RESULTS FROM THE FIRST YEAR OF ON-FARM N RATE AND TIMING STUDIES

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ABSTRACT

Studies have shown over the past couple of years that utilizing sensor based nitrogen rate calculator (SBNRC) for in-season fertilizer has proven beneficial to yields and protein in the southern Great Plains. However, current SBNRC recommendations and algorithm are based upon trials conducted in central Oklahoma, rather than regionally based. The objective of the larger study is to determine if it is possible to develop a regional dependency component of SBNRC in Oklahoma. For year one of this study, the objective was to employ a nitrogen timing and rate study to assess differences on responses of yield and protein across multiple on-farm locations. In the 2018-2019 growing season, eight locations were established and harvested ranging from the central, north central, and panhandle regions of the state. Each location had a RCBD trial consisting of a check, and a preplant and topdress application of four rates of N fertilizer. Canopeo and NDVI readings were taken in season, with yield and protein being measured post harvest.

INTRODUCTION

Producers aim to maximize production while still staying profitable with inputs. Over the past 15 years, the average price per bushel of winter wheat have been variable, while for the most part, the cost of fertilizer has steadily increased (USDA-NASS, 2019).This charges researchers with providing the information that allows producers to maximize their production, with efficient amounts of nutrients. One option is aiding producers against production cost by increasing nutrient use efficiency.

Nutrient use efficiency is the efficiency of a crop to utilize nutrients that are both from the soil and via fertilizer application, and use those nutrients to produce grain (Raun and Johnson, 1999). Estimation of the world's nutrient use efficiency has shown to be 33, 16, and 19% for N, P, and K, respectively (Dhillon *et al.*, 2019). Though these are estimates, such low use efficiencies are not sustainable at today's standards. Increasing these values has become a mission within the agronomic community, leading to the formation of the 4R Nutrient Stewardship concept (Johnston and Bruulsema, 2014). The 4R's stand for applying the Right source of nutrients, at Right rate, at the Right time, and in the Right place.

One aspect of increasing NUE is by applying fertilizer at the right time. Timing of Nitrogen fertilizer has been looked at by many. Melaj *et al.* (2003), when looking at N fertilizer timing in winter wheat in Argentina, found that lowest values of NUE were found in pre-plant fertilizer applications, and applications around Feekes 3. This is thought to be caused by N immobilization due to the environment and climate. The highest amount of nitrogen uptake was found to be around the time of rapid wheat growth, in the spring during green-up.

Souza (2018) echoed these results, reporting that delaying of nitrogen fertilizer until Feekes 8 did not lead to a loss in yield, and in most cases, protein continued to increase at later fertilizer applications. A significant finding of this study was that the highest usage efficiency of fertilizer applied was found to be when the crop was growing at higher rates, around Feekes 6 and 7.

OSU currently employs the use of the Sensor Based Nitrogen Rate Calculator (SBNRC). Raun *et al.* (2002) observed that the yield potential of winter wheat could be predicted in-season using optical sensor readings. These optical sensor readings taken from an active sensor gives a readout of reflectance, read as Normalized Difference Vegetation Index (NDVI), which is then used to calculate a nitrogen rate. Building the model for this calculation required much data, all of which derived using long term trials in Lahoma and Stillwater, OK across many years and varying conditions (Raun et al., 2005). The SBNRC uses this algorithm as the current sensor based recommendations for N in winter wheat. These current recommendations are based for the entire state of Oklahoma.

Oklahoma's climate can vary greatly across the state. Annual Temperature, precipitation, and growing season changes across the state can affect the phenological growth stages in winter wheat (Porter and Gawith, 1999). Across the state, length of growing season, annual rainfall, and annual temperature can vary from region to region. Oklahoma Climatological Survey divides the state of Oklahoma into 9 climatological zones (Figure 1), each consisting of counties that have average climates similar to their respective group. When looking at regionalizing the state for this study, climatological zones offer distinctions and characteristics between regions that fit well with wheat growth changes in climate.

The objective of this study is to employ a nitrogen timing and rate study to assess differences on responses of yield and protein across multiple on-farm locations.

