RESEARCH ON SOIL FERTILITY IN SUGARCANE PRODUCTION

Brenda Tubana[1], Daniel Forestieri[1], Hector Fajardo[1], Diego Mayorga[1], Hector Mendoza[1],
Krizzia Guardado[1], Andrew Bratton[1], Skarleth Navarro[1], and Marilyn Dalen[1]
[1]School of Plant, Environmental, and Soil Sciences

Summary

Field trials were conducted in 2021 to evaluate cane and sugar yield responses to different sulfur (S) rate and source, and potassium (K)-based starter fertilizer. For the S trials, the treatment structure consisted of a control, different MST®-based (Micronized Sulfur Technology) fertilizers from Sulvaris (ammonium sulfate MST or AS-MST[17-0-0-16 S]; monoammonium phosphate MST or MAP-MST[9-43-0-16 S]; muriate of potash MST or MOP-MST[0-0-50-15 S]; and liquid MST[5-0-0-38 S]), ammonium sulfate (AMS – 21-0-0-24 S), and ammonium thiosulfate (NH_4 thiosulfate – 12-0-0-26 S) applied at 25 lbs S/ac. Also, response of sugarcane to MOP-MST, Liquid MST, and NH_4 thiosulfate applied at 0, 20, 40 and 60 lbs S/ac was documented. For the K-starter study, the treatments included two rates (15 and 30 lbs/ac) of K starter with (at 80 lbs K/ac) and without spring K application. Yield, quality components, and nutrient content of leaf, shredded stalk, and soil samples were determined. The S trials showed that while the effects were not all statistically significant, the application of S generally improved cane and sugar yield. At Site 1 where sugar yield increase was significant ($p<0.1$), MOP-MST (+1034 lbs/ac) and Liquid-MST (+687 lbs/ac) were as effective as the NH_4 thiosulfate (+555 lbs/ac), a common S source in sugarcane production in Louisiana. Based on these results, both MOP-MST and Liquid-MST can be considered as potential S sources for sugarcane. The application of 15 lbs/ac starter K fertilizer tended to improve sugarcane yield even in the absence of spring K fertilization. While increasing S rate increased soil S, leaf S, and stalk S content, all these did not translate in significant improvement in cane tonnage and sugar yield. There was a 15 lbs/ac reduction in soil S within 3 weeks during the grand growth period. Whether the losses were due to absorption by cane or via leaching, the unfertilized plots at that time had insufficient level of soil S for the remainder of the cropping season suggesting that S mobility in the soil should be considered when making fertilizer recommendations.

Objective

This research was designed to evaluate the effect of K-starter fertilizer, S source, and S rate on sugarcane yield and quality components. This annual progress report is presented to provide the latest available data on certain nutrient management practices and not as final recommendation for growers to use.

Results

Effect of Potassium Starter Fertilizer

The K-starter fertilizer application had no significant effect on sugarcane yield and theoretical recoverable sugar or TRS (Table 1). Cane and sugar yield tended to be higher with 15 lbs K/ac starter fertilizer application, with or without spring K fertilization using the control and

Farmer's standard as references. It also appeared that increasing K-starter rate to 30 lbs/ac decreased sugarcane yield. On the other hand, there were significant differences detected on stalk K content and removal rate with sugarcane under Farmer's standard and those received 15 and 30 lbs K/ac starter rates followed by spring application of MOP at 80 lbs/ac. While there was an apparent improvement on sugarcane K nutrition, and that the initial soil samples were tested low for K (average at 104 mg/kg), these did not translate to significant improvement in sugarcane yield.

Sugarcane Response to Different Sulfur Sources and Rates

The results on the analysis of variance (ANOVA) and mean yield, TRS, and plant S status are reported in Table 2. Significant effect of the treatments on yield, TRS, and soil S was observed on the L01-299 ratoon crop (Site 1) but not on the plant cane (Site 2). However, there were significant differences on the stalk S content and removal rate among treatment means. For Site 1, the sugarcane which received MOP-MST, Liquid MST and NH_4-thiosulfate recorded the highest cane tonnage and sugar yield with an average increase of 3.5 ton/ac and 759 lbs/ac, respectively in reference to the control. The stalk S content and removal rate were different but only between the control and the S-fertilized sugarcane regardless of source indicating that S fertilization had dramatically improved sugarcane S uptake. The S fertilization effect on soil S was not observed at harvest because of the mobile nature of S in the soil. It is possible that S losses occurred via leaching from the time of application and harvest thus the amount of S in soil was essentially the same across the treatment.

