

# Calibrating Energy Cane Biomass and Nitrogen Uptake with Vegetation Indices Derived from Canopy Reflectance at the Red, Red-Edge and Near Infrared Wavebands

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## INTRODUCTION

- Remote sensing has emerged as one of the most useful technologies in modern agriculture for non-invasive monitoring of plant N status.
- Remote sensing utilizes several spectral domains from the visible to short-wave infrared regions of the electromagnetic spectrum.
- Near infrared relates with cell and plant geometrical structure while visible wavelength shows unique signatures of plant pigments. Red-edge has been reported as a good indicator of plant chlorophyll content.

## OBJECTIVE

- Identify vegetation indices derived from canopy reflectance readings within the red, red-edge, and near infrared wavebands that can be used to characterize energy cane (*Saccharum* sp.) biomass and N uptake.

## MATERIALS AND METHODS

➤ **Research Site:** LSU AgCenter Sugar Research Station, St. Gabriel, Louisiana.

➤ **Experimental design:** 2 x 4 factorial treatment structure was superimposed on 9 m x three 1.8 m bed plots using split plot in randomized completely block design with four replications.

➤ **Treatments:**

- Energy cane varieties: Ho 02-113 and US 72-114.
- Nitrogen rates: 0, 56, 110, and 224 kg N ha<sup>-1</sup>

➤ **Data collection:**

a. Canopy reflectance readings were collected using a Jaz<sup>®</sup> hyperspectral spectrometer (300 to 1100 nm) and 2- and 4-band handheld active sensors (GreenSeeker<sup>®</sup>) from a 1 m<sup>2</sup> area of each plot. NDVI was computed using the following formula:

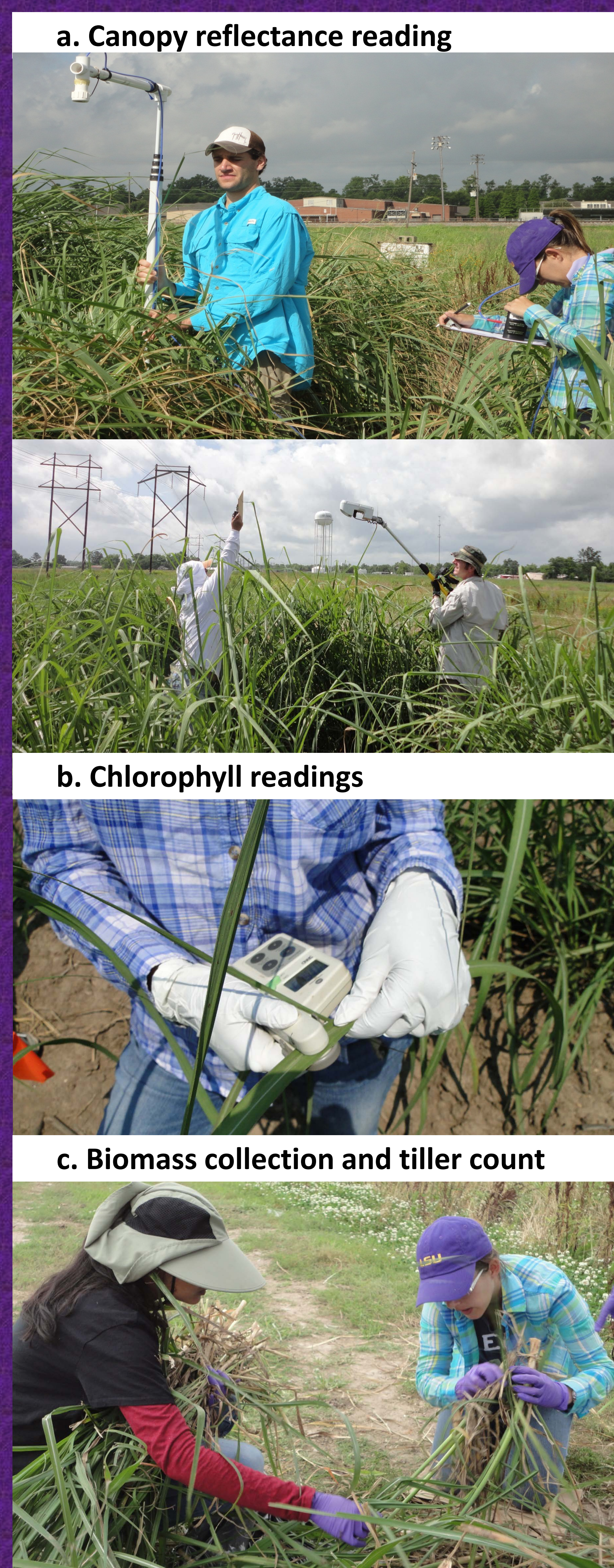
$$NDVI = \frac{Ref_{NIR} - Ref_{RED}}{Ref_{NIR} + Ref_{RED}}$$

