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

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Summary:

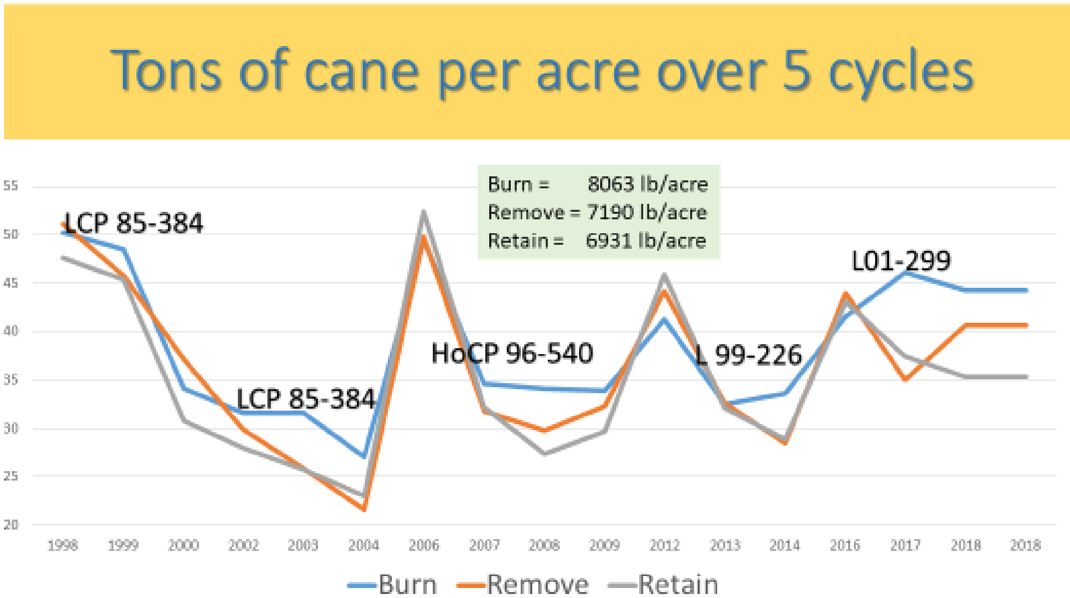
Field trials consisted of: **I)** evaluation of the long-term effects of post-harvest residue management on sugarcane; **II**) evaluation of third stubble response of L 01-299 to different sources and rates of sulphur fertilizer; **III)** assessing the efficacy of fallow land applications of a mixture of filter press mud (FPM) and bagasse; and **IV**) measuring the yield of sugarcane following ryegrass grazing on fallow land. The long-term residue management study was in the second stubble crop of the fifth production cycle. Burning continues to show a yield advantage compared to residue retention. Neither source nor rate of sulfur fertilizer applied to third stubble L 01-299 resulted in significant increases in tonnage or sugar yield. The application of FPM/bagasse did not produce positive yield results. Plant development may have been compromised by an infestation of West Indian cane fly. A study designed to measure the influence of fallow-period ryegrass grazing on subsequent sugarcane yields was initiated in 2017. Plant cane yields following grazed ryegrass plots ranged as high as 46 tons of cane per acre, and suggest a ryegrass/sugarcane rotation should be feasible.

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 five. The study has clearly confirmed what other investigations have found, that retention of 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, and the plant-cane crop of cycle number five further confirmed that reality. While burning does not always produce superior yields, burning averages approximately 1000 lb of sugar per acre more than the residue retain management treatment.

II. Response of L 01-299 to Different Sources and Rates of Sulphur Fertilizer:



A field trial on L 01-299 first stubble was initiated in 2016 and continued through third stubble in 2018 using two sources of sulphur, ammonium thiosulfate and elemental S, and three application rates, 25, 50 and 75 lb per acre, in addition to a control. The soil type was a Baldwin silty clay loam, soil that is typical of the "heavy" soil texture types used in the sugar growing region of Louisiana. For the third stubble test in 2018 both tonnage and sugar yield were not significantly affected (P = 0.05).

