NUTRIENT MANAGEMENT IN DUAL-USE WHEAT PRODUCTION

John Sij[1*] and Kurt Lemon[1]

[1]Texas Agricultural Experiment Station, P.O. Box 1658, Vernon, TX 76385
*Corresponding author's e-mail address: jsij@ag.tamu.edu

INTRODUCTION

Conservation of our region's natural resources is a major priority at the highest levels of government. Conserving those resources is essential to long-term viability of rural economies. Crop residue on the soil surface is beneficial in terms of reduced soil erosion, rainfall capture, rainfall retention, and seedling protection. Producers in this area have not adopted no-till in a grazing system because of uncertainties about stand establishment, soil compaction, soil fertility, lack of proper equipment, and weed control. Understandably, most do not want to risk their future on an unproven technology. However, a few producers have successfully implemented no-till management in grain-only systems.

The Texas Rolling Plains has very large and diverse wheat/stocker operations which rural economies depend on as a major source of revenue. In these systems, wheat is planted in September under conventional tillage. Numerous field operations with large, expensive equipment along with high operating and labor costs are required to prepare "clean" fields prior to seeding. Unfortunately, soil moisture is lost in the process. Soil erosion by wind and water can cause significant damage on exposed soil. Wheat seedlings are unprotected from desiccating wind and washing out under conventional tillage. Large areas are subject to replanting, creating costly delays in wheat establishment and plant growth needed in a graze-and-grain wheat/stocker system. Conservation tillage (e.g. no-till) holds promise in mitigating soil and moisture losses in wheat/stocker systems through increased soil organic matter, enhanced capture and retention of limited precipitation and decreased risk of reseeding.

Fertilizer requirements in conservation tillage systems for wheat and stocker cattle production in the Rolling Plains are relatively unknown. A high research priority has been placed on no-till and reduced-till systems in a dual-purpose wheat/stocker enterprise, particularly development of efficient nitrogen (N) and phosphorus fertility programs. A key input to all wheat production is N fertilizer. Information on N fertility response of wheat in a no-till grazing system does not exist, although this knowledge is vital to successful implementation of no-till grazing systems.

Our current research indicates that stand establishment in no-till systems can be successful with the proper equipment. Furthermore, soil compaction may not be as serious as previously believed, as long as a reasonable amount of residue is maintained on the soil surface to cushion hoof action and the impacting effect of rain. It may take several years for a new production system to stabilize, particularly when converting from conventional tillage to a conservation tillage system.

The primary objective of this research is to identify N fertility levels that maximize forage and beef yields as well as maintaining grain yield and quality in no-till and conventional-till wheat/stocker production systems.

MATERIALS AND METHODS

The research site is located about 10 miles south of the Vernon Research Center on the Smith/Walker research unit. Approximately 550 acres are devoted to wheat, forage, and stocker cattle research. Pastures are near commercial production size (25 to 35 acres) with individual watering sources. Studies are conducted under dryland conditions. The soil is a clay loam and prone to wind and water erosion when left bare.

One N fertility study was nested in a larger 35-acre pasture with free-ranging stocker cattle (400 to 500 weights). Plots size was 20 ft by 100 ft. All fertilizer was surfaced applied as liquid material. Fertilizer treatments in each tillage system (no-till and conventional-till) included 0, 30, 60, 90, and 120 lb N/ac, with and without 45 lbs N/ac top-dressed in January in a randomized complete block design with 4 replications. The "Cutter" wheat variety was planted mid-September at 60 lbs seed/ac. No-till plots were kept weed free with herbicides. In August of each year, soils were sampled to the 2-foot depth for nitrate determination. Plots were clipped periodically to determine forage production. Cattle were removed (pulled-off) from pastures when wheat reached the 'first hollow stem' growth stage to allow grain production. Wheat was machine-harvested for grain yield.

RESULTS AND DISCUSSION

Forage production in 2003 to February 2004 was virtually non-existent due to record dry weather from November 2003 through January 2004. Therefore, these data are not presented. Rainfall in the fall of 2004 resulted in more normal forage production (Fig.1). There was no significant difference ($P \geq 0.05$) in forage production to March 1, 2005 between conventional tillage and no-till production system. This is promising from a wheat stocker grazing standpoint. Increasing amounts of pre-plant N resulted ($P \geq 0.05$) in increasing amounts of forage (Fig. 1).

