MID-SEASON PREDICTION OF WHEAT GRAIN YIELD POTENTIAL AND NITROGEN RESPONSE

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Introduction

Algorithms based on active sensors for in-season nutrient management in cereals are affordable, easy to use, and accurate. Solie et al. (2012) advanced a sensor-based approach for winter wheat N recommendations that uses in-season NDVI readings. Stone et al. (1996) was the first to report accurate grain yield prediction from mid-season NDVI and this over a range of locations.

Published work coming from this group has failed to identify the climatological boundary for determining exactly when the mid-season sensor reading should be collected. Several of their papers suggested that Feekes growth stage 5 (Large, 1954) provided improved prediction of final grain yield, but this inherently morphological method is highly subjective.

Rationale

Soil nutrient management has made significant advances in efficiency, especially with nitrogen (N) fertilization. Improved mid-season prediction of grain yield and ensuing fertilizer nitrogen rates is needed.

Objective

Sequential normalized difference vegetation index (NDVI) measurements from two long-term nutrient management experiments (Exp. 222 and Exp. 502) were used to further inspect predicting yield potential and decipher situations where added N is unlikely to increase winter wheat (Triticum aestivum L.) grain yields in the southern Great Plains.

Materials and Methods

- Eleven and ten NDVI sensor readings were collected for Exp. 222 and Exp. 502, respectively, over the course of the 2016 growing season (Table 1)
    - These readings were used by-date, and over dates to better predict grain yield collected from the same plots at harvest.
- Growing degree days retrieved from the Mesonet Wheat Growth Day Counter (https://www.mesonet.org/index.php/agriculture/category/crop/wheat/number_of_days_gdd_0)
- NDVI sensor readings collected with the GreenSeeker™
- Yield potential (YP_0) = NDVI/GDD where GDD is the number of days from planting to sensing where GDD>0.

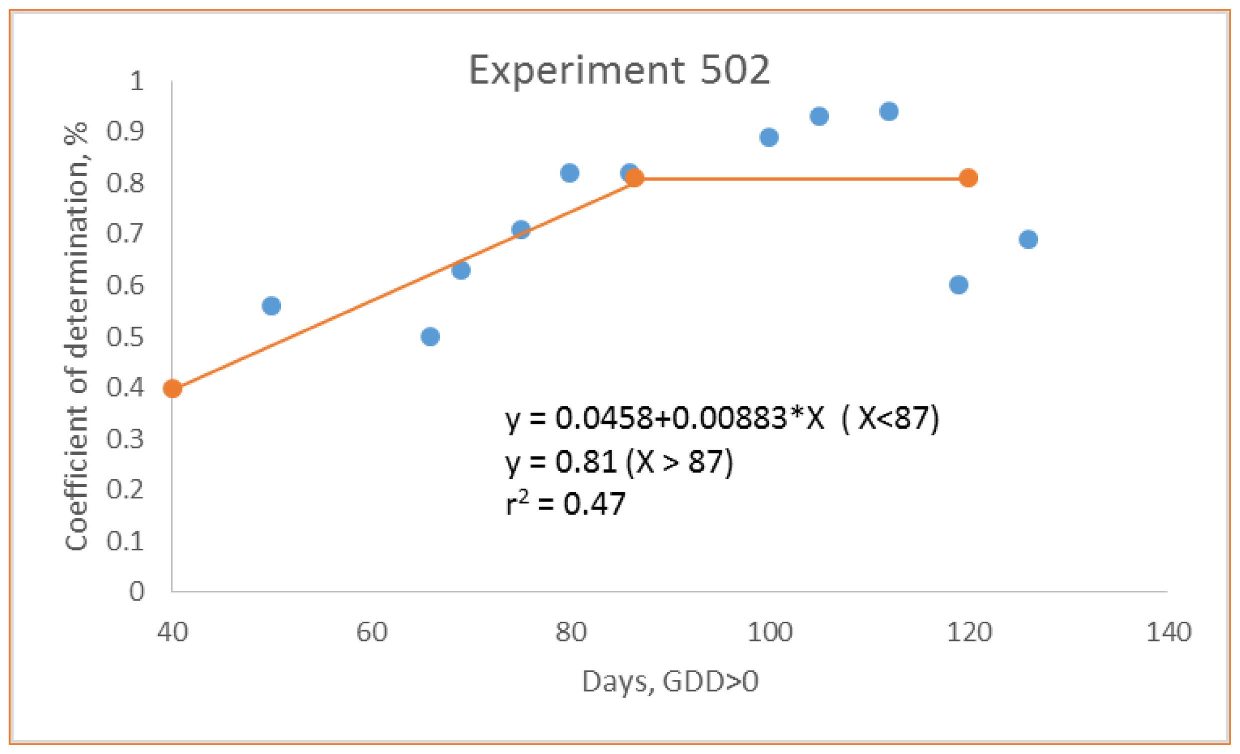

Figure 1. Relationship between the coefficient of determination (r^2) and GDD>0, for NDVI data collected over time, Exp. 502, Lahoma, OK, 2016.