b. Chlorophyll readings were collected using Minolta SPAD 502 from the middle row of each plot (30 readings then averaged).

c. Biomass clippings and tiller count were collected from a 1 m<sup>2</sup> area of each plot.

➤ **Field data collection:** initiated three weeks after N fertilization and done once a week for three consecutive weeks.

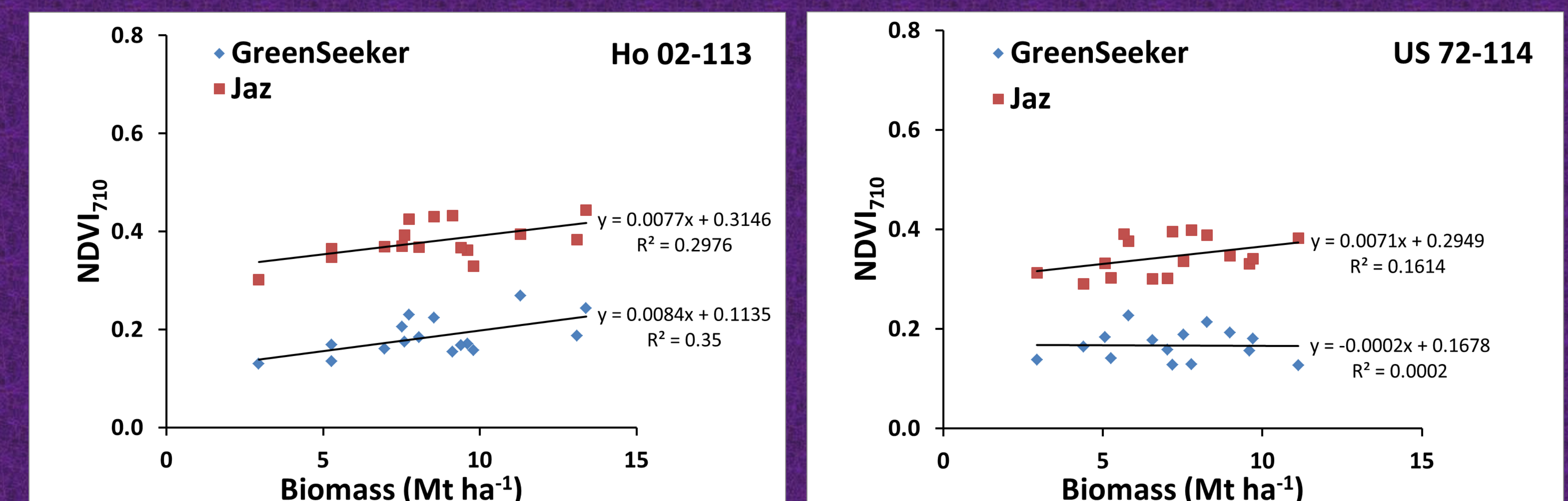
➤ **Data analysis:** The relationship among measured parameters were determined using regression analysis and ANOVA in SAS 9.3.