Sulphur Rate & Source (lb/A)	**Tonnage (T/A)**	**TRS (lb/T)**	**Sugar (lb/A)**
0	40.9a	168ab	6834a
25 lb ATS	40.5a	156 b	6399a
50 lb ATS	36.0a	174a	6184a
75 lb ATS	37.3a	157ab	5864a
25 lb S90	34.2a	172ab	5831a
50 lb S90	36.4a	160ab	5794a
75 lb S90	39.9a	161ab	6429a

Numbers within a column that have the same letter are not significantly different (P=0.05). All values are the means of six replications. Ammonium Thiosulfate (ATS) and Tiger 90CR (S90) were used as sulfur sources.

III. Fallow-land Application Trial with Filter Press Mud/Bagasse Mixture:

Louisiana sugar mills pile approximately 900,000 tons of bagasse and also discard about 350,000 tons of filter press mud (FPM) annually**.** Cost to transport and store these waste streams totals millions of dollars and requires significant land areas for deposition. A field trial to evaluate sugarcane response to an application of a FPM/bagasse mixture was initiated in the summer of 2017. A mixture of one part FPM and one part bagasse by volume was applied on fallow land with a spreader at rates of 1.45, 2.91, 5.82 and 11.64 tons/A. Variety L01-299 was planted in the fall of 2017. Plant cane and sugar yields were measured in the fall of 2018 and soil nutrient levels will be monitored for the duration of the trial. The first table below contains the yield data acquired on December 18, 2018. While the field trial was setup as a demonstration and not as a research trial with appropriate replication and randomization, it can clearly be observed that land application of the mill-waste mixture tended to lower cane tonnage. Numerical yield reductions occurred with each incremental increase in application rate (table below). The results are only observational and further investigation of land application of mill wastes is warranted before recommendations can be offered. The grower reported sooty mold associated with an infestation of West Indian cane fly, which may have differentially affected areas of the field with more vigorous growth.

Application rate of FPM/bagasse, tons/A	Tonnage (T/A)	TRS (lb/T)	Sugar (lb/A)
0	38.4	223	8563
1.45	36.4	227	8263
2.91	34.7	224	7773
5.82	34.2	224	7661
11.64	32.5	235	7638

Soil nutrient levels determined in the spring of 2018 are shown in the table below. There is a trend for P and K levels to increase with increasing application rates. Levels, however, for P and K for all treatments are considered low by soil test standards.

Application rate of FPM/bagasse, tons/A	Phosphorus, ppm	Potassium, ppm	Organic matter %
0	9.95	83.0	1.69
1.45	9.20	85.0	1.73
2.91	13.58	82.6	1.90
5.82	12.08	82.4	1.74
11.64	14.60	90.0	1.75

IV. Influence of Fallow-period Ryegrass Grazing on Plant Cane Yield:

An investigation into the effects of fallow-land management on the subsequent plant cane yields was initiated in 2017. Grazed and ungrazed annual ryegrass plots preceded the establishment of plant cane L 01-299. Because a conventional control plot without ryegrass was not included caution must be exercised when drawing conclusions. Nevertheless, it appears that acceptable yields were measured following ryegrass grazing, with plot tonnage ranging from 36.8 to 45.6 tons of cane per acre. Additional sites have been established for this evaluation.

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 a producer's field in Napoleonville, LA to evaluate the effect of different N sources on sugarcane productivity. All treatments (control, urea, knife-in UAN, calcium nitrate – $CaNO_3$, ammonium sulfate – NH_4SO_4, and knife-in UAN + foliar N) were replicated four times and arranged in randomized complete block design. The demonstration trial on producer's field evaluated only three N sources (knife-in UAN, $CaNO_3$, and NH_4SO_4) and a control. Images of sugarcane canopies were taken using DJI Phantom 4 equipped with Micasense rededge™ M sensor in early April. On the same day, normalized difference vegetation index (NDVI) readings were collected using a GreenSeeker® handheld sensor. The relationship between these two sets of NDVI readings was evaluated. Nitrogen response index (in-season estimate of cane response to applied N) based on these NDVI readings was also evaluated. Cane tonnage, quality components, and sugar yield were determined at harvest. Sugarcane was very responsive to N application; across the sites the highest increase in cane tonnage and sugar yield was 21 ton/ac (76%) and 5,035 lbs/ac (82%), respectively ($p<0.001$). The effect of N source was only observed in sugarcane planted on silt loam soil wherein the use of knife-in UAN had higher benefit than using urea and NH_4SO_4 as N sources ($p<0.001$). Cane tonnage and sugar yield obtained from knife-in UAN-treated plots were 7.1 ton/ac and 1,996 lbs/ac higher than urea-treated plots, and 3.5 ton/ac and 867 lbs/ac higher than NH_4SO_4-treated plots, respectively. Overall, the results from the 2018 field trials demonstrated that UAN remains an effective N source for sugarcane production in Louisiana. The NDVI derived from aerial images can capture cane canopy information similar to what can be acquired from ground-based sensor for estimating both sugarcane yield potential and in-season response to applied N.