The source and rate of S had no apparent effect on cane tonnage, sugar yield, and TRS (Table 3). However, the increasing rate of S increased soil S three and six weeks after fertilization (Figure 1). There was a difference of 7.5 mg S/kg or 15 lbs S/ac between these two sampling dates indicating the absorption by sugarcane, and possibly S leaching, had begun taking place. Clearly, leaf and stalk S content increased with increasing S rate regardless of source (Figure 2). While the initial soil S was around 15 mg/kg which is above the 10 mg/kg critical S level, the mobility of S in the soil should be accounted for when making recommendation. The 15 lbs/ac reduction in soil S within 3 weeks had placed the control plots below the critical level (7 mg/kg). Whether the losses were due to absorption by cane or via leaching, the unfertilized plots at that time had insufficient level of soil S for the remainder of the cropping season.

Acknowledgement

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

Table 1. Yield, theoretical recoverable sugar, and stalk K content and removal rate of L01-299 plant cane in response to starter and spring K fertilizer treatments, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2021

Trt	**K Rate**		**K Source**	**Cane yield**	**Sugar yield**	**TRS**	**% Stalk K**	**Stalk K Removal**
	Starter, lbs/ac	Spring, lbs/ac		ton/ac	lbs/ac	lbs/ton		Lbs/ac
Control	0	0	-	37.5	8227	219	0.446 ab	91 b
Farmer's Std	0	80	MOP	38.3	8566	223	0.480 a	103 a
1	15	0	-	40.0	9040	226	0.434 ab	101 a
2	15	80	MOP2	40.0	9188	230	0.375 b	83 b
3	15	80	MOP	39.5	9012	228	0.480 a	105 a
4	30	0	-	38.1	8261	217	0.412 b	82 b
5	30	80	MOP2	38.6	8600	223	0.419 b	88 b
6	30	80	MOP	36.4	8293	228	0.492 a	99 a
	p<value			NS	NS	NS	<0.1	<0.1

MOP2: A different source of K by Nachurs®

Table 2. Cane tonnage, sugar yield, and quality component of sugarcane treated with different sulfur sources, St. Gabriel, LA, 2021

Treatment	Cane Yield ton/ac	Sugar Yield lbs/ac	TRS	Leaf S %	Stalk S %	Stalk S Removed lbs/ac	Soil S mg/kg
Site 1, L01-299 3rd Ratoon							
Control	38.9 bc	8679 bc	223	0.105 c	0.016 b	3.8 b	12.2
AS-MST	31.7 c	8242 c	228	0.156 ab	0.067 a	15.0 a	13.4
MAP-MST	38.0 c	8158 c	215	0.153 ab	0.060 a	13.5 a	14.3
MOP-MST	44.5 a	9713 ab	218	0.148 b	0.053 a	14.2 a	16.9
MOP + AMS	39.4 bc	8982 bc	228	0.172 a	0.069 a	16.7 a	13.2
Liquid MST	40.2 abc	9366 ab	233	0.145 b	0.058 a	14.3 a	14.7
NH_4 Thiosulfate	42.4 abc	9234 ab	218	0.161 a	0.059 a	15.1 a	15.8
p<value	<0.1	<0.1	NS	<0.1	<0.001	<0.001	NS
Site 2, L01-299 Plant Cane							
Control	44.8	11552	258	0.109	0.066 b	19.1 b	13.8
AS-MST	44.6	11496	258	0.122	0.089 a	24.1 a	15.2
MAP-MST	45.5	11486	252	0.123	0.085 a	28.8 a	15.6
MOP-MST	47.1	12225	260	0.135	0.089 a	25.7 a	16.5
MOP + AMS	44.7	11546	258	0.122	0.084 a	23.1 ab	14.1
Liquid MST	46.5	11744	253	0.118	0.100 a	28.8 a	14.9
NH_4 Thiosulfate	46.8	11740	250	0.114	0.080 a	22.4 b	14.6
p<value	NS	NS	NS	NS	<0.1	<0.1	NS

TRS: theoretical recoverable sugar
AS: ammonium sulfate
MST®: Sulvaris micronized sulfur technology
MAP: monoammonium phosphate
MOP: muriate of potash
AMS: ammonium sulfate
Values with the same letter within column for each site are not significantly different at *p*<0.10.
NS: not significant at *p*<0.1.

Table 3. Effect of sulfur source and rate on cane tonnage, sugar yield, and theoretical recoverable sugar of L01-299 2nd ratoon crop, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2021

Treatment	Level	Cane Tonnage ton/ac	Sugar Yield lbs/ac	TRS lbs/ton
Source	MOP-MST	29.4	5927	201
	UAN + ATS	29.2	5945	204
	UAN + MST	29.0	5912	205
	p<value	NS	NS	NS
Rate, lbs/ac	0	28.1	5790	206 ab
	20	30.4	6038	199 b
	40	30.0	6032	209 a
	60	29.3	5851	200 b
	p<value	NS	NS	<0.1
Source x Rate	*p*<value	NS	NS	NS

TRS: theoretical recoverable sugar
MOP: muriate of potash
ATS: ammonium thiosulfate
UAN: urea ammonium nitrate solution
MST®: Sulvaris Micronized Sulfur Technology
NS: not significant at $p<0.1$.
Values with the same letter within column for each site are not significantly different at $p<0.10$.

