Impact of Tillage on Spring Wheat Yield

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RESEARCH SUMMARY

Tillage is being reduced in cropping systems in southwestern North Dakota. Past research at the Dickinson Research Extension Center indicated that grain yield of hard red spring wheat (*Triticum aestivum* L. emend. Thell.) increased when clean-till (CT) systems were replaced with no-till NT) systems. The objective of this study was to determine if grain yield increases under NT persisted over time. Hard red spring wheat was seeded between 2000 and 2007 into CT, reduced-till (RT), and no-till (NT) seedbeds and grain yield determined. Wheat grain yield was enhanced by an average of 10 bu/acre, or by almost 40%, under NT compared with CT ($P < 0.05$). Conversely, differences in grain yield between CT and RT were not detected. Soil moisture conservation and improved stand establishment under NT explain much of the yield increase. Results of this study support the conversion from CT and RT to NT systems as a strategy for increasing spring wheat grain yield in southwestern North Dakota.

INTRODUCTION

Southwestern North Dakota can be characterized as a region with widely varying precipitation and shortgrass prairie native vegetation (Padbury et al., 2002). Historically, tilled wheat-fallow systems dominated the region and state. More recently, tillage has been reduced and even eliminated on a growing number of farms. For example, almost 20% of spring seeded, small-grain crops were grown under NT in 2004 (Carr et al., 2006). No-till production of spring wheat and other spring seeded, small-grain crops occurred on roughly 2 million acres that year.

Previous research in Saskatchewan indicated that wheat yield tended to increase as tillage was reduced (Lafond et al., 1992). Similar results were reported more recently at the Dickinson Research Extension Center (Carr et al., 2006). Soil moisture benefits were suggested as explaining the grain yield benefits of NT in both studies.

The objective of this study was to determine if the grain yield benefits of NT persisted over time.

MATERIALS AND METHODS

The study was conducted from 2000 through 2007 at the Dickinson Research Extension Center in southwestern North Dakota on a Farnuf fine sandy loam soil. A spring wheat monoculture was established and maintained in 30 by 40 ft plots under CT, RT, and NT management. The tillage systems had been in place since 1993, and a spring wheat-fallow system maintained until the study began. Clean-till plots were cultivated with a tandem disc to a three inch depth in September or October each year and again the following April prior to seeding spring wheat or field pea. Reduced-till plots were lightly disced each April prior to seeding but otherwise were not cultivated. No soil disturbance except by a low-disturbance planter at seeding occurred in no-till plots.

Adequate fertilizer was applied for a 50 bu/acre yield goal for spring wheat, based on soil test results. Details of soil sampling and analyses methods as well as fertilizer applications strategies for these and other plots are discussed elsewhere (Carr et al., 2006).

A 10-ft wide John Deere (Moline, IL)[1] 750 low-disturbance drill was used to seed hard red spring wheat in late April to mid May in 7.5 inch rows each year. Three separate passes were required to seed each plot. Spring wheat was seeded at 28 live kernels/ft^2 (1.2 million kernels/acre). The hard red spring wheat cultivar Parshall was seeded in all years except 2005, when the cultivar Ernest was seeded because of damage to spring wheat plots caused by the wheat stem sawfly (*Cephus cinctus* Norton) in 2004.

Roundup plus ammonium sulfate were applied as a pre-plant burndown at 1 qt/acre of ammonium sulfate and 0.75 to 1.3 pt/acre (product) Roundup in NT plots, depending on the year and weeds present. Pre-plant tillage was used to control weeds prior to seeding in CT and RT plots. Post-plant applications of herbicides were used to control grass and broadleaf weeds, as needed. Excellent weed control was achieved in all six years of the study.

Spring wheat grain was harvested at maturity (Zadoks growth stage 92) from the center seven rows using a small-plot combine. Grain yield was reported on a 12% moisture basis.

Data were analyzed across all years as a randomized complete block using the GLM procedure for balanced data available from SAS. Tillage systems were considered fixed effects, while blocks and years were considered random. Mean comparisons using an *F*-protected LSD were made to separate tillage treatments where *F*-tests indicated that significant differences existed ($P < 0.05$) in the combined analyses.

RESULTS AND DISCUSSION

An interaction between year and tillage system for grain yield was not detected in this study (*P* = 0.08). Grain yield averaged 36 bu/acre under NT compared with 26 bu/acre under CT. This amounted to almost a 40% yield advantage for NT. Similarly, grain yield was enhanced by 8 bu/acre, or by almost 30%, under NT compared with RT. In contrast, no difference in grain yield was detected under CT and RT.

Previous research suggests that the grain yield benefit which can result from replacing CT with NT may result from the soil moisture savings that can occur following the adoption of NT. An additional 1.1 inches of water was stored in the top 2-ft of soil in wheat production systems under NT compared with CT at Dickinson, and modern yield models suggest that this amount could account for much of the grain yield increase that can occur (Carr et al., 2006). An additional benefit of adopting NT is the plant stand establishment can be improved when dry conditions are present during seeding (Carr et al., 2006).

Tillage can exacerbate soil water evaporation, even when these operations are limited. In this study, the RT system involved a single pass of a light tandem disk, and the resulting crop residue cover was adequate to meet conservation tillage criteria (data not presented). Still, the limited tillage done under RT was enough to eliminate the soil moisture conservation that existed under NT (Carr et al., 2006), and as a result grain yield benefits were not provided by RT.

CONCLUSIONS

This study demonstrated that grain yield benefits to hard red spring wheat should be expected following the replacement of CT with NT in southwestern North Dakota. Grain yield increases of around 40% should occur under conditions similar to those encountered during this study. Similarly, grain yield increases of between 30% should be expected following the replacement of RT with NT. These results support the continued adoption of NT systems by hard red spring wheat growers in southwestern North Dakota, if a goal is to maximize grain production.

The importance of low-disturbance openers and other equipment that minimizes soil disturbance is essential for the grain yield benefit offered by converting from CT and RT to NT systems. Similar grain yield advantages following adoption of NT as demonstrated in this study may not occur when high-disturbance openers and other equipment that buries crop residue are used in a system that is described as NT.

LITERATURE CITED

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