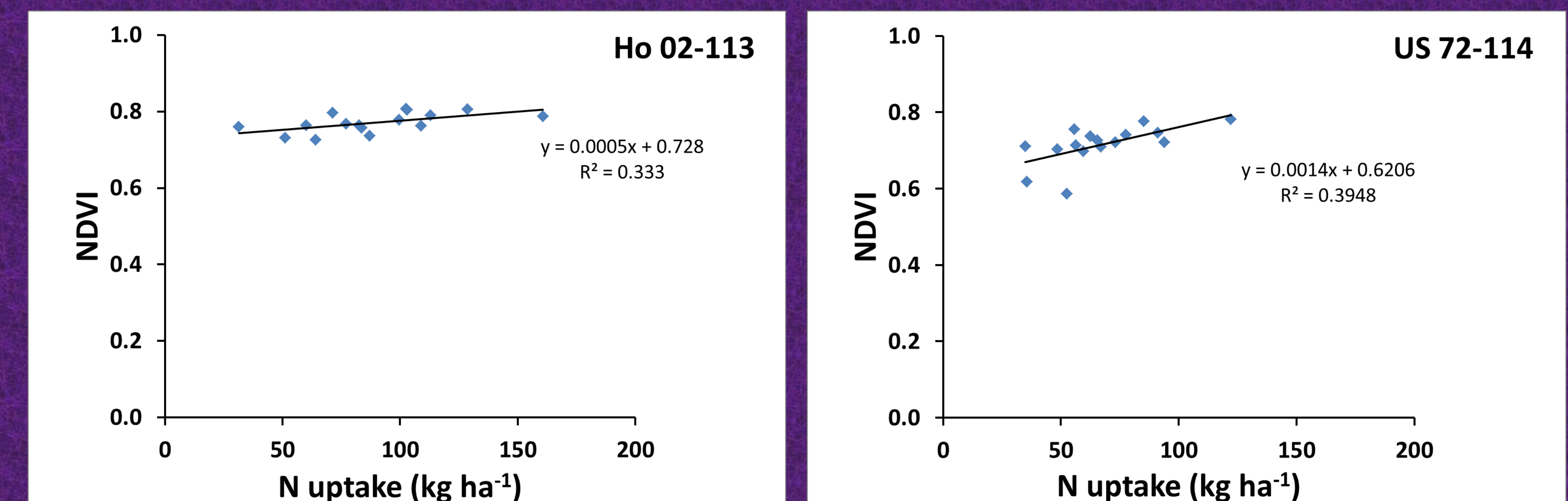
## RESULTS AND HIGHLIGHTS

**Table 1.** Analysis of variance of the different agronomic parameters as affected by different nitrogen rates at five weeks after N application.

N Rate (kg ha <sup>-1</sup> )	Biomass Yield (Mt ha <sup>-1</sup> )		N Uptake (kg ha <sup>-1</sup> )		Chlorophyll Reading		Tiller Number (count m <sup>-2</sup> )	
	Ho 02-113	US 72-114	Ho 02-113	US 72-114	Ho 02-113	US 72-114	Ho 02-113	US 72-114
0	7.87	5.08	68.5	50.2	32.4	31.1	96	78
56	9.35	8.23	95.7	81.5	38.2	35.5	92	94
110	8.40	7.15	99.2	69.5	39.8	36.8	93	87
224	8.27	7.76	113.4	97.9	41.4	38.8	84	86
P-value	0.9114	0.1731	<0.0001	0.2672	0.0049	0.0012	0.8368	0.7370



**Figure 1.** The relationship between biomass and NDVI<sub>710</sub> readings from GreenSeeker and Jaz at four weeks after N application.



**Figure 2.** The coefficient of determination ( $r^2$ ) between NDVI and N uptake at four weeks after N application.

- A few vegetation indices have been identified that are potentially useful for non-destructive characterization of energy cane biomass and N uptake. These include the NDVI computed from NIR and red reflectance readings (Figure 1).
- The effect of N rate was only observed at five weeks after N application and only on a few measured agronomic parameters of Ho 02-113 and US 72-114 (Table 1). However, the NDVI readings of Ho 02-113 began corresponding to changes with both biomass and N uptake at four weeks after N application but for US 72-114, the NDVI readings were associated only with N uptake (Figures 1 and 2).
- Our initial results suggest that there is a narrow window for collecting canopy reflectance readings for non-invasive characterization of N-related agronomic parameters.
- Continuing research effort is focused on building the sensor database system and refinement of the relationships among energy cane N-related agronomic parameters and sensor based-vegetation indices.