NITROGEN FERTILIZER MANAGEMENT FOR WHEAT UNDER DUAL PURPOSE GRAZING AND GRAIN PRODUCTION

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ABSTRACT

Dual purpose winter wheat is a common system used in many regions of the Southern Great Plains. The objective of this study was to i.) evaluate the interaction of wheat grazing management and soil and fertilizer nitrogen requirements with emphasis on dual purpose wheat. This study was established at three locations during the 2015-2016 growing season. Experimental design was a randomized split block design with 16 treatments including simulated grazing and grain only treatments and varying rates of nitrogen fertilizer application. Simulated grazing was performed with a self-propelled bagging lawn mower and was initiated at a growth threshold of 5 inches. Clippings were removed from the study area and weighed for dry matter estimation and analyzed for total nitrogen. NDVI sensor readings were taken before each simulated grazing to be used to estimate total forage and nitrogen requirements. Grain was harvested and collected for yield, test weight, moisture and total nitrogen analysis.

INTRODUCTION

The use of winter wheat as both a forage and grain crop in a dual purpose system has been used profitably in the Southern Great Plains for many years. Dual purpose systems can be more profitable than a grain only system in many situations (Epplin et. al., 2001). Wheat provides a high protein forage source for cattle, with crude protein levels as high as 25 to 30 percent, that can promote high weight gains at times when there are few other forage options (Shroyer et al., 1993). Wheat that has been grazed can also be harvested for a grain crop with minimal yield loss, and under some circumstances yield gain, as long as proper cultural practices are followed (Edwards et al., 2011).

The effectiveness of a dual purpose wheat system depends on the production decisions of the producer. Early planting date, beginning of September for most of Kansas, is important to the establishment of an ample amount of forage in the fall and winter. Early planting allows the plant to produce more tillers and increase plant height before dormancy in the winter months. Along with early planting, increased planting rate is also highly important. 50-100% increases, above grain only rates, are commonly recommended in Kansas (Shroyer et. al., 1993). Removing cattle from wheat before first hollow stem (Feekes 6) occurs is perhaps the most important management practice to retain high grain yields (Edwards and Horn, 2010). Grazing past first hollow stem can reduce grain yields by up to 5% each day (2010).

In addition to these cropping practices, fertilization is a key factor when managing a productive dual purpose system. Nitrogen management is especially important as nitrogen is typically the most limiting nutrient for forage yield and quality as well as grain yield (Shroyer et al., 1993). Optimum nitrogen fertilization within a dual purpose system can differ when compared to a grain only system. Higher levels of available nitrogen in the fall are required by the plant to support the lush growth needed for grazing. The removal of high amounts of nitrogen rich biomass along with harvesting grain creates much higher depletion rates of nitrogen within the field. Exact nitrogen requirements can vary year to year depending on moisture availability, but typical recommendations are an extra 30 to 50 lbs above a grain only situation (Shroyer et. al., 1993). There is a need for more precise nitrogen management in dual purpose systems. The objective of this study was to evaluate the interaction between grazing management for dual purpose wheat and nitrogen fertilization and assess the use of NDVI sensors for nitrogen management of dual purpose wheat.

MATERIALS AND METHODS

This study was conducted at three locations during the 2015-2016 growing season. A description of sites is located in table 1. The experimental design was a randomized split block design with 16 treatments and a reference strip. Treatments included 12 grazed treatments and 4 grain only treatments. Grazing treatments included four rates of fall nitrogen application; 0, 30, 60, and 90 lbs ac^{-1}. Each fall rate was accompanied by a spring topdress of no nitrogen, 90 lbs ac^{-1} or a sensor based N application rate. Grain only plots received a fall N rate of 0, 30, or 90 lbs ac^{-1}. Spring topdress of these plots was 90 lbs ac^{-1} applied for the no nitrogen fall treatment, 60 lbs ac^{-1} for 30 lbs ac^{-1} rate fall application, a sensor based application applied to the 30 lbs ac^{-1} fall rate, and no nitrogen applied to the 90 lbs ac^{-1} fall rate. Plot size was 6 feet by 30 feet. Urea (46-0-0) was broadcasted by hand for both fall fertilization and spring topdress. Treatments were applied within a week of planting in the fall and spring topdress application occurred at first hollow stem (Feekes 6).