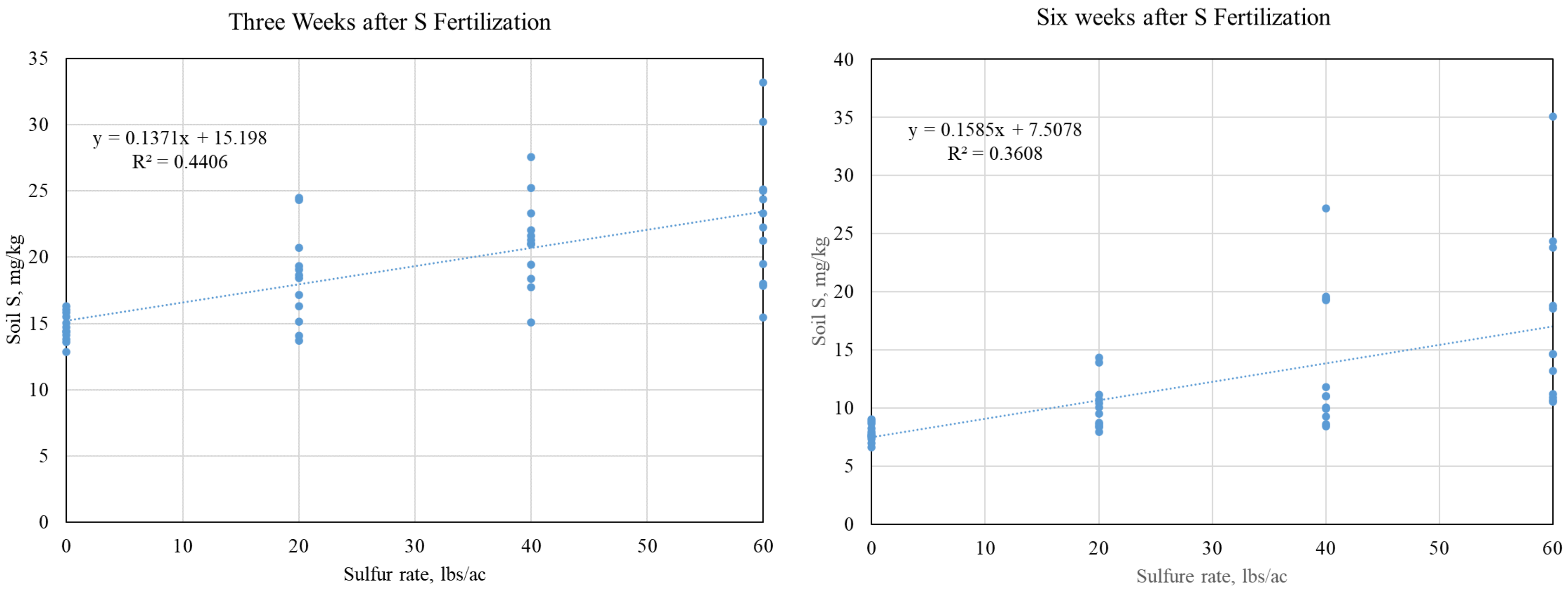

Figure 1. Soil sulfur content three and six weeks after S fertilization at 0, 20, 40, and 60 lbs/ac rates, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2021.