Objectives

This project intends to evaluate the effect of different N sources on sugarcane productivity. In addition, this project also aims to establish the relationship between aerial images-derived NDVI readings and GreenSeeker NDVI readings.

Effect of Nitrogen Source on Sugarcane Yield

There was an evident sugarcane yield response to applied N across sites ($p<0.001$). Based on mean separation analysis, the control plots (no N) consistently obtained lower cane tonnage and sugar yield than the N-fertilized plots (Tables 1-3, Figures 1 and 3). The highest yield increase due to applied N was obtained from sugarcane on silt loam soil with 21 ton/ac (76%) cane tonnage and 5,035 lbs/ac (82%) sugar yield higher than the control (Table 1; $p<0.001$). The N-fertilized plots of the 1st stubble cane (Table 2) and plant cane (Table 3) on silty clay loam soil had 15 (47%) and 5.3 (11%) ton/ac higher cane tonnage, and 3,297 (45%) and 764 (7%) lbs/ac higher sugar yield than that of the control, respectively ($p<0.001$). Similar benefit was obtained from applied N on the producer's field in Napoleonville (Figures 1 and 3) where N-fertilized plot had 13.6 ton/ac (35%) and 2,831 lbs/ac (39%) higher cane tonnage and sugar yield, respectively, than the control. Generally across the sites, cane tonnage had more influence on sugar yield than the quality components. In fact, there was a tendency for % Brix, % sucrose, and theoretical recoverable sugar being lower in N-fertilized plots than the control. There were no evident differences among N sources observed except on 1st stubble cane on silt loam soil (Table 1). The results from the mean separation analysis showed that knife-in UAN was a better source than urea and NH_4SO_4 but had similar impact on sugarcane yield as $CaNO_3$ and knife-UAN + foliar N. Cane tonnage and sugar yield were 7.1 ton/ac and 1,996 lbs/ac higher in knife-in UAN-treated plots than urea-treated plots, and 3.5 ton/ac and 867 lbs/ac higher than NH_4SO_4-treated plots, respectively.

Linking Aerial-NDVI and Ground-Based Sensor NDVI Readings

GreenSeeker® NDVI readings and images taken by DJI Phantom 4 equipped with Micasense rededge™ M sensor were concurrently collected (from sugarcane canopies) in early April. Regression analysis between the two sets of NDVI readings were performed for each trial. The GreenSeeker- and aerial- NDVI were highly correlated with coefficient of determination (r^2) values reaching as high as 0.83 (83%). However, the r^2 value dropped to 32% when regression analysis was performed on pooled data i.e., combined across the trials (Figure 4). It is important to note that cane crop age and soil type were different for each trial. GreenSeeker- and aerial-NDVI predictions on sugarcane response to applied N had a r^2 value of 0.84 (or 84%) even when the data was pooled across the trials (Figure 5). All of these demonstrate that the NDVI from aerial images can capture cane canopy information similar to what can be acquired from ground-based sensor. This information is useful for estimating sugarcane yield and response to applied N; both are vital for implementing variable N rate technology in sugarcane production.

Acknowledgements

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Table 1. Effect of different N sources on yield and quality components of 1st stubble L01-299 cane variety on a silt loam soil in 2018, St. Gabriel, LA.