Soil samples were collected from each block, before fertilization, at depths of 0-6 inches and 0-24 inches. Samples were dried at 104°F and then ground to pass a 2mm mesh before being submitted to the Kansas State Soil Testing Laboratory for analysis. The 0-6 inch samples were analyzed for pH with a 1:1 (soil:water) method (Watson and Brown, 1998), phosphorus with Mehlich-3 extraction (Frank et al., 1998), potassium by ammonium acetate (Warncke and Brown, 1998), and organic matter by loss on ignition (Combs and Nathan, 1998). 0-24 inch samples were analyzed for nitrate using a KCl extractant (Gelderman and Beegle, 1998).

Simulated grazing was performed in season using a Honda self-propelled bagging lawnmower. Plots were sensed with a Holland rapid scan NDVI sensor for total biomass estimation before each simulated grazing. Individual plots were mowed and then all clippings in bag were weighed for biomass estimation. Simulated grazing was initiated once plants had reached a height threshold of 5 inches and were mowed to a height of 2 inches. Sub samples from each plot were hand clipped 2 inches from the ground and 30 inches in length from two rows. Sub samples were then weighed, dried at 140°F, and reweighed for moisture estimation before being ground to pass a 2 mm mesh. Tissue samples were then submitted to be analyzed for total nitrogen content using a sulfuric peroxide digest. Grain was harvested using a plot combine and tested for moisture and test weight. Grain was then ground using a burr coffee grinder and submitted for total nitrogen content using the sulfuric peroxide digestion.

RESULTS AND DISCUSSION

Results of this study were similar across sites with some differences, particularly grain yields. Regression analysis was performed on yield data for three different spring topdress nitrogen rates as well as data points for grain only treatments. The site in Hillsboro showed the widest range of yield difference between treatments, with the no fertilizer spring applied treatment consistently yielding 20 to 25 bushels per acre less than the other treatments (Figure 1). All rates of spring N application also showed trendlines that increased with fall N application at Hillsboro as well. At the Hutchinson site, yields were less widespread with the widest variability occurring at a fall N application rate of 0 pounds per acre (Figure 2). There was a 16 bushel per acre difference between highest and lowest yield levels. The Hutchinson site also shows that when a spring application of 90 lbs ac^{-1} is made, fall N application has very little impact on yield. Manhattan shows a wide yield difference at 0 lbs ac^{-1} fall N application, however each trendline of spring application rates converge to less than 5 bushels per acre at 90 lbs ac^{-1} fall application rate (Figure 3). The averages of the three sites show that all three spring N application rates increase in yield as the fall N application rate goes up (Figure 4). The amount of yield increase with higher fall N application is least in the high spring N and greatest in the 0 lbs ac^{-1} spring N.

SUMMARY

More analysis is needed to assess the performance of sensors for nitrogen management in dual purpose wheat. However, results from this study shows that sensors can likely contribute to accurate N rate estimations for dual purpose wheat systems. This study also shows the relationship between grazing wheat and grain yield is not necessarily negative. Overall more analysis needs to be performed on forage quantity and quality and grain N concentration.

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Table 1. Predominant soil and description of each site during the 2015-2016 growing season.

Site	Soil Series	Soil Subgroup	Variety	Planting Date	Planting Rate lbs ac^{-1}	Tillage†
Hutchinson	Taver loam	Udertic Argiustolls	Iba	9/24/2015	63	CT
Hillsboro	Wells Loam	Udic Argiustolls	Iba	9/17/2015	63	NT
Manhattan	Smolan silt loam	Pachic Argiustolls	Everest	10/1/2015	122	CT

†CT, conventional tillage, NT, no-tillage

Table 2. Soil test averages of all four blocks at each location during the 2015-2016 growing season.