MATERIALS AND METHODS

This trial was applied in the 2018-2019 growing season to 14 sites, with harvest occurring at 8 sites, across 3 climatological zones. Plots consist of a 2 x 4 factorial plot, 2 timings (preplant and topdress [Feekes 5] fertilizer application) by 4 rates (25%, 50%, 75%, 100% yield potential rate). Rates were determined using the OSU recommendations of 2 lb ac^{-1} N per 1 bu ac^{-1}, using ammonium nitrate (34-0-0) as the source. Site specific rate was determined using the yield potential of the area, considering the productivity of the location, environment parameters, and historical yield. RCBD plot design was utilized, with 4 repetitions. Plot size is 6' x 6', with 4' alleys between repetitions. Canopeo and Greenseeker readings were taken throughout the growing season to monitor growth of plots. At topdress fertilizer application, final NDVI readings were taken for SBNRC calculations. At maturity, 3' x 3' samples were taken from each plot, total biomass removal. Samples are threshed using small grains harvester. Post-harvest grain quality were analyzed using near infrared spectroscopy Diode Array NIR analysis Systems model DA 7000 (Kungens Kurva, Sweden) to measure grain moisture and protein from grain. Statistical analysis was ran in SAS 9.4.

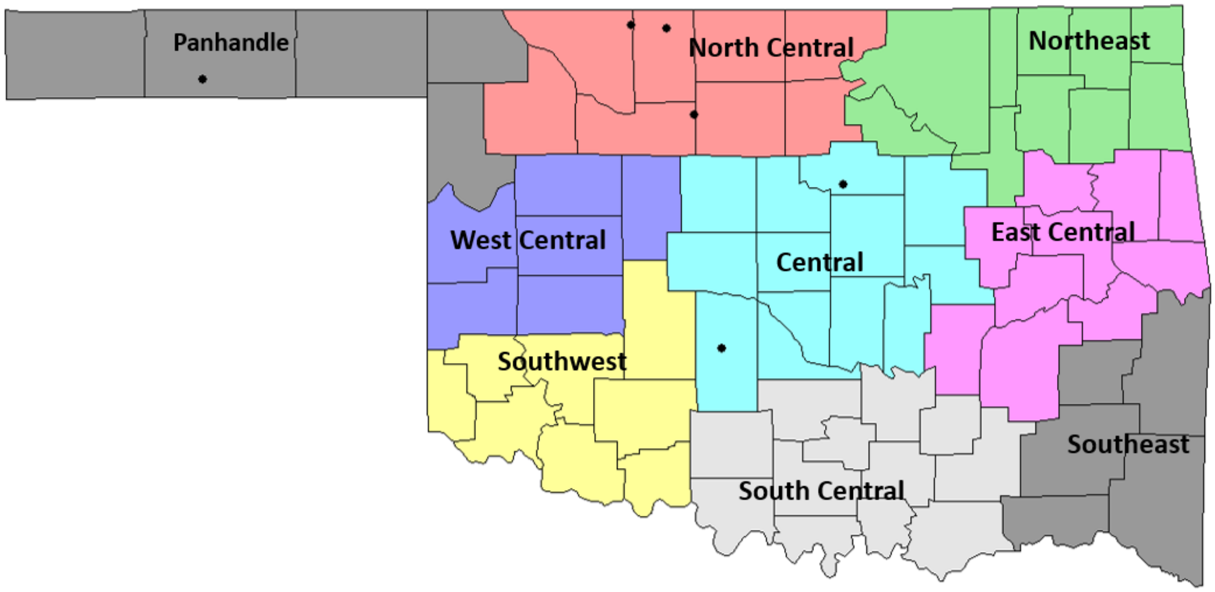

Figure 1 Oklahoma, broken into each Climatological Zone, and all the locations harvested from this trial. The point in Panhandle Zone represents two sites in a similar location. The southernmost point in Central Region also represents two sites in similar location

RESULTS AND DISCUSSION

This trial was applied in the 2018-2019 growing season to 14 sites, with harvest occurring at 8 sites, across 3 climatological zones (Figure 1). Of these 8 sites, two sites had a response in yield, and 7 had a response in protein.

The Byron (North Central) and Perkins (Central) locations had significance for yield and protein (Figure 2). For both of these locations, there was an increase in yield in the preplant applications all the way to the 100% rate (for both locations, 100 lb N ac^{-1}). Bryon maximized its yield (68 bu ac^{-1}) with the pre-plant application with 100 lb N ac^{-1}, while the topdress application maximized yield (73 bu ac^{-1}) with the top-dress application of 75 lb N ac^{-1}. This is attributed to loss of nutrient use efficiency of applying early in season. The proteins at this location increased with the larger applications of N, as expected, but also increased more with the top-dress

