Relation Between Early Season-Measured Agronomic Variables and Sugar Yield Responses to Nitrogen

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Introduction

The nitrogen (N) recommendation for sugarcane (*Saccharum officinarum*) is commonly refined based on crop age and soil texture in Louisiana production systems. However, this method can over- or underestimate sugarcane N rate requirements due to temporal and spatial variability. Several researchers have demonstrated the use of mid-season plant N response to refine N rate recommendation. However, the relationship of early-season growth and responses to N fertilization to stalk and sugar yield at harvest has not been pursued.

Objective

The objective of this study was to evaluate and relate the early-season response to N fertilization (RI) of select agronomic variables to RI of measured sugar yield at harvest of three sugarcane varieties (HoCP 96-540, L 01-283, and L 99-226).

Materials and Methods

Two field experiments were conducted from 2010 to 2013 at two locations in Louisiana: St. Gabriel and Jeanerette. The soils from these locations belong to Mississippi Alluvial soils of Louisiana which are highly diverse in nature and generally fertile. Treatments included cane variety and N rate arranged in a randomized complete block design with four replicates. Three cane varieties with different canopy structure were selected for this study. Different N rates (0, 45, 90, and 135 kg N ha^{-1}) were knifed-in in spring using urea ammonium nitrate liquid fertilizer (32-0-0).

Dry biomass weight, N content (%), N uptake and tiller number were collected from 1 m^2. Data were collected every week for four consecutive weeks from three weeks after N fertilization (WKN). For each of the agronomic variables, response index (RI) was computed using following equations.

$$RI_{45}= \text{Agronomic variable at 45 kg N ha}^{-1} \text{ plot/check plot}$$
$$RI_{90}= \text{Agronomic variable at 90 kg N ha}^{-1} \text{ plot/check plot}$$
$$RI_{135}= \text{Agronomic variable at 135 kg N ha}^{-1} \text{ plot/check plot}$$

where agronomic variable included sugar and stalk yield, dry biomass, number of tillers, N content, and N uptake.
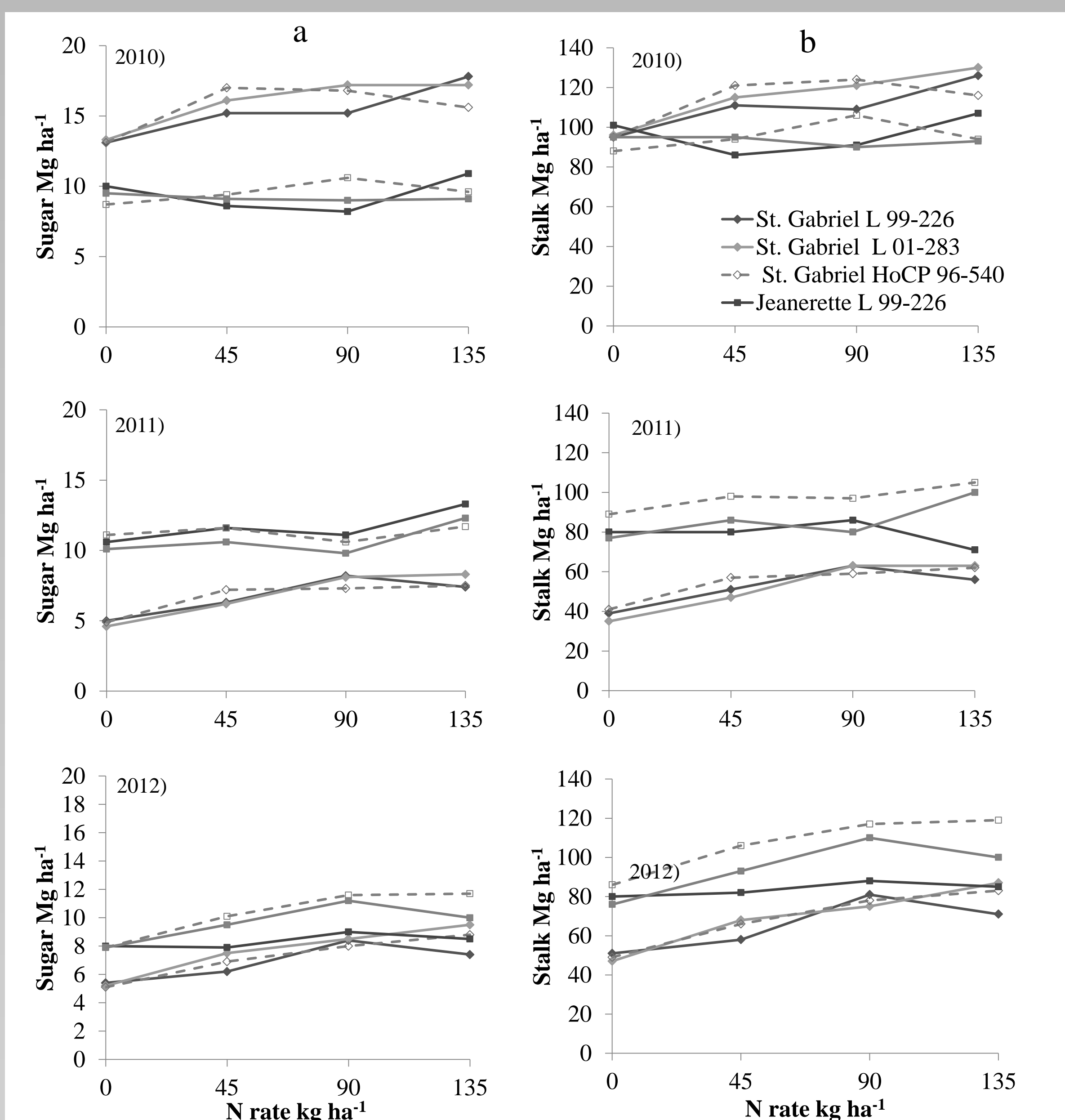
Results

