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# Occasional Tillage and Nitrogen Application Effects on Winter Wheat and Grain Sorghum Yield

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# Occasional Tillage and Nitrogen Application Effects on Winter Wheat and Grain Sorghum Yield


## Abstract

Occasional tillage ahead of winter wheat planting could alleviate herbicide-resistant weeds, redistribute soil acidification, and improve seedbed at wheat planting. The objective of this study was to determine occasional tillage and nitrogen (N) fertilizer application effects on winter wheat, and grain sorghum yields and soil quality in a wheat-sorghum-fallow cropping system. Treatments were three tillage practices: 1) continuous no-tillage (NT); 2) continuous reduced-tillage (RT); and 3) single tillage operation every 3 years (June-July) ahead of winter wheat planting [occasional tillage (OT)]. The sub-plot treatments were assigned to four N fertilizer rates (0, 40, 80, and 120 lb/a of N). Results showed tillage had no effect on winter wheat grain yield. Averaged across the 2 study years, wheat yields were 29.4 bu/a with NT, 31.0 bu/a with RT, or 31.6 bu/a with OT. Applying N fertilizer increased wheat yield, ranging from 20 bu/a with no N fertilizer to 38.7 bu/a when N fertilizer was applied at 120 lb/a of N. However, tillage ($P$ = 0.04) and year × N rate interaction ($P$ = 0.003) had significant effect on grain sorghum yield. Average grain sorghum yield with RT (73.6 bu/a) was less than NT (79.4) or OT (75.4 bu/a). Averaged across tillage and years, sorghum grain yield was 60.3 bu/a with no N fertilizer and 86.8 bu/a when N was applied at 120 lb/a of N. In most years, sorghum and winter wheat grain yields obtained with 80 lb/a of N were not different from those with 120 lb/a of N, suggesting 80 lb/a of N may be adequate for both crops.



## Keywords

nitrogen, occasional tillage, sorghum, winter wheat

# Occasional Tillage and Nitrogen Application Effects on Winter Wheat and Grain Sorghum Yield

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## Summary

Occasional tillage ahead of winter wheat planting could alleviate herbicide-resistant weeds, redistribute soil acidification, and improve seedbed at wheat planting. The objective of this study was to determine occasional tillage and nitrogen (N) fertilizer application effects on winter wheat, and grain sorghum yields and soil quality in a wheat-sorghum-fallow cropping system. Treatments were three tillage practices: 1) continuous no-tillage (NT); 2) continuous reduced-tillage (RT); and 3) single tillage operation every 3 years (June-July) ahead of winter wheat planting [occasional tillage (OT)]. The sub-plot treatments were assigned to four N fertilizer rates (0, 40, 80, and 120 lb/a of N). Results showed tillage had no effect on winter wheat grain yield. Averaged across the 2 study years, wheat yields were 29.4 bu/a with NT, 31.0 bu/a with RT, or 31.6 bu/a with OT. Applying N fertilizer increased wheat yield, ranging from 20 bu/a with no N fertilizer to 38.7 bu/a when N fertilizer was applied at 120 lb/a of N. However, tillage ($P = 0.04$) and year × N rate interaction ($P = 0.003$) had significant effect on grain sorghum yield. Average grain sorghum yield with RT (73.6 bu/a) was less than NT (79.4) or OT (75.4 bu/a). Averaged across tillage and years, sorghum grain yield was 60.3 bu/a with no N fertilizer and 86.8 bu/a when N was applied at 120 lb/a of N. In most years, sorghum and winter wheat grain yields obtained with 80 lb/a of N were not different from those with 120 lb/a of N, suggesting 80 lb/a of N may be adequate for both crops.

## Introduction

Adoption of NT practices during fallow by many producers in the central Great Plains (CGP) has increased the quantity of residues retained on the soil surface, and soil moisture storage. This has allowed for cropping intensification in dryland systems in the CGP from winter wheat-fallow to winter wheat-summer crop-fallow or a more intensified cropping system with no fallow depending on soil water availability. The benefits of NT include reduction in soil erosion, increased soil organic matter accumulation, improved soil structure, and increased soil water storage.

