Harvest Date Effects on the Relationship Between Spectral Reflectance and Energy Cane Yield

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INTRODUCTION

- Energy cane production in Louisiana can potentially play a major role in the establishment of lignocellulosic biofuel industry in the United States.
- One of the leading crops being considered as a source of feedstock is energy cane that could yield up to ten times more ethanol per hectare than corn.
- Depending on crop age, cane is harvested between October to December thus the supply of feedstock from this energy crop may be available for only few months during the year.
- One of the essential facets to achieve full-scale commercialization of lignocellulosic-based biofuel industry is the accessibility to year-round supply of high quality feedstock.

OBJECTIVES

- To evaluate the relationship between spectral reflectance and energy cane yield as affected by different harvest dates.
- To determine the effect of nitrogen (N) rates and harvest dates on energy cane yield and N uptake.

MATERIALS AND METHODS

- **Research Site:** LSU AgCenter Sugar Research Station, St. Gabriel, Louisiana.
- **Treatment Structure and Experimental Design**: 2 x 4 factorial treatment structure was arranged using split plot in randomized complete block design with four replications. The main plot was the energy cane varieties (Ho 02-113 and US 72-114). The sub-plot was the nitrogen rates (0, 56, 112, and 224 kg N ha^{-1}).
- **Harvesting:**
  - Two- and one-month earlier than scheduled harvest
    - Fifteen stalks per plant were manually cut from the base (Photo 1a and 1b).
  - Scheduled harvest date
    - Fifteen stalk per plot were manually cut before harvesting the entire plot with a combine.
    - Millable stalks were cut using combine harvester and loaded to wagon with load cell to determine plot weight (Photo 1c).


Photo 1a


Photo 1b


Photo 1c

MATERIALS AND METHODS

- **Field data collection:**
  - Canopy reflectance readings were collected using Jaz® hyperspectral spectrometer (300 to 1100 nm) from a 1.0 m^2 area.
  - Three spots per row were flagged; a total of 9 spots/plot.
  - Reflectance readings were taken from each spot (Photo 2a and 2b). Nine spots remained undisturbed for the entire crop growth duration wherein reflectance readings were taken twice a month until one month prior to scheduled harvesting.
  - Simple Ratio (SR) and Normalized Difference Vegetation Indices (NDVI) were computed using the following formula:

$$SR = \frac{\rho_{NIR}}{\rho_{red}} \qquad NDVI = \frac{\rho_{NIR} - \rho_{red}}{\rho_{NIR} + \rho_{red}}$$

- **Processing:**
  - Fifteen stalks were partitioned into stems and leaves and weighed separately.
  - Cleaned stalks were shredded and passed through the SpectraCane Near Infrared System to determine the quality parameters such as BRIX, sucrose and fiber content (Photo 3a and 3b).
  - Sub-samples of the shredded stalks were collected for C:N analysis (Photo 3c).
- **Data analysis:** The relationships of vegetation indices with biomass and millable stalks were determined using regression analysis in Excel while test for significant effect of N and variety was done using ANOVA in SAS 9.3.