Figure 1. Sugar (a) and stalk (b) yield in 2010, 2011, and 2012 at different N rate for three sugarcane varieties in two locations, LA.
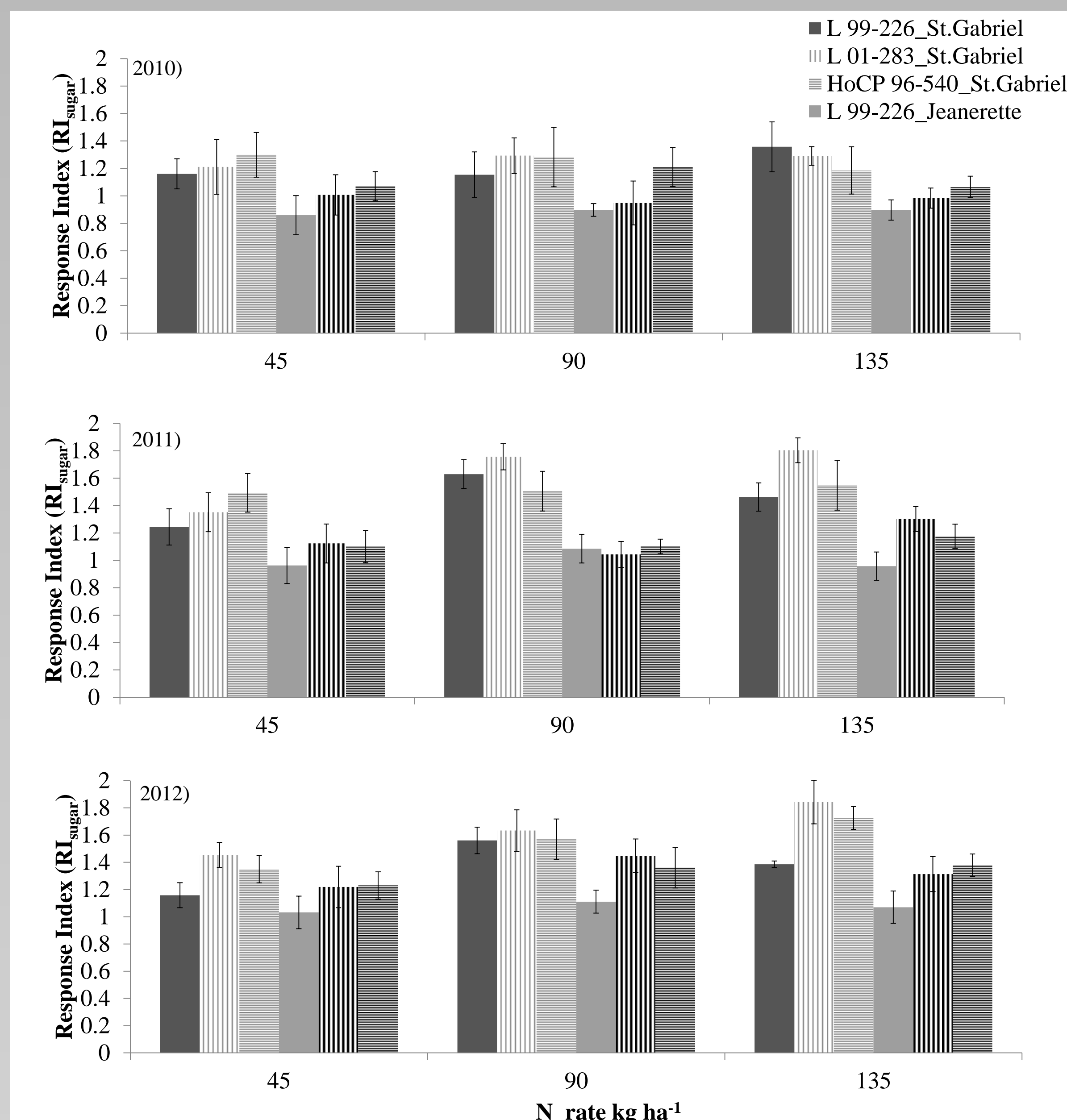