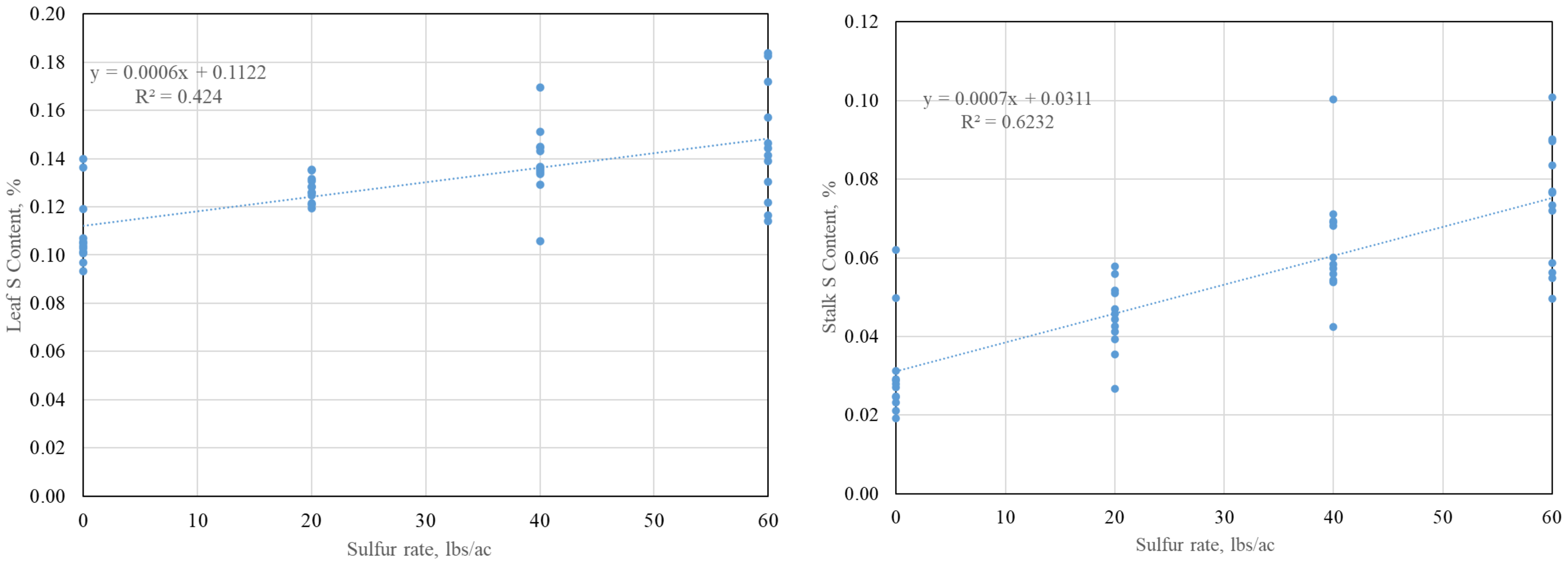

Figure 2. Leaf and stalk sulfur content three and six weeks after S fertilization at 0, 20, 40 and 60 lbs/ac rates, LSU AgCenter Sugar Research Station in St. Gabriel, LA, 2021.

NITROGEN MANAGEMENT RESEARCH IN LOUISIANA SUGARCANE PRODUCTION SYSTEMS

Brenda Tubana[1], Daniel Forestieri[1], Hector Mendoza[1], Marilyn Dalen[1], Hector Fajardo[1], Krizzia Guardado[1], Andrew Bratton[1], Skarleth Navarro[1], and Diego Mayorga[1]
[1]School of Plant, Environmental, and Soil Sciences

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 performance of different coated urea (45% N) products and urea-ammonium nitrate (UAN – 32% N) solution was evaluated. In addition, the effect of N sources containing different N forms, *i.e.*, nitrate (NO_3), ammonium (NH_4), and urea was evaluated. The performance of sensor-based N recommendation + N-rich strip technology (Sensor+N-Rich) and combinations of best management practices (BMPs) was compared to a Farmer's standard N practice using a replicated strip trial on Commerce silty clay loam soil and on a production field in Napoleonville. Cane tonnage, quality components, and sugar yield were determined at harvest. Soil, leaf tissue, and shredded stalks samples were taken as well from some trials for soil NH_4 and NO_3 and plant N monitoring. There was a 27% average increase in cane tonnage and sugar yield due to N fertilization. Overall, the significant differences on all measured variables were detected between the check (no N applied) and N-fertilized plots suggesting that some of the new N sources evaluated in these studies when applied at the same rate can produce the same benefit to sugarcane as UAN. The N recommendation by Sensor+N-Rich and BMPs was lower by 20 lbs N/ac than the Farmer's standard N practice but did not result in significant yield reduction. For the Sugar Model Farm, 15 lbs N/ac was saved but resulted in sugar yield loss by 293 lbs/ac. This suggests that implementation of on-a-need basis N decision tool can save up N fertilizer but can also result in yield loss, perhaps in years where soil N loss potential is high.

Objectives

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

Performance Evaluation of Coated Urea and UAN

The cane tonnage, sugar yield, and theoretical recoverable sugar (TRS) response to different coated urea products and UAN are presented in Table 1 for both the research plots at the LSU AgCenter Sugar Research Station and the strip trial in Napoleonville. For the research plot, cane tonnage was responsive to N application increasing the production by as much as 17.4 ton/ac. While the application of N tended to reduce TRS, the increase in cane tonnage offset this effect resulting in positive increases in sugar yield. The Coated F treatment recorded the highest cane tonnage and sugar yield, but the levels were statistically the same as those attained by plots treated with UAN, straight urea, and ESN ($p<0.01$). On the other hand, Coated N-treated cane recorded a lower tonnage and sugar yield compared to cane treated with any of the N sources but, was higher than the check ($p<0.01$). The results on soil ammonium and nitrate analysis indicated Coated N had released urea three weeks after application, a release rate that was faster than UAN and straight urea (Figure 1). The results obtained after harvest clearly showed the tailing effect of ESN, *i.e.*, delayed release of ammonium and nitrification process. The data on soil ammonium and nitrate at two sampling times (three weeks after N application and at harvest) was not useful to elaborate the sugarcane yield response to these different N sources. On the other hand, the plant N response to N sources was in agreement with the yield data (Table 1). Stalk N content and removal rate was the highest in Coated F-treated plots ($p<0.05$). The lower leaf N content of the Coated F-treated sugarcane indicated a dilution effect typically observed in plants with robust growth and biomass production.