N Source†	Brix %	Sucrose %	TRS lbs/ton	Cane Tonnage ton/ac	Sugar Yield lbs/ac
Control	18.0 **C**	15.4	219	28.2 **D**	6,163 **D**
Urea	18.3 **BC**	15.6	222	45.0 **C**	9,974 **C**
Knife UAN	18.7 **A**	16.1	230	52.1 **A**	11,970 **A**
NH_4SO_4	18.6 **AB**	16.0	228	48.6 **B**	11,103 **B**
$CaNO_3$	18.6 **AB**	15.8	223	51.4 **AB**	11,485 **AB**
Knife UAN + foliar	18.4 **AB**	15.8	224	51.1 **AB**	11,460 **AB**
***p*-value**	**0.027**	**0.118**	**0.172**	**<0.001**	**<0.001**

UAN – urea ammonium nitrate; TRS – theoretical recoverable sugar
† - N application rate was 80 lbs N/ac across N sources; control plots were not fertilized with N. Values with the same uppercase letter within a column indicate no significant differences between N sources at 0.05 level of confidence.

Table 2. Effect of different N sources on yield and quality components of 1st stubble L01-299 cane variety on a silty clay loam soil in 2018, St. Gabriel, LA.

N Source†	Brix %	Sucrose %	TRS lbs/ton	Cane Tonnage ton/ac	Sugar Yield lbs/ac
Control	18.8	16.1	230	31.9 **B**	7,288 **B**
Urea	18.6	16.0	227	46.9 **A**	10,655 **A**
Knife UAN	18.6	15.7	222	48.0 **A**	10,642 **A**
NH_4SO_4	18.4	15.6	221	48.1 **A**	10,650 **A**
$CaNO_3$	18.4	15.5	218	48.4 **A**	10,529 **A**
Knife UAN + foliar	18.5	15.6	221	47.3 **A**	10,449 **A**
***p*-value**	**0.558**	**0.323**	**0.270**	**<0.001**	**<0.001**

UAN – urea ammonium nitrate; TRS – theoretical recoverable sugar
† - N application rate was 80 lbs N/ac across N sources; control plots were not fertilized with N. Values with the same uppercase letter within a column indicate no significant differences between N sources at 0.05 level of confidence.

Table 3. Effect of different N sources on yield and quality components of plant cane L01-299 cane variety on a silty clay loam soil in 2018, St. Gabriel, LA.

N Source†	Brix %	Sucrose %	TRS lbs/ton	Cane Tonnage ton/ac	Sugar Yield lbs/ac
Control	17.6	15.1	215	48.1 B	10,343
Urea	17.6	14.9	211	55.0 A	11,627
Knife UAN	17.4	14.6	205	54.5 A	11,182
NH_4SO_4	17.7	14.9	209	52.2 AB	10,925
$CaNO_3$	17.7	14.8	207	51.5 AB	10,672
Knife UAN + foliar	17.6	14.7	207	53.8 A	11,130
***p*-value**	**0.854**	**0.832**	**0.739**	**0.073**	**0.473**

UAN – urea ammonium nitrate; TRS – theoretical recoverable sugar
† - N application rate was 80 lbs N/ac across N sources; control plots were not fertilized with N.
Values with the same uppercase letter within a column indicate no significant differences between N sources at 0.10 level of confidence.