Despite these benefits, stratification of soil nutrients, organic matter, and pH tend to develop near the soil surface in long-term continuous NT systems. In addition, the lack of effective herbicides for perennial grass weeds such as three-awn grass (*Aristida purpurea* Nutt.) and tumble windmill grass (*Chloris verticillata* Nutt.) control, and the emergence of glyphosate-resistant weeds pose challenges in NT crop production. In addition, in drier years, the upper layer (0–2 inches) of soils in NT tends to be "hard" and presents a challenge to placing seed in subsoil moisture at the time of wheat planting. This may cause poor plant establishment and reduce winter wheat yields. Occasional tillage of NT soils may be necessary to alleviate herbicide-resistant weed issues, redistribute soil acidity, and improve seedbed at wheat planting. The objective of this study was to determine occasional tillage and nitrogen (N) fertilizer application effects on winter wheat, and grain sorghum yields and soil quality in a wheat-sorghum-fallow cropping system.

## Procedures

Field experiments were initiated in spring 2017 at the Kansas State University Agricultural Research Center near Hays, KS, to address the previously mentioned objectives. Study design is a split-split-plot with three replications in a randomized complete block design. Main plots were three crop phases of a wheat-sorghum-fallow, sub-plot treatments were three tillage practices: 1) continuous NT; 2) continuous RT; and 3) single tillage operation every 3 years (June-July) ahead of winter wheat planting (OT). The sub-sub-plots were assigned to four N fertilizer application rates (0, 40, 80, and 120 lb/a of N). The reduced tillage treatments had two to three tillage operations during fallow ahead of wheat planting and one tillage operation prior to sorghum planting. All tillage operations were done with a sweep-plow to a depth of 3 to 4 inches. Each phase of the crop rotation, tillage, and N fertilizer treatment was implemented in each year of the study. Winter wheat and sorghum grain yields were determined by harvesting a 5- × 80-ft area from the center of each plot using a small plot combine. Statistical analysis with the PROC MIXED procedure in SAS version 9.4 (SAS Inst., Cary, NC) was used to examine winter wheat and grain sorghum yields as a function of tillage and N fertilizer application.

## Results

### *Winter Wheat Grain Yield*

Winter wheat grain yield was not affected ($P = 0.54$) by tillage in this study (Figure 1a). Averaged across N rates and years, wheat grain yield was 29.4 bu/a with NT, 31.6 bu/a with OT, and 31.0 bu/a with RT. Winter wheat grain yield response to N fertilizer application varied by year (Figure 1b). In 2018, there were no significant wheat yield increases when N fertilizer was applied beyond 80 lb/a of N. Nonetheless, 120 lb/a N was required for maximum wheat yield in 2019. Across years grain yield increased linearly with N fertilizer application, ranging from 20.5 bu/a with no N fertilizer to 38.7 bu/a when N fertilizer was applied at 120 lb/a of N. However, wheat grain yield was not different when N was applied at 80 lb/a of N or 120 lb/a of N in 2018 (Figure 1b).

Tillage had a significant ($P = 0.04$) effect on sorghum grain yield over this 3-year study. Averaged across N rates and years, sorghum grain yields with NT (79.4 bu/a) or OT (75.4 bu/a) were not different. However, RT operations reduced sorghum grain yield compared to the other tillage treatments (Figure 2). Year × N rate interaction had a significant effect on sorghum grain yield (Figure 3). Application of N fertilizer increased sorghum yields in 2017, but grain yields produced with 40 lb/a of N were similar to those achieved with greater N rates. In the 2018 growing season, applying N fertilizer resulted in a linear increase in sorghum grain yield. Similarly, N fertilizer application did increase sorghum grain yield but significant yield increases occurred beyond 80 lb/a of N. The differences in N response between 2017, 2018, and 2019 growing seasons were because of the differences in precipitation amount in the 3 years that affected amount of available soil water for sorghum production. Across the 3 years and tillage treatments, applying N fertilizer increased grain yield from 60.3 bu/a with the check treatment (no N applied) to 86.8 bu/a with 120 lb/a of N. However, grain yield with 80 lb/a of N in 2 of the 3 years of the study were not different from that obtained with the highest N rate of 120 lb/a of N.