The performance evaluation based on cane tonnage and sugar yield came back in favor of UAN for the strip trial in Napoleonville (Table 1). On average, the application of Coated N, Coated F, and Coated I resulted in ~ 4 ton/ac cane tonnage and ~950 lbs/ac sugar yield increase in reference to the check (control). The increase from applying UAN was higher at levels of 10.7 ton/ac and 2,362 lbs/ac for cane tonnage and sugar yield, respectively. The TRS values across the treatments were very similar. The results on soil ammonium and nitrate analysis also suggest the high solubility of Coated N compared to other sources (Figure 2). However unlike in the research plots, the differences between N sources were not statistically significant. There were no differences in terms of plant N health status, *i.e.*, stalk and leaf N content, and stalk N removal rate (Table 1).

The outcomes from these two studies were not consistent such that the study on the research plots at the Sugar Research Station suggested the high potential of Coated F as N source even surpassing the performance of UAN and ESN. On the other hand, Coated F was not as effective as UAN in the strip trial.

Effect of Nitrogen Sources on Sugarcane Yield

The effect of N source was significant on both cane and sugar yield ($p<0.001$; Table 2). The significant difference was mainly between the control and the N-fertilized sugarcane, regardless of N source. Based on the mean values, the urea-treated sugarcane obtained the (numerically) highest cane yield for both soils. For silty clay loam soil, the application of N that led to >2,000 lbs/ac increase in sugar yield was achieved using urea and UAN-2 as sources whereas for the silt loam soil, it was urea, knife UAN, and urea + AMS. There were no significant differences among the treatment means for all the quality components (Brix, TRS, polarity, purity, and sucrose). 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. Sugar yield is determined as the product of cane yield and TRS. In this study, the minimal decline in TRS was offset by the large boost in cane yield (almost doubled) due to N application. Essentially the increase in sugar yield relied heavily on the increase in cane tonnage.

Leaf N content at midseason and at harvest was generally higher in N-fertilized sugarcane for both soil types (Table 3). The increase in leaf N content was significant at midseason for sugarcane grown on silt loam and at harvest for sugarcane grown on silty clay loam. There were differences between means of N sources, notably with Urea-2 treatment recording the highest leaf N at midseason with urea and UAN-2 treatments recording the lowest on silt loam soil. For the silty clay soil, the lowest leaf N also came from urea and UAN-2 treatments. These significant effects of N sources on leaf N content were not observed in stalk N content although the pattern was similar such that urea and UAN-2 treatments recorded the (numerically) lowest mean stalk N content. Stalk N removal rate was computed as the product of cane yield and stalk N content. Thus, the result of analysis of variance for stalk N removal rate was very similar to cane yield, and to any cane yield-determined parameter in this study, *i.e.*, sugar yield. The amount of N removed by stalks was the highest in sugarcane treated with urea + AMS on the silty clay loam although, this was not statistically different from Urea-2 and straight urea. For the silt loam soil, the significant difference in stalk N removal rate was determined between the control and all the N-fertilized sugarcane. All these observations were confirmed by the soil N content measured at harvest where the unfertilized plot recorded the lowest soil ammonium and nitrate content for both soils (Table 3). Perhaps, higher and significant differences could had been attained between these treatments if the soil samples were collected a few weeks after N application.

Using the average values, the amount of N needed to produce a ton of cane and the cane nitrogen use efficiency (NUE) were computed. For both soils, the lowest amount of N needed to produce a ton of cane was 8.1 lbs for silty clay soil and 5.6 for silt loam using urea as N source. Higher N was needed if Urea-2 was used as N source compared to the rest of the sources. The NUE was higher in urea + AMS treated sugarcane than the rest of the N-treated sugarcane for both soil types. The cane and sugar yield were not different among the N sources suggesting that these sources when applied at the same rate can produce the same benefit to sugarcane. The ultimate productivity is determined by sugar yield. An increase of 2,000 lbs per ac is approximately equivalent to $440 with the price per lb sugar at $0.22. The required amount of N to produce a ton of cane came back with the highest difference of only 2 lbs. It is possible that a different N application rate is needed to maximize sugar yield, and that one or two of these N sources did not need to be applied at 80 lbs N/ac to attain the same level of sugar yield.