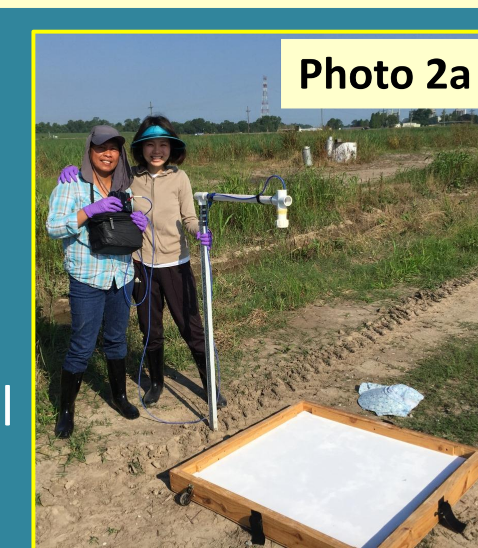
Photo 2a


Photo 2b


Photo 3a

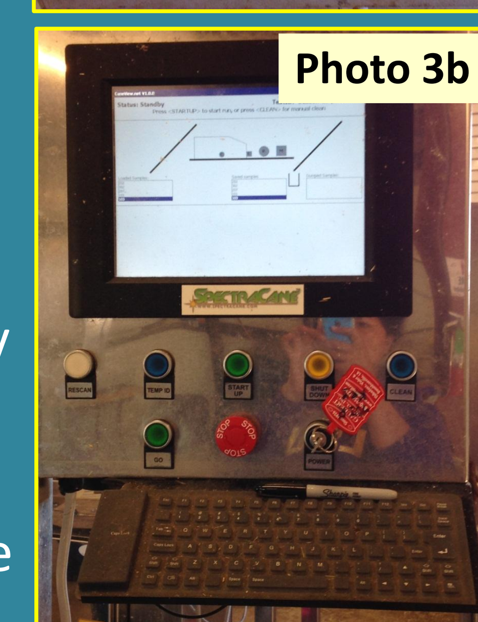
Photo 3b


Photo 3c

RESULTS AND HIGHLIGHTS

- Vegetation indices computed from reflectance readings at 670 nm showed relatively good relationships with millable stalks harvested at different dates. The sampling time where SR and NDVI showed a good correlation with millable stalk yield was at eight weeks after N application for plant cane cropping (Figures 1A and 1B) and fourteen weeks after N application for first ratoon cropping (Figures 2A and 2B).

RESULTS AND HIGHLIGHTS

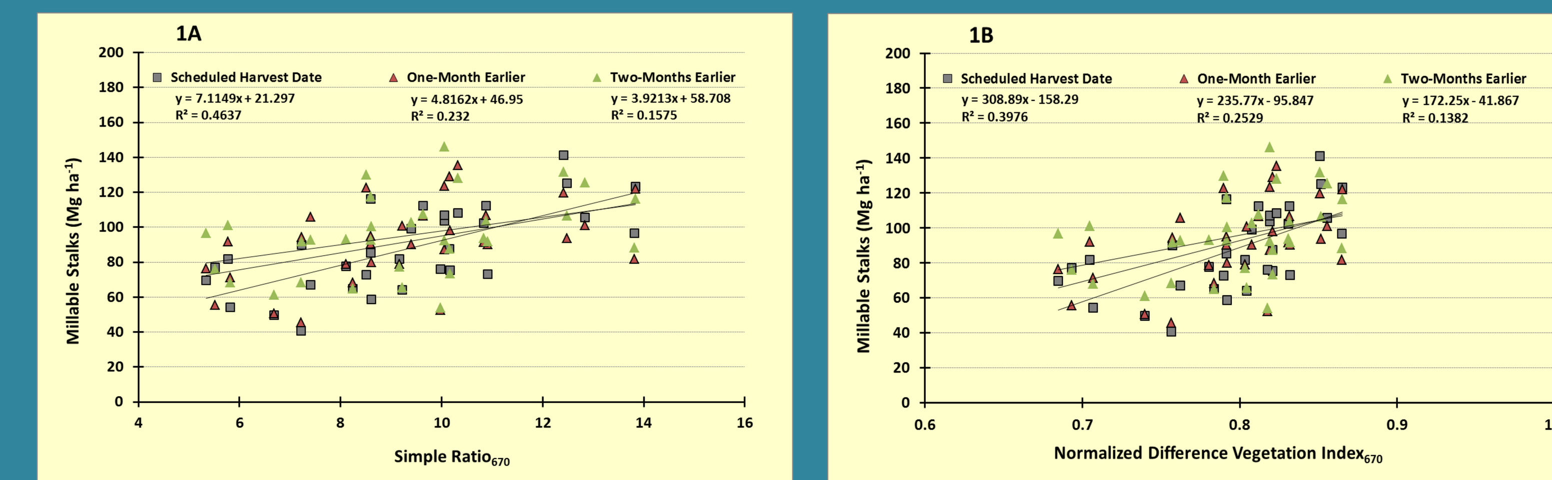

Figure 1. The relationship of SR (A) and NDVI (B) measured at eight weeks after N fertilization with millable stalks harvested at different dates, plant cane cropping (2013).