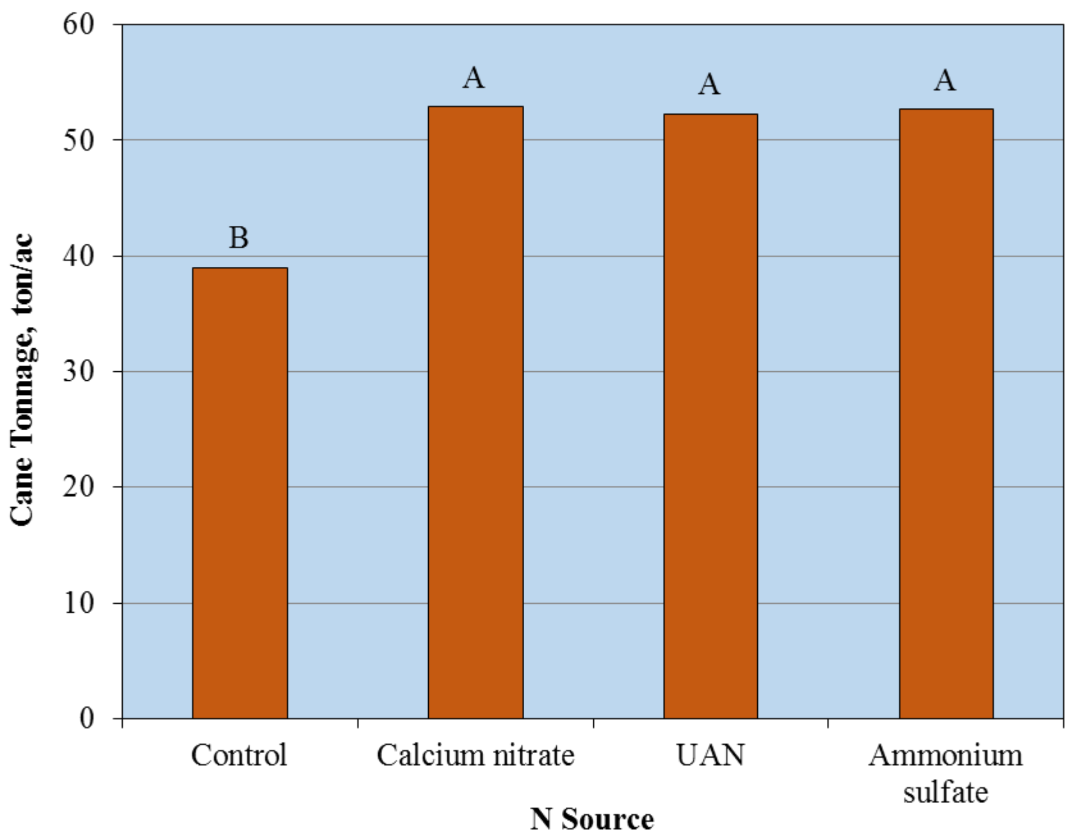

Figure 1. Cane tonnage response of 1st stubble L01-299 to different N sources in 2018, Napoleonville, LA. Same uppercase letters on top of the bars indicate no significant differences between N sources at 0.10 level of significance.

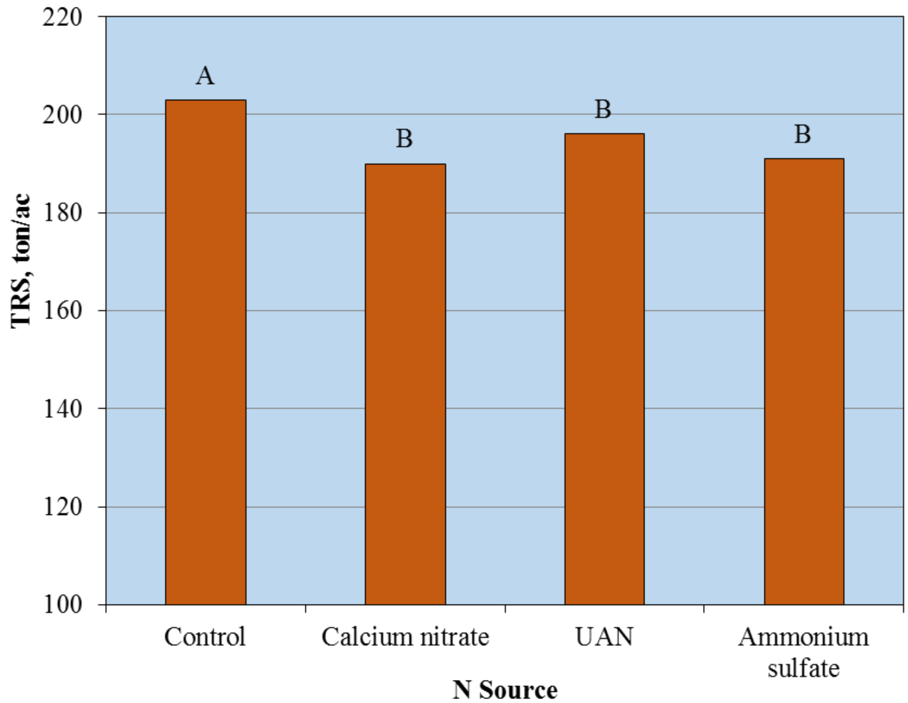

Figure 2. Theoretical recoverable sugar of 1st stubble L01-299 in response to different N sources in 2018, Napoleonville, LA. Same uppercase letters on top of the bars indicate no significant differences between N sources at 0.10 level of significance.