Evaluation of Nitrogen Recommendation Approach

A replicated, strip (plot size: 5 rows x 400 ft long) trial was conducted to evaluate the impact of different best management practices (BMPs) on sugarcane productivity. Among the treatments included are the farmer's standard N practice (Farmer's Standard; uniform application of N at 120 lbs/ac), sensor-based N recommendation in combination with N-rich strip technology (Sensor+N-Rich), and the BMPs which constituted the Sensor+N-Rich, sweep-residue and cover cropping. Table 4 shows the stalk and sugar yield, and TRS for these treatments along with the N rate applied. While mean yields among these treatments were statistically the same, the Sensor+N-Rich and BMPs N rate recommendations were lower by 20 lbs N/ac than the Farmer's Standard, sweep-residue, and cover cropping. At the Sugar Model Farm in Napoleonville, the average cane and sugar yield levels of the three BMP blocks was lower than the Farmer's Practice (Figure 3). All the BMP plots received lesser N than the Farmer's Practice with one yielding higher cane and sugar while the other two had lower cane and sugar yield than the Farmer's practice. The average amount of N fertilizer saved per acre in BMP plots was 15 lbs with a sugar yield loss of 293 lbs per acre. This suggests that implementation of on-a-need basis N decision tool can save up N fertilizer but can also result in yield loss, perhaps in years where soil N loss potential is high.

Acknowledgements

The authors wish to express appreciation for the financial support provided by the American Sugar Cane League, Patrick F. Taylor Foundation, Yara North America Inc., and CARBO Ceramics Inc.

Table 1. Mean yield and theoretical recoverable sugar of cane treated with coated urea and UAN at the Sugar Research Station in St. Gabriel and Napoleonville, LA, 2021

N Source	Cane	Sugar	TRS	Stalk N	Leaf N %		Stalk N Uptake
	ton/ac	lbs/ac	lbs/ton	%	Midseason	Harvest	lbs/ac
Research Plots - Sugar Research Station							
Check	31.9 B	8653 B	271	0.374 B	1.571 C	1.397 B	76 C
UAN	45.3 AB	11666 AB	258	0.402 B	1.853 A	1.539 A	114 BC
Urea	44.7 AB	11625 AB	260	0.410 B	1.831 A	1.526 A	116 B
ESN	46.4 AB	12033 AB	259	0.420 B	1.848 A	1.533 A	123 AB
Coated F	49.3 A	13058 A	265	0.503 A	1.707 B	1.410 B	160 A
Coated N	41.3 B	10897 B	264	0.425 B	1.838 A	1.578 A	89 B
p<value	<0.01	<0.01	NS	<0.1	<0.01	<0.05	<0.05
Strip Trial in Napoleonville							
Check	38.0 B	8074 B	212	-	-	-	-
UAN	48.7 A	10436 A	214	0.290	1.981	1.288	89
Coated F	42.5 AB	8944 AB	211	0.286	1.835	1.228	77
Coated N	42.4 AB	9100 AB	214	0.276	1.925	1.200	74
Coated I	42.5 AB	8925 AB	209	0.250	1.975	1.262	69
p<value	<0.01	<0.01	NS	NS	NS	NS	NS

TRS – theoretical recoverable sugar

NS: not significant at 0.05 level of confidence.