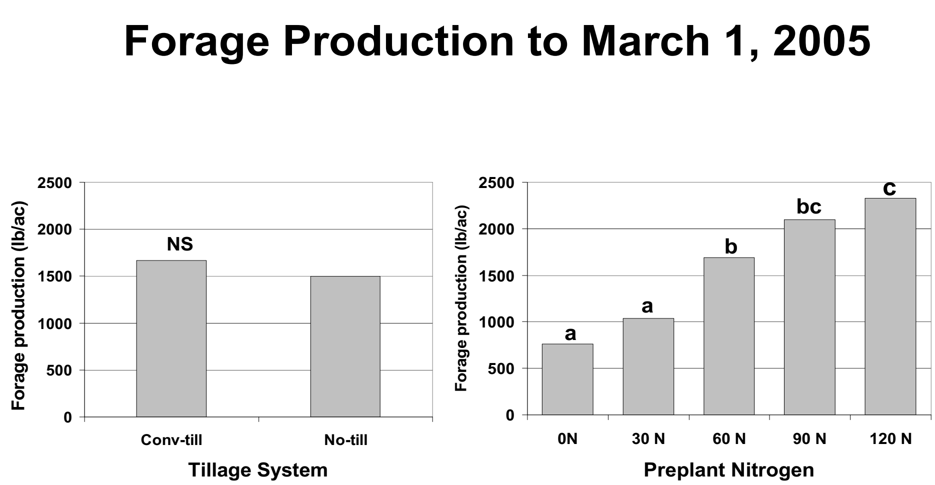


Figure 1. Wheat forage response to tillage and preplant N.

Table 1 shows that among all main effects and interactions, only top-dressed N significantly influenced gain yield ($P \leq 0.05$) both years. Tillage and pre-treatment N were significant in 2004 but not in 2005. The fact that tillage x N and tillage x top-dressed N interactions were not significant indicates that, over time and with proper management, changing from conventional-till to a no-till system may not result in reduced grain yield in a dual-use wheat system. These results must be considered preliminary, however.

Analysis of Variance for Grain Yield

Source	DF	2004	2005
		---Prob (F)---	
Rep	3	0.001	0.152
Tillage (T)	1	0.001	0.215
Nitrogen (N)	4	0.001	0.032
T x N	4	0.545	0.884
Top-dress (TD)	1	0.001	0.000
TD x T	1	0.506	0.735
TD x N	4	0.116	0.162
TD x T x N	4	0.586	0.764

Table 1. ANOVA for wheat grain yield.

Results show that tillage may have some affect on wheat yield (Fig. 2). Yields were significantly higher with conventional tillage than with no-till in 2004 but not in 2005, although grain yield was numerically less under no-till in 2005. Additional research will be needed to verify the effect of tillage on grain yield in a dual-use system. Reduced income from a slight yield reduction may be offset by the increased cost of establishing the wheat crop under conventional tillage.

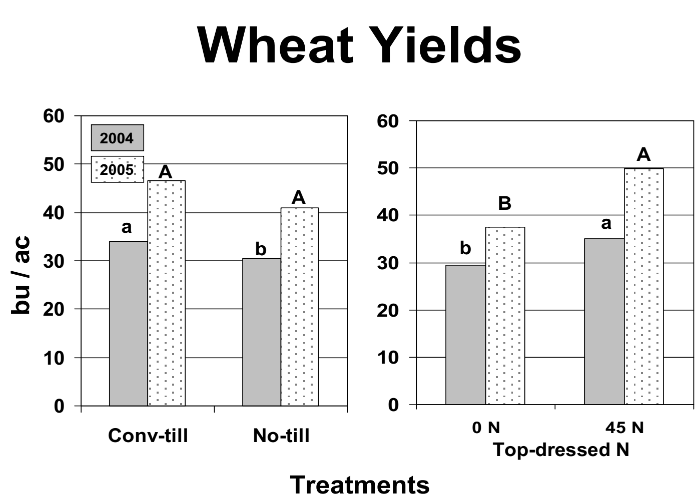


Figure 2. Effect of tillage and top-dressing N on wheat yields.