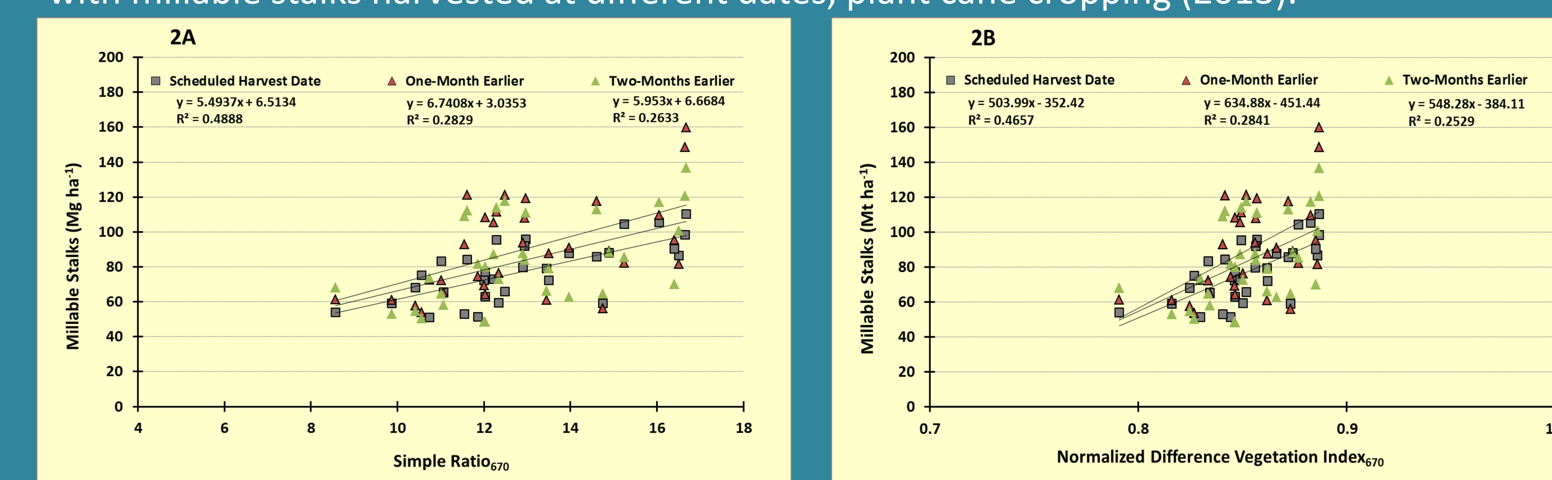

Figure 2. The relationship of SR (A) and NDVI (B) measured at fourteen weeks after N fertilization with millable stalks harvested at different dates, first ratoon cropping (2014).

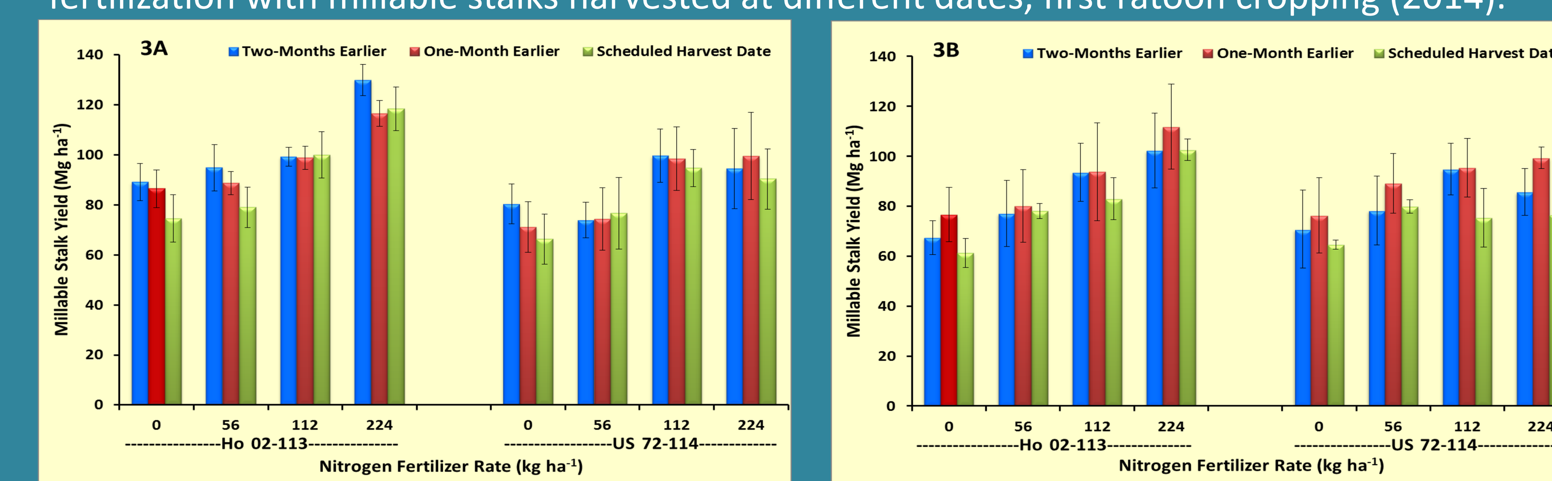

Figure 3. Effect of nitrogen and harvest date on millable stalks of energy cane variety Ho 02-113 and US 72-114 for plant cane (A) and first ratoon (B) cropping.