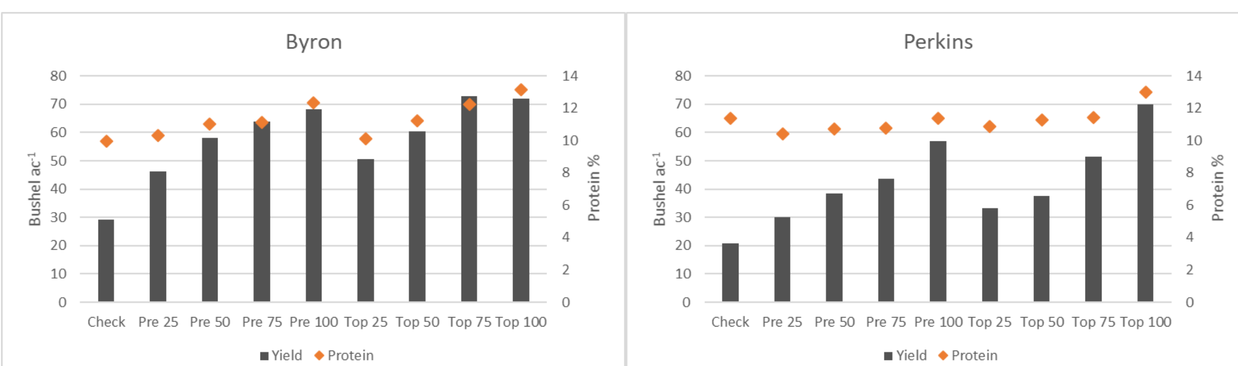

Figure 2 Byron and Perkins locations. These graphs show the yield (represented by bars, left side axis) and protein (represented by points, right side axis) plotted against treatments on the x axis ("pre 25" means pre-plant 25 lb ac^{-1} N application, "top 50" means top-dress 50 lb ac^{-1} application, etc.)

application. This is attributed to the application of N was applied during the time of highest N uptake, allowing more N available to move into protein.

Perkins never plateaued, so it was unknown whether yield or protein was maximized. Yield was increased with the top-dress application, as Byron did. The proteins increased with the larger applications of N, but also increased more with the top-dress application, echoing the Byron location.

Chickasha 1 and Lahoma were two of the 7 locations that did not have a yield response, but had a response in protein. The protein increased with the larger applications of N, and also increased with the top-dress application against the pre-plant application. Again, this is attributed to the application of N being applied during the time of highest N uptake, allowing more N available to move into protein.

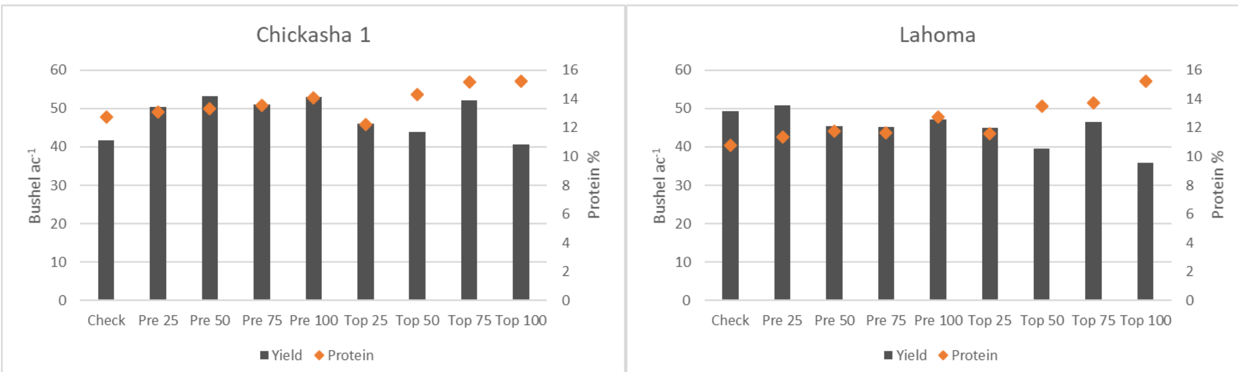

Figure 3 Chickasha 1 and Lahoma locations. These graphs show the yield (represented by bars, left side axis) and protein (represented by points, right side axis) plotted against treatments on the x axis ("pre 25" means pre-plant 25 lb ac^{-1} N application, "top 50" means top-dress 50 lb ac^{-1} application, etc.)

While one portion of this study is to look at regional differences in responses to sensor based management, the lack of responsive locations has resulted in no conclusive answers. However, the responses recorded give further support to using top-dress applications of N for potential increases in yield and protein over pre-plant applications.

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