PREDICTION OF PHENOLOGICAL STATUS OF SUGAR CANE BY MULTISPECTRAL IMAGES OF ORBITAL SENSOR PASSIVE

CARLOS CESAR SILVA JARDIM [1], ANAMARI VIEGAS DE ARAUJO MOTOMIYA[2], ROSILENE OLIVEIRA DOS SANTOS[3], VALERIA LIMA DA SILVA[4], EGAS JOSE ARMANDO[5], ROGERIO ALVES DE OLIVEIRA[6]

[1] Doutorando em Agronomia, Universidade Federal de Goiás, 66-999356288, carlosbirosk@hotmail.com
[2] Prof.ª Dra na Faculdade de Ciências Agrarias da Universidade Federal da Grande Dourados
[3] Mestranda em Engenharia Agrícola, Universidade Federal da Grande Dourados
[4] Mestranda em Desenvolvimento Rural Sustentável, Universidade Estadual de Goiás
[5] Prof. Msc na Faculdade de Agronomia e Engenharia Florestal, Universidade Eduardo Mondlane - Moçambique
[6] Mestrando em Engenharia Agrícola, Universidade Federal da Grande Dourados

ABSTRACT:
The use of sensors to evaluate plants is dated from the first images made available in 1964. In order to use the images in the character of temporal studies, the conversion of Digital number into absolute reflectance, denominated as Reflectance at the top of the atmosphere of the observed scene, was done the equation provided by USGS Explorer is used. The objective of this study was to evaluate the spectral bands in the prediction of the phenological stages of sugarcane. Descriptive statistics, variance analysis and regression were used to determine the properties of the spectrum reflected in the sugarcane in the regrowth phase. The spectral bands were evaluated separately to obtain the regression model that demonstrated the vegetative development of the crop as a function of days after regrowth. The temperature requirement for the development of sugarcane is divided into the vegetative phases of the crop, requiring 200 ADD to complete the stage of establishment of the crop, 800 days accumulated days to reach the maximum vegetative potential, and 1600 DD to start maturation. These values can vary appreciably according to techniques of standardization of maturation with the application of hormonal regulators. The spectral bands evaluated showed significant determination functions for the maximum biomass production that occurred at 10 days after the pigment saturation of the spectral bands.

KEYWORDS: Degrees days, Saccharum officiarum, Spectral band

PREDIÇÃO DE ESTADO FENOLÓGICO DA CANA-DE-AÇÚCAR POR MEIO DE IMAGENS MULTIESPECTRAIS DE SENSOR ORBITAL PASSIVO

RESUMO:
A utilização de sensores para avaliar plantas é datada desde as primeiras imagens disponibilizadas em 1964. Para utilizar as imagens em caráter de estudos temporais, foram realizadas a conversão de *Digital number* em refletância absoluta, denominada como Refletância no topo da atmosfera da cena observada, onde se utiliza a equação fornecida pela USGS Explorer. Objetivou-se avaliar as bandas espectrais na predição dos estádios fenológicos da cana-de-açucar. Foram realizadas as estatísticas descritivas, análise de variância e regressão para a determinação das propriedades do espectro refletido na cana de açúcar na fase de rebrota. As bandas espectrais foram avaliadas separadamente para a

obtenção do modelo em regressão que demonstrasse o desenvolvimento vegetativo da cultura em função dos dias após a rebrota. O requerimento em temperatura para o desenvolvimento da cana de açúcar é dividido nas fases vegetativas da cultura, sendo requerido 200 GDA para completar a fase de estabelecimento da cultura, 800 graus dias acumulados para alcançar o máximo potencial vegetativo, e 1600 GD para início da maturação. Esses valores podem variar sensivelmente de acordo com técnicas de uniformização da maturação com a aplicação de reguladores hormonais. As bandas espectrais avaliadas demostraram funções de determinação significativas para a máxima produção de biomassa que ocorreu aos 10 dias após a saturação de pigmentos das bandas espectrais.
PALAVRAS-CHAVE: Graus Dias, Saccharum officiarum, Banda Espectral

INTRODUCTION

The use of sensors to evaluate plants has been dated since the first images made available in 1964, with the first vegetation index called Simple Ratio - SR (simple ratio index) (BIRTH; MCVEY, 1968). After the evolution of the products offered, there was also a great increase in the number of existing indexes, with the most diverse applications .