Top-dressing N significantly increased yield both years of the study, but to a greater extent in 2005 (Fig. 2). It appears that in 2005, no matter what level of pre-plant N the plots received, top-dressing 45 lb N/ac maximized final yield (Fig. 3). It should be recognized that the same N treatment was placed on the same plot in 2004 and 2005. Figure 3 also shows that the greatest increase in grain yield in 2005 occurred when N was top-dressed on plots that received no pre-plant N. From a grain production standpoint, this system may be most economical. However, from a forage standpoint, pre-plant N is essential in a dual-use system (Fig. 1).

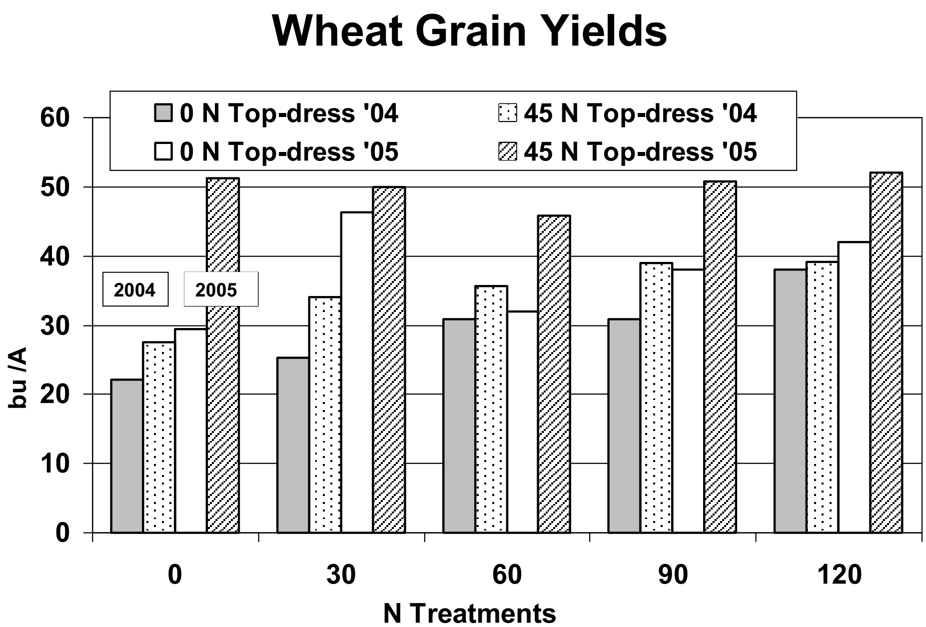


Figure 3. Effect of N treatments of grain yield, 2004 and 2005.

A preliminary economic analysis of top-dressing N to increase grain yield was attempted (Fig. 4). Top-dressing N resulted in a positive net return with all pre-plant N applications, except the highest pre-plant N rate of 120 lbs N/ac. Applying all top-dressed N with zero pre-plant N generated the highest net return. Inputs included the cost of the liquid fertilizer, application costs, harvest costs, and price received for the harvested grain. Seed costs, labor, fuel, maintenance, interest, etc. were not included in developing the net returns.