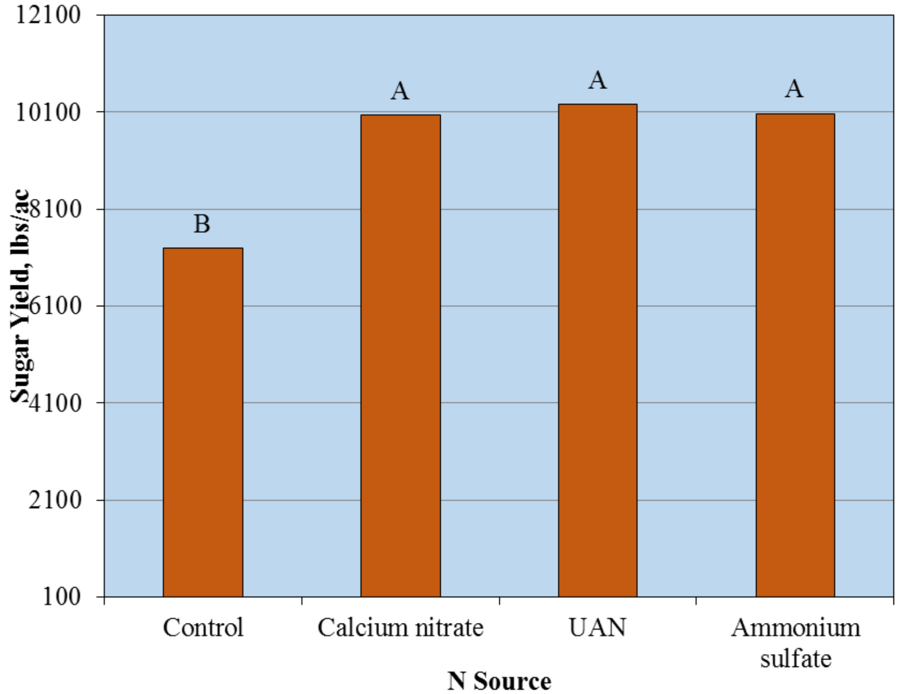

Figure 3. Sugar yield response of 1st stubble L01-299 to different N sources in 2018, Napoleonville, LA. Same uppercase letters on top of the bars indicates no significant differences between N sources at 0.10 level of significance.

