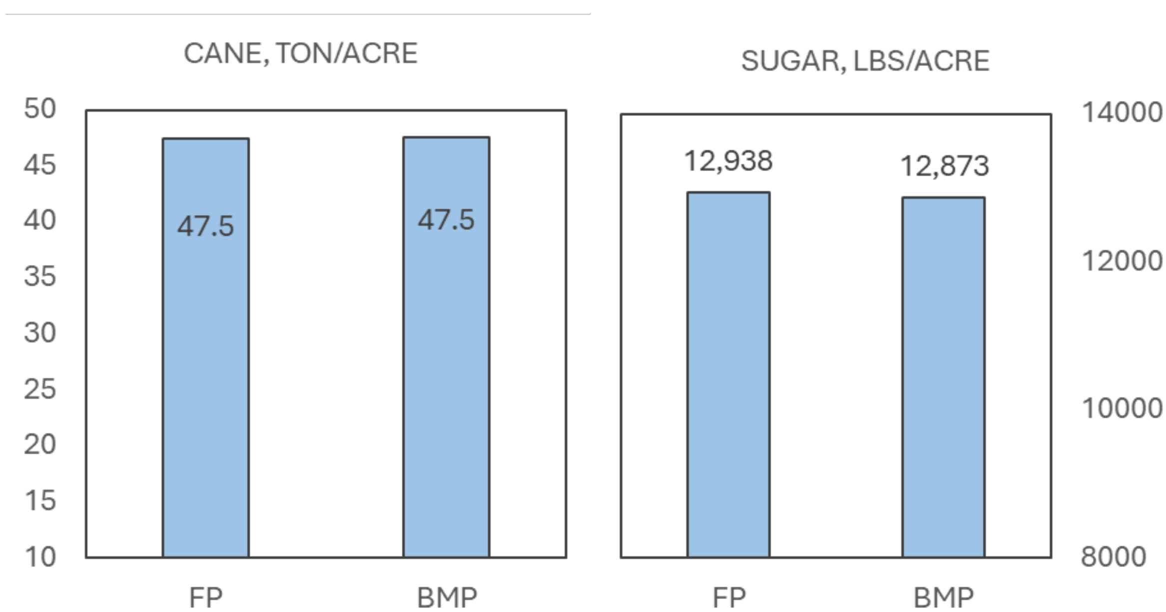

Figure 4. Average cane and sugar yield in 2023 at the Sugar Model Farm in Napoleonville, LA. BMPs received 75 lbs N/acre while FP had 120 lbs N/acre.

Table 1. Cane tonnage, sugar yield, soil ammonium and nitrate, and stalk N concentration and removal rate of Ho12-615 and L01-299 first ratoon crop fertilized with varying N rates, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2023.

Variety	N Rate lbs/ac	Cane ton/acre	Sugar lbs/acre	TRS lbs/ton	Soil NH_4 lbs/acre	Soil NO_3 lbs/acre	Stalk N %	Stalk N Removed lbs/acre
Ho12-615	0	18.9 b	4523 b	241	15	11	0.207 b	21 c
	40	24.7 a	5986 a	242	27	33	0.367 a	51 b
	80	26.7 a	6161 a	231	23	18	0.363 a	54 ab
	120	26.8 a	6117 a	228	29	63	0.457 a	68 a
	p<0.05	**	*	NS	NS	NS	**	***
	STERR	1.65	391	5.8	4.0	15.6	0.045	5.14
L01-299	0	18.8 b	4381	233	2.9	3.6	0.287	31 c
	80	30.5 a	7053 a	231	2.2	4.7	0.277	50 a
	120	26.6 a	6047 a	227	2.9	4.2	0.260	40 b
	p-value	**	**	NS	NS	NS	NS	**
	STERR	1.99	450	0.92	0.13	0.18	0.005	3.13

*, **, *** significant at $p<0.05$, 0.01, and 0.001 level, respectively
NS – not significant at $p<0.05$
TRS – theoretical recoverable sugar
STERR – standard error