Location	pH	OM	P	K	NO3-N
		%	- - - - - ppm- - - - -		
Hutchinson	7.3	2.2	38	350	11.6
Hillsboro	6.6	3.5	86	430	1.5
Manhattan	5.8	3.0	12	309	7.0

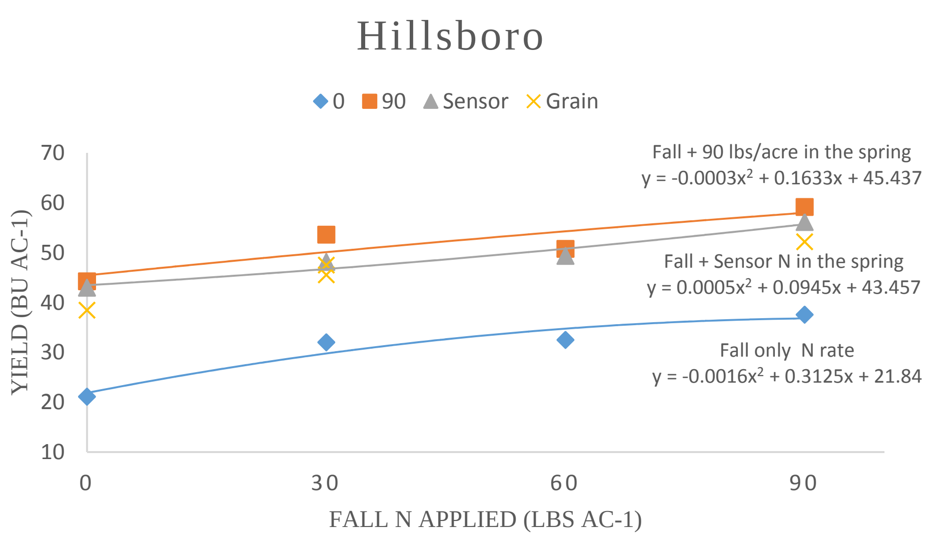

Figure 1. Yield response to fall applied and additional spring N application rates for simulated dual purpose system at the Hillsboro location. Four independent points are also shown for grain only treatments which have fall and spring (F, S) nitrogen application rates of (0, 90), (30, 60), (30, Sensor), and (90, 0) all in lbs ac^{-1}.

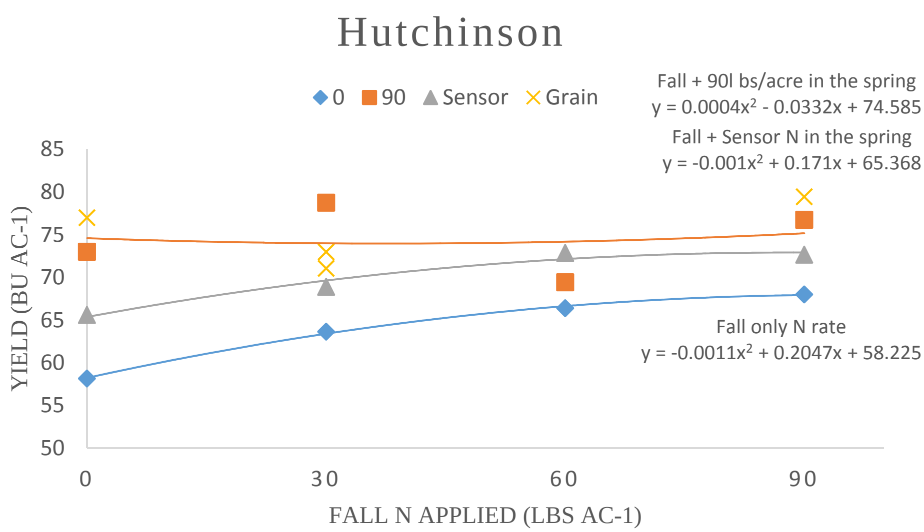

Figure 2. . Yield response to fall applied and additional spring N application rates for simulated dual purpose system at the Hutchinson location. Four independent points are also shown for grain only treatments which have fall and spring (F, S) nitrogen application rates of (0, 90), (30, 60), (30, Sensor), and (90, 0) all in lbs ac^{-1}.

