ANALYSIS OF 10 YEARS OF N RATE AND TIMING WORK IN OKLAHOMA WINTER WHEAT

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ABSTRACT

Producers face many hurdles throughout the year and with the price of chemical herbicides and fertilizer on the rise, one of the ways producers can mitigate their margins is by perfecting their nitrogen fertilizer rates and timing f applications. In this study that was started in the 2009-2010 winter wheat cropping season, winter wheat was planted in multiple location from the 2009-2010 cropping season to the 2019-2020 winter wheat cropping season. During this time period the study has had 16 different nitrogen application treatments over four replications. During this time period of the 38 site years there was 25 that had reported a response to nitrogen application on winter wheat grain yields.

INTRODUCTION

In the year 2020, the state of Oklahoma planted 4.25 million acres of winter wheat; of those 4.35 million acres, 2.6 million acres were harvested. Those 2.6 million acres produced 104 million bushels of winter wheat, which sold for an average 4.55 dollars a bushel (USDA-NASS, 2020). Producers face many hurdles to make their margins and with the price of wheat varying from year to year and the cost of fertilizers increasing over the years, it’s not getting any easier.

One way a producers can help themselves is to increase their nitrogen use efficiency (NUE). NUE can be defined as the efficiency of a crops to utilize the nitrogen that is already present in the soil as well as the nitrogen applied as fertilizer and is currently 33% for the worldwide (Raun and Johnson, 1999). Raun and Johnson (1999) go on to say that one of the many ways we can increase NUE is to apply fertilizer as a top-dress application. This goes to support the idea of the 4Rs created by (Johnston and Bruulsema, 2014), the 4Rs stand for the Right time, Right source, Right place, and Right rate. The objective of this study was to evaluate and determine the optimum nitrogen fertilizer timing and rate by location and environment so it may be replicated in the future.

MATERIALS AND METHODS

This study has was started in the year 2009 and has continued to be planted to this current cropping season. This study has been conducted in five different locations across Oklahoma over the years. These locations are Lahoma, Hennessy, Lake Carl Blackwell (LCB), Stillwater (Efaw), and Perkins, with the study having multiple locations a year. A RCBD was created originally with ten different nitrogen applications over 4 replications, these ten nitrogen treatments can be seen in the first ten treatments in (table 1). In the 2010-2011 cropping season four more treatments were established adding four pre-plant application rates of 50 lb N ac^{-1}, 75 lb N ac^{-1}, 125 N lb ac^{-1}, and

200 lb N ac^{-1}. An addition two treatments were added to the previous fourteen in the 2014-2015 winter wheat cropping season. These two treatments were sensor-based nitrogen rate applications, where the top-dress nitrogen rate would be determined by the sensor-based nitrogen rate calculator. The sensor-based applications were determined by using a green seeker to establish an average NDVI for a fully fertilized treatment and then the treatments that were sensor-based applications. Averages were input into the sensor-based nitrogen rate calculator which then gave a rate for the treatments. Throughout the season NDVI data was collected with green seekers during feekes 3, 4, 5, and 7 to determine variability in biomass. All applications of nitrogen were in the form of urea-ammonium nitrate (UAN, 28-0-0).

Treatment	N Preplant (lbs N/ac)	N Topdress (lbs N/ac)	N Total (lbs N/ac)	Method of Application
1	0	0	0	Check
2	150	0	150	N Rich Strip
3	25	0	25	
4	25	25	50	
5	25	50	75	
6	25	75	100	
7	25	100	125	
8	25	125	150	
9	50	50	100	
10	100	0	100	
11	50	0	50	
12	75	0	75	
13	125	0	125	
14	200	0	200	
15	0	TBD		SBNRC
16	50	TBD		SBNRC

Table 1. represent the most current up to date treatment table.

Trails were soil sampled each year prior to the application of pre-plant nitrogen and after harvest. Soil samples were taken to a 6-inch depth in each replication to evaluate the soil nutrient levels of total carbon and nitrogen. These soil samples were then ran through a LECO to determine these values.