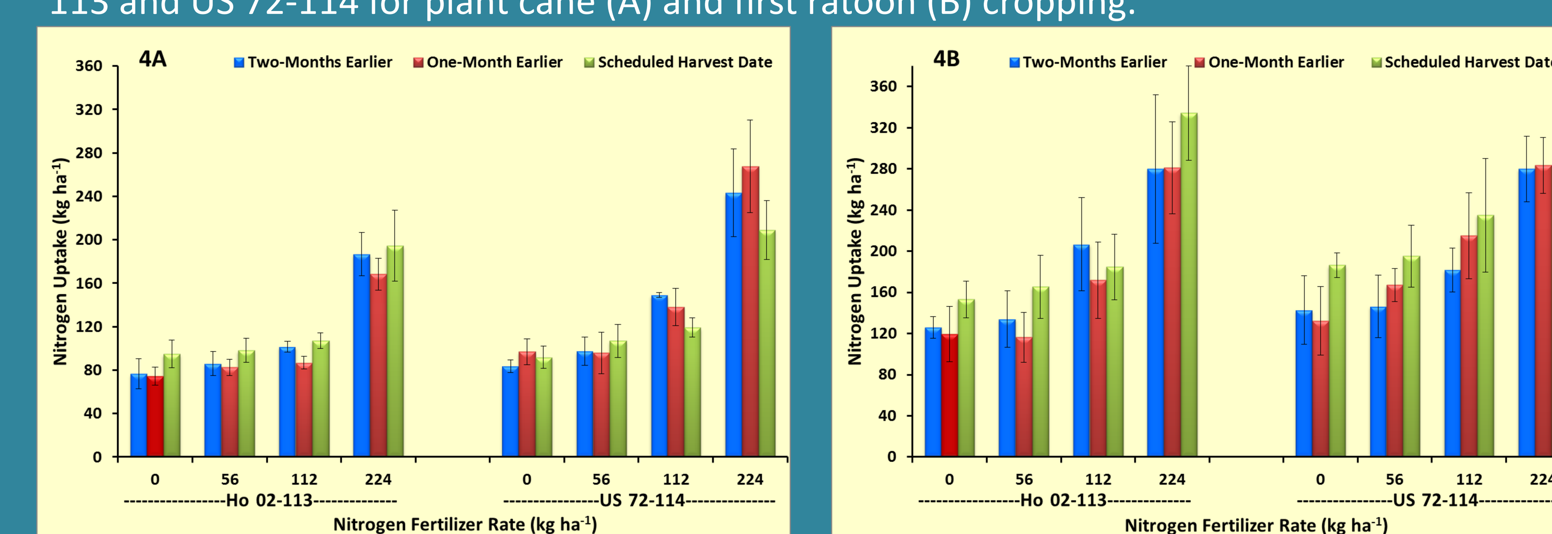

Figure 4. Effect of nitrogen and harvest date on nitrogen uptake of energy cane variety Ho 02-113 and US 72-114 for plant cane (A) and first ratoon (B) cropping.

- Simple Ratio and NDVI had a slightly higher coefficient of determination, r^2=0.48 and r^2=0.43, respectively when millable stalk was harvested at scheduled date and showed a decreasing r^2 values with earlier harvesting dates.
- Millable stalk yield was generally higher when harvested at earlier dates with an average yield of 101 and 85 Mg ha^{-1} for plant cane and first ratoon, respectively. Also, yield increased with increasing N rate for both plant cane and first ratoon cropping (Figures 3A and 3B).
- Cane harvested at scheduled harvest date showed: 1) higher N uptake for plant cane and first ratoon (128 and 217 kg N ha^{-1}) than those harvested at earlier dates, and 2) N uptake increased with N application rate (Figures 4A and 4B).