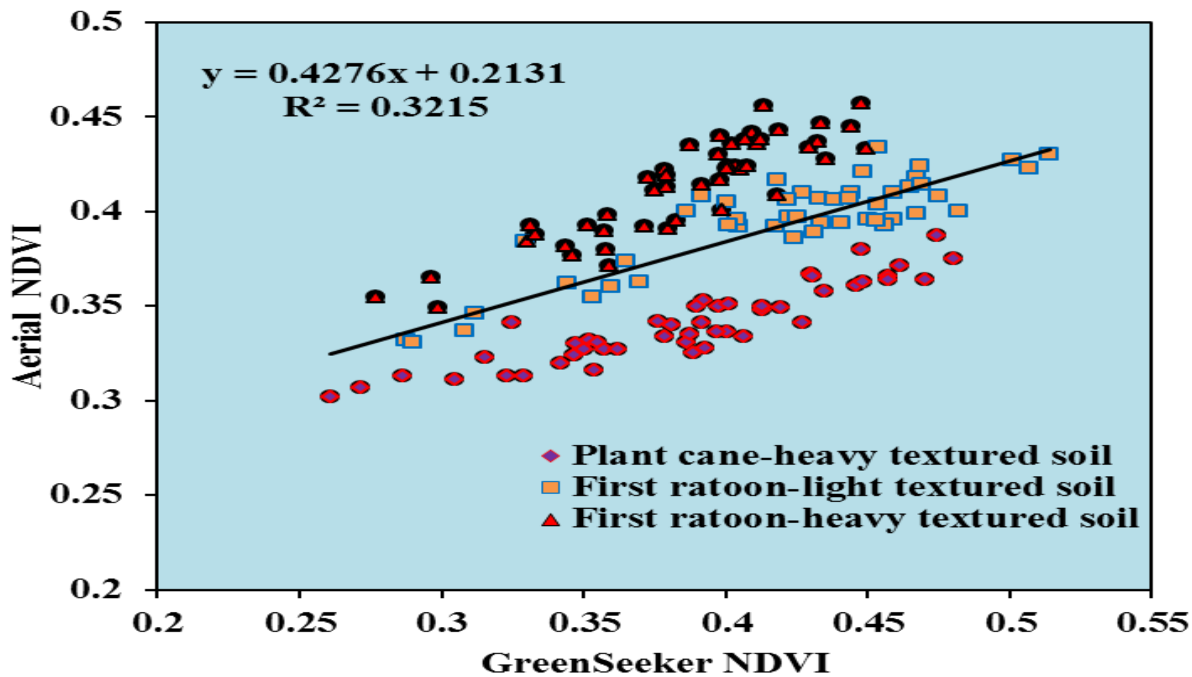

Figure 4. Relationship of GreenSeeker normalized difference vegetation index (NDVI) readings with NDVI derived from aerial images of sugarcane canopy, 2018, St. Gabriel, LA.

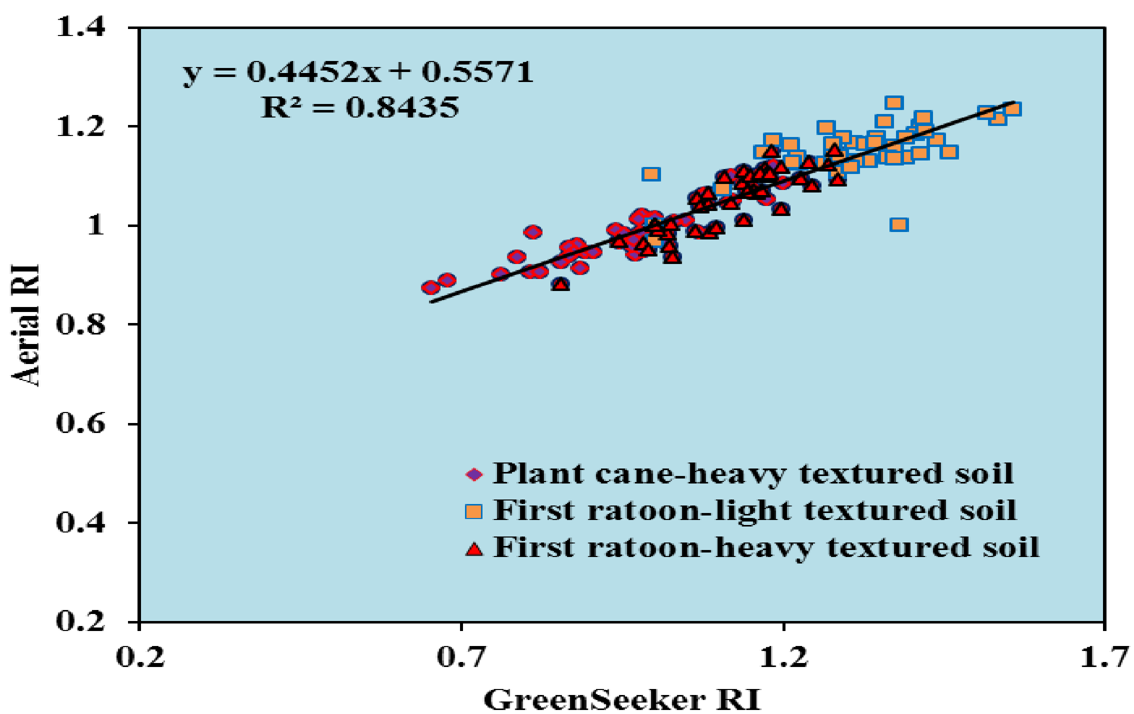

Figure 5. Relationship of nitrogen response index based on normalized difference vegetation index (NDVI) readings taken using GreenSeeker® sensor and aerial images of sugarcane canopy, 2018, St. Gabriel, LA.