Harvest was conducted after plant maturity with a small plot combine with a 5 foot header. Moisture content, plot weight, and test weight were collected with an onboard harvest monitor. Grain samples were collected from each plot and analysis. The grain samples later would be dried, ground and then run through a LECO to estimate the percent total carbon and nitrogen. Grain yield was corrected to 12.5% and statistical analysis was ran using SAS 9.4.

RESULTS AND DISCUSSION

Of the 38 site years of this experiment 25 of them reported a response of yield to nitrogen application. In the year 2010 out of the three locations planted 2 locations (Lahoma and Hennessy) reported a response in yield to nitrogen and one location (LCB) did not. Of the two locations that had a response, Hennessy was the only location that had a difference between treatments beyond that of the control. The responsive treatments were 150 lb N ac^{-1} pre-plant application and the split application of 25 lb N ac^{-1} pre-plant followed by 125 lb N ac^{-1} at top-dress. Where the location Hennessy had an average high of 60 bu ac^{-1} in a split application of 25 lb N ac^{-1} pre- plant and 125 lb N ac^{-1} top-dress. In 2010, Lahoma had a highest average yield of 38 bu ac^{-1} in a split application of 50 lb N ac^{-1} at both pre plant and top-dressFinally, the LCB location where it did not show a yield response to nitrogen, had a highest yield of an average of 57 bu ac^{-1} in split application of 25 lb N ac^{-1} pre-plant and 75 lb N ac^{-1} top-dress. These treatments out preforming the other treatments may be attributed to the availability of nitrogen later in the season. In the year 2012 there was a nitrogen response in all three locations (Lahoma, LCB, and Hennessy). In the three locations the highest average yield in Lahoma’s was the pre-plant application of 75 lb N ac^{-1} (50 bu ac^{-1}), at the LCB location the application of 25 lb N ac^{-1} pre- plant and 125 lb N ac^{-1} top-dress (46 bu ac^{-1}) had the highest average yield, and in the Hennessy location the pre plant application of 150 lb N ac^{-1} resulted in the highest average yield(70 bu ac^{-1}).

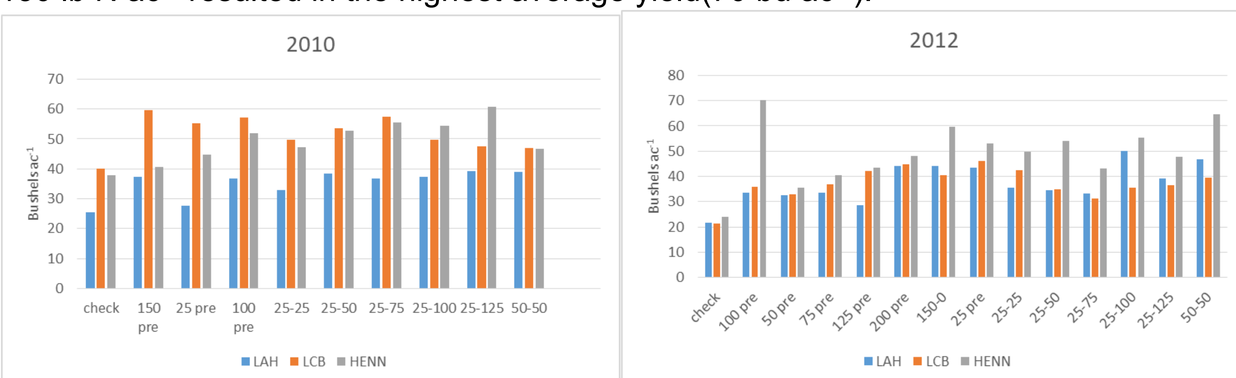

Figure 1.. Average yield (bu ac^{-1}) for the 2009-2010 (left) and 2011-2012 (right) winter wheat growing seasons. Treatments are unfertilized check, 150 lb N ac^{-1} pre-plant, 25 lb N ac^{-1}, 100 lb N ac^{-1}pre-plant, and split applications where the first number is lb ac^{-1} pre-plant and the second number is lb ac^{-1} top-dress.