For the characterization using the blue spectrum (450 - 510 nm), it is possible to evaluate the distinction between soil and vegetation, mapping of water bodies and representation of deciduous vegetation. The use of the green spectrum (530 - 590 nm) helps in the identification and quantification of healthy vegetation . The red spectrum (640 - 670 nm) comprises the quantification of chlorophyll a and the differentiation between plant species. The near infrared band (850 - 880 nm) is used to survey and quantify biomass, while the short wave infrared “Short-wave Infrared - SWIR1” (1570 - 1650 nm) is used to measure moisture in plants and soil (SHIRATSUCHI, 2014).

With the use of this information, it is possible to model several indices that result in the inference of a characteristic of the analyzed surface, being popularized those that have greater versatility and application, like the Normalized Difference Vegetation Index (NDVI). For measurement of plant characteristics attention should be paid to the plant physiology with requ erimentos light between 400 and 700nm, also known as radiation fotosintet sterically active (Dal Pai et al., 2016). The objective was to evaluate the temporal spectral response of sugarcane with different simple spectral bands in order to determine the stage of development .

MATERIAL AND METHODS:

The present study was carried out in an area of cane, cultivated in the second year after planting, with an average cycle of approximately 12 to 18 months that comprises the phenological phases from the first harvest to the next harvest. The clone used for evaluations was RB985476, which fits with the characteristic of “Energy cane” as described by MATSUOKA et al. (2014). The evaluated site is located at 22 ° 51'18.0 "S and 54 ° 40'00.6"W with an area of approximately 11 hectares, projected in geographic coordinates SIRGAS 2000.

The collection of the image ns for the use of the geoprocessing processes was carried out from August 30, 2017 to September 18, 2018, with the base date of 24 revisits, and on 15 dates there were no interference from clouds above the observed object, the other dates were discarded due to the impossibility of full observation. The image collections were selected

from the USGS explorer file, free of charge and with Tier 1 correction processing, which includes the post-processed image treatment and positioning correction.

For the use of images in the character of temporal studies, the conversion of DN (digital number) into absolute reflectance was carried out, called Reflection in the top of the atmosphere (TOA) of the observed scene, where the equation provided by the USGS explorer is used.

After correcting and converting the images in the Qgis 3.2.3 Las Palm, with integration of complements with SAGA GIS 2.3.2. The centroid values of the pixels of the bands corresponding to the spectral were extracted bands of blue (b2), green (b3) , red (b4), near infrared (b5), and short wave infrared (B6) along the vegetative evolution of plants in the area.

To characterize the accumulated degrees days (ADD or *GDD in portuguese*), it was performed the sum of the degrees days with daily use of the equation for Arnold (1960) whereas the core temperature as limiting ly lower.

Descriptive statistics, analysis of variance and regression were performed to determine the spectral properties reflected in the sugarcane in the regrowth phase, in order to model the development of the culture using remote sensing. The bands were evaluated separately to obtain the regression model that demonstrated the vegetative development of the crop according to the days after regrowth.

RESULTADOS E DISCUSSÃO:

For the characterization of the experimental area compared to weather elements (Figure 01) were used information available in the database Institut National Meteorology (INMET) among peri ll August 2017 and September 2018. The variables were previously requested to the server, since the detailed meteorological elements are of restricted access, and provided upon formal request.

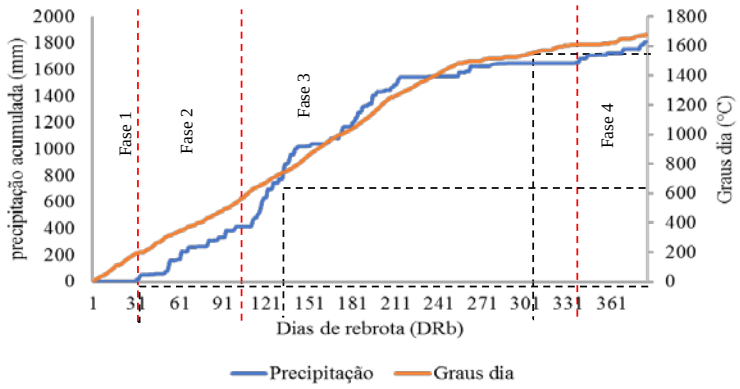

Figura 01- Precipitação acumulada e graus dias para a cultura da cana em Jutí-MS

According to Caetano (2017), the temperature requirement for the development of sugar cane is divided into the vegetative phases of the crop , requiring 200 GDA to complete the phase of establishment of the crop, 800 degrees accumulated days to reach the maximum vegetative potential, and 1600 degrees days to start maturation. These values may vary substantially according to maturation uniformization techniques with the application of hormonal regulators.