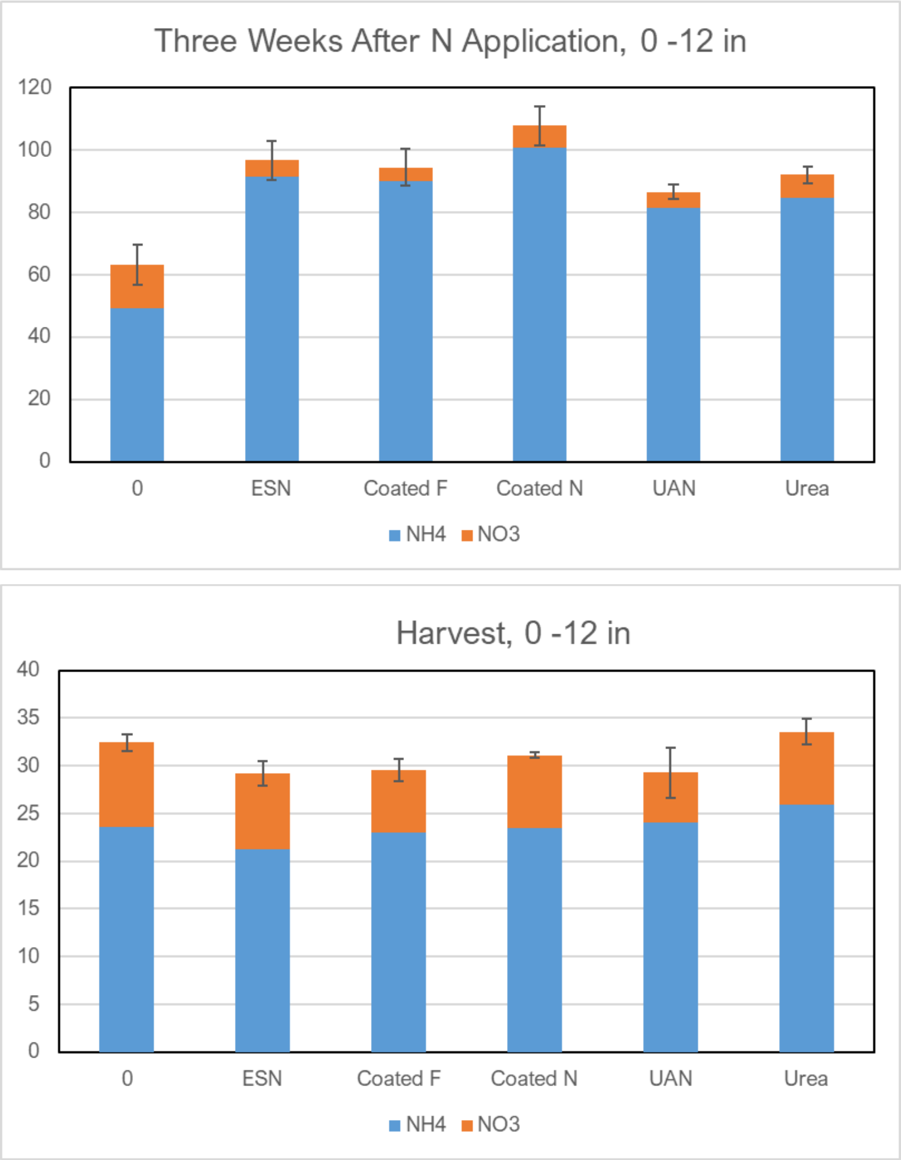

Figure 1. Soil ammonium and nitrate content (lbs/ac) at 0-12-inch depth three weeks after N application and after harvest of sugarcane, St. Gabriel, LA.

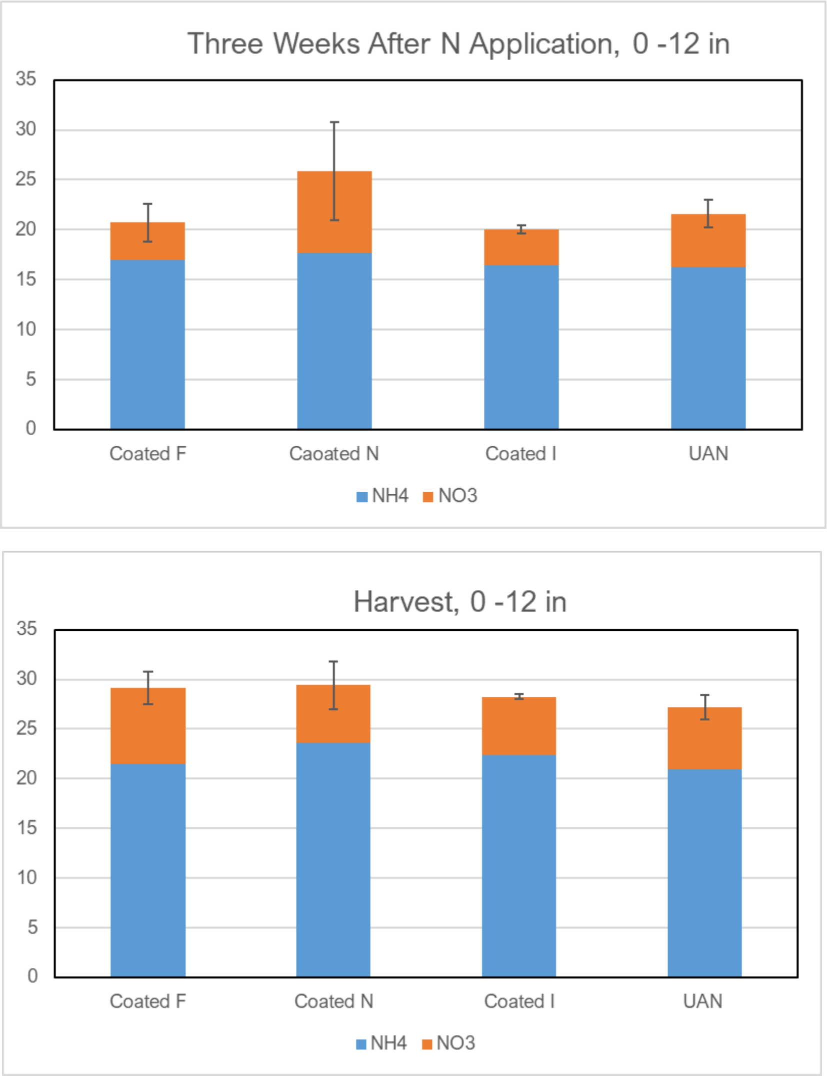

Figure 2. Soil ammonium and nitrate content (lbs/acre) at 0-12-inch depth three weeks after N application and after harvest of sugarcane, Napoleonville, LA.

Table 2. Mean and analysis of variance of sugar yield and quality components to evaluate the effect of different N sources on sugarcane production at two sites (silt loam and silty clay loam) at the Sugar Research Station in St. Gabriel, LA, 2021.

