ABSTRACT

Precision Agriculture has the goal of reducing cost which is difficult when it is related to fertilizers application. Nitrogen (N) is the nutrient absorbed in greater amounts by crops and the N fertilizers application present significant costs. The use of spectral reflectance sensors has been studied to identify the nutritional status of crops and prescribe varying N rates. This study aimed to contribute to the determination of a model to discriminating biomass and nitrogen status in wheat through two sensors, GreenSeeker and Crop Circle, using the Resilient Propagation and Backpropagation Artificial Neural Networks algorithms. As a result was detected a strong correlation to the sensor readings with the aboveground biomass production and N extraction by plants. For both algorithms it was established a satisfactory model for estimating wheat dry biomass production. The best Backpropagation and Resilient Propagation models defined showed better performance for the GreenSeeker and Crop Circle sensors, respectively.

Keywords: Backpropagation, Crop Circle, Greenseeker, Nitrogen Fertilization, Triticum Aestivum L., Resilient Propagation

INTRODUCTION

Precision Agriculture has the goal of reducing cost which is difficult when it is related to fertilizers application. Currently, research has been carried out aiming to estimate the minimum fertilizers rates need to be applied involving aggregate technology equipment, such as the use of spectral reflectance sensors, which consist of equipment able to absorb bands of...
light reflected by plants and measuring them so that they can be interpreted and associated with different levels of cultures attributes. Among the key plants attributes being correlated with reading spectral reflectance sensors are potential productivity (Lofton et al., 2012), dry biomass accumulation (Hansen & Schjoerring, 2003), N accumulation in the leaves (Feng et al., 2008a; Yao et al., 2010).

Nitrogen (N) is a crucial element for plants development (Pathak et al., 2011), being essential for vegetative growth and the photosynthetic process. Nitrogen fertilizers account for a significant portion of the agricultural production costs. Due to the N dynamics in the soil, loss of considerable element may occur and may even lead to environmental damage (Shanahan et al., 2008).

Since there may be demands variables for N in the same agricultural area (Koch et al., 2004), it would be important have the N fertilizer distribution following the principles of Precision Agriculture, which consists of techniques that evaluate several features found along the same area in the agricultural production cycle, thus allowing analysis and interventions on the crops at variable rates (Inman et al., 2005; Kitchen, 2008).

Grohs et al. (2009) found a quadratic relationship between the Normalized Difference Vegetation Index (NDVI) and aboveground biomass production of wheat and barley cultivars. This led to the determination of the NDVI saturation point occurring when the curve reached its inflection point, without reducing the maintenance of NDVI response depending on the biomass production. Some papers in the literature reinforce these results looking for a positive correlation between reading spectral reflectance attributes of wheat plants increasing N rates during the crop development (Erdle, Schmidhalter & Mistlele, 2011; Hansen & Schjoerring, 2003).

The correlation between reading plant reflectance attributes is also observed in studies with other crops such as cotton (Rossato et al., 2012), sugar cane (Portz et al., 2012), maize (Solari et al., 2008), and apple (Perry & Davenport, 2007).

All these studies support the use potential of this technology to develop algorithms to manage variable N rate application. For this, Raun et al. (2002) proposed the identification of the crop productive potential without fertilizer with NDVI (forming an index YP0) which multiplied by an response index to fertilizer application (RI - response index) can determine the crop yield potential with applying additional N rate, assisting in the management of nitrogen fertilizer. If the N response is expected, then management strategies can be changed to N application based on crop response (Mullen et al., 2003).

In this way, Bredemeier et al. (2013) suggest a unique model for N rate prescription based only on wheat crop yield potential. So for low yield potential sites, detected by lower NDVI value, the N amount to be applied would be lower than for sites with high yield potential, because in these places, the high yield dilutes the N content in plants. Raun et al. (2002) found an increase in N fertilization efficiency by 15% using the model proposed by Bredemeier et al. (2013).

In general, to perform correlations between crops attributes and the readings spectral reflectance sensors typically statistical techniques are used (Grohs et al., 2011; Feng et al., 2008b). Alternative methods have been proposed based on the concepts of Machine Learning (ML) (Jiang et al., 2010; Mishra et al., 2011). One technique that has proved to be workable is using Artificial Neural Network (ANN) through the Backpropagation algorithm (Yang et al., 2011, Liu et al. 2010). To improve the performance of the backpropagation algorithm the Resilient Propagation algorithm was proposed (Riedmiller & Braun, 1993).

This study was carried out to contribute to the generation of models in agriculture through the use of ANN, specifically studying their performance discriminating biomass and...
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