Table 1. Sequential NDVI sensing dates of Exp. 222, Stillwater, OK and Exp. 502, Lahoma, OK, 2016

Exp.	Sensing Date
222	12/23/2015
	1/28/2016
	2/4/2016
	2/11/2016
	2/18/2016
	2/25/2016
	3/3/2016
	3/24/2016
	3/31/2016
	4/7/2016
502	12/18/2015
	2/2/2016
	2/9/2016
	2/18/2016
	2/23/2016
	3/1/2016
	3/15/2016
	3/22/2016
	3/29/2016
	4/5/2016
	4/12/2016

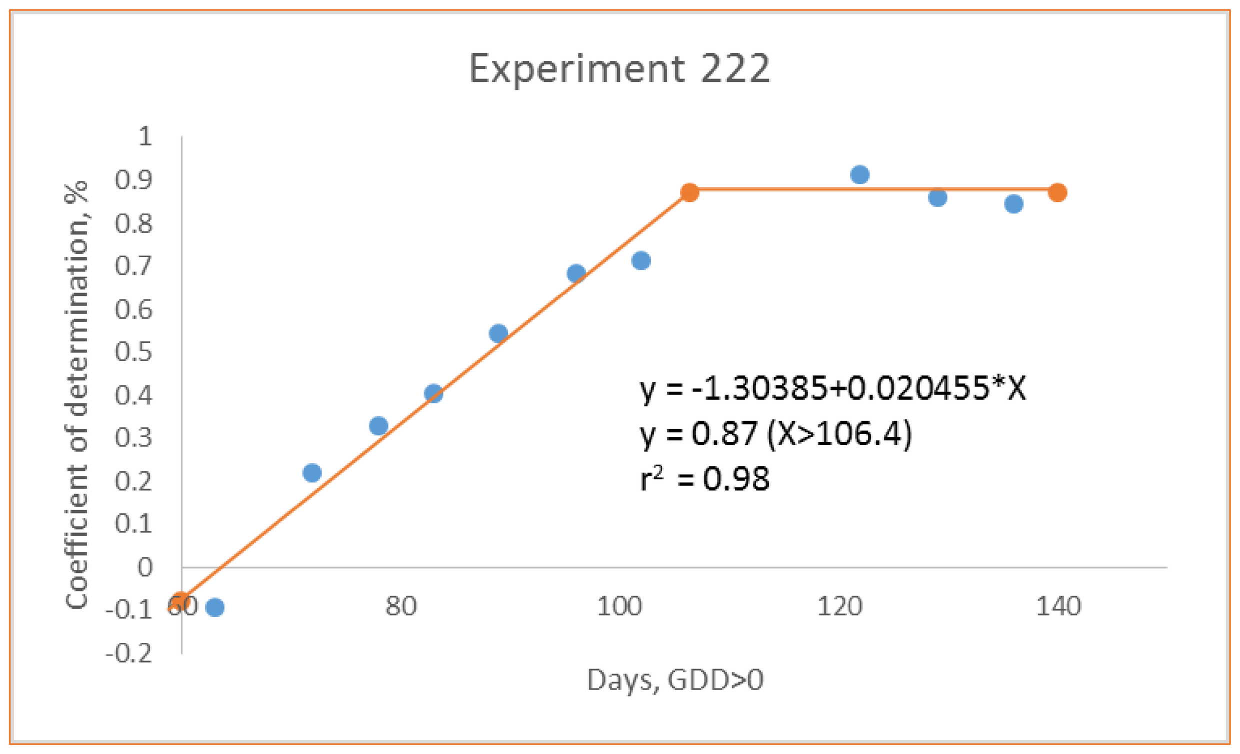

Figure 2. Relationship between the coefficient of determination (r^2) and GDD>0, for NDVI data collected over time, Exp. 222, Stillwater, OK, 2016.

Results

A significant relationship (α = 0.05) between NDVI and final grain yield for each of the sensing dates was found. The coefficient of determination (r^2) for each NDVI/yield relationship was then plotted as a function of corresponding GDD>0. A linear-plateau model was then fit to this relationship to determine if a viable joint and/or intersection existed. This would be apparent if an increase in GDD>0 no longer resulted in the improvement of the r^2 value (Nelson et al., 1985). This point or joint (GDD>0) would in theory be the ideal stage for predicting yield. Or in other words that point where the correlation between NDVI and wheat grain yield was maximized.

Exp. 222, r^2= 1.305+0.0204(GDD>0), when GDD<106; plateau for r^2 at 0.87 when GDD>=106 (Figure 2).

Exp. 502, r^2= 0.046+0.0088(GDD>0), when GDD< 87; plateau for r^2 at 0.81 when GDD>= 87 (Figure 1).

Conclusions

Linear plateau models for Exp. 222 and Exp. 502 showed that the correlation between NDVI readings and grain yield increased with advancing GDD>0. The linear-plateau model delivered an applied method for establishing when the correlation was the highest.

For Exp. 222 and Exp. 502, the point at which yield prediction was maximized was 106 and 87 (GDD>0), respectively.

Past, project work has focused on “growth stage” but where “growth stage” was subjective and could change depending on the individual collecting the reading. Utilizing the number of days where GDD>0 is more refined because as it embeds climatological estimates of growth that can be used in another year and/or environment. This parameter fits well into what is already a predictive tool, and that could be monitored as any given season progresses. Knowing this value can serve as a guide as to exactly when the NDVI reading should be collected.

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