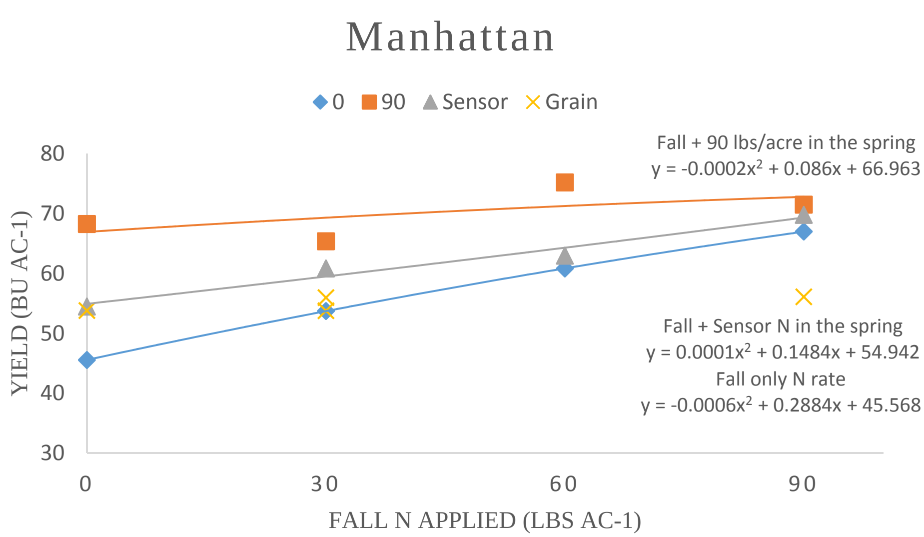

Figure 3. Yield response to fall applied and additional spring N application rates for simulated dual purpose system at the Manhattan location. Four independent points are also shown for grain only treatments which have fall and spring (F, S) nitrogen application rates of (0, 90), (30, 60), (30, Sensor), and (90, 0) all in lbs ac^{-1}.

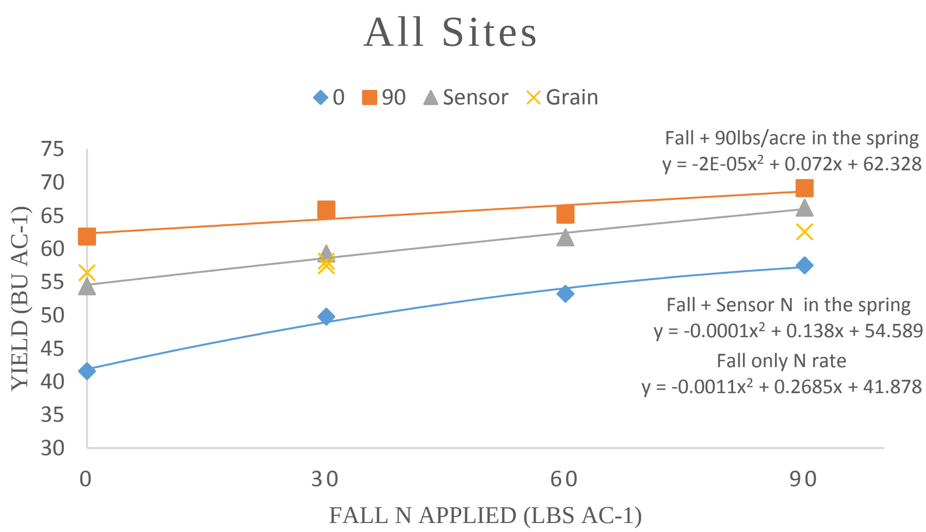

Figure 4. Yield response to fall applied and additional spring N application rates for simulated dual purpose system averaged across all sites. Four independent points are also shown for grain only treatments which have fall and spring (F, S) nitrogen application rates of (0, 90), (30, 60), (30, Sensor), and (90, 0) all in lbs ac^{-1}.

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