According to Silva et al. 2010, the application water per phase of sugar cane-sugar varies near 3.0 mm days to Phase 1 suming approximately 90 mm in phase; 3.8 mm dia for Phase 2, adding up to approximately 230 mm; and 5.1 mm day in Phase totaling approximately 1070 mm , and the ripening stage no significant losses by restricting hydric, immediately note that there was no restriction on water in any phase of vegetative culture.

The period of comparison and modeling using spectral bands in sugar cane showed a significant difference until the 133 days of regrowth, and after that period, the plants did not show variances that showed a correlation with the production and biometric attributes. of the plants (Figure 02).

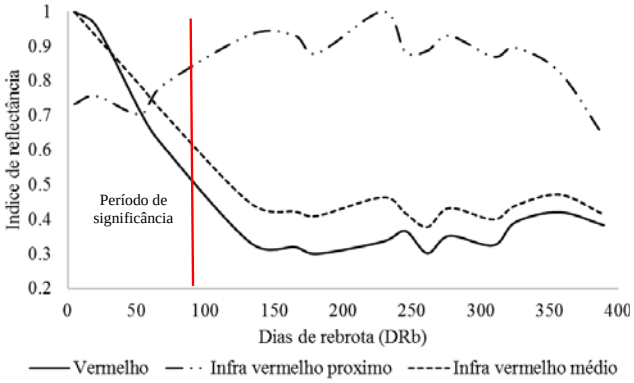

Figura 02 – Saturação de bandas espectrais em função de dias após a rebrota

CONCLUSIONS

The spectral bands evaluated showed significant determinant functions for the maximum biomass production that occurred at 10 days after the saturation of the spectral bands. Saturation of chlorophyll A and B pigments captured by the orbital sensor occurs at 133 days of regrowth. The use of the near infrared beam (NIR) can be applied at any time in order to verify the biological stress of the plant by varying the balance between chlorophyll A and B, but with a low predictive power for determining the development phase.

REFERENCES:

BIRTH, G. S.; MCVEY, G. Measuring the Color of Growing Turf with a Reflectance Spectrophotometer. **Agronomy Journal**, v. 60, p. 640–643, 1968.

CAETANO, J.M. **Modelagem agrometeorológica da cana-de-açúcar nas condições edafoclimáticas do centro-oeste goiano**, 2017. 125 f. Tese (Doutorado em Agronomia: Solo e Água) Escola de Agronomia, Universidade Federal de Goiás, Goiânia, 2017.

DAL PAI, A.; ESCOBEDO, J. F.; DAL PAI, E.; PAULA, B. V. H. N. Equações de estimativa da radiação solar fotosinteticamente ativa para diferentes coberturas de céu. In: XXXIX REUNIÓN DE TRABAJO DE LA ASOCIACIÓN ARGENTINA DE ENERGÍAS RENOVABLES Y MEDIO AMBIENTE (ASADES) (LA PLATA, 2016). Disponível em: <http://hdl.handle.net/10915/66936>. Acesso em: 1 mar. 2019.

MAIA JUNIOR, Sebastião de Oliveira. **Tolerância de cultivares de cana-de-açúcar ao déficit hídrico: relações hídricas, trocas gasosas, fluorescência da clorofila e metabolismo antioxidante**. 2017. 146 f. Tese (Doutorado em Agronomia: Produção Vegetal) - Centro de Ciências Agrárias, Programa de Pós-Graduação em Agronomia, Universidade Federal de Alagoas. Rio Largo, 2017.

MATSUOKA, S.; KENNEDY, A. J.; SANTOS, E. G. D. Dos; TOMAZELA, A. L.; RUBIO, L. C. S. Energy Cane: Its Concept, Development, Characteristics, and Prospects. **Advances in Botany**,v. 2014, p. 1–13, 2014.

SILVA, M. de A.; PINCELLI-SOUZA, R. P.; BARBOSA, A. de M. Efeitos do estresse hídrico na fluorescência e conteúdo de clorofila em cultivares de cana-de-açúcar com tolerância contrastante. **Bioscience Journal**, v. 34, n. 1, p. 75–87, 2018.

SILVA, T. G. F. da. et al. Requerimento hídrico e coeficiente de cultura da cana-de-açúcar irrigada no semiárido brasileiro. **Revista Brasileira Engenharia Agrícola e Ambiental**, Campina Grande, v. 16, n. 1, p. 64-71, 2012.

SHIRATSUCHI, L. S.; BRANDÃO, Z. N.; VICENTE, L. E.; VICTORIA, D. de C.; DUCATI, J. R.; DE OLIVEIRA, R. P.; VILELA, M. de F. Sensoriamento Remoto: conceitos básicos e aplicações na Agricultura de Precisão. **Agricultura de precisão: resultados de um novo olhar**, 2014.