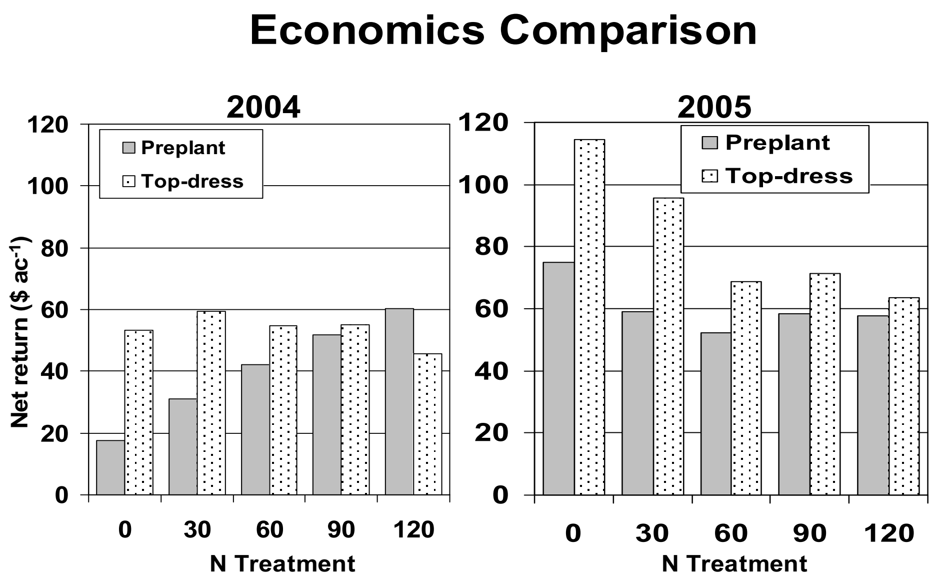
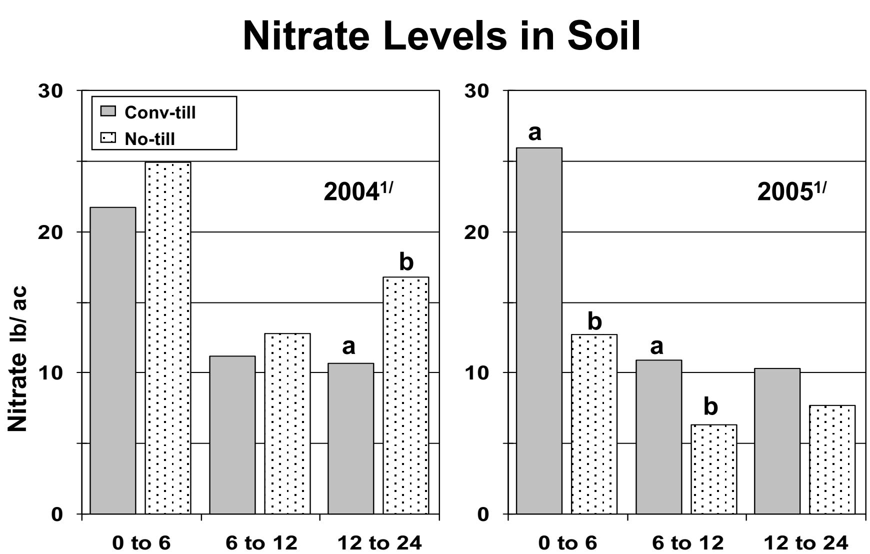


Figure 4. Economic comparison of preplant and top-dressed N application for grain yield.

Figure 5 shows nitrates in the top two feet of soil for the two tillage systems for 2004 and 2005. There were significant ($P \leq 0.05$) differences between the two systems at different depths. In 2005, there was significantly less nitrate in the top foot of soil under no-till. Since 2005 was the wetter year, we hypothesize that nitrates may have been immobilized in the decomposition of organic matter or lost through denitrification.



1/Samples taken in August each year before application of treatments
Tillage systems with different letters are significantly different at $P<0.05$.

Figure 5. Soil nitrate levels in the upper 2 feet of soil under two tillage systems.

CONCLUSIONS

The past two growing seasons were quite different with 2003-2004 being extremely dry and 2004-2005 being abnormally wet in the fall and early winter. Consequently, fall forage production and grain yields were much higher in 2005. In 2005 there was no significant difference between tillage systems with respect to forage production to March 1, the general cattle pull-off date. Forage production and grain yield had a near linear response to pre-plant N application. Top-dressing 45 lb N/ac resulted in a significant increase in grain yield at all pre-plant N application levels except at the highest pre-plant application of 120 lb N/ac. Grain yields in 2004 were significantly higher with conv-till compared with no-till. However, in the second year of the study, grain yields from conv- till were numerically, but not significantly (P = 0.22), superior to those from no-tillage. In 2005, a top-dressed application of 45 lb N/ac resulted in maximum grain yield in all plots regardless of the pre-plant N treatment. This was less evident in 2004. From a grain production stand point, the greatest yield increase occurred when 45 lb N/ac was applied to plots that received no pre-plant N, and those plots also generated the highest economic net return. The economics of beef production were not included in this study. Forage yield to March 1 was minimal in plots receiving no N, and in a dual-use system, this would not be acceptable. We are developing management programs that attempt to find the optimum economic balance between forage production, grain yield, beef production, and reduced animal health risk.

ACKNOWLEDGMENTS

The authors wish to thank the Fluid Fertilizer Foundation, the Potash and Phosphate Institute, and the Texas Wheat Producers Board for financial and in-kind support of this research.