ESTIMATING TIME AND RATE OF HARVEST-AID APPLICATION USING REMOTE SENSING DATA

Juan Landivar-Bowles
Mahendra Bhandari
Daniel Gonzales
Jose L. Landivar-Scott
Texas A&M AgriLife, Research
Corpus Christi, TX
Murilo Maeda
Texas A&M AgriLife Extension
Lubbock, TX
Anjin Chang
Texas A&M University – Corpus Christi
Corpus Christi, TX
Jinha Jung
Purdue University
West Lafayette, IN
Josh McGinty
Texas A&M AgriLife Extension
Corpus Christi, TX
Craig Bednarz
West Texas A&M University
Canyon, TX

Abstract

Defining the time and rate of harvest-aids application are key management parameters to assure an efficient harvest and premium fiber quality. Producers often defoliate when most of the field meets certain maturity stage, however spatial variability in field maturity often affect the uniformity of the defoliation. We propose estimating the time and rate of defoliation using remote sensing data (vegetative indexes). A linear regression model was developed using Excessive Greenness Index (ExG) as the independent variable and the % open boll for both, the irrigated and dryland plots as dependent variables. The coefficient of determination (R^2) for the resulting model was 0.97. The study demonstrated that ExG can be used to estimate time and rate of defoliation and proposed that spatial variability in ExG can be used to develop management zones for prescription application of harvest-aids.

Introduction

Senescence is the final stage of leaf aging and crop maturity. The application of harvest-aid chemicals is a widely adopted cultural practice to induce premature leaf abscission and prepare the crop for mechanical harvest. These compounds interact with environmental and physiological factors to promote leaf drop and allow timely and efficient harvest of the lint, reducing harvest losses from weathering. These factors include the effects of water stress on the thickness and composition of the leaf cuticle (Roberts et al., 1996, Cathey 1986, Oousterhuis et al., 1991), plant nitrogen status effects on fruit set, vegetative growth, and senescence (Hake., et al., 1990 and Hake, et al., 1996). In general, mature plants are more responsive to harvest aids (Gwathmey et al., 2001). Also, environmental, and physiological conditions induce complicated interactions between plant hormones which affect the maturity process (Cothren et al., 1991), and the effectiveness of harvest-aid chemicals in cotton. Several methods have been proposed to determine the best time and rate of harvest aid applications (Brecke et al. 2001). Generally, these methods are classified into two groups; temporal and relative measures (Gwathmey et al., 2016). Temporal measures place crop maturity on a time scale, for example, the time of` 60% open boll. Relative measures quantify maturity differences between fields based on the physiological status of the crop; an example is Nodes Above Cracked Boll (Kerby et al., 1992, Gwathmey et al. 2016).

Overall Objectives and Hypothesis

The objectives of this study are to explore the feasibility of using crop health status (vegetative index), obtained via remote sensing to estimate crop maturity. Specifically, our hypothesis is: *Vegetative indexes such as Excessive*

Greenness Index (ExG) can be used to estimate % open boll of a crop, and therefore can be used to determine the time and rate of defoliation.

Time course of green and open boll development was measured weekly from bloom initiation until harvest for cultivar PHY 499 WRF at Corpus Christi, Texas, during the 2016 season, under dryland and irrigated conditions. This data was used to estimate % open bolls through the season. An Unmanned Aircraft Vehicle equipped with an RGB sensor was flown weekly over both, the irrigated and dryland plots.

Excessive Greenness Index (**ExG**) is an RGB-based Vegetative Index calculated using the following equation.

$$\mathbf{ExG} = 2\boldsymbol{Gn}-\boldsymbol{Rn}-\boldsymbol{Bn};$$

where, R$\boldsymbol{n}$, G$\boldsymbol{n}$ and B$\boldsymbol{n}$ are normalized Red, Green and Blue, respectively. ($\boldsymbol{Rn}$=$\boldsymbol{R}$/($\boldsymbol{R}$+$\boldsymbol{G}$+$\boldsymbol{B}$); $\boldsymbol{Gn}$=$\boldsymbol{G}$/($\boldsymbol{R}$+$\boldsymbol{G}$+$\boldsymbol{B}$); $\boldsymbol{Bn}$=$\boldsymbol{B}$/($\boldsymbol{R}$+$\boldsymbol{G}$+$\boldsymbol{B}$)).

A linear regression model was developed using ExG as the independent variable and the % open boll for both, the irrigated and dryland plots as dependent variables. The coefficient of determination (R^2) for the resulting model was 0.97.

This study demonstrated that (1) the Excessive Greenness Index (ExG) can be used to estimate time and rate of defoliation, (2) 50 and 60% boll open corresponds to a greenness index of 0.18 to 0.22, respectively, (3) defoliants can be applied when most of the field reaches an ExG < 0.22, (4) ExG can be used to adjust harvest-aid rates by developing management zones for prescription application of harvest-aids.

Results of this study will be used to develop a defoliation management tool to forecast the optimum date of defoliation of a crop, by using the excessive greenness index. The tool will have the capability of adjusting harvest-aid rates based on the spatial variability of crop maturity.

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