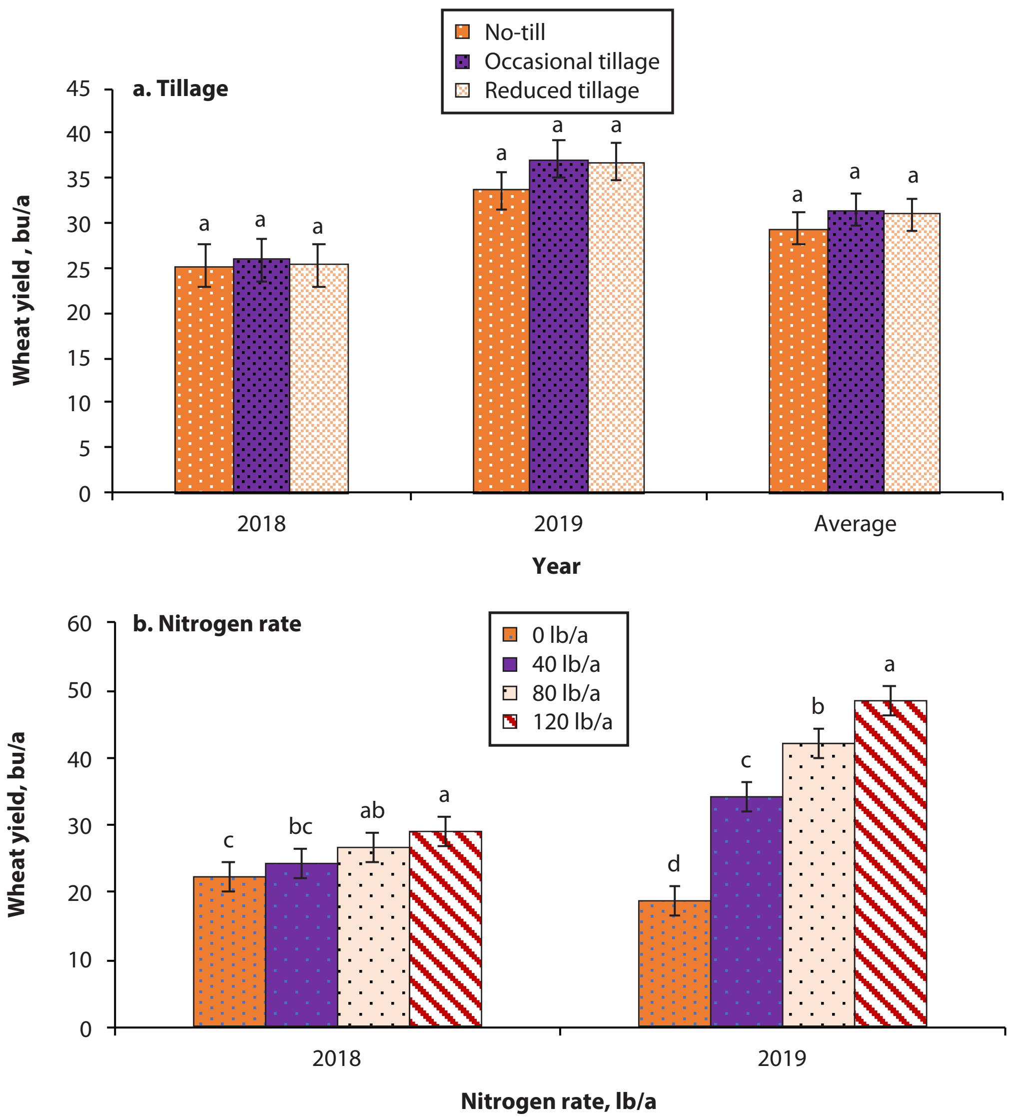


**Figure 1. Winter wheat grain yield as affected by tillage (a) and nitrogen (N) fertilizer application rate (b) in 2018 and 2019 growing seasons at Hays, KS. Data for tillage effects are averaged across four N rates and three replications (n = 12), and data for N rate effects are averaged across three tillage treatments and three replications (n = 9). Means followed by same lowercase letter(s) are not significantly different ($P > 0.05$).**