Soil	N Source	Cane Yield ton/ac	Sugar Yield lbs/ac	Brix %	TRS lbs/ton cane	Polarity %	Purity %	Sucrose %
Silty clay loam	Control	26.8 B	6208 B	19.7	232	71.4	82.3	16.6
	Urea	36.7 A	8500 A	19.6	231	70.9	82.5	16.4
	Knife UAN	35.5 A	8108 A	19.5	228	70.0	81.9	16.2
	Urea + AMS	34.8 A	8014 A	19.5	231	70.7	82.6	16.4
	Urea-2	34.6 A	8065 A	19.7	234	71.4	82.8	16.6
	UAN-2	35.5 A	8382 A	19.8	235	72.1	82.7	16.7
p<value		<0.001	<0.001	NS	NS	NS	NS	NS
Silt loam	Control	28.3 B	7342 B	19.7	238	72.5	83.8	16.8
	Urea	42.6 A	9611 A	19.5	238	72.0	84.2	16.7
	Knife UAN	41.6 A	9646 A	19.3	231	70.4	83.1	16.4
	Urea + AMS	41.6 A	9531 A	19.6	239	72.3	84.4	16.8
	Urea-2	39.5 A	9210 A	19.4	233	71.0	83.4	16.5
	UAN-2	41.5 A	9163 A	19.7	236	72.0	83.4	16.7
p<value		<0.001	<0.001	NS	NS	NS	NS	NS

UAN: urea ammonium nitrate (32%N)
AMS: ammonium thiosulfate
Urea-2: urea + sulfate
UAN-2: 50% UAN + 50% nitrate-N
NS: not significant at 0.05 level of confidence.

Table 3. Mean and analysis of variance on plant and soil N parameters to evaluate the effect of different N sources on sugarcane productivity at two sites (silt loam and silty clay loam soils) at the Sugar Research Station in St. Gabriel, LA, 2021

Soil	N Source	Leaf N %		Stalk N %	Stalk N Removed lbs/ac	Soil NH_4 lbs/ac	Soil NO_3 lbs/ac	lbs N to produce a ton†	NUE, %
		Midseason	Harvest						
Silty clay loam	Control	1.658	1.261 C	0.367	59.7 c	15.1	6.92	-	-
	Urea	1.925	1.414 AB	0.366	81.4 ab	19.3	7.41	8.1	27.1
	Knife UAN	1.982	1.462 AB	0.346	74.2 bc	17.2	8.79	9.2	18.1
	Urea + AMS	1.960	1.496 A	0.436	91.0 a	17.8	8.92	10.0	39.1
	Urea-2	1.949	1.486 AB	0.403	84.6 ab	16.4	7.58	10.3	31.1
	UAN-2	1.914	1.370 BC	0.330	69.7 bc	18.0	9.50	9.2	12.5
p<value		NS	<0.05	NS	<0.05	0.170	0.954		
Silt loam	Control	1.914 d	1.414	0.310	62.6 b	14.9	8.21 b	-	-
	Urea	1.961 cd	1.494	0.377	95.0 a	18.9	17.42 a	5.6	40.5
	Knife UAN	2.097 b	1.476	0.379	91.5 a	16.2	19.76 a	6.0	36.1
	Urea + AMS	2.127 b	1.506	0.393	96.8 a	16.6	17.72 a	6.0	42.8
	Urea-2	2.276 a	1.490	0.405	95.2 a	16.6	14.76 a	7.1	40.8
	UAN-2	2.065 bc	1.503	0.357	86.3 a	16.8	19.91 a	6.1	29.6
p<value		<0.001	0.790	0.300	<0.01	0.318	0.018		

UAN: urea ammonium nitrate solution
AMS: ammonium sulfate
Urea-2: urea + sulfate
UAN-2: 50% UAN + 50% nitrate-N
Soil NH_4 and NO_3: measured within the 12-inch depth of soil at harvest
NUE: nitrogen use efficiency
†: a ton of cane with moisture
NS: not significant at 0.05 level of confidence.

Table 4. Mean and analysis of variance of sugar yield and quality components to evaluate the effect of different N sources on sugarcane production at two sites (silt loam and silty clay loam) at the Sugar Research Station in St. Gabriel, LA, 2021

Treatment	N Applied lbs/ac	Cane Yield ton/ac	Sugar Yield lbs/ac	TRS lbs/ton cane
Farmer's Standard	120	27.4	5311	194
BMPs	100	26.8	5281	197
Cover Crops	120	27.4	5275	192
Sweep-Residue	120	28.9	5912	205
VRT	100	29.8	5986	200
p<value	-	NS	NS	NS

TRS: theoretical recoverable sugar

Farmers' Standard: 120 lbs N/ac uniform application; burned residue

BMP's: cover cropping, sweep-residue, VRT

Sweet-residue: residues were swept off from the top of bed

VRT: sensor-based N recommendation

NS: not significant at 0.05 level of confidence.

Figure 3. The area distribution of cover cropping and harvested sugarcane in 2021 at the Sugar Model Farm in Napoleonville.