The year 2014 reported 3 out of 4 locations had no yield response to nitrogen. The Lohoma, LCB, and EFAW locations had no significant impact of the application of nitrogen fertilizers on the winter wheat grain yield, where the check with no N produced yields equal to or greater of the other treatments.(Figure 2). The location of Perkins did however have a nitrogen response, with the an average yield of 30 bu ac^{-1} across all treaments which was greater than the control. In the year 2020, on the other hand, 3 of the 4 locations had a nitrogen response. In this year at the Lahoma, LCB, and Hennessy locations the split application of 25 lb N ac^{-1} pre-plant and 125 lb N ac^{-1} top-dress treatment produce the highest average yields at all locations. Where at the Perkins location that did not have a nitrogen response had an overall average of yeild of 66 bu/ac^{-1} .

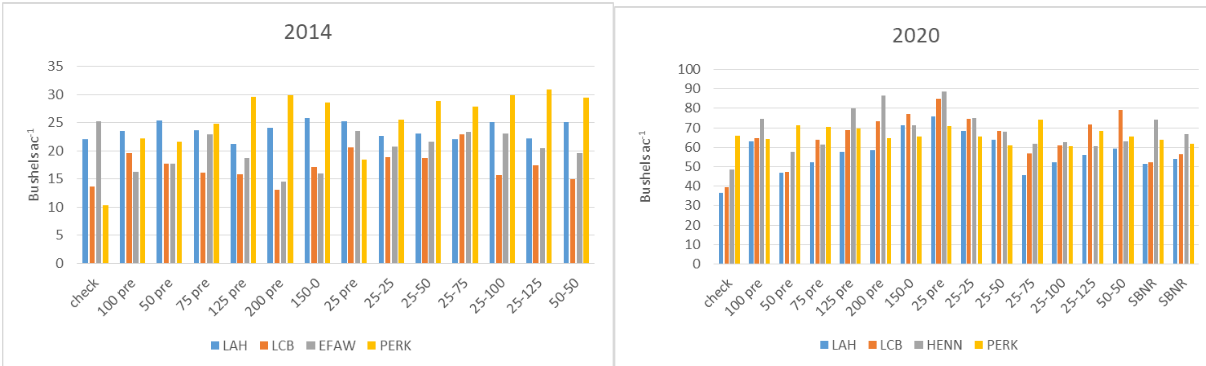

Figure 2. Average yield (bu ac^{-1}) for the 2013-2014 (left) and 2019-2020 (right) winter wheat growing seasons. Treatments are unfertilized check, 150 lb N ac^{-1} pre-plant, 25 lb N ac^{-1}, 100 lb N ac^{-1}pre-plant, and split applications where the first number is lb ac^{-1} pre-plant and the second number is lb ac^{-1} top-dress.

With winters in the state of oklahoma being sporadic, winter rainfall can be attributed to why some years top-dress applications out preform pre-plant and vis versa. In 2010 the state of Oklahoma had a dry winter, with Payne county averaging 3.55 inches over the winter and 1.74 inches in the month of march (Mesonet Long-term). The month of march averaged almost half of the winter average in Payne county, which is a substaincal rainfall during the time of top-dress. Similarly in the year of 2012 where all three of the locations have a nitrogen response Payne county experienced an winter average of 5.44 inches, later in march however, the county received 4.52 inches of rain (Mesonet long-term), which very well could have leached out the top-dress applications. Dissimilarly, in 2014 Payne county averaged 1.39 inches of rain over the winter and averaged 1.11 inches in the month of march (Mesonet Long-term), this lack of rainfall may would have caused fertlizer applications to be volitilized off before it could be pushed into the ground, causing us to see a lack in response to fertilizer in 3 of our 4 locations. The winter of 2020 was a decent winter for rainfall for Payne county, averaging 5.21 inches over the winter, and seeing an average of 5.78 inches in the month of march (Mesonet Long-term). These four years help show that just as weather can vary from year to year so can fertilizer application practices. In years where the state hardly recieves any rain over the winter and rainfall after top-dress applications the expectations are that top-dress applications will preform better than pre-plant applications with an opposite effect when the winter cropping seasons receive higher rainfall.

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