Figure 2. Response Index (RI) in sugar yield in 2010, 2011, and 2012 for three sugarcane varieties in two locations, LA.

Table 1. Summary of simple linear regression between RI at harvest (sugar and stalk) and RI at early season agronomic variables.

Response Index	Time	n	Mean	Correlation Coefficient Sugar Yield	Correlation Coefficient Stalk Yield
RI$_{biomass}$	3WKN¶	72	1.14	0.49	0.49
	4 WKN	60 €	1.15	0.53	0.55
	5 WKN	72	1.22	0.69	0.68
	6 WKN	72	1.28	0.44	0.48
RI$_{tiller}$	3WKN	72	1.07	NS	NS
	4 WKN	60 €	1.11	0.50	0.50
	5 WKN	72	1.10	0.46	0.44
	6 WKN	72	1.16	0.48	0.48
RI$_{\%N}$	3WKN	72	1.09	0.47	0.45
	4 WKN	60 €	1.15	0.57	0.55
	5 WKN	72	1.10	0.53	0.51
	6 WKN	60 €	1.16	0.70	0.69
RI$_{Nuptake}$	3WKN	72	1.24	0.55	0.50
	4 WKN	72	1.37	0.47	0.51
	5 WKN	72	1.45	0.64	0.62
	6 WKN	60 €	1.53	0.71	0.73

‡ NS, not significant at α=0.05 level
¶ WKN, number of weeks after N fertilization
€ Twelve samples were treated as missing due to unforeseen incident during sample collection and processing

High variability in sugar and stalk yield were observed across variety, year and location (Fig. 1). Both yields showed distinct linear, quadratic, and cubic responses to N rates however, these relationships were not consistent across varieties. Spatial, temporal and varietal variability in RIs at harvest were also observed (Fig. 2). Sugarcane with high sugar yield was not always responsive to N (high yield but low RI such as 2011 in Jeanerette) and sugarcane that was responsive to N or higher RI did not always produce higher yield (2012 in St. Gabriel). These results highlights that it is essential to utilize in-season estimates of sugarcane response to added N to determine N fertilizer. In terms of early-season measure agronomic variables, there were disconnected patterns of RI (Data not presented). Among the agronomic variables, RI$_{\%N}$, and RI$_{Nuptake}$ maintained *r* values equal or higher than 0.45 across sampling times noting that on average, RI$_{Nuptake}$ had the highest correlation with RI$_{sugar}$ and RI$_{cane}$. These findings suggest that RI$_{Nuptake}$ which is the product of biomass and N content can provide good information on the responsiveness of sugarcane to N fertilization as early as three weeks after N application.

Acknowledgements

Conclusions

Sugar and stalk yield response to N were highly variable across sites, variety, and year. Agronomic variables at mid-season were notably related with yields at harvest and this result suggests that response of these agronomic variables to applied N early in the season can be used as a basis for in-season determination of the potential increase in sugar yield due to N application.