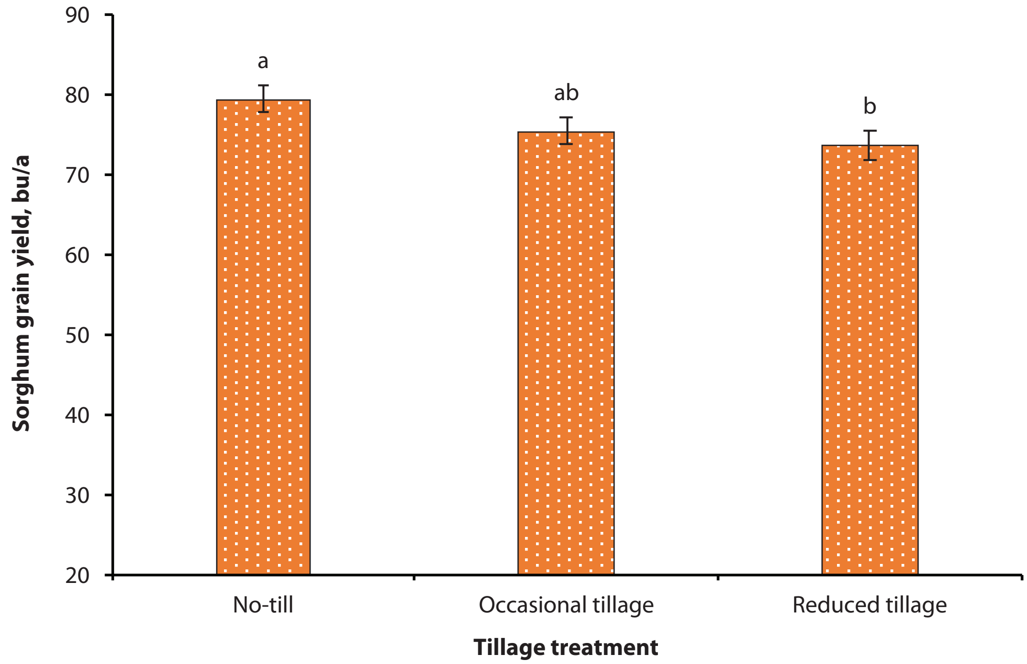


**Figure 2. Grain sorghum grain yield as affected by tillage system in three (2017–2019) growing seasons at Hays, KS. Data are averaged across four nitrogen treatments, three years and three replications (n = 36). Means followed by same lowercase letter(s) within a year are not significantly different (*P* > 0.05).**

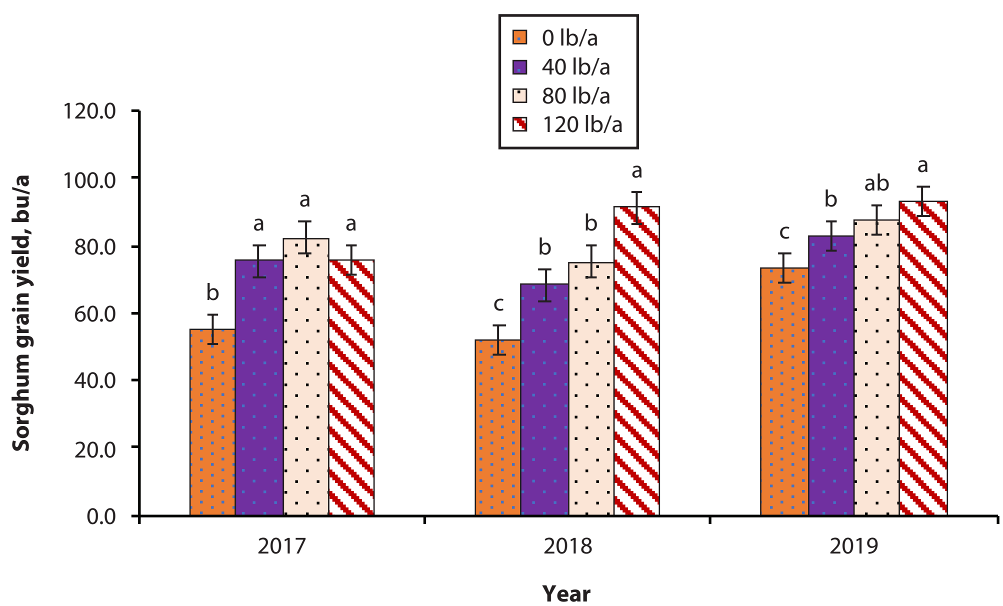


**Figure 3. Grain sorghum grain yield as affected by nitrogen fertilizer application rates in three (2017–2019) growing seasons at Hays, KS. Data are averaged across three tillage treatments and three replications (n = 9). Means followed by same lowercase letter(s) within a year are not significantly